

33<sup>rd</sup> International Geological Congress  
Oslo August 6 -14<sup>th</sup> 2008

# General Proceedings



Main sponsor





## PREFACE

The 33<sup>rd</sup> session of the IGC was held in Oslo, Norway, August 6 to 14, 2008, and was the third Congress in the Nordic countries (or Norden) after Stockholm in 1910 and Copenhagen in 1960. On behalf of the Nordic IGC Foundation and the Organising committee it is a great pleasure to present the General Proceedings from the 33<sup>rd</sup> IGC in which all the pre-, mid-, and post-Congress activities are summarized.

The Oslo IGC brought together 6,260 participants from 113 countries, demonstrating the truly global character of IGC. A large number of organisations used the opportunity to arrange 96 business meetings, and 20 workshops and short courses. The Geohost stipend programme awarded stipends to 562 scientists from 76 different countries.

Approximately 4,200 oral presentations in 337 different sessions and 2,470 poster presentations took place during the eight days of Congress, recording recent advances in a wide range of Earth Science disciplines. "Earth System Science: Foundation for Sustainable Development" was the theme of the Congress, and the programme reflected a broad geoscientific platform. 2008 comprises both the International Year of Planet Earth (IYPE) and The International Polar Year (IPY). IYPE was presented in a special symposium on Global Geology during the first day of the Congress. The Polar component, and in particular the Arctic, received a strong focus in the programme, particularly through several of the Regional (Special) Symposia.

We are very pleased to see the increased participation from the petroleum and mining industries. More than 50 symposia were related to petroleum and economic geology. The partnership with the industry is of great importance for the future of IGC. The longstanding and excellent cooperation with national geological surveys continued, and the decision was taken at the Congress to form a permanent association of geological surveys. The surveys and the industry comprised a large part of the 86 exhibitors participating in GeoExpo 2008.

Excursions have always been an important part of every IGC. The 33<sup>rd</sup> IGC had 38 excursions with a total of 714 participants. The excursions lasted from one day to nearly two weeks, with excursion sites in all the Nordic countries including the Faeroe Islands and the Arctic areas of Svalbard and Greenland, as well as in Russia and Ukraine. We wish to express our sincere thanks to all the local field trip organizers for a tremendous job.

The 33IGC's "Themes of the Day" sessions, with plenary lectures, discussions and press conferences, was a new, successful addition to IGC. The main purpose of these seven full-day plenary sessions was to communicate, partly through wide media coverage, the enormous span of our sciences, and to show how important and relevant the geosciences are to society at large. It was essential to invite scientists, politicians, governmental experts and managers from the industry sector to this unique platform. The themes were: Early life, evolution and biodiversity; Climate Change; Geohazards; Water, health, and environment; Mineral resources; Energy in the future; and the cosmic perspective in "Earth and beyond" at the last day of the Congress.

Limitation on travel for environmental or other reasons may in the future restrict on-site participation in IGC, with more people following the congress in a virtual setting. Many of the presentations of the "Themes of the Day" were webcast, and our experience is positive. We believe that webcasting will be even more important in future IGCs.

In addition to traditional circulars and flyers, the internet is becoming increasingly important for distribution of information. The 33IGC website had 510,387 visitors, which on average spent 5:28 minutes per visit. During the two years preceding the Congress we ran an extensive Google campaign to gather users searching for key words like "geology", "sedimentology", "climate change" etc., in order to inform these potential participants about the Congress. Our advertisement was shown to 93,273,676 visitors. 114,472 opened the page and 3,151 opened the pages for making reservations. This clearly shows the importance of web communication.

33IGC commissioned a professional communications agency for media and public relations activities, which proved very successful in increasing media coverage. The project was shortlisted for an award by the Norwegian Public Relations Consultants Association. The opening of the Congress was covered by national TV and radio broadcasters. One of the Norwegian TV news channels featured a debate between the Norwegian Minister of science and higher education, and the President of 33IGC. Monitoring of media coverage showed a total of 24 articles in Norwegian print newspapers and magazines. The majority of stories covered the opening of the Congress by HM King Harald V of Norway.

Several international press agencies and TV channels were present at the Congress. The USGS Arctic petroleum study and the launch of OneGeology attracted most attention from international media, but other topics such as climate change and



energy resources also generated interest. Our experience from the 33<sup>rd</sup> IGC communication work is that it is crucial to start this activity as early as possible, and to employ the services of professionals.

We warmly thank all participants for making the 33IGC a success, with high scientific standards and a superb meeting place for all interested in geoscience. We hope to meet you all in Brisbane in August 2012.

Arne Bjørlykke  
33IGC President

Anders Solheim  
33IGC Secretary General





# CONTENTS

Preface	1	<b>THE SYMPOSIA PROGRAMME: REPORTS</b>	117
Contents	3	Major geoscience programmes	119
<b>HISTORY AND PLANNING</b>		Interdisciplinary symposia (Topical)	123
Historical summary of the IGC	4	Regional symposia (Special)	144
IGC sessions and summary of participation	5	Disciplinary symposia (General)	163
Statutes of the Congress	6	Workshop reports	251
Scientific Freedom Policy Statement	8	Short courses reports	255
Place, date and theme of the Congress	8	Field trips reports	258
Official language	9		
The Nordic invitation and early planning activities	9		
The Nordic cooperation	10		
Host and sponsors	11		
Membership, registration fees and refund policy	11		
Invitations to attend	12		
HM King Harald V - patron of the 33 <sup>rd</sup> IGC	14		
<b>CEREMONIES AND SOCIAL EVENTS</b>			
Opening ceremony	15		
Closing ceremony	20		
Prizes and awards	24		
Social events	24		
Accompanying members programme	25		
<b>EVENTS CONNECTED WITH THE 33<sup>rd</sup> IGC</b>			
International Year of Planet Earth - IYPE	25		
OneGeology	25		
Fossil Art	26		
Larvikite - the Norwegian National Rock	26		
Photo exhibition of Norwegian minerals	26		
Geoprints	27		
Activities in central Oslo	27		
<b>REGISTRATION</b>			
Registration by country	28		
Registrations per week	29		
<b>BUSINESS MEETINGS</b>			
Reports on IUGS and IGCC meetings	30		
Participants of the 2 <sup>nd</sup> IUGS-IGC Joint Council	37		
Business meetings of the IUGS, affiliated bodies and other scientific organisations	41		
<b>COMMITTEE REPORTS</b>			
33IGC Congress committees	45		
Organising Committee report	48		
Science Committee report	49		
Excursion Committee report	54		
Geohost Committee report	62		
Report of the Finances and Sponsorship work	65		
Advisory Board report	67		
Communication Committee report	67		
Youth Congress report	72		
GeoExpo Committee report	72		
Business Meetings, Workshops and Short Courses Committee report	76		
<b>THEMES OF THE DAY</b>	78		
Themes of the Day abstracts	83		



## HISTORY AND PLANNING

### HISTORICAL SUMMARY OF THE INTERNATIONAL GEOLOGICAL CONGRESS

During the mid 19<sup>th</sup> century, the necessity of holding an international congress was increasingly felt among the community of geologists in Europe and North America. The International Geological Congress (IGC), originally the International Congress of Geologists, was founded on August 25, 1876, at the 25<sup>th</sup> meeting of the American Association for the Advancement of Science, held in Buffalo, New York, immediately after the 1876 Centennial Exhibition of Philadelphia - “being the means of securing the attendance of foreign savants”. The Founding Committee (later referred to as the Philadelphia Founding Committee) was composed of participants from the USA and Canada, with the addition of three geologists from Sweden, the Netherlands, and the UK.

The alleged date of 1875 for the Founding Committee was a mistake introduced in the *Compte Rendu of the Pretoria 1929 IGC* (1930, p. xiv), the first proceedings written in English. This historical mistake was propagated in all subsequent IGC proceedings, including those for Washington 1933 and 1989.

The Founding Committee inquired the Geological Society of France on the possibility of organising an international

geological convention to be held on the occasion of the Paris Exposition in 1878 as the first IGC. The French Geological Society accepted the request and succeeded in hosting the First International Geological Congress.

Since then, a total of 33 IGCs have been held in 24 different countries of all continents at a 3 to 5 year interval. France, USA and Russia have hosted the Congress three times, and Italy, UK, Mexico and Canada twice. The Nordic countries have hosted the Congress three times; first in Stockholm, Sweden in 1910, then in Copenhagen, Denmark in 1960, and lastly in Oslo, Norway during the 33<sup>rd</sup> IGC. We are happy to see that the next two congresses, in 2012 and 2016, follow the principle of regional rotation and will be held in Australia and South Africa, respectively.

A summary of past sessions and participation is given in the table on the following page.

#### Founding Committee (1876)

President: James Hall (USA)

Secretary: T. Sterry Hunt (Canada)

Members: William B. Rogers, J.W. Dawson, J.S. Newsberry, C.H. Hitchcock, R. Pumpelly, J.P. Lesley (USA and Canada), T.H. Huxley (UK), Otto Torell (Sweden), E. H. de Baumhauer (The Netherlands).



## IGC SESSIONS AND SUMMARY OF PARTICIPATION

Session	Year	Country	City	President	Secretary General	Countries	Total	Present	Delegates
1	1878	France	Paris	E. Hébert	E. Jannettaz	22	410	312	7
2	1881	Italy	Bologna	G. Capellini	T. Taramelli F. Giordano	22	421	225	15
3	1885	Germany	Berlin	E. Beyrich	M. Hauchecorne	22	445	262	13
4	1888	U.K.	London	J. Prestwich	J.W. Hulke W. Topley	25	830	422	37
5	1891	U.S.A.	Washington	J.S. Newberry	H.S. Williams S.F. Emmons	26	546	251	30
6	1894	Switzerland	Zurich	E. Renevier	H. Gollier	20	401	273	14
7	1897	Russia	St.Petersburg	A. Karpinsky	T. Tschensyshev	27	1037	704	121
8	1900	France	Paris	A. Gaudry	C. Barrois	30	1016	461	61
9	1903	Austria	Vienna	E. Tietze	C. Diener	31	664	393	42
10	1906	Mexico	Mexico City	J.G. Aguilera	M.E. Ordonez	34	707	321	52
11	1910	Sweden	Stockholm	G. De Geer	J.G. Andersson	36	879	625	175
12	1913	Canada	Toronto	F.D. Adams	R.W. Brock	49	981	467	362
13	1922	Belgium	Brussels	J. Lebacz	A. Renier	38	518	321	123
14	1926	Spain	Madrid	C. Rubio	E. Dupuy de Lome	52	1123	722	277
15	1929	Union of S.Africa	Pretoria	A.W. Rogers	A.L. Hall	50	575	298	117
16	1933	U.S.A	Washington	W. Lindgren	W.C. Mendenhall	54	1182	665	141
17	1937	U.S.S.R.	Moscow	I.M. Goubkin	A.E. Fersman	50	2362	949	157
18	1948	U.K.	London	H.H. Read	A.J. Butler L. Hawkes	84	1778	1226	472
19	1952	Algeria	Algiers	C. Jacob	R. Laffite	82	2910	1129	440
20	1956	Mexico	Mexico City	A.G. Rojas	E.J. Guzman J. Gonzalez Reyna	105	3696	2120	607
21	1960	Denmark, Finland, Norway, Sweden	Copenhagen	A. Noe-Nygaard	T. Sorgenfrei	101	3379	2386	625
22	1964	India	New Delhi	D.N. Wadia	B.C. Roy R.K. Sundaram	109	2479	1516	646
23	1968	Czechoslovakia	Prague	J. Svoboda	A. Dudek	103	3793	2911	883
24	1972	Canada	Montreal	R.E. Folinsbee	J.E. Armstrong	110	4700	3896 <sup>2</sup>	701
25	1976	Australia	Sydney	N.H. Fischer	A. Renwick	85	3461	2953 <sup>3</sup>	362; 145 <sup>4</sup>
26	1980	France	Paris	J. Aubouin	P. Sangnier	116	4883	4541 <sup>5</sup>	1914
27	1984	U.S.S.R.	Moscow	E.A. Kozlovsky	N.A. Bogdanov	107	5239	4666	--
28	1989	U.S.A .	Washington	C.L. Drake	B.B. Hanshaw	104	5786	5645 <sup>6</sup>	1624
29	1992	Japan	Kyoto	T. Sato	S. Ishihara	93	4186	4026 <sup>7</sup>	101
30	1996	China	Beijing	Song Ruixiang	Zhang Hongren	116	6147	5853 <sup>8</sup>	114
31	2000	Brazil	Rio de Janeiro	U. Cordani	C.O. Berbert	103	4536	3654 <sup>9</sup>	106
32	2004	Italy	Firenze	A. Boriani	E. Abbate	120	7331	7281 <sup>10</sup>	153
33	2008	Norway, Denmark, Finland, Sweden, Iceland	Oslo	A. Bjørlykke	A. Solheim	113	5916	5784 <sup>11</sup>	189

1. Does not include Accompanying Members (relatives).

<sup>a</sup> Including Non-Attending Members.

<sup>b</sup> Including Student Members.

2. 1480 relatives and friends accompanied the members.

3. 510 relatives and friends accompanied the members.

4. National Delegates nominated under the Statutes for the IGC adopted at the 25<sup>th</sup> Session.

5 The members were accompanied by 839 relatives and friends. The total attendance was accordingly 5380.

6. 399 registered relatives and friends accompanied the members. The total audience was accordingly 6044.

7. 251 relatives and friends accompanied the members. The total attendance was accordingly 4277.

8. 333 relatives and friends accompanied the members. The total attendance was accordingly 6186.

9. 202 relatives and friends accompanied the members. The total attendance was accordingly 3856.

10. 369 relatives and friends accompanied the members. The total attendance was accordingly 7650.

11. 331 relatives and friends accompanied the members. The total attendance was accordingly 6247



## STATUTES OF THE CONGRESS

The Statutes and Bylaws Task Group was presented at the IUGS-IGC council meeting in Oslo on the issue of merging the statutes and bylaws of IUGS and IGC. All revised documents by the Statutes and Bylaws Task Group together with proposed amendments by Council or members of the IUGS EC were submitted to Council. The revised document was presented to Council for approval. A motion to accept the revised and merged streamlined Statutes and Bylaws was tabled. To pass, a clear two-thirds majority as per existing Statutes and Bylaws from Council was required.

### Motion to accept revised and merged streamlined Statutes and Bylaws

Total votes = 192; Yes = 111; No = 72; Abstain = 9  
Motion rejected

Council instructed the IUGS EC and the IGCC to work on revising the two separate Statute and Bylaw documents over the next four years and to present these revisions at the next Council Meeting in Brisbane, 2012. Until the next council meeting at the 34<sup>th</sup> IGC in Brisbane 2012 IGC will follow the Statutes and Bylaws approved by the 32<sup>nd</sup> IGC.

## STATUTES OF THE CONGRESS APPROVED BY THE IGC COUNCIL AND THE IGC GENERAL ASSEMBLY OF THE 32<sup>ND</sup> IGC

### Preamble

The International Geological Congress (IGC) has, since its beginnings, adhered to rules which were at first adapted from those developed by similar organizations, and later refined to meet its changing needs over the years.

Permanent statutes and by-laws were first proposed in 1913 and, in 1922, Statutes which essentially 'codified tradition' were adopted. These, with minor modifications, remained in force until the formation of the International Union of Geological Sciences (IUGS) in 1961 made a major modification necessary. A committee was appointed at the 22<sup>nd</sup> Session (1964) to make recommendations for amending the Statutes. The recommendations were adopted at the 23<sup>rd</sup> Session; but, not surprisingly in view of the major changes which had to be incorporated, when first implemented at the 24<sup>th</sup> Session they were found to contain anomalies and uncertainties to the extent that a Commission was appointed in Montreal to make recommendations for further revisions to the Statutes.

This Commission included officers of IUGS as well as those of several Sessions of the Congress. The recommended revision was widely promulgated before the 25<sup>th</sup> Session, and was there adopted and put into practice. More recently, in the light of perceived ambiguities, further minor modifications have been incorporated. These Statutes differ extensively in format from those they

replace, but in content still serve to codify tradition and respond to perceived needs. They also more clearly define the relationship with IUGS, and are consistent with its Statutes agreed to by its Council in 1980.

The Strategic Plan of IUGS, approved during the 31<sup>st</sup> IGC in Rio de Janeiro in the year 2000, noted that IGC is the premier forum for presentation of results from IUGS programs and provides a vital venue for IUGS committees, commissions and programs.

In March 2002, following the recommendations of the IUGS Strategic Planning Committee, the IUGS Executive Committee approved a proposal for the merger of the IUGS and IGC.

One of the envisaged advantages should be a clear and simple representation of the geological world by a unified body. Another advantage will be a more effective management of both IUGS and IGC.

The matter was discussed by the IGC Steering Committee in Florence in October 2002. It was decided to ask immediately by mail the IGC member countries (national bodies that can be identified) about their feeling on the recommendations for the integration of IUGS and IGC.

These new Statutes take into account some of the IUGS proposals, the suggestions of the IGC Steering Committee and the responses received from the National Committees. The Statutes of the IGC entered into force immediately after adoption by the Council and the General Assembly of the IGC and the Council of IUGS 20 August 2004 in Florence, Italy. The Council and the General Assembly of the IGC ceased to exist after the close of the respective meetings of the Council and General Assembly of the IGC.

### Definitions

Appropriate Authority (5.5.3) is, in countries represented in the Council of IUGS, the Adhering Organization of IUGS appointed by that country. In other countries it is the national (science) academy, the national Geological Society, or the Geological Survey, preferably if recognized by the International Council for Science (ICSU).

Organizing Committee is the body appointed by the appropriate Authority in the host country or group of countries for the forthcoming Session of the Congress. The term of office of an Organizing Committee shall be from the termination of the period of office of its predecessor until one year after the closure of the Session for which it was appointed.

Preparatory Committee is the body appointed by the appropriate Authority in the host country or group of countries for the next but one Session of the Congress, if decided by the Council eight years in advance of the Session.

It shall become the Organizing Committee after the



termination of the period of office of the previous Organizing Committee.

## ARTICLES

A Session of the Congress lasts from the beginning of the first excursion until the end of the last one.

The IGC Committee fulfils the functions set out in many different parts of the Statutes. In addition, it may be called upon by the Organizing Committee for advice, or to resolve any problem which would normally be referred to the Council but whose resolution could not be deferred without risk to the well-being of the Congress.

### 1. Aims

1.1. The aims of the IGC are:

1.1.1. to contribute, in collaboration with and under sponsorship of the IUGS, to the advancement of fundamental and applied research in the geological sciences.

1.1.2. to provide a venue for geologists to exchange ideas and information.

1.1.3. to provide the opportunity, by way of geological excursions, to examine geological problems and features in the field.

### 2. Membership

2.1. There is no permanent membership of the IGC. Application for membership of a Session is made to the Secretary General of the Organizing Committee for that Session.

2.2. No professional title is required to support a request to register.

2.3. Classes of membership normally are Members, Accompanying Members and Student Members. Fees and privileges of the different classes of members and definition of Student Member are determined by the Organizing Committee of the Session.

### 3. Sessions

3.1. The Sessions of the Congress are normally called every fourth year and are open only to members of the Session.

3.2. The scientific program and business meetings of the Session normally last for 7 to 10 days, during which the Council shall meet.

3.3. The scientific program of the Session is preceded by the Opening Ceremony and followed by a Closing Ceremony, the first of which is opened by the President of the previous Session, or the President's representative, who resigns the Chair and announces the appointment of the President of the current Session.

3.4. The affiliated bodies of the IUGS are invited, and other geological organizations may apply, to hold scientific and business meetings as part of the Session, provided that they accept the regulations of the Organizing Committee with regard to registration fees, schedules, publications, and costs.

3.5. Business meetings are arranged to avoid, so far as is possible, conflict in timing with scientific meetings.

### 4. Excursions

4.1. Each Session includes a number of geological field excursions that are an important feature of the Congress. They normally both precede and follow the scientific program and business meetings.

4.2. The excursions give members every possible facility to study geological features of the country or region in which the Session is being held.

4.3. Excursions are arranged with due regard to keeping costs to both the participants and host at a reasonable level. They are directed by competent leaders, and the geological features to be visited are described in guidebooks made available to participants.

### 5. Administration

5.1. The responsibility for administration of the Sessions of the Congress passes from one Organizing Committee to another. The Secretary General of the Session provides the Secretary General of the incoming Organizing Committee for the next Session with all pertinent information and documentation.

The permanent interests of the Congress shall be looked after by the IGC Committee in close collaboration with the incoming Organizing Committee.

5.2. Any country or group of countries wishing to host a Session of the Congress informs the IGC Committee of its proposal. Invitations to hold the next Session are decided by the Council.

5.2.1. If a given invitation is considered adequate and desirable, Council may consider the possibility of deciding a venue as early as 8 years in advance of the Congress date.

5.2.2. A regional rotation system, with an agreed ordered sequence of continents, shall be implemented in order to ensure the global character of the Congress.

5.3. As soon as practicable after the termination of a Session, the Organizing Committee of the next Session shall make its address known to the geological community.

5.4. During the Session, the Organizing Committee refers to the Council through the IGC Committee, matters requiring discussion other than those directly concerned with the administration of the current Session.

5.5. The Organizing Committee is, in addition to the foregoing, responsible for:

5.5.1. preparing a program for the forthcoming Session of the Congress in collaboration with the IUGS and its affiliated organizations, and publishing and distributing it to members in advance of the scientific and business meetings.

5.5.2. organizing excursions as defined in Article 4.

5.5.3. inviting the appropriate authority in each country to nominate Delegates to the Council.

5.5.4. inviting Academies, Geological Surveys, International and National Geological Societies, Universities and other appropriate institutions to send representatives to the Session.

5.5.5. preparing and giving wide distribution to circulars concerning plans for the forthcoming Session and





information for prospective members.

**5.5.6.** publishing, in advance of the Session, summaries of papers which have been accepted by the Organizing Committee.

**5.5.7.** promoting publication of presented contributions that are of appropriate scientific standard.

**5.5.8.** preparing and distributing to Members a volume of General Proceedings of the Session as soon as practicable after its conclusion.

**5.5.9.** providing meeting rooms and other facilities for the scientific and business meetings which it has accepted for inclusion in the program.

**5.5.10.** introducing its nominees for President and Secretary General for the Session for adoption by the Council.

**5.5.11.** negotiating with the IUGS the amount to be included in the registration fee as an income for the IUGS.

**5.6.** The IGC Committee consists of:

(a) the President and the Secretary General of the ongoing Organizing Committee;

(b) the President of the immediate past Session;

(c) the President, the Secretary General and the Treasurer of IUGS;

(d) the Secretaries General of the three immediate past Sessions.

As observers may be invited the President and the Secretary General of the Preparatory Committee of an eventual next but one IGC and up to three congress organizing experts.

**5.6.1.** The IGC Committee is co-chaired by the President of IUGS and by the President of the immediate past Session or their representatives.

**5.6.2.** A quorum of the Committee shall consist of five members. Voting may be made in person, or in writing, including by fax or electronic mail. Decisions are made by simple majority of members having voted.

**5.6.3.** The IGC Committee draws up the agenda for the Council meetings regarding IGC matters.

**5.6.4.** The IGC Committee also determines any contentious matter which cannot be resolved by Council, and may appoint ad hoc committees for this purpose; it further determines any dispute concerning the interpretation of these Statutes.

**5.7.** The Council for matters regarding the IGC includes

(a) all the members of the IGC Committee;

(b) Delegates of all countries represented at the Session, the number of Delegates from each country corresponding to the category of its membership of IUGS, but countries which are not members of IUGS may accredit one Delegate;

(c) other members of the Executive Committee of IUGS;

(d) other members of the Session as Council decides to co-opt.

For matters regarding the IGC the Council holds office for the duration of the Session.

**5.7.1.** All Members of the Council must be participants at the Session, and all Members of the Council may take part in discussions and vote, on matters regarding the IGC, at Council meetings. One delegate from a country may vote all votes allotted to that country, or the votes may be

distributed among all delegates present from that country.

**5.7.2.** A quorum of the Council, for matters regarding the IGC, shall consist of fifty percent of the member countries which submit delegates to the Congress.

**5.8.** Congress policy is discussed by the IGC Committee and by the Council.

## 6. General Provisions

**6.1.** The Congress may award prizes for works of merit in the various fields of Geology.

**6.2.** Any proposals to modify the Statutes of the Congress must be submitted in writing to the IGC Committee at least 9 months before the beginning of the next Session.

**6.2.1.** Such proposals shall be transmitted by the Secretary General of the Organizing Committee of the current Session to the IUGS adhering organizations and the National Contacts for the Congress.

**6.2.2.** After consolidation of the received amendments by the IGC Committee, the final proposal shall be submitted to Council, and to be approved must receive the votes of at least two thirds of the members of Council present and voting.

**6.3.** The English text of the Statutes shall be considered to be the authoritative text for their interpretation.

## SCIENTIFIC FREEDOM POLICY STATEMENT

The Organising Committee of the 33<sup>rd</sup> International Geological Congress will observe the principle of the Universality of Science in accordance with the Statutes of the International Council of Scientific Unions.

*“The principle of the Universality of Science is fundamental to scientific progress. This principle embodies freedom of movement, association, expression and communication for scientists as well as equitable access to data, information and research materials.”*

## PLACE, DATE AND THEME OF THE CONGRESS

*In pursuing its objectives in respect of the rights and responsibilities of scientists, the International Council for Science (ICSU) actively upholds this principle, and, in so doing, opposes any discrimination on the basis of such factors as ethnic origin, religion, citizenship, language, political stance, gender, sex or age. ICSU shall not accept disruption of its own activities by statements or actions that intentionally or otherwise prevent the application of this principle.”*

The 33<sup>rd</sup> session of the International Geological Congress was organized as a joint effort by all the Nordic countries Norway, Sweden, Finland, Denmark, and Iceland, and held in Oslo, Norway, 6-14 August 2008. The Congress was organized in cooperation with and under the sponsorship of the International Union of Geological Sciences (IUGS).





## OFFICIAL LANGUAGE

The formal hosts were the national IUGS committees of the five Nordic countries, supported by the Academy of Sciences in each of the five countries. Appreciating the fact that the International Geological Congress has widened its scope to span all the geosciences, the Congress was termed “Geoscience World Congress 2008”, and assigned the theme: “Earth System Science: Foundation for Sustainable Development”.

English was the official Congress language. All abstracts were submitted in English and all presentations, oral as well as posters, were in English, with a few exceptions. Simultaneous translation from Russian to English, sponsored by the Norwegian Petroleum Directorate, was offered in one symposium (*AAA-07 Russian - Norwegian scientific co-operation in the Barents Sea region*). One of the presentations in the “Theme of the Day” sessions on climate change was given in Chinese, but with written translation on the screen and with slides in English.

## THE NORDIC INVITATION AND EARLY PLANNING ACTIVITIES

The idea of inviting the IGC to the Nordic region for a third time in 2008 was inspired by the first Nordic IGC in Stockholm in 1910 (the 11<sup>th</sup> IGC) and the 21<sup>st</sup> IGC held in Copenhagen in 1960 (where the International Union of Geological Sciences was founded), as well as the significant advances of Nordic geology since the discovery of oil in 1968. The proposal was a joint Nordic bid from Norway, Sweden, Iceland, Finland and Denmark including the Faeroe Islands, supported by all the respective national geological surveys. International collaborations are essential in our modern world, and have become a tradition within the Nordic region.

The Nordic bid was announced at the 31IGC in Rio de Janeiro 2000 with an official letter to Professor Carlos Oití Berbert, Secretary General of the 31IGC, from Professor Richard Sinding-Larsen, Chairman of the Norwegian National Committee for IUGS, on behalf of the Nordic delegations. The intention of the proposed Congress was to be organized along traditional lines, with General Sessions, Special Symposia, and Topical Symposia for particular groups - such as the International Lithosphere Program, the International Year of Planet Earth etc. The Special Symposia would focus on major themes affecting Nordic countries and the Arctic region. Excursions were planned to the Nordic regions, as well as to neighbouring regions such as the Kola Peninsula and Novaya Zemlya in Russia. An acceptance of the Nordic countries' bid would move the IGC from the Mediterranean to the Arctic – focusing the community on a quarter of the globe and the complete geological timescale.

An interim working group was formed after the 31<sup>st</sup> IGC, and a Nordic Bidding Committee chaired by Professor Ivar Ramberg was formally established in January 2002. Since Australia, India, UK and Egypt initially had submitted an invitation for the same 33IGC, the selection became an issue for the IGC Steering Committee. An interim meeting of the Steering Committee was held in Florence 2 October 2002 to preliminarily evaluate the two competing proposals. A first version of the bidding circular was sent to the IGC Steering Committee prior to the meeting. After presentation of the two bids by the official representatives of the two applicants, Ivar B. Ramberg and Mohamed Y. El-Sharkawi (in writing), and a following discussion, a straw vote indicated that the Steering Committee preferred the Nordic bid. Letters of support by the Prime Minister of Norway, Kjell Magne Bondevik (16 September 2002), and the mayor of Oslo, Per Ditlef-Simonsen (16 September 2002), were submitted to the Steering Committee, together with a series of supporting declarations by Norwegian and Nordic scientific institutions and associations.

Preparatory work continued with the organisation of the 52<sup>nd</sup> IUGS Executive Committee Meeting held in Oslo 15-19 March 2004. During the meeting the participants visited the Lillestrøm Congress Centre, located within walking distance from the airport express rail link to central Oslo, where most of the hotels, museums and historical monuments are located. The meeting was preceded by a two day geological field trip to the Arctic archipelago of Svalbard. The party visited the Svalbard University (UNIS). The IUGS President gave a presentation at UNIS about the IUGS initiative Planet Earth 2005-2007 about Earth Sciences for Society. The excursion ended with a visit to the Svea coal mine.

Much effort went into the preparation of the Nordic stand for the GeoExpo Exhibition of the 32<sup>nd</sup> IGC in Florence 2004. The Nordic stand was designed to review the ongoing geoscience research under the auspices of the Nordic Geological Surveys, and to provide information and interaction about the organisation of the 33IGC.

Almost 5,000 copies of the bidding document were distributed at the 32IGC in Florence 2004. Rationale and aims of the invited Congress were highlighted focusing on the innovation to promote the Arctic. A co-operative approach to the scientific programme of the Congress starting from an Arctic Consortium of Northern hemisphere countries was anticipated as a tool and an open window toward the geoscience challenges in the Arctic. The key headline selected to draw attention and focus was “Earth System Science: Foundation for Sustainable Development”. An outline of Nordic geology introduced a list of scientific highlights and research areas offering some 60 possible domestic and international Nordic field trips. Some new angles and approaches for the scientific programme were outlined, and an open list of preferred topics was suggested in order to stimulate a bottom-up process for compiling the scientific content of the Congress. A popular new Geohost programme for early



career researchers was presented, offering a range of resources. Logistic and organisational innovations were also planned to shorten the total duration of the Congress, and to reduce transfer time wastage by using the special facilities of the Lillestrøm conference venue.

Egypt and Norway had the opportunity to present their bid to hold the 33<sup>rd</sup> session of the IGC at a Steering Committee meeting held on 19 August 2004, and subsequently at the 32IGC Florence council meeting. Richard Sinding-Larsen presented the Nordic bid highlighting the facilities at Lillestrøm and the scientific importance of an Arctic venue that could benefit from the unique advantages of Norway and the other Nordic countries. Mohamed Y. El-Sharkawi (Egypt) said that a number of factors hindered the completion of the Egyptian bid, and as a result the bid was withdrawn. As the Nordic countries' offer was the only one on the table, the Council voted by a show of hands. The Council voted in favour of holding the 33IGC in the Nordic countries by acclamation.

Following the election of the Nordic countries as organizers for the 33IGC, "The Nordic IGC Foundation" was formed with Anders Elverhoi as Chair. The Board of the IGC Foundation elected an Organising Committee with Arne Bjørlykke as President, and Anders Solheim was contracted from the Norwegian Geotechnical Institute as Secretary General. An Executive Committee with members from the Organising Committee was also formed. The Organising Committee established a number of sub-committees late autumn 2004 and early 2005, including the Advisory Board (chaired by Gunnar Berge), the International Panel, the Science Committee, the Communication Committee and National Working Groups.

The secretariat was hosted by congress organising agency Congress-Conference in Oslo, with the exception of the science secretariat which was localised in Uppsala, Sweden, with David Gee as leader of the Science Committee and Björn Sundquist as secretary. Most of the communication activities were based in Trondheim under the leadership of Berit Forbord Moen, Chair of the Communication Committee.

The First Circular was produced and issued in 2006 with an invitation to the geoscience community to develop special, topical and general symposia. The special symposia were focused on arctic and bipolar geology and regional geological studies. The Year of the Planet Earth was planned to be a major part of the topical symposia. The importance of hydrocarbon and mineral resources in the Nordic countries was also reflected in the invitation to organize topical symposia. The general symposia followed traditional disciplinary divisions from earlier IGCs. Approximately 80 excursions to all Nordic countries and to Russia and Ukraine were proposed.

A major breakthrough came with the acceptance from HM King Harald V of Norway to be the patron of the 33IGC.

King Harald's interest and participation in the Congress was of major importance in the planning and the opening of the Congress. Statoil also played an important part, together with the Norwegian Government where four ministries contributed. Together they contributed with approximately 60 per cent of the sponsor budget. Without their generous contribution it would have been impossible to arrange the Congress.

The International Geological Congress Committee (IGCC; previously named the Steering Committee by the UGS) was invited to the venue at Lillestrøm in 2006. IGCC has long experience in arranging IGC, and a good dialogue was established with the 33IGC. From 2004 to 2008 the 33IGC was represented at most executive committee meetings of IUGS to inform IUGS about the preparation and progress of the 33IGC.

The planning phase culminated with the publishing of the second circular. More than 400 symposia, 50 excursions, and 50 workshops and short courses had been proposed. More than 900 conveners and excursion leaders had volunteered to organize the scientific part of the congress. IGC had previously not had a visible profile amongst petroleum geologists, geophysicists and economic geologists. With more than 30 symposia in petroleum geology and 20 symposia in ore geology, the profile of the whole congress changed.

A major change was also introduced by the "Theme of the Day" sessions. The program was ambitious and directed to the general public, media and specialists from other areas of earth science. Top scientists, specialists from other parts of society and politicians were invited to contribute and discuss important geoscience related subjects, such as climate change, sustainable energy, minerals, geohazards, health and water, origins of life, and the earth and space. The presentations were broadcast as webcasts, and are accessible on the 33IGC website. This marks the beginning of a virtual congress in parallel with the physical event.

## THE NORDIC COOPERATION

The International Geological Congress (IGC) has been arranged twice before in Norden; Stockholm 1910 and Copenhagen 1960. Due to their ability to cooperate the Nordic countries were awarded the organisation of the 33<sup>rd</sup> IGC. A Nordic Foundation was established by the Academies of Science in all Nordic countries as the legal body underpinning the Organising Committee. The members of the Foundation Board were elected by the Academies of Science in all Nordic countries. The Organising Committee included VPs from all Nordic countries, and the Science secretariat was based in Uppsala, Sweden. In addition all Nordic countries elected local 33IGC committees, and were represented with members in the Science committees and in the International Panel. Norway had a major responsibility for funding and



technical/administrative tasks. The Nordic cooperation worked very well and the other Nordic countries contributed to the science programme and the excursion programme.

Nordic ministers were invited to open these sessions and to participate in panel debates and press conferences related to the 'Themes of the day'. In relation to the IPY the Arctic received particular attention, which is important since it is in this region that the effects of climate change are first seen and expected to be the largest.

The countries organising an IGC will always receive significant international focus, leading to increased dialogue and exchange of knowledge between the countries. Nordic geoscientists and students benefited greatly from this unique possibility to strengthen scientific networks and create new ones. As with previous IGCs the 33IGC increased the interest for geosciences in particular and natural sciences in general in the host countries.

100 students from Nordic universities participated in the organisation of the Congress. They were working in all lecture halls assisting the speakers, and had the possibility to follow lectures by top scientists.

## HOST AND SPONSORS

The 33<sup>rd</sup> IGC was hosted by the Nordic Foundation for IGC, which was initiated by the Academies of Science in the five Nordic countries (Norway, Sweden, Denmark, Finland and Iceland). The initial support from the Norwegian Ministry of Trade and Industry and the Geological Survey of Norway was crucial in the early phase. Sponsor contributions, of which over 50% came from the industry, made up more than half of the total budget.

A number of companies and governmental organisations supported the Congress. In particular, the Organising Committee would like to mention our main sponsor StatoilHydro (now Statoil), who provided significant economic support in addition to providing key personnel for the organisation. StatoilHydro's support was provided over the period 2006-2008 and therefore secured sufficient cash flow to run the organisation. The second largest industry sponsor was Shell Norway, who provided a significant contribution in a critical planning phase. Other industry sponsors consisted mainly of Nordic and international oil/gas and mining/mineral companies. The largest contributions from industry after StatoilHydro and Shell came from Boliden, DONG Energy, Store Norske Spitsbergen Grubekompani, Det Norske, PGS, and Saudi Aramco. All sponsors are listed later in this report.

The Congress could not have been arranged without the important support from the Norwegian government, the Research Council of Norway (RCN) and the Nordic

Council of Ministers. Four different Norwegian government ministries provided funding for the Congress. In addition to the Ministry of Trade and Industry, mentioned above, these were the Ministry of Petroleum and Energy, the Ministry of Research and Higher Education, and the Ministry of Foreign Affairs (which provided a major part of the Geohost Programme). RCN provided funding over three years, which is very important for the running of an organisation like IGC. The Nordic Council of Ministers provided a generous contribution on behalf of the Nordic cooperation.

Several geo-institutions in the Nordic countries supported the Congress by providing personnel and facilities. In particular the contributions from the Geological Survey of Norway (NGU), the Norwegian Geotechnical Institute (NGI) and Uppsala University, Sweden, should be mentioned. NGU gave initial funding through the IUGS secretariat and provided the President of the Congress. NGI provided the Secretary General, supported the Themes of the Day economically and hosted almost all meetings in the Executive and Organising Committees, as well as many of the Science Committee meetings. Uppsala University hosted the science secretariat and provided the VP and coordinator for the scientific programme. The Swedish Research Council supported the Science Secretariat financially over two years.

As can be seen from the table of income and expenditures, the 33<sup>rd</sup> IGC could not have been arranged without the support of the organisations mentioned above, as well as many others.

## MEMBERSHIP, REGISTRATION FEES AND REFUND POLICY

In accordance with the statutes of the Congress, article 2, there is no permanent membership of the IGC. No professional qualifications are required for enrollment to the Congress. Membership categories are Full Member, Accompanying Member and Student Member. Registration options were for the full conference, half conference or single-day participation. In the following, the term member is replaced with participant.

For participants giving oral or poster presentations, an abstract fee of €40 was charged in addition to the registration fees shown in the table on the following page. Deadline for abstract submission and payment of the abstract fee was set to 7 March 2008. The Congress registration fee had to be paid before 30 April 2008 in order for the inclusion of an accepted abstract into the programme.

A contribution of €15 to IUGS was included in the fees. Students were required to submit documentary evidence of being enrolled at an educational institution in the year 2008. Youth Congress participants should be accompanied



by Congress participants and were eligible only if between 7 and 15 years of age. All categories of participants could take part in field trips or other arrangements when duly registered.

Congress fees included:

*All participants (full or half Congress):*

- Access to Scientific sessions and exhibitions, Congress

Congress Fees	Until 30 April 2008		1 May - 15 July 2008		Later and on-site		Single day fee**
	Full	Half*	Full	Half*	Full	Half*	
Congress participants	€ 560	€ 410	€ 610	€ 460	€ 660	€ 510	€ 150
Student participants (in 2008) Pensioners (over 65)	€ 160	€ 110	€ 160	€ 110	€ 260	€ 160	€ 150
Accompanying participants	€ 200	€ 150	€ 200	€ 150	€ 200	€ 150	-
Youth Congress participants	€ 125	€ 75	€ 125	€ 75	€ 125	€ 75	-

\* Half-Congress dates were: 1st half: 6-10 August; 2nd half: 10-14 August

\*\* Single day registration did not include lunch and railway travel. Single day registration was permitted for more than one day on the condition that these were consecutive days.

documents and publications.

- Lunches and coffee / tea in the Congress Centre.
- Rail travel to and from the Congress Centre
- Opening and Closing ceremonies, Icebreaker party

*Accompanying and Youth Congress participants:*

- As above, with the exception of access to the Scientific Sessions, the Congress documents and publications.

Cancellations of registrations should be notified in writing to the Congress Secretariat. Cancellations received by 30 November 2007 received a 100% refund, less a €35 administrative charge. Cancellations received from 1 December 2007 to 30 June 2008 received a 50% refund. No refunds were given for cancellations received after 1 July 2008. In the case of partial reduction of room nights received after 1 July 2007, the hotel decided if a penalty charge was to be applied. In the event of a no-show, hotel reservations were cancelled after one night. No-shows could not be refunded. Refunds were made using the same method as for the payment (i.e., payment by credit card was refunded to the same credit card).

## INVITATIONS TO ATTEND

### Invitations to participate in the planning and to attend the Congress

The initial planning of the Congress programme was done through a “bottom-up” process. Invitations to participate in planning the programme were distributed in letters, flyers, and in the First Circular. The Organising Committee invited geoscience organisations throughout the world to plan their 2008 events to take place in Oslo during the 33<sup>rd</sup>

IGC, as workshops, business meetings, or other activities, in a bid to attract as much activity as possible to the Congress, and also to avoid clashes with other important events in the geoscience community:

Letter of May 2005, to geoscience organisations:

**33rd International Geological Congress, Oslo, Norway, 2008.**

*During the period 5-14<sup>th</sup> August 2008, the 33<sup>rd</sup> International Geological Congress (IGC-33) will be arranged in Oslo as a joint venture between the Nordic countries. Excursions will take place both before and after the Congress and cover a wide region, including Greenland, Svalbard, Russia and the UK, in addition to the Nordic countries (Norway, Sweden, Finland, Iceland, and Denmark). The main Congress activities, including the pre- and post-congress excursions, will last for almost a month, between July 26<sup>th</sup> and August 21<sup>st</sup>, 2008.*

*Our intention is that the IGC-33 should be beneficial for Earth Science at large, attracting participants from all fields of the Geosciences. The programme will highlight the global theme ‘Earth System Science: Foundation for Sustainable Development’. The scientific programme of the congress is only in its initial stages of development, and is therefore open for suggestions; we are writing now to solicit interaction and participation.*

*Our aim is that IGC-33 will be the main international forum for exposure of on-going Earth Science research in 2008, as well as being the main international meeting place for geoscientists for that year. Therefore, we hope to avoid collision with other events during the summer of 2008, and welcome integration. With this background, we invite Your organization to arrange its 2008 activities in cooperation with IGC-33. Examples of joint events can be common excursions, seminars, special sessions, themes symposia, or business meetings. At IGC-33, we can offer meeting facilities and the necessary logistics. We think that arranging Your meetings under the umbrella of a large international event, such as the IGC, may attract more people and also give easier access to attractive key-note speakers, etc. Of course, joining forces will also be beneficial to us as organizers of IGC-33, and as such would lead to a win-win situation.*

*In summary, therefore,*

*Please be aware that IGC-33 activities are scheduled to take place between July 26<sup>th</sup> and August 21<sup>st</sup>, 2008, with the main Congress being held in the period 5-14<sup>th</sup> August.*

*You are hereby invited to contact the IGC-33 Organising Committee for arranging joint events in Oslo, either directly before or after the Congress or fully integrated under the umbrella of IGC-33.*

*We look forward to your response.*

*Sincerely yours,*

*Prof. Anders Solheim (Secretary General) and Prof. Arne Bjørlykke (President)*

Secondly, in order to plan the science programme, invitations were sent out, also with flyers and circulars, to propose themes for the three different categories of





symposia, as well as for field trips, short courses and workshops:

#### Invitation included in the first flyer and circular:

*Outlined in the 1<sup>st</sup> Circular is a preliminary science programme for the Congress. We invite geoscientists worldwide, both individuals and organisations, to make suggestions for themes in any of the three categories of symposia, as well as for alternative excursions, workshops, short courses and other activities. Please send us your proposals before August 31, 2006.*

The above invitations resulted in an overwhelming amount of suggested symposia and other events, as well as field trips.

In the Second Circular, an invitation to attend the Congress was printed:

*Dear fellow geoscientists*

*Since 1878, the International Geological Congress - IGC has every four years been the meeting place for people interested in Earth Science, and in 2008 the Nordic countries will arrange the 33<sup>rd</sup> International Geological Congress in Oslo, Norway. 2008 will be 'The Year of Earth Sciences' including the 33<sup>rd</sup> IGC, the International Year of Planet Earth (IYPE), and the International Polar Year (IPY). With its strong emphasis on cross-disciplinary symposia, Earth sciences' societal impact, and on the Arctic, the Congress in Oslo will give you a unique opportunity to discuss high-level science in a broad perspective. Even with the best preparations, however, the success of the meeting depends on your participation. We have a vision of seeing up to 8-10 000 of you in Oslo at the 33<sup>rd</sup> IGC, the Geoscience World Congress 2008. There are a number of reasons for you to help us make this vision come true:*

- *The IGCs are arranged only every 4 years, and comprise the whole gamut of the Earth Sciences. The Congress focuses on topics which are of utmost importance for our modern society.*
- *The 33<sup>rd</sup> IGC will be a showcase for themes related to the International Year of Planet Earth and the International Polar Year, and will aim at showing the world that the Earth system sciences are the foundation for a sustainable development.*
- *The Congress will include a number of pre- and post-congress excursions to all the Nordic countries, as well as to the Arctic regions of Greenland and Svalbard. In addition to great geology, you will also see magnificent scenery, created by active geological processes.*
- *The lively and international city of Oslo, founded 1000 years ago, with its beautiful surroundings and spectacular geology.*
- *The 33<sup>rd</sup> IGC will be the best meeting place for geologists from the entire world.*

*Since the first IGC in 1878, the Earth Sciences have experienced a period of increased specialization. Now is the time for a more holistic view on the Earth sciences and the 33<sup>rd</sup> IGC is the best forum! We*

*wish you all welcome to Oslo in 2008.*

*Arne Bjørlykke (President) and Anders Solheim (Secretary General)*

#### Official invitation to delegates

In the Second Circular, issued in May 2007, the national committees or other appropriate authorities were asked to appoint official delegates for the Congress:

*Appointment of Official Delegates to the Congress National Committees and/or appropriate authorities of participating countries will appoint delegates in accordance with article 5.7 of the Statutes of the Congress, to represent them at the Session of the joint IUGS and IGC Council. The delegates will sit for the duration of the Congress.*

On 30 April 2008, the official letter of invitation to national Congress delegates were sent out by the Secretary Generals of IUGS and the 33<sup>rd</sup> IGC, respectively:

TO: IUGS Affiliated Organizations

FROM: Peter Bobrowsky, IUGS Secretary General and  
Anders Solheim, 33<sup>rd</sup> IGC Secretary General

DATE: 30 April 2008

SUBJECT: REGISTRATION OF  
REPRESENTATIVES TO IUGS-IGC COUNCIL and  
SPECIAL MEETING OF THE IUGS AFFILIATED  
ORGANIZATIONS

*We cordially invite each IUGS Affiliated Organization to submit the name of their official and designated representative to the Second Ordinary Session of the Council of the International Union of Geological Sciences and the International Geological Congress, which will take place in Oslo, Norway in conjunction with the 33<sup>rd</sup> International Geological Congress (IGC). According to the agreement reached during the previous Council session, the present session covers the combined Council of the IUGS and the IGC.*

#### COUNCIL MEETINGS

*The first meeting of the IUGS-IGC Council will be held on Wednesday, August 6, starting at 10:00 a.m. Registration begins at 8:30. This meeting will continue on Sunday, August 10 starting at 10:00 a.m. Registration starts at 9:00 and the meeting will end at 18:00.*

#### SEND NAME OF REPRESENTATIVE

*Please notify the IUGS Secretariat, preferably by e-mail <[iugs.secretariat@ngu.no](mailto:iugs.secretariat@ngu.no)> providing the name and address of your representative to the Council. The IUGS Secretariat will subsequently send all meeting documentation via e-mail to the appointed delegate.*

*Should you require any further information, please do not hesitate to contact the Permanent Secretariat.*

#### SPECIAL MEETING OF AFFILIATED ORGANIZATIONS

*Following the example set at the previous congress, there will be a special meeting of IUGS affiliated organizations and IUGS leadership. We therefore also would like to invite you and/or the*



*representative of your organization to this meeting which is scheduled for August 7, 17:30 -19:30. The Meeting room will be announced later.*

*On behalf of the IUGS Executive Committee and IGC Committee, we are all looking forward to meeting your representative and to holding a productive and informative Council Session.*

*Yours sincerely,*

*Peter Bobrowsky  
IUGS Secretary General*

*Anders Solheim*

*33<sup>rd</sup> IGC Secretary General*

*Attached:*  
*Provisional Agenda of 2<sup>nd</sup> IGC-IUGS Council Meeting*

*Meeting Registration Form*

## HM King Harald V - patron of the 33<sup>rd</sup> International Geological Congress



*The King of Norway: HM King Harald V.  
(Photo: Morten Krogvold)*





## CEREMONIES AND SOCIAL EVENTS

### OPENING CEREMONY

The 33IGC Opening Ceremony was launched Wednesday 6 August at 6:15 PM in the Plenary Hall of the Norwegian Trade Centre at Lillestrøm. All Congress participants and dignitaries were invited to this event as well as to the following icebreaker party, and more than 4,000 participants and accompanying members attended both.

At the Opening Ceremony we wanted to focus on the Nordic cooperation behind the congress, showing video postcard presentations from each of the five Nordic countries followed by music and dance performances, alternating with the welcome speeches. Significant resources were spent on the opening ceremony, in order to make this a memorable event for the participants. To achieve this, we contracted the professional event bureau Trond & Trond of Oslo to plan and manage the ceremony, whereas another Oslo-based company, Christiania Arrangement Compagnie, was responsible for the sound and light during the ceremony, as well as during the sessions in the plenary hall for the rest of the Congress (Themes of the Day and the Closing Ceremony).

We were honored by the presence of **HM King Harald V of Norway**, who was also the patron of the congress. His Majesty conducted the official opening of the congress with the following opening speech:

*Ministers, delegates and participants. It is a great pleasure to welcome you to Norway and to the 33rd International Geological Congress. The IGC has a long tradition with meetings every four years, similar to the Olympic Games, which also is just about to start.*

*I saw in the program that scientific results from a wide spectrum of disciplines in earth science are on your agenda. Earth science and natural resources have always been important for Norway. Minerals and fisheries through many centuries, and now oil and gas. Knowledge of earth science is increasingly needed in the study of climate change and to protect us from natural hazards.*

*Earth science and geology have long traditions in Norway going back to 1757 and the establishment of the Mining Academy in Kongsberg. Geology and mining became an important part when the University of Oslo was founded, and today geology has a strong position in the Norwegian science community.*

*The 33 IGC is the largest scientific congress organized in Norway and I am certain that the congress with nearly 6000 participants, 350 scientific symposia and 37 excursions will be of great benefit and inspiration to the Nordic geological community. I hope the congress will stimulate scientific debate, increase the network between scientists and stimulate further research. I hereby declare the 33rd International Geological Congress officially opened.*



*Gisele Jackson sings 'Circle of life' at the Opening ceremony. (Photo: Gudmund Løvø)*

The official opening of the congress was followed by the overture "Circle of life" as a solo performance by Gisele Jackson, enhanced by a choir carrying flags from all participating countries.

The **President of the 33<sup>rd</sup> IGC Arne Bjørlykke** greeted the participants with the following words:

*Your Majesty, Minister, Your Excellencies, delegates, ladies and gentlemen. On behalf of the 33 International Geological Congress I welcome you to the Nordic Countries or Norden and to Oslo. IGC is the Olympic Games for geoscientists, it takes place every four years and encompasses a wide spectrum of disciplines within the Earth Sciences. The first IGC was held in Paris in 1878, and previous IGCs in Norden took place in Stockholm in 1910 and in Copenhagen in 1960.*

*The 33 IGC will demonstrate that knowledge in earth science has*



*33IGC President Arne Bjørlykke (right) and Secretary General Anders Solheim (left), show HM King Harald V the Norwegian national rock larvikite. (Photo: Gudmund Løvø)*



become vital to society, both globally and locally. Climate change, geohazards, water supply and health, production and supply of minerals and energy resources, underground constructions and fundamnetation, management of marine resources and tourism are all areas that demand knowledge in earth science of high quality.

The most important challenge now is the climate change, and the large uncertainties in most models show how complex the Earth system is. We must increase our efforts in climate research. The debate on climate change has a profound societal impact and is a good illustration of how difficult it can be to combine constructive scientific criticism of models and theories and providing clear knowledge and advice to society and its political leadership.

The huge natural disasters we have seen in the last few years, the tsunami in the Indian Ocean, cyclones in Burma and New Orleans, earthquakes in Pakistan and China, all remind us about the great importance of Earth Sciences in order to cope with the challenges of an increasingly populated world.

It is 150 years since Charles Darwin wrote his famous book on the origin of the species. The founding of IGC took place during the debate that followed Darwin's book. After more than a hundred years of specialization, we are now developing a more holistic view of nature again. This is demonstrated in climate change research, where the complexity of nature require large research teams comprising specialists in many different fields.

The global challenges we are facing must be met by increased international cooperation. The Chinese Prime Minister and geologist Wen Jiabao has said that "Geological sciences and geological structures do not end at national boundaries. Working on the same planet, geologists need to communicate and share knowledge with each other, and to draw on each other's experiences."

At the 33 IGC we want to follow up on the holistic approach and we have called the 33 IGC for the World Geosciences Congress to demonstrate the interdisciplinary character of IGC. We are happy to see that many specialists from fields outside the IUGS are attending the Congress and contributing in symposia and discussions.

This holistic approach is not reflected in the global organization of the Earth Sciences, which are divided into seven disciplinary unions. The impact of earth science in the global community has therefore been low. We need change. We must join forces and establish one earth science union. We should also follow Wen Jiabaos advice and improve the international communication by arranging a world congress in earth science every year.

We see, however, that change is indeed taking place. New non-disciplinary organizations like the International Year of Planet Earth and OneGeology are important initiatives to provide geoscientific information to the global community. IGC has the ambition to be one of the preferred platforms for these organizations in their communication with the scientific community.

We strongly believe in improving communication with society. The Themes of the Day is our new platform for such communication. The themes comprise global geology, early life, climate change, geohazards, water and health, mineral supply, energy supply, and earth and

beyond. The Theme of the Day will tell us how important geoscientific knowledge is for society. Several presentations will be webcasted and we will provide as much background material as possible for the media. This is a new invention for this IGC, and we hope it will be continued by future IGCs.

We are thankful for all the support we received from petroleum industry, mining industry, governmental and other organizations in the Nordic countries. We want particularly to thank our main sponsor StatoilHydro and the Norwegian Government. It would not have been possible to hold this congress here without your generous contributions. And last but not least I want to thank Secretary General Anders Solheim, the Organising Committee, Science Committee, and Advisory Board for your hard and enthusiastic work.

I would also like to thank the Organising Committee of 32IGC for all the help and support. Your Congress in Florence in 2004 was a great success and an inspiration to us.

We have received 6500 scientific contributions to the 33<sup>rd</sup> IGC. We are particularly satisfied with the increase in contributions from the petroleum and mining geosciences, which are broadening the IGC platform. I thank you all for your contributions.

I hope you will have some interesting days at IGC. I also hope that you will enjoy the excursions and social events. Welcome to Oslo and the 33 IGC.

A beautiful video postcard of geological hallmarks of idyllic Denmark and magnificent Greenland was presented by **Professor Finn Surlyk** of the University of Copenhagen, followed by the percussion performance "Nordic rhythm" by Erik Smith and Joakim Nordin.

StatoilHydro, the main sponsor of the 33<sup>rd</sup> IGC, was represented by **Chief Executive Officer Helge Lund** who presented the following opening address:

*Your majesty, minister, ladies and gentlemen. An American physicist once said that "Science is a great game. It is inspiring and refreshing. The playing field is the universe itself." That is particularly true for this audience. Every four years, the elite of the Earth Sciences gathers to share and bring knowledge in their field even further. The 33<sup>rd</sup> event in this series has now landed in Oslo and it is a pleasure for me to welcome you all to Norway.*

*Sub surface skills are the core competence and backbone of any energy company. Little oil and gas would have been found by economists and lawyers. You have the knowledge that can turn scattered seismic charts into reservoirs, and eventually oil and gas. Without your competence there simply would be no oil and gas industry.*

*With most of the "easy oil" gone, the task of finding new resources only gets tougher. To find it we need to explore for new opportunities and develop new ideas. StatoilHydro employs a majority of the geoscientists in Norway and has created a strong and diverse scientific environment within the company. It is therefore natural and a pleasure for us to contribute both economically and professionally to make this congress a success here in Oslo.*



*The oil and gas industry is experiencing rapid global change. Market developments that few would think were possible are now happening:*

- *The oil price has again gone through the ceiling hitting levels close to 150\$/pr. Barrel*
- *The financial markets are shaking due to unsecured mortgages in the US, making the development of the global economy uncertain.*
- *Availability of industry professionals and equipment is scarce – putting a huge pressure on costs*
- *And, with tougher fiscal conditions and limited new opportunities, the competition for new resources has never been tougher.*

*Our response to these challenges is the biggest merger in the Nordic countries. As you join forces here at this conference to share knowledge, develop new ideas and learn from each other, Statoil and Hydro - the two national oil champions in Norway - have recently joined forces to become a new forceful international energy company. We have created an international oil and gas company that ranks among the world's 10 largest of its kind. We believe this gives us the necessary strength to compete internationally for access to reserves and production.*

*As an energy executive I am constantly faced with two issues dominating the world headlines, namely climate change and security of energy supply. These are important issues where one can impact the way we live and the other is crucial for any country to fuel its economic development. I see from the programme that climate will be an important topic at the congress, and you are certainly also in the business of finding more resources.*

*In a climate perspective oil and gas is often perceived both a blessing and a curse. Fossil fuels drive economic development, but also impact our climate. At present the world is struggling to strike the right balance between development and climate change. I believe that any constructive climate discussion has to recognize this dilemma.*

*The world slowly seems to recognize that there is no quick fix route to a non-fossil future. Fossil fuels will be crucial to meet growing energy demand the next 20-30 years. Some claim that it is lack of will that hinders renewable energy from "taking over". I think such a view underestimates the huge task it is to substitute oil and gas. In my view, we have the main technical tools to reduce CO<sub>2</sub> emissions. What we lack is a firm and predictable regulatory and economical framework. In short: If CO<sub>2</sub> has sufficiently high price we know what to do to reduce emissions. But agreeing on such a framework is the political challenge of our time.*

*As the world is thirsting for more energy, securing sufficient supply is climbing the international agenda. Energy powers development, and securing sufficient supply is therefore a fundamental question for any country. This also puts a burden on your shoulders, because you are the ones who have the knowledge to find it. Our experience tells us that this task will not get easier. Therefore it is increasingly important to develop and strengthen our scientific communities, and at the same time put strong effort in encouraging young people to study science. This is a joint task for both governments and industry. In this respect I hope this congress will be a showcase for how interesting and important geoscience is.*

*During your stay I also hope you all take the opportunity to explore the Nordic countries. Studying is about rising early and working hard, but it is also about having a great deal of fun. Good luck with the congress and thank you for the attention!*

A stunning video postcard from Finland, "the land of thousand lakes", presented by **Professor Elias Ekdahl**, Director General of the Geological Survey of Finland, focused on the importance of geological sciences for society, and was followed by the performance "Illusion of Planet Earth" by juggler Tom Persey and illusionist Roy B.

The next speaker was the **President of the International Union of Geological Sciences, Zhang Hongren**, who greeted the audience with the following words:

*Your Majesty, his Excellency Minister, Distinguished Delegates, Ladies and Gentlemen. It is my great pleasure and privilege on behalf of the International Union of Geological Sciences to congratulate the successful opening of the 33<sup>rd</sup> International Geological Congress.*

*In 1960, five Nordic countries successfully sponsored the 21<sup>st</sup> International Geological Congress, which played an important role in the founding of our organization, the International Union of Geological Sciences. Nearly half a century later, Nordic countries host IGC again in Oslo with the title "Earth System Science: Foundation for Sustainable Development". Nordic countries have made great contributions to the formulation of the concept of Sustainable Development; two milestones are the Stockholm Conference and the Brundtland report "Our Common Future". I hope this Congress can make a big step forward in promoting the Earth Sciences to serve the sustainable development of the society.*

The various geological regions of Sweden were presented in a beautiful video postcard by **Professor Vivi Vajda** of Lund University, who also focused on the importance of geologists for the founding of the Swedish society. This was followed by wonderful Swedish music, "Götlands sommernatt" played as a trumpet solo by Lasse Rössing.

The 33<sup>rd</sup> IGC has enjoyed strong support from the Nordic Council of Ministers, which was represented by **Secretary General Halldór Ásgrímsson**:

*I am very pleased to welcome the international community of geological scholars back to "Norden". This is the third time in the long history of the International Geological congress that the congress is held in one of the Nordic countries, and I am very proud that a scientific meeting of this importance and magnitude is held here in the Nordic countries.*

*The Icelandic and Nordic writer Snorri Sturluson wrote in the thirteenth century that the world was made out of the giant Ymir's body. And he stated: "Above the earth is a big tree. The tree has three roots, each of which lies in a well. One is situated in the giants' world, another in the very cold world far up in the north and the last one in heaven, the home of the Aesirs". Our geological knowledge is another today, but we know that great resources are in the underground, wells which can make a great difference to the future of mankind.*





*The amazing new knowledge and innovations that the geological sciences have produced about the earth and its developments over the years have made important economic and social contributions to the development of the societies of the North. The planning of this congress through the national working committees in the five Nordic countries is an important manifestation of modern Nordic research collaboration. A wide range of Nordic researchers and research organizations have pulled their resources together and joined team with international partners on all levels to make this congress a reality.*

*The Nordic Council of Ministers, formed in 1971, is the formal forum for Nordic governmental co-operation. The prime ministers of the five Nordic countries have recently taken an important initiative to meet the challenges and to grasp the opportunities from globalization by promoting a more skilled, visible and thriving Nordic region. This is an initiative where education, research and innovation hold a central position. The Nordic Council of Ministers is continuously increasing its effort to exploit the opportunities that are vested in Nordic as well as broader international cooperation in research. The unique meta-regional Nordic research board NordForsk has the mission to strengthen and develop research co-operation between the Nordic countries, and to enhance the region's possibilities to make a global contribution.*

*Situated in Iceland and actively participating in this congress, the Nordic co-operating body Nordic Volcanological Center (NordVulk) has made important contributions to our understanding of the volcanic activity around the world. Through its work it has strengthened the co-operation between Nordic students and young scholars for more than three decades.*

*The greatest threat to our earth is the climate change. If we are not able to limit the emission of carbon dioxide we can risk greater suffering in human life than we can imagine. Snorri Sturluson wrote: "The world will come to an end when three winters appear in a row without any summer in between". But he also stated. "But there's still hope! The earth will rise from the sea again and then it'll be green, fertile and beautiful." Although the danger of climate change is great there is still hope. And that hope lies in science and new knowledge. Some resources are renewable and we can solve the energy crisis with them, others are not renewable and will come to an end. These are the wells where we must limit our utilization. Snorri Sturluson used a hot spring at his farm for bathing which was very unusual. Today 90 per cent of houses in Iceland are heated up by geothermal energy, and 24 countries in the world use geothermal power to produce between 15-22 per cent of their electricity need.*

*A farmer I knew once said about his farm: "There is gold in the mountain, heavy water in the stream by the farm, and oil under the surface. This has not been found yet. If it is there we can question the worth of it in the future, if we are not successful in controlling emission of CO<sub>2</sub> and other pollutants. One thing is certain; the water in the stream will always be valuable if it is unpolluted".*

*The challenges concerning climate, energy and environment is on top of the agenda in the Nordic co-operation and we work hard to strengthen research co-operation within this fields. We are at the moment preparing an initiative to develop a platform for Nordic and international top-level research cooperation within these fields.*

*In view of the agenda of this conference, I am convinced that this forum will contribute to improving our understanding of these complex and important issues. In this context I would like to state that the Nordic Prime Ministers have expressed that the Nordic countries have an important role to play in facilitating a global agreement in the current climate change, negotiations that we hope will yield concrete results at the Climate Change Conference in Copenhagen next year.*

*Today, we have urgent global needs for raising the interest for the natural sciences in schools and among young people. And you can all be a part in that mission! In line with this, I hope that this congress can stimulate new young generations of students and scientists to take part in the search for new knowledge and make the hope a reality. I wish you all a successful conference and an enjoyable stay in Norden!*

The impressive video postcard of Iceland, by far the geologically youngest of the Nordic countries, was presented by **Professor Haraldur Sigurðsson**, and gave a glance of the short, but dramatic geological history of "the country of ice and fire". This presentation was followed by the forceful and dynamic "Nessum Dorma" by Puccini, performed by the tenor Henrik Engelsen and accompanied by small geyrs on the stage.

The key note address of the Opening Ceremony was given by the **Minister of Research and Higher Education Tora Aasland**:

*Your Majesty, excellencies, ladies and gentlemen. On the occasion of the 29<sup>th</sup> October 1653 earthquake in New England US, Reverend Peter Bulkeley wrote as follows: "The earth doth heave, with groanings of distress, Beneath the weight of human sinfulness. Shall not our eyes drop penitential rain, When all creation travaileth in pain?" The Reverend's poem has relevance also today.*

*It is a great pleasure to take part in the opening of the 33<sup>rd</sup> International Geological Congress. Today we mark the beginning of a week where the broad significance of the Earth Sciences will be highlighted from many perspectives. The congress is a result of Nordic co-operation, and is the largest science congress ever organized in Norway. I am impressed to hear that the 6000 participants come from 117 different countries. The programme of the congress is equally impressive, including a wide range of symposia, plenary lectures and excursions.*

*As Minister of Research and Higher Education, I am proud that Norway is hosting such an important event for the international scientific community. One could perhaps say that it is quite suitable that the congress is held in this country, where the significance of geology is easy to acknowledge. We have a lot of geology obviously visible – ours is a country of rocks and mountains. And those of you that have heard about Norwegian trolls certainly know that they live inside the mountains. Important parts of our history could in fact be characterized as continuous labour, sometimes even struggle, with our geology; in mining, in the building of roads and later of tunnels, and not least in the industry which has become so important to us, the oil and gas industry. In all these fields, the knowledge of geologists is the necessary starting point.*



*Not surprisingly, Norway has developed strong research communities in Earth Sciences, especially within petroleum related research. They are a part of “the bedrock”, so to speak, of our society as we know it today. But the scope of the geological sciences, or Earth Sciences, is much broader than rocks, mountains and petroleum exploration – a fact which the programme of this congress clearly illustrates. Earth Sciences are also about climate change, natural disasters, water, environment and health – as well as about questions concerning the Earth in relation to space and the origins of life on our planet.*

*So, my main point here today is that the Earth Sciences have important contributions to make in the face of a number of challenges. Many of the challenges are daunting. This should not come as a surprise. The Earth for one thing is a highly complex system where many different processes play together and affect each other.*

*The 13<sup>th</sup> century monarch and intellectual Alphonso the Wise is reported to have said the following upon hearing an explanation of Ptolemy’s theory of astronomy: “If the Lord Almighty had consulted me before embarking on Creation thus, I should have recommended something simpler.” Consequently, the scientific work to understand the Earth and its processes is also complex. The programme of the 33<sup>rd</sup> International Geological Congress illustrates this complexity, as it includes symposia in a wide range of disciplines. These different scientific disciplines complement each other. Together they may make important contributions to the broad knowledge platform we need for the challenges we face.*

*This platform is developed also through the International Year of Planet Earth in 2008, initiated by UNESCO and the International Union of Geological Sciences. The year’s motto is “Earth Science for society”. This motto effectively emphasizes what is a central aim both of this congress and of the International Year of Planet Earth, namely to increase awareness of the contributions the Earth Sciences can make to the development of our societies.*

*In this regard I am pleased that the congress has a strong focus on the Arctic. The High North is of course important both to my country and the other organising countries. The Norwegian government has set the High North as an important strategic area in the years to come and with knowledge, in terms of research, education and competence, as a driving force in its High North Policy. The Earth Sciences clearly will be vital to provide the knowledge we need to secure a safe development in these rich but vulnerable areas, where interests related to new opportunities for oil and gas exploration must be balanced with environmental issues and the interests of fisheries.*

*The High North is not only important to the countries in its close geographic proximity. It is of equally great importance to the global community, in particular because it functions as a warning area for climate change. The Arctic region is where the effects of climate change both may hit us first and also can be observed first - in fact, we can already see them there. More research is needed, and the Earth Sciences clearly have a central role to play. As the Earth Sciences are collecting information about climate and climate changes in the past, they are helping us improve our understanding of climate changes today and of possible future climate developments. Norway welcomes more research in the High North, and more international co-operation. We do not least welcome more and better use of the*

*Norwegian archipelago Svalbard as a research platform. Svalbard has easy access, and is an important arena for climate related research in many disciplines. Geology is among the fields of study that have especially interesting conditions there. Many countries have already established research stations on Svalbard, and we welcome even more researchers to this international research platform. I am also very pleased that the significance of projects in Earth Sciences under the International Polar Year will be highlighted during this congress. The Polar Year effectively illustrates the need for international research cooperation in order to secure knowledge we need in the face of common challenges, also at Svalbard.*

*The seven “Themes of the day” chosen for the scientific programme of this congress shows that topics of relevance to developing countries will also be addressed by this congress. I applaud this. The countries in the south could experience some of the most damaging effects of climate change in the future, both related to rising sea levels and to more extreme weather. This adds to other challenges facing these countries. They should not face them alone.*

*One measure is to find a better balance in the global research effort. The richer countries of the world, with the most resources to perform research, should to a greater degree take into account also the challenges facing the poorer countries. An increased focus on the needs of developing countries in research must however be complemented by other measures. It is not least vital to promote international exchange of knowledge and to contribute to capacity building in education, research and technology in developing countries. In this context I commend the initiative by the Nordic IGC Foundation organizing this congress. Through the Geobost programme, which is financially supported by the Norwegian government, the foundation has provided grants to scientists from developing countries to make them able to participate at this important scientific event.*

*The topic of climate change is important, and a challenge we all share. In the same manner, the subject matter of the Earth Sciences, the Earth, is so clearly common to us all. The philosopher Hanna Arendt called the Earth the very quintessence of the human condition. The Earth, simply put, is our common home, the symbol of mankind’s togetherness. It provides us with rich resources, but also many challenges. As recognized by the Millennium Development Goals, millions of people live without access to clean water, and groundwater sources become polluted as a result of human activity. The Earth also presents us with more immediate dangers, for example in the form of volcanoes, landslides, earthquakes and tsunamis. In this respect too, we need the knowledge the Earth Sciences can provide, both to take advantage of the rich opportunities the Earth gives us, and to increase security in face of its dangers. On the one hand, the many Earth scientists of the world already have knowledge that could be used more effectively, for example to predict natural disasters like tsunamis, and to provide for safe and healthy living environments. On the other hand, we still need much more knowledge, both to solve problems we face today, and to be ready to meet the challenges of the future that we do not yet know. I am confident that the International Geological Congress will contribute both to increased interest in and awareness of the importance of the Earth Sciences. It is also my hope that it will contribute to a continued effort to support research and education in the Earth Sciences, and increased use of this knowledge also in policy making.*





*The American poet and philosopher Ralph Waldo Emerson said: "We learn geology the morning after the earthquake". Let us hope that this congress will contribute to making the quote less relevant in its literal meaning, by contributing to increased use of Earth Sciences to meet the challenges the Earth confronts us with, and with more knowledge to be prepared to protect our source of life.*



HM King Harald V unveiling a full-scale replica Plesiosaurus.  
(Photo: Gudmund Løvø)

*The Norwegian government has decided to give financial support to this congress as well as to the international secretariat of the International Year of Planet Earth, which is based in Norway, at Norway's Geological Survey. We do this because we recognize the significance of these international initiatives to increase awareness of the importance of Earth Sciences, and hopefully also to help recruit students and researchers to these fields of study. In line with this, I see it as very positive that both the International Geological Congress and the International Year of Planet Earth place great weight on outreach activities to increase public understanding of the significance of the Earth Sciences, and to awaken the interest of students who may become the geoscientists of tomorrow.*

*I wish to take this opportunity also to emphasise the importance of fundamental research in Earth Sciences. The quest for pure knowledge, without commercial or other obvious "useful" applications often results in important unexpected discoveries and insights. Fundamental research therefore forms the basis for the many benefits to society we see of applied forms of Earth Sciences.*

*Dear audience, science develops through debate and criticism, and meeting places are therefore important. With its wide scope and thousands of contributions, the International Geological Conference is an important scientific meeting place in Earth science. I wish all participants good luck with your presentations and discussions!*

The spectacular video postcard of Norway, presented by **Professor Trond H. Torsvik** of the Geological Survey of Norway, focused on the long northward journey, dramatic collisions and volcanic events in the geological history of the country, and was followed by the Grand Finale of the ceremony, a rock version of Edward Grieg's "In the hall of the mountain king" accompanied by live fireworks. Afterwards His Majesty and invited guests proceeded to

watch a video presentation by Professor Jørn Hurum of the Natural History Museum at the University of Oslo, and take part in the unveiling of a full-scale replica of the Mesozoic Plesiosaurus found in recent excavations on Svalbard. At this point His Majesty was also presented with a large sculpture of larvikite, newly elected the 'Norwegian national rock'. Afterwards all the participants were invited to take part in the icebreaker party, where they could enjoy some light food and refreshments and listen to the StatoilHydro Big Band.

## CLOSING CEREMONY

The Closing Ceremony of the 33<sup>rd</sup> IGC was held on Thursday 14 August at 14:00 PM. The focus of this ceremony was "Farewell to Norden and Welcome to Brisbane Australia in 2012". More than 2,000 participants took part in this Farewell ceremony, which started with music played on traditional Nordic lute instruments by the famous musician Odd Sylvarnes Lund. Master of ceremonies **Ellen Ramberg, Vice President of Operations**, welcomed everyone to the Closing ceremony and stated that this was a moment of mixed feelings: relief because there had been no major problems during the congress, but also a touch of sadness because the planning and preparations had been going on for such a long time. She then invited **Secretary General of the 33<sup>rd</sup> IGC Anders Solheim** to present a brief summary on the 33<sup>rd</sup> IGC activities.

Solheim started with focusing on 33IGC as a joint Nordic effort and reminded the audience of the Nordic IGC History: Stockholm 1910, Copenhagen 1960 and Oslo 2008. A roughly 50 years recurrence interval seems to be valid for the Nordic countries - meaning that there is still some time to plan for the next. He also presented some 33IGC statistics: Ca. 6,260 registered participants, 86 exhibitors and 6,300 presentations during 340 symposia. Participants from 113 countries - the five biggest countries were Norway: 966; Russia: 504; USA: 390; China: 375; and Italy: 266. 38 excursions were arranged: 30 pre- and post-Congress excursions and 8 single day excursions. In total there were 714 participants on the excursions going to all the Nordic countries, Svalbard, Greenland, the Faeroe Islands, Russia and Ukraine. In addition 96 business meetings were arranged, including IUGS/IGC Council meetings and 20 workshops and short courses. In total 562 Geohost stipends were awarded. The IUGS/IGC Council Meetings resulted in two very important decisions: Alberto Riccardi was elected the new IUGS President, and South Africa was selected as the place for the 35<sup>th</sup> IGC in 2016.

The "Themes of the Day" sessions were a new feature at the IGC focusing on "Geosciences for Society". The selected themes were Global geology; Early life, evolution and biodiversity; Climate change; Geohazards; Water, human health and environment; Mineral resources; The Energy race; and Earth and beyond.





Solheim also touched on the social activities during the 33IGC. He then went on to thank the 100 Nordic students that had been working as staff during the congress. Other important thanks went to the 33IGC sponsors: The main sponsor StatoilHydro, the Norwegian Government, Shell, the Research Council of Norway, and all others who contributed significantly. Solheim concluded his brief summary by welcoming everyone back to Oslo.

After Solheim's summary, **Arne Bjørlykke, the President of the 33IGC**, was invited to present some final words:

*Dear participants, ladies and gentlemen. I would first like to use this opportunity to thank all of you that have contributed with oral presentations and posters. Without your interest and hard work this congress would never have taken place, and I am impressed by the quality in your contributions.*

*It is eight years since Richard Sinding-Larsen phoned me late one evening and said: "Arne, we must make a bid for the IGC in 2008". He took me by surprise and I said yes. Together with a lot of friends we were able to announce and present our bid in 31IGC in Rio. After Rio the bidding committee under the leadership of Ivar Ramberg and later by Richard Sinding-Larsen started their work, and the final bid was presented in Florence in 2004. The Council meeting of IGC in Florence selected Oslo for the 33IGC.*

*The four years after the 32IGC have been a period of hard work, of planning and securing financial support. We had a fantastic team with:*

*Anders Solheim, with the help of Asgeir Knudsen running the Secretariat*

*David Gee and Bjørn Sundquist running the Science Programme*

*Finn Roar Aamodt running finances and sponsors*

*Berit Forbord Moen running communications*

*Ellen Ramberg running operations and social events*

*Richard Sinding-Larsen running international relations and Geobase*

*Elias Ekdahl representing Finland*

*Olle Selinus representing Sweden*

*Johnny Fredericia representing Denmark*

*Kristinn Albertsson representing Iceland*

*Øivind Lie and the staff from Congress-Conference, the PCO*

*100 students from all Nordic Countries that helped us in the lecture rooms and media centre.*

*Thank you all for very hard work and positive attitude through all this years. I am already looking forward to the 34IGC in Brisbane and wish Neil Williams and his team good luck in the preparation.*

The **International Commission on Stratigraphy** awarded two prestigious prizes during the 33IGC and **Professor Stanley Finney, Chairman of the ICS Prize committee** reported on these:

*The International Commission on Stratigraphy (ICS) is a leading entity of the International Union of Geological Sciences (IUGS) with responsibility for establishing international standards in stratigraphy, such as the Geological Time Scale and the International*

*Chronostratigraphical Scale, defined by boundary stratotypes (GSSPs). Stratigraphy is the core discipline of the geological sciences, concerned with the relationships in time and space of rocks (not just sedimentary, but also igneous and metamorphic rocks) and the varied processes that have formed and affected them. Results and interpretations deriving from other disciplines can only be integrated into a coherent all-embracing geological history if they are based on sound stratigraphy.*

*To emphasise this key role of stratigraphy, the International Commission on Stratigraphy awards two ICS Prizes to outstanding geoscientists every four years during an International Geological Congress. The first awards were made at the 32<sup>nd</sup> IGC in Florence, 2004; the second will be made at the 33<sup>rd</sup> IGC in Oslo, 2008.*

*The awards are made at two levels: The **Digby McLaren Prize** is awarded to recognize a significant body of internationally important contributions to stratigraphy sustained over a number of years. Thus, it is a career achievement award. The prize is named in honor of the Canadian geologist Digby McLaren who was so influential in developing the key "golden spike" concept of a Global Stratotype Section and Point (GSSP) with reference to the Silurian - Devonian boundary, and a major force behind the International Geological Correlation Programme (IGCP) of UNESCO. The **ICS Prize** is awarded to honor high-quality research in stratigraphy by recognizing a single major achievement in advancing stratigraphic knowledge. The research may comprise a single paper of distinction or a series of papers over a short period of time that have similar impact.*

*For 2008, the Prize Committee included myself along with Dr. Brian Pratt of Canada, Dr. Finn Surlyk of Denmark, and Dr. Andre Strasser of Switzerland.*

**Carlton E. Brett** of the University of Cincinnati is a distinguished and award-winning American geologist who for the past 30 years has produced a prodigious quantity of articles, edited books and guidebooks covering an enormous range of stratigraphic subject matter. He began his career with the study of lower Paleozoic echinoderms and quickly became a leading international authority on crinoid systematics. While that might be enough for many earth scientists, not Carl: he insists on asking ever larger questions about the fossils and their host sediments. Integrating field geology, sedimentology, paleontology, paleoecology and taphonomy, within the tectonic framework of the basin, Carl has acquired a 'feel' for the detailed dynamics of physical and biological sediment accumulation, reworking and erosion that is both profound and peerless—it is as if he had been there to witness it. Not limited to nearly 200 specialist papers, using his fine understanding of the concepts of lithostratigraphy, biostratigraphy and sequence stratigraphy he has instituted fundamental revisions to the basic stratigraphic architecture of the Ordovician, Silurian and Devonian of eastern North America, areas first studied a century and a half ago but still replete with uncertainties that have required his unique talents to solve. His career of achievements in stratigraphy include not only research but also the training of more than 15 PhD and 20 MS students and many more undergraduate students. Unfortunately, Dr. Brett could not be at the Closing Ceremony to receive the prize; nevertheless, please join me in applauding the outstanding career of achievements of Carl Brett.



**József Pálffy** of the Hungarian Natural History Museum in Budapest has made a series of fundamental contributions to the Triassic and Jurassic portion of the geologic timescale. An experienced stratigrapher and versatile paleontologist, József has led the integration of biostratigraphy, geochronology, magnetostratigraphy and chemostratigraphy to generate a highly refined understanding of the lower half of the Mesozoic. For example, his 2000 paper in *Canadian Journal of Earth Sciences* is a milestone for the calibration of Jurassic time. His integration in turn has opened the door to explore global phenomena like perturbations of the carbon cycle and mass extinction, especially at the Triassic/Jurassic boundary. In this regard, his 2001 paper in *Geology* and his 2007 paper in the thematic issue of *Palaeogeography, Palaeoclimatology, Palaeoecology* devoted to the boundary stand out as seminal contributions. That issue, which he co-edited, represents the results of IGCP Project 458 which József proposed and co-led. It also is unfortunate that Dr. Pálffy could not be at the Closing Ceremony; nevertheless, please join me in applauding his accomplishments.

**The 33<sup>rd</sup> IGC NordForsk Poster Award** was initiated by NordForsk, the research organisation of the Nordic Council of Ministers, and was given to the three best poster presentations given by a PhD student from a Nordic University. The winners were announced by **Dr. Harry Zilliaceus, Chairman of the Committee:**

Mr Chairman, Mrs Master of Ceremonies, dear guests. NordForsk is an independent organisation, based in Oslo, under the Nordic Council of Ministers. Our three main roles are to fund Nordic research and researcher education activities, mainly by launching calls, to co-ordinate Nordic research in a variety of ways, and lastly, to provide policy advice to those engaged in Nordic research affairs. We do support all scientific sectors equally, and it's perhaps more how you would like to co-operate with colleagues from other Nordic countries that counts, rather than the exact subject you've chosen for your project. The results should add to Nordic strength, though, so that as many of the five countries as possible may benefit from the achievements and innovations that make up the outcome of the scientific work carried out.

NordForsk decided to support the 33<sup>rd</sup> International Geological Congress held in Oslo, in principle in two ways. We have funded the participation of 30 nationally chosen PhD students representing all five Nordic countries in the activities of the Congress. This was a gesture by us to make it easier for young researchers to participate in events where it's possible to meet colleagues from all around the world in order to exchange views on matters that they feel are relevant for their future work.

The second means of supporting the Congress was the establishment of the NordForsk Poster Awards, which I'm just about to deliver to the winners, thoroughly selected and sieved out of those 19 candidates that registered for the competition. There will be three Awards of 25,000 NOK each, presented here in alphabetical order. We have not tried to produce any ranking order for these three, a task which probably would not have led to a fair result. A professional Nordic Evaluation Panel, chaired by me as a NordForsk representative, has done its work, looked at the posters, listened to oral presentations by the first authors of each group behind these pieces of work, and evaluated the

posters so that we finally came up with three names we feel fulfil our criteria the best. All posters looked good, to say the least, but this time we had to cut the number of candidates down to three. These three were just perfect, couldn't have been better, according to the views of the Panel. Please note that we did not judge the scientific work merely as such, but looked at the presentations mainly as posters, i.e. as instruments for communicating what's been done in the field, laboratories and in the office, and what seems to be the most important conclusions of the data produced. It is essential, as we know, not only to do excellent work, but also to be able to show the entire research community what it is that's interesting, innovative and relevant for you, this time.

The names of the winners of the NordForsk Poster Awards are, and I'm here only referring to the affiliation of the first author, whereas it's up to the groups themselves to decide how the Award should be split between their members. We hope, naturally, that here, as in life and in scientific co-operation elsewhere, everybody will get what he/she deserves for his/her contribution to the joint effort:

**Mrs Evy Glørstad-Clark**, University of Oslo

**Group:** J. Faleide, J. Nystuen & K. Leever

**Title:** Sequence stratigraphic framework for the Norwegian Barents Sea with a focus on the Triassic succession

**Mr Jussi Pokki**, University of Helsinki

**Group:** T. Andersen, J. Kohonen & O. T. Rämö

**Title:** A detrital zircon U-Pb provenance study of a post-Svecofennian conglomerate, Island of Suursaari

**Mr Kristian Vasskog**, University of Bergen

**Group:** E. N. Støren, A. Nesje, D. Ariztegui, E. Chapron & N. Waldmann

**Title:** A 7,300 year reconstructed history of climate, floods and colluvial events

NordForsk wishes to congratulate the three winners of the NordForsk Poster Award! You've done a great job, and keep it up throughout your coming career! And, finally, when thinking about partners for project groups or networks or the like, why not meet up with your Nordic colleagues? We have long traditions of co-operation, and it's been proved many times over that it's a good investment to join forces with your Nordic neighbour colleagues in order for you to expand the critical mass that you may find at home. And, on the other hand, here there's always someone who will understand you! Many thanks to all participants of the NordForsk Poster Award – and good luck for the future!

The Organising Committee had arranged a contest among children in the area to name the inflatable full scale replica of the Mesozoic Plesiosaurus standing at the venue entrance in Lillestrøm. The name and the winner were announced by **Professor Jørn Hurum**, who discovered the fossil during recent excavations on Svalbard. The winning name was 'Dinodille' in Norwegian, or 'Dinodile' as the more international version, and the young winner was three-years-old **Sam Falkenberg Kjølø** from Oslo who came to the podium and received his prize.



The **Secretary General of IUGS Peter Brobrowsky** was then called to the podium to present an address from The International Union of Geological Sciences:

*Distinguished guests, ladies and gentlemen, dear colleagues. Warm regards first of all from the IUGS president Alberto Riccardi, who also extends his apologies as he had to return to Argentina to just personal issues a few days ago. But on behalf of the IUGS president and the rest of the global family of IUGS, I wish to extend our warmest congratulations to the President and the Secretary General and the entire supporting team of the local Organising Committee, on an extremely successful delivery for the 33<sup>rd</sup> International Geological Congress here in Oslo. Well done indeed!*

*As you know The International Union of Geological Sciences has always been recognized, and will continue to remain, the main scientific sponsor of the congress. As such we wish to acknowledge the incredible response of our international scientific community as represented by the commissions, initiatives, the IGCP projects, the various members of national bodies, the bearing organizations, and the many, many other scientists who are actually the real character and soul of both IUGS and IGC. It is actually you, the 6,000 plus scientists, who come to the IGC now and every four years to share your scientific accomplishments, who deserve the recognition, and to whom we wish to give special thanks. Without your hard work inside perseverance and diligence, geology would not be as important as it is today, and all of us would have difficulty being so proud to be geologists. Thank you very much indeed.*

*The Union thanks the efforts of the Nordic Foundation, The International Advisory Panel, the Scientific committees and the many others, including the exceptional generosity of the financial sponsors, such as StatoilHydro, Shell, the Government of Norway etc., who made the 33<sup>rd</sup> IGC a notable and global event. We very much acknowledge your support and we recognize that a congress such as this could not possibly succeed without your help.*

*All of us leave this country, this city, very much more enriched with any number of Nordic experiences. We all leave much more enlightened and informed after enjoying so many scientific presentations. And equally important, we all leave Oslo with many more friends and many more new acquaintances.*

*This particular IGC marks the mid point in our triennium International Year of the Planet Earth celebration. We really hope that all of you leave this congress with renewed vigor to continue to promote the Earth Sciences globally and at home as part of IYPE. Remember all along the importance of geology rests with the youth which are the future of geosciences.*

*I wish you all a safe journey and invite you to prepare now for the next congress in Brisbane. Your scientific participation in 2012 is essential. Tusen takk!*

The joint IGC/IUGS council had decided that the 35<sup>th</sup> IGC in 2016 will be arranged in Cape Town, South Africa, and **Dr. Sue Frost-Killian**, Chair of the organising committee, welcomed everyone to Cape Town in 2016, where the main theme of the congress will be: Dance with

the Earth.

After the announcement of the 35<sup>th</sup> IGC the Closing Ceremony focused on the 34<sup>th</sup> IGC which will be arranged in Brisbane, Australia. This part of the program started with traditional Australian music played on a didgeridoo by Zotora, before **Neil Williams, CEO Geoscience Australia and President of the 34<sup>th</sup> IGC**, presented some plans for the next IGC, including a video presentation:



34IGC President Neil Williams. (Photo: Gudmund Løvø)

*We are grateful to the people of the Scandinavian countries for hosting such a successful event in the last couple of weeks. Oceania will host the next International Geological Congress in August 2012 and the host city will be Brisbane in Queensland, Australia. The 34<sup>th</sup> IGC organising committee aims to build further on the success of Oslo and the prestigious history of the IGC dating back to 1878.*

*The theme for the 34<sup>th</sup> IGC in Brisbane in 2012 is "Unearthing our Past and Future", and the IGC will showcase the Oceania region's geoscience strengths, innovations and natural wonders, through an exciting range of pre and post Congress field trips. There will be some 30 geology field trips offered with the Congress and numerous tourism opportunities. Australia 2012 will include a GeoExpo, an education outreach program and a support program to encourage young delegates to attend. The IGC will demonstrate the crucial role that geoscience plays in the quest for sustainable development and show how geoscience contributes directly to the future of its resource-based industries, land and water management and mitigation of geohazards.*

*The Congress will be staged at the highly acclaimed Brisbane Convention and Exhibition Centre, a world class venue that has hosted numerous large and very successful international meetings. We have established a well qualified organising committee for AUSTRALIA 2012 and preparations have already begun. The importance of the Congress is reflected in the high level support from the Australian Government. Brisbane, the host city, is the home town of Australia's Prime Minister, the Honourable Kevin Rudd MP. Brisbane offers great Australian weather, a sophisticated level of service with great value for money, and a proximity to geo-tourist features such as the Great Barrier Reef.*

*We have prepared a video to give you an overview of what you might expect when you visit Australia in 2012. Please enjoy.*





*We will have the video you have just seen and others available at the AUSTRALLA 2012 website "www.34igc.org", for those of you that wish to see it again and so that you can let others know.*

*In closing, I repeat our very warm invitation to come to Australia in four years time and we look forward at the 34<sup>th</sup> International Geological Congress to showing the spectacular cosmopolitan culture of Australia and the awesome geology of Oceania.*

The Master of Ceremony concluded by thanking everyone for their participation and their contribution during the 33<sup>rd</sup> IGC.



*Zotora's didgeridoo farewell to 33IGC. (Photo: Gudmund Løvø)*

## PRIZES AND AWARDS

Several prizes were awarded during the Congress.

**Professor Bjørn Bølviken** (Norway) received the Vernadsky Medal, which is the most prestigious award of the International Association of Geochemistry (IAGC), for his important scientific accomplishments in geochemistry throughout his career.



*Bjørn Bølviken (right) receiving the Vernadsky Medal from Dr. Clemens Reimann, Geological Survey of Norway. (Photo: Gudmund Løvø)*

During the Business Meeting of the International Commission on Stratigraphy (ICS), three prizes were awarded. Professor Maria Bianca Cita (Italy) received the ICS Special Service Award for lifetime dedication, excellence and leadership in national and international

stratigraphy; the Digby McLaren Medal was awarded to Professor Carlton Brett, USA, to honour a significant body of internationally important contributions to stratigraphy sustained over a number of years; and the ICS Medal to honour high-quality research in stratigraphy was awarded to Dr. József Pálffy (Hungary).

In the Closing Ceremony, three Nordic PhD students - Evy Glørstad-Clark (Norway), Jussi Pokki (Finland), and Kristian Vasskog (Norway) - received the "Nordforsk Prize for best Nordic student poster", each NOK 25,000.

## SOCIAL EVENTS

On Friday 8 August the Organising Committee had reserved the new Opera House in Oslo for the congress participants, to experience the popular musical "Porgy and Bess" performed by a South African company from Cape Town. The performance sold out, with 1,400 participants and accompanying members enjoying an evening at the brand new Opera house close by the waterfront in Oslo. Earlier the same day two Congress presentations focused on the various challenges associated with the location of the Opera house as well as the choice of building materials.

On Sunday 10 August the Organising Committee arranged a reception for the main delegates to the congress. More than 200 delegates enjoyed snacks and refreshments in the newly redecorated Tøyen farmhouse located in the Garden of the Natural History Museum. The participants were welcomed by the President of the 33<sup>rd</sup> IGC, Arne Bjørlykke, and General Manager of the Natural History Museum Elen Roaldset, who also gave the participants some insight into the history of the museum.



*The Mayor of Oslo, Fabian Stang (left), chatting with Prof. Richard Sinding-Larsen during the congress barbeque. (Photo: Gudmund Løvø)*

Monday 11 August all participants and accompanying members were invited to a barbeque dinner at the Botanical Garden associated with the Natural History Museum. The Geological museum and the Zoological museum were open for the participants, and the Zoological



Museum featured the famous exhibition “Meisler on tour” which shows rainforest fossils from 150 million years ago, amazingly well preserved. More than 2,000 participants signed up for the event. The President of the 33<sup>rd</sup> IGC wished everyone welcome and introduced the mayor of Oslo, Fabian Stang, to greet the congress participants. Music was provided by the Silurian Jazz Band. This event was primarily intended for the participants to mingle and getting to meet old and new friends.

Tuesday 12 August Smuget Jazz and Rock Club was reserved for the congress participants. More than 300 participants and accompanying members enjoyed an evening of music and light refreshments.

## ACCOMPANYING MEMBERS PROGRAMME

A schedule of half-day and all-day sightseeing tours were arranged for accompanying members. These included visits to art museums, historical museums and sites, as well as trips to scenic areas, boat trips on the Oslo Fjord or hiking trips in the forests surrounding Oslo. Parts of this programme were arranged in the evenings in order to make events available for congress participants. The events were attended by a majority of the participants and accompanying members. This programme was arranged by our professional PCO company Congress-Conference AS.

## EVENTS CONNECTED WITH THE 33rd IGC

### INTERNATIONAL YEAR OF PLANET EARTH - IYPE

The importance of Earth Science in addressing global challenges is increasing, and new organisations have been established. The International Year of Planet Earth and OneGeology are examples of such organisations, which are working for dissemination of information and for the increased visibility of Earth Science. Traditionally the UN and its organisations have been regarded as the most important bodies for this. There is, however, an increasing commercial market for geoscientific knowledge through internet-based companies, such as Google and others. The International Year of Planet Earth started in 2007 and will end in 2009. The 33IGC is therefore organized at the peak of IYPE activities.

A presentation of IYPE opened the Global Geology, which was the first Theme of the Day.

#### 15:30-16:00 **Global Geology: Introspection and perspectives**

Eduardo de Mulder

International Year of Planet Earth, IYPE (The Netherlands)

More than 80 international leading experts contributed to the programme for these seven days of plenary lectures. Seven themes were selected for particular emphasis. They were all related to the priorities of the International Year of Planet Earth. In parallel with the Congress symposia program, each day of the meeting highlighted one of these major themes.

The themes included Global geology; Early life and evolution; Climate change; Geohazards; Water, health, and environment; Mineral resources; Energy resources and the future; and Planetary geoscience. The programme focused



*Eduardo de Mulder, Executive Director of IYPE, presenting the organisation. (Photo: Gudmund Løvø)*

on both scientific and societal aspects of each theme. Speakers for the lunchtime StatoilHydro keynote lectures were Richard Fortey, Gerald Haug, Herbert Einstein, Ghislain deMarsily, Neil Williams, Mark Moody Stuart, and Maria Zuber.

During the Congress a meeting of the IYPE Board and a meeting of national IYPE representatives were held.

## ONEGEOLOGY

OneGeology is an International Year of Planet Earth initiative of the geological surveys of the world, supported by a number of global bodies. The prime objectives are: to make geological map data accessible on the internet, to accelerate the interoperability of geoscience data, and to share know-how and expertise in digital map web delivery.



At a time when transnational environmental problems, in particular climate change, have an unprecedented high profile, when many geological surveys are reviewing their role and contribution, when the internet and digital systems are providing innovative global reach, and when many regional groups are establishing spatial data infrastructures, it is essential to combine and share our experience and assets in this way. While geological surveys have always played an invaluable role within our own individual nations and also worked bilaterally to assist each other, we have never before pooled our unrivalled expertise and data and knowledge bases on this scale to deliver something that can add value and make a difference globally.

OneGeology is now a viable operation that has proved its capacity to increase the accessibility of geological data, improve the interoperability and consistency of that data, transfer know-how and not least raise the profile of geoscience and geological surveys. This Global Geology symposium at the 33<sup>rd</sup> IGC formally launched the project to the world on the opening day of the Congress as apart of the Global Geology Session.

16:00-16:30: **Formal launch of the OneGeology Project.**

**A 21st Century map to change the world?**

Simon Winchester (UK)

**Local knowledge, globally accessible**

Ian Jackson

British Geological Survey, BGS (UK)



*Author Simon Winchester launching the OneGeology initiative. (Photo: Gudmund Løvø)*

## FOSSIL ART

Thanks to sponsorships from StatoilHydro and the Norwegian Petroleum Directorate we were able to bring the spectacular and impressive exhibition Fossil Art from Poland, where it toured in 2008, to the 33IGC. This

exhibition is by Dr. A. Seilacher from Tübingen University, Germany, who has broken new ground in the presentation of fossil art both aesthetically and intellectually. While previous examples of art have used the specimens themselves as objects of beauty, Dr. Seilacher's artworks represent the activities and behaviours of organisms - burrows, traces, tracks and trails - rather than their anatomies. "Thus we see that organic effort can be as beautiful as organic form", Dr. Seilacher said in his presentation of the exhibition.

A new book published March 2008, 'Fossil Art', could be used as an exhibition catalogue as it shows all the fossils on display with full-page colour photos. It also contains a number of drawings by the author detailing how the exhibited patterns have been made and preserved. Each photograph and drawing is accompanied by a scientific explanation by Dr. Seilacher, who has attributed an artistic name to each panel.

Thanks to sponsoring by Lundhs Labrador AS, one of the major larvikite producers, a large sculpture of larvikite made by the artist Martin Kuhn was on display outside the main entrance to the Convention Center during the congress. In 2008 this beautiful blue-coloured rock was selected as the Norwegian national rock. The larvikites is of Early Permian age and form a series of semi-circular intrusions in the Oslo Field.

## LARVIKITE - THE NORWEGIAN NATIONAL ROCK

Larvikite has for more than a hundred years been appreciated as one of the world's most attractive dimension-stones. Today its production and use is more extensive than ever. The main reason for the continuous success of this unique Norwegian rock on the world market is the blue iridescence displayed on polished surfaces. These spectacular colours are caused by optical interference in microscopic lamellae within the feldspars.

## PHOTO EXHIBITION OF NORWEGIAN MINERALS

Outside the Plenary Hall of the Convention Center a set of outstanding photos of Norwegian minerals were on display, another example of the beauty found in nature. The pictures are taken by photographer Per Aas, and were generously lent to the congress by the Natural History Museum of the University of Oslo. On Monday August 11<sup>th</sup>, Dr. Rune Selbekk, Head Curator of Minerals at the Natural History Museum, gave a presentation of the minerals and the photos.

Some of these beautiful photos were also for sale at the Natural History Museum.



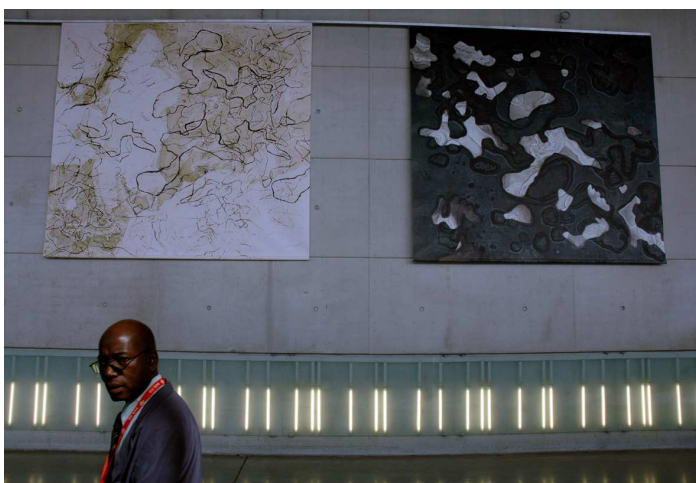


## GEOPRINTS

The exhibition of Geoprints on the wall in the corridor displayed examples of art resulting from a four-year collaboration between the Norwegian artist Ellen Karin Mæhlum and the Physics of Geological Processes (PGP) research centre. PGP is a cross-disciplinary research centre currently employing about 60 geologists, physicists and applied mathematicians from 15 nations. Its mission is to obtain a fundamental and quantitative understanding of the complex patterns and processes of the Earth through integrated field, experimental, theoretical, and computer simulation studies.

PGP is particularly interested in natural pattern-forming processes. To communicate the relevance of such studies to society in a broad sense, as well as an enthusiasm and understanding of geological patterns, PGP has engaged in a long-term collaboration with Norwegian artists.

Ellen Karin Mæhlum has participated in several field investigations arranged by PGP, including work in Svalbard and South Africa. She has also studied rock thin sections and followed some of PGP's experimental research activities. Graphical prints inspired by the patterns of the Earth were the basis for the series Geoprints.



*The Geoprints exhibition. (Photo: Gudmund Løvø)*

## ACTIVITIES IN CENTRAL OSLO

To increase the interest for geology among the public of Oslo, and young people especially, the Organising Committee arranged an exhibition and various activities at the University Square in central Oslo, including both factual and fun features. Dr. Rune Selbekk, Head Curator of Minerals at the Natural History Museum, led this project.

A set of exhibitions focused on the importance of geological knowledge for the society, and career

opportunities for young people. The Geoscience Institute, the Natural History Museum and the Natural Science Centre (all of the University of Oslo) presented possibilities for new knowledge in Earth Sciences. The Year of the Planet Earth presented their 10 focus areas, while the 33IGC presented the “Themes of the day” activities at Lillestrøm and offered free access to Themes webcasts in the Old University Hall in central Oslo.

Children could take on the geology quiz challenge or hunt for different types of rock material used in buildings nearby, and they were also given a sample of the ‘Norwegian national rock’ Larvikite to take home. Children were also invited to participate in a naming contest for the full scale replica of the pliosaur newly found on Spitsbergen, with the winner announced at the IGC Closing Ceremony on 14 August.

In addition there were sale of minerals, jewellery, fossils and meteorites, and a striking feature was Norway's largest excavated quartz, weighing in at 1,7 tonnes and displaying beautiful crystals of different sizes.



*A 1.7 tonne quartz, the largest sample excavated in Norway, displayed in Universitetsplassen, Oslo.*



## REGISTRATION

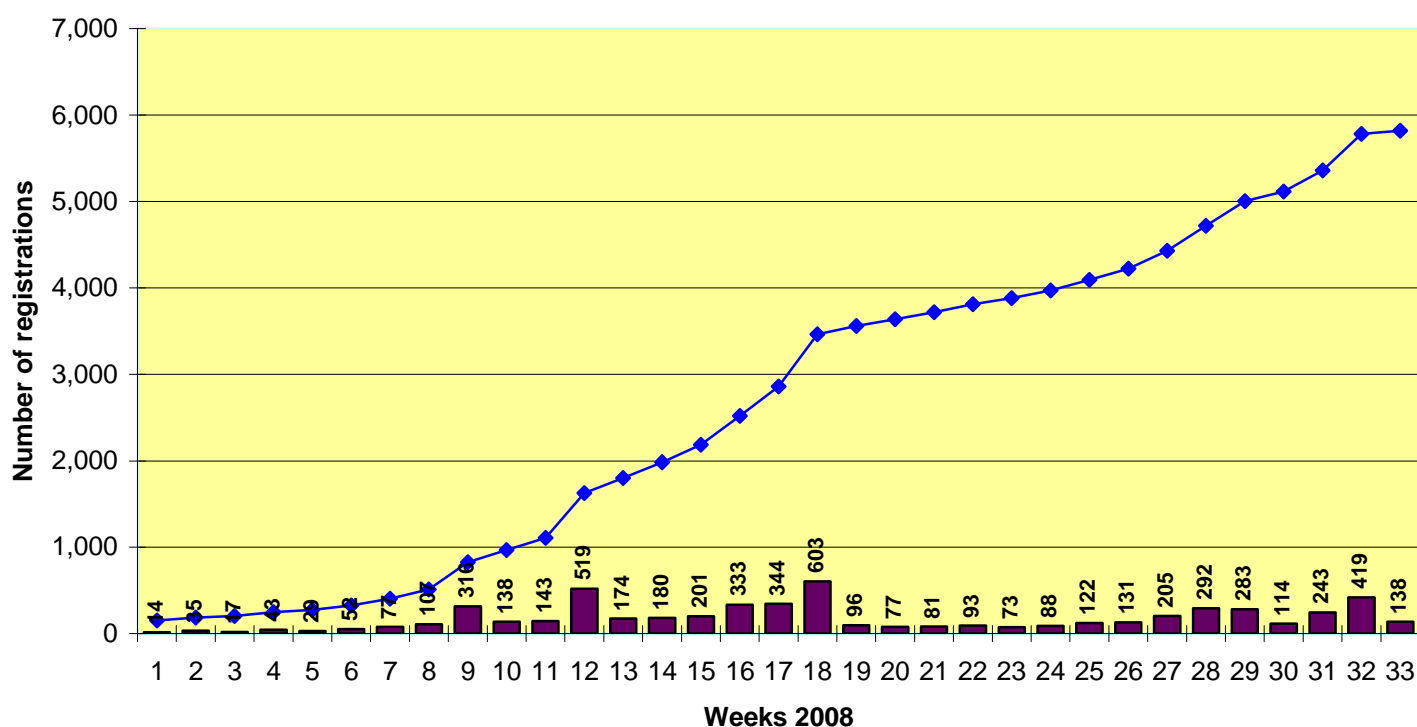
## REGISTRATION BY COUNTRY

Afghanistan	1	Hungary	26
Albania	7	Iceland	21
Algeria	5	India	96
Argentina	30	Indonesia	3
Armenia	3	Iran	83
Australia	148	Iraq	11
Austria	34	Ireland	26
Azerbaijan	8	Israel	12
Bangladesh	5	Italy	266
Belarus	1	Ivory Coast	3
Belgium	29	Jamaica	1
Bhutan	3	Japan	184
Bolivia	1	Jordan	1
Botswana	1	Kazakhstan	80
Brazil	148	Kenya	1
Bulgaria	13	Korea, Republic of	85
Cameroon	5	Kosovo	3
Canada	134	Kuwait	3
Chile	10	Kyrgyzstan	14
China	375	Latvia	7
Colombia	18	Lebanon	3
Congo,	1	Lesotho	1
Democratic Republic of		Lithuania	10
Costa Rica	1	Macedonia, FYR	1
Croatia	18	Madagascar	1
Cuba	1	Malawi	1
Cyprus	1	Malaysia	5
Czech Republic	58	Mexico	18
Denmark	113	Mongolia	6
Egypt	9	Morocco	20
Estonia	7	Mozambique	5
Ethiopia	5	Namibia	5
Faroe Islands	12	Nepal	1
Finland	118	Netherlands	76
France	144	New Zealand	28
Gambia	3	Nigeria	23
Germany	259	Norway	966
Ghana	2	Oman	1
Greece	27	Pakistan	6
Greenland	1	Peru	2
Hong Kong	8	Philippines	4



Poland	79	Taipei, China	13
Portugal	45	Tajikistan	2
Romania	78	Tanzania	5
Russian Federation	504	Thailand	8
Saudi Arabia	6	Tunisia	8
Serbia, Republic of	21	Turkey	56
Singapore	2	Uganda	4
Slovakia	14	Ukraine	29
Slovenia	21	United Arab Emirates	5
South Africa	23	United Kingdom	257
Spain	101	United States	390
Sri Lanka	3	Uruguay	2
Sudan	1	Uzbekistan	32
Sweden	206	Venezuela	6
Switzerland	98	Vietnam	13
Syrian Arab Republic	2	Yemen	6

**Registrations per week**  
(on-site registrations not included)



## BUSINESS MEETINGS

### REPORTS ON IUGS AND IGCC MEETINGS

#### IUGS-IGC COUNCIL MEETING

(Lillestrøm, Norway, 6 August 2008)

#### INTERNATIONAL GEOLOGICAL CONGRESS (IGC) (*Chair: President of the IGC Committee*)

Arne Bjørlykke (President, 33rd IGC) and Zhang Hongren (IUGS President) opened with some procedural comments about Agenda Item 11 (deciding on the order of presentations for bids to host the 2016 IGC), before moving to report on the IGC Geohost Program.

**a. IGC Geohost Programme** Richard Sinding-Larsen (Norway) reported that a significant Geohost stipend programme was established to help deserving young scientists to attend the 33rd IGC. The Geohost Stipend Programme gave priority to young scientists with academic Earth Science qualifications. In total there were 577 stipends allocated, 351 to men and 226 to women from 71 countries. This represented 61 percent of the total number of applications. All 577 were granted a waiver of the registration fee, whereas 469 received free accommodation in Oslo for the duration of their stay at the Congress. Sinding-Larsen acknowledged the support of Norwegian Ministry of Foreign Affairs, the Finnish and Swedish International Development Agencies, the EU and Euro GeoUnions.

#### b. Report from the Chairs of the IGC Committee

Arne Bjørlykke reviewed the history of the IGCC, noting that it replaced the old Steering Committee, and now, in composition, comprises an IGCC-IUGS committee. The changes simplified the structure, and the new committee acts as a bridge between congresses, gives advice, and receives bids for future congresses. Activity in the period 2004-2008 was intense, with both physical meetings and communication by email. The streamlining of the Statutes and Byelaws may create a new relationship between the IGC and IUGS. The IGC Council abolished the General Assembly of IGC in Florence. Ending, Bjørlykke thanked Attilio Boriani for his contributions to the IGC and IUGS, and for his support from beginning to end.

Neil Williams reported on preparations for the 34th IGC in Brisbane, Australia, August 2nd to 10th, 2012. He thanked Arne Bjørlykke and Attilio Boriani for his inclusion as an observer and had learned much from this opportunity. Activities have begun in earnest and everything is currently on schedule. Oceania's bid was supported by ICSU and is

being handled by the Australian Geoscience Council. The venue in Brisbane is a very large convention centre in the city centre. The Organising Committee is in place, and a professional conference organizer has been hired to take care of the Congress matters. Promotion is ramping up, including a symposium on Oceania and a video show (featuring by the Australian Prime Minister) to be shown at the closing ceremony of the 33rd IGC. Geosciences Australia, as well as the New Zealand and Australian State Geological Surveys are also supporting the event.

#### SELECTION OF THE VENUE OF THE 35th IGC IN 2016 (*Chair: President of the IGC Committee*)

The three bidding countries were India (August, Hyderabad); Morocco (March-April, Marrakech) and South Africa (August, Cape Town). Arne Bjørlykke outlined the agenda, beginning with the ratification of scrutineers (Colin Simpson, Ester Szein and David Huntley). Each host candidate was then invited to present their bid (20 minutes each) and answer questions from the floor.

The South African delegation presented first. Questions arising concerned the cost of accommodation from Japanese delegates: hotel costs expected to range from 700-1000 Rand. Norwegian delegates asked about the convention centre: it was noteworthy that the proposed venue was very large and could be sub-divided. Also, hotels surrounding the convention centre have the capability to hold sessions.

Morocco followed. Questions from the floor concerned whether the size of the venue could accommodate the scale of the congress: amphitheatres and meeting rooms were expected to accommodate up to 4000.

India (and SE Asia) concluded the 3 presentations. The Japanese delegation asked whether Visas would be an issue and about access to money: neither was seen to be a problem. Registration was expected to be around €600, including lunches. The Norwegian delegates noted that the convention centre was 10-15 km from the hotels and wondered about access.

Before voting proceeded, there was general discussion on Statutes, the rotation system and global aims of IGCs. Criteria and guidelines must be considered in a bid. Arne Bjørlykke noted that a site inspection was useful before a decision is made, and if the new Statutes and Byelaws are eventually accepted, then the IUGS-IGC covers the expense and not the hosting country.





Sospeter Muhongo stressed that the rotation system was vital: Europe has hosted the last two; and that Africa is ready to host. Sylvi Haldorsen asked whether there was any consideration of collaboration between the two African bids (i.e., a pan-African IGC), and wondered how soft-rock geology is to be accommodated in the African bids.

It was emphasized that in the voting process, each delegation was to vote according to its Category of Membership in IUGS (except Inactive and Non-Members who were entitled to one vote per delegation).

#### Round 1 Vote

Total votes = 199; Morocco = 52; India = 56; South Africa = 91; no abstaining votes

#### Round 2 Vote

Total votes = 198; India = 72; South Africa = 115; Abstain = 10; Spoiled = 1

**Cape Town, South Africa was selected as the venue for the 35<sup>th</sup> IGC in 2016.**

The Ambassador of South Africa made a short speech accepting the approved nomination and congratulating the unsuccessful bidding countries on their efforts.

### **STATUTES AND BYE LAWS (*Chair: President of the IGCC and President of the IUGS*)**

Eldridge Moores and Arne Bjørlykke (President, 33<sup>rd</sup> IGC) began by recounting a brief history of the streamlining of the Statutes and Byelaws. The Task Group came up with a draft for the Punta Arenas EC meeting following the request by the IGCC to separate documents for the IGC and IUGS. Two separate documents were presented and approved in principle at the Nara EC meeting.

Attilio Boriani explained why he was against the merger of the two Statutes. In Florence the IGC Council decided to ask an *ad hoc* task group to streamline the IGC Statutes after the changes approved in Florence, not to merge the two Statutes. During the IGC Committee meeting held in Oslo in 2006 a proposal of merging the two Statutes was rejected and it was decided that the two Statutes should remain separate. The merger of the Statutes would imply the loss of independence of the IGC, a much older organization strictly related to IUGS, but with its own specific aims and traditions.

All the revised documents by the Statutes and Byelaws Task Group, together with proposed modifications by Council or members of the IUGS EC, were submitted to Council in a timely manner before June. The revised document was presented to Council for approval.

After considerable discussion led primarily by Gian Battista Vai (Italy), Edmund Nickless (United Kingdom) and others on the details, a motion to accept the revised and merged streamlined Statutes and Byelaws was tabled. To pass, a clear two thirds majority as per existing Statutes and Byelaws from Council was required.

### Motion to accept revised and merged streamlined Statutes and Byelaws

Total votes = 192; Yes = 111; No = 72; Abstain = 9

### **Motion rejected**

Council clearly instructed that the IUGS EC and the IGCC to work on revising the two separate Statute and Bylaw documents over the next four years and to present these revisions at the next Council Meeting in Brisbane, 2012.

### **OTHER BUSINESS (*Chair: IUGS Secretary General*)**

Tajikistan was ratified by Council to become an Adhering Organization, bringing the total number to 120 members. On the topic of *Episodes*, Peter Bobrowsky noted that after 12 years, the MoU with China is coming to an end, and that offers to take over the running of the journal were invited and two positive replies have come from the USA and GSI. Council members stressed the transition of *Episodes* should be an EC high priority.

Edmund Nickless (United Kingdom), Arne Bjørlykke (Norway) and others encouraged the EC to bring forward as an immediate priority a recommendation to see revised drafts of the Statutes and Byelaws for both the IUGS and the IGC, discuss changes on advisement, and approval by electronic voting.

Representatives from Greece suggested forming a Commission on Minerals; names and emails of interested parties to be sent to the Secretary General. Jean-Paul Cadet (France) saw Marine Geology as a niche yet to be properly realized in IUGS as a Commission.

### **CLOSING OF THE MEETING (*Chair: IUGS Outgoing President*)**

Eldridge Moores introduced Zhang Hongren as the representative of the outgoing EC. Zhang thanked all for support over the last four years and wished the new EC well before closing the 2<sup>nd</sup> Ordinary Session of the Joint Council of IGC and IUGS.



## MEETINGS OF THE INTERNATIONAL GEOLOGICAL CONGRESS COMMITTEE (IGCC)

Two IGC committee meetings were held during the congress. Meeting 2008-1 with the outgoing committee was held on 5 August, the day before the official opening of 33IGC, and the second meeting, 2008-2, with the incoming committee was held on 13 August. The final and approved (by all committee members) minutes from both meetings follow below. Both minutes were written and sent to all committee members on 11 September 2008 and, after comments by the members, finalised on 13 November 2008.

### IGCC MEETING 2008-1 (Oslo, Norway. 5 August 2008)

#### MINUTES

##### Present:

Zhang Hongren (ZH) President IUGS  
 Attilio Boriani (AB) President 32<sup>nd</sup> IGC  
 Arne Bjørlykke (ABj) President 33<sup>rd</sup> IGC  
 Anders Solheim (AS) Secretary General 33<sup>rd</sup> IGC  
 Peter Bobrowsky (PB) Secretary General IUGS  
 Antonio Brambati (Abr) Treasurer IUGS  
 Ernesto Abbate (EA) Secretary General 32<sup>nd</sup> IGC  
 Carlos Oiti Berbert (COB) Secretary General 31<sup>st</sup> IGC  
 Paul Kay (PK) Observer from the 34<sup>th</sup> IGC local organising committee, Australia  
 Neil Williams (NW) Observer from the 34<sup>th</sup> IGC local organising committee, Australia  
 Ian Lambert (IL) Observer from the 34<sup>th</sup> IGC local organising committee, Australia

##### Agenda

1. Approval of the Agenda
2. Communications
3. IGC-related matters in the agenda of the IGC-IUGS Council meetings
4. Regional rotating system for future IGCs
5. Submission to the Council of the streamlined version of the IGC statutes
6. Last update on the present 33<sup>rd</sup> IGC, 6-14 August, 2008.
7. Status of planning of the 34<sup>th</sup> IGC
8. Short presentation of bids for future venues (35<sup>th</sup> IGC):
  - 8.1. Morocco
  - 8.2. South Africa
  - 8.3. India.
11. Other business

##### 1. Approval of the Agenda

ABj suggested discussing the IGCC report to the Council to give the IGCC a chance to comment on it before it is presented to the Council.

*The agenda was then approved.*

##### 2. Communications

All have received bidding documents from India and South Africa, but not yet from Morocco.

ABj informed about a change in the starting time of the plenary session on “Global Geology” from 16.00 to 15.30, due to security reasons related to the presence of the King of Norway at the opening ceremony.

##### 3. IGC-related matters in the agenda of the IGC-IUGS Council meetings

The IGC-related agenda items 9, 10 and 11 in the Council agenda will be chaired by ABj, and the committee agreed that these should be postponed to the 2<sup>nd</sup> Council meeting on 10 August.

ABj had comments to the order of business for the council meeting. He would like to have all elections at the end of the Council meeting. The suggestion is to finish the debate and decision of the statutes before the elections. If a merger between IUGS and IGC is done, then the leaders of IUGS will also be the leaders of IGC. However, a change in the order



of business will have to be decided by the Council during its first meeting, and the suggestion has to come from one of the national delegations.

#### 4. Regional rotating system (RRS) for future IGCs

COB reported on the rotating system subcommittee and showed a presentation of the results of the subcommittee's work. The RRS was initiated in Rio 2000, and is found in the statutes, 5.2.2. 4 regions were initially defined:

1. North, South, and Central America
2. Africa and the Middle East
3. Australasia and Central Asia (including former Soviet republics)
4. Eastern and Western Europe

The subcommittee was set up after the IGCC meeting in Oslo, April 2006, to draft a system for rotations, and COB went through the rules governing the RRS and a set of proposed new guidelines:

Using region and population, the subcommittee suggested 9 regions:

1. North and Central America
2. South America
3. Europe
4. Western Asia
5. Middle Asia
6. Eastern Asia
7. Oceania
8. Northern, Saharan Africa
9. Sub-Saharan Africa

Other requirements for choosing a region were suggested to comprise:

- Capacity of the country or countries to host an IGC and the governmental support
- Adequate infrastructure and safety
- Cooperation with and capacity of other nations in the region
- Presentation of a main geoscientific problem of relevance to Earth as the main theme of the Congress.

COB handed out a note describing the sub-committee's suggestions in more detail.

During the 32<sup>nd</sup> IGC in Florence it was suggested that Africa should host the Congress in 2016, but the committee still intends that the Council should vote for this, and thus also consider the above-mentioned criteria.

With as many as 9 regions (rather than only 4) one could preference 2-4 regions and let them compete between them regarding the other criteria. This would follow the idea that the regional rotation is the main criterion, but that the other criteria must also be fulfilled.

For the Council meeting, the committee agreed that COB should start agenda point 11 (selection of the venue for 35IGC) by presenting the set of guidelines for the council delegates to keep in mind when they vote.

#### 5. Submission to the Council of the streamlined version of the IGC statutes

The IGCC meeting in Paris, November 2007 decided that the Council should vote for the change of statutes proposed by the statutes committee (Alt. 2 of the Paris meeting final minutes).

The Committee had a short discussion on whether the proposed change is a “radical change” or a “streamlining” of the statutes, and the chairman of the statutes committee, ABj, agreed that the statutes committee may have gone a bit further than the exact mandate given to the committee, but maintained that the proposed change is a better one.

The decision on the new statutes was now in principle “lifted” to the Council's decision through voting, and the IGCC did not take the discussion further.

#### 6. Last update on the present 33<sup>rd</sup> IGC, 6-14 August, 2008

AS gave a short update on the status of the Congress, which was just about to be formally opened. The preparations were carried through and most details were now under control. All technical facilities had been tested and the registration as well as the IT and AV solutions seemed to function in accordance with expectations. The economy is in balance, after a long and hard job to secure sufficient external sponsorship.

AS also briefly went through and handed out the report from the IGCC to the Council. A brief report on the 33IGC status



is part of this report.

The IGCC complimented the 33IGC LOC on the preparations.

#### 7. Status of planning of the 34<sup>th</sup> IGC

IL reported on behalf of the 34IGC LOC that a PCO is now contracted for the event, and that the LOC is now approaching industry for sponsorship. The venue is conveniently located in the centre of Brisbane and is world class in its meeting facilities, catering, etc.

Regarding the Geohost Programme, the Australian aid agency thought to be the main Geohost sponsor mainly focuses on countries in Oceania. This may be a problem regarding other parts of the world, but the 34IGC LOC is looking into ways of solving this, and has started exploring different possibilities for external funding to also support candidates from other continents.

They are also now working toward other associations to combine meetings and avoiding competition. IL also reported that 34<sup>th</sup> IGC plan to follow up the “Themes of the Day” from the 33<sup>rd</sup> IGC.

#### 8. Short presentation of bids for future venues (35IGC):

8.1. Morocco, with support from neighbouring countries.

The bidding documents from Morocco were distributed before the presentation.

8.2. South Africa, with support from neighbouring countries.

The presenting group represented all the bidding countries, and the S. African Ambassador in Norway was present.

8.3. India, with support from neighbouring countries.

The Indian ambassador to Norway was present and opened the Indian presentation.

All three groups gave excellent presentations of their bids. It was noted that the Indian presentation was the only one which did not exceed the time given to them. The IGCC asked question to all the bidders regarding criteria mentioned above, such as the capacity of the venue, the support from government(s), security issues, climatic conditions, hotels and catering, the Geohost Programme, etc.

The questions were responded adequately to by the representatives of the bidding countries, and the IGCC agreed that all three bids were clearly of sufficient quality to be voted for by the Council meeting.

After the round of presentations, the IGCC discussed how to proceed to the Council. PB proposed a type of ballots in which the first three options are the three bidders, and where the term “abstain” is the fourth option. The council members may only choose one of the four options. Unless one bidder gets more than 50% of the votes a second vote between the two with the most votes in the first round is needed. The committee decided to follow PB’s suggestion for ballots.

The committee also discussed whether it should provide recommendations to the Council or not, but agreed that only some of the benefits of the different bids should be pointed out. The Council should also be reminded of the criteria to base the voting on, as discussed in agenda item 4 (above).

#### 11. Other business

ABj suggested that when a country is awarded the Congress 8 years in advance, they should be asked to reconfirm the bid after 4 years to check that they are really following up the promises given. This should be followed up with a site visit. In worst case the award of the Congress may be withdrawn and offered to another bidder.

The new IGCC chairman ABj acknowledged Attilio Boriani’s years of good and dedicated work for the committee, as Boriani now steps down as chairman of IGCC.





## IGC COMMITTEE (IGCC) MEETING 2008-2 (Oslo, Norway. 13 August 2008)

### MINUTES

#### Present:

Arne Bjørlykke (ABj) Incoming IGCC Co-chair, President 33<sup>rd</sup> IGC  
 Anders Solheim (AS) Ongoing IGCC member, Secretary General 33<sup>rd</sup> IGC  
 Peter Bobrowsky (PB) Ongoing IGCC member, Secretary General IUGS  
 Ernesto Abbate (EA) Ongoing IGCC member, Secretary General 32<sup>nd</sup> IGC  
 Neil Williams (NW) Incoming IGCC member, President 34<sup>th</sup> IGC, Australia  
 Ian Lambert (IL) Incoming IGCC Secretary General, Secretary General 34<sup>th</sup> IGC, Australia  
 Attilio Boriani (AB) Outgoing IGCC Co-chair, President 32<sup>nd</sup> IGC  
 Zhang Hongren (ZH) Outgoing IGCC Co-chair, Past President IUGS  
 Paul Kay (PK) Observer from the 34<sup>th</sup> IGC local organising committee, Australia

#### Observers from the newly selected 35<sup>th</sup> IGC:

Susan Frost-Killian, S. African IUGS National Committee Chair  
 Sharad Master, S. African IUGS National Committee  
 Geoffrey Grantham, S. African IUGS National Committee  
 Wayne Colliston, S. African IUGS National Committee  
 Frik Hartzler, Council for Geoscience, S. Africa  
 Nthombikayise Q. Mdlulijacha, Council for Geoscience, S. Africa  
 Martin Lekotoko, Council for Geoscience, S. Africa  
 Lebogang Nhleko, IUGS observer, S. Africa  
 Gabi Schneider, Namibian IUGS National Committee Chair

#### Apologies:

Alberto Ricardi, Incoming IGCC Co-chair, President IUGS  
 William Cavazza, Incoming IGCC member, Treasurer IUGS  
 Carlos Oiti Berbert (COB) Ongoing IGCC member, Secretary General 31<sup>st</sup> IGC  
 Antonio Brambati (ABr) Outgoing IGCC member, Past Treasurer IUGS

#### Agenda:

1. Presentation of the new IGCC and other persons present at the meeting
2. Site visits to Australia and to S. Africa
3. Comments regarding the results of the Council's vote on the statutes and byelaws
4. The 33IGC closing ceremony
5. AOB

#### 1. Presentation of the new IGCC and other persons present at the meeting

The new IGCC Co-chair ABj chaired the meeting, which was quite brief. EA and AB clarified the composition of 2008-2012 IGCC and the functions of the committee members:

Arne Bjørlykke (Co-chair)  
 Alberto Ricardi (Co-chair)  
 Peter Bobrowsky  
 William Cavazza  
 Ian Lambert (Secretary General)  
 Neil Williams  
 Ernesto Abbate  
 Carlos Oiti Berbert  
 Anders Solheim

#### 2. Site visits to Australia and to S. Africa

##### *Australia*

ABj suggested having the site visit to Australia at the same time as the EC meeting in January 2009, to minimise the amount of travelling. However, IL suggested having the meeting in 2010, as originally planned, for a number of reasons:

- This would be a mid-term meeting of the IGCC in line with previous practice, when the LOC would have made significant progress and would benefit from the opportunity to receive advice from the IGCC;



- January is not a good time to visit Brisbane, as it can be uncomfortably hot and humid. For this reason the 2009 IUGS EC meeting is to be held in Sydney and a site visit linked to this would entail significant extra planning and cost. Further, January is summer holidays, and many people are away.

It was agreed that the site visit be held in Brisbane in 2010, sometime between April and September when weather is normally very pleasant. Representatives of the Australian Organising Committee will try to meet with the Norwegian Organising Committee as soon as possible for exchange of information on the organisation details (addresses, software, etc.) on the next occasion of travel to Europe.

#### *South Africa*

ABj suggested a site visit to S. Africa in 2011, and also to combine this meeting with an IUGS EC meeting. The exact timing for such a visit/meeting is to be discussed further, but some time in the period May-September 2011 is possible. It was also discussed whether another meeting could be held at a place and time of opportunity. This could take place during normal travels or international conferences. It was therefore agreed to keep each other informed about major travel plans of members of the S. African LOC and the IGCC, respectively.

#### 3. Comments regarding the results of the Council's vote on the statutes and byelaws

Since the Council voted against the revised statutes and byelaws, as proposed by the Statutes Committee, the discussion has to continue. Some of the actions from 32IGC in Florence therefore remain unperformed, and the discussions will have to proceed for the next 4 years, until the 34<sup>th</sup> IGC in Australia. The IGCC and IUGS will need to agree on the process for developing the streamlined Statutes.

#### 4. The 33IGC Closing Ceremony

ABj and AS went through the programme for the Closing Ceremony, and S. Africa will be given time (2-3 minutes) for a brief statement and a "welcome to S. Africa 2016".



## PARTICIPANTS OF THE 2<sup>ND</sup> IUGS-IGC JOINT COUNCIL

### ***IUGS Executive Members:***

Zhang Hongren (Pres.), Peter Bobrowsky (Sec. Gen.), Antonio Brambati (Treas.),  
Sylvi Haldorsen and Eldridge M. Moores (Vice Pres.), Ryo Matsumoto, Gabi Schneider,  
Mikhail A. Fedonkin and Marta Mantovani (Councillors)

### ***IGC Officers:***

Arne Bjorlykke (33rd IGC Pres.), Anders Solheim (33rd IGC Sec. Gen.), Attilio C. Boriani (32nd IGC Pres.), Ernesto Abbate, 32nd IGC Sec. Gen.), Carlos Oiti Berbert, 31st IGC Pres., Neil Williams (34th IGC Pres.), Ian Lambert (34th IGC Sec. Gen.)

### ***IUGS Executive Committee Nominees:***

William Cavazza, Jacques Charvet, Gerel Ochir, Ezzoura Errami, Wesley Hill, Colin Simpson, Alberto C. Riccardi, Sadrack Felix Toteu

### ***Representatives from IUGS adhering organisations (and category)***

#### **Argentina (3)**

Eduardo Zappettini

#### **Australia (6)**

Neil Williams  
Ian Lambert  
David Mason  
Philip O'Brien  
Mr Paul Kay  
Richard Blewett

#### **Austria (3)**

Werner E. Piller  
Hans Georg Krenmayr  
Hans Peter Schönlaub

#### **Bangladesh (1)**

Afia Akhtar

#### **Botswana (2)**

Felix Toteu

#### **Brazil (4)**

Maria Glicia da N. Coutinho  
Carlos Schobbenhaus Filho  
Marta Mantovani

#### **Cameroon (1)**

Sospeter Muhongo

#### **Canada (6)**

Marc Diorio  
John Clague  
Jim Teller  
David Liverman  
John Broome  
Maurice Colpron

#### **Chile (1)**

Paula Cornejo

#### **China (7)**

Zhijian Li  
Fengzeng Yan  
Xiyuan Cai  
Hongtao Zhang  
Shuwen Dong  
Ganguo Wu  
Shaoping Zhou

#### **Congo DR (1)**

Joseph Kokonyangi

#### **Cote d'Ivoire (1)**

Victor Nda Loukou

#### **Croatia (2)**

Mladen Juracic

#### **Czech Republic (3)**

Vladislav Babuska  
Zuzana Krejci

#### **Denmark (4)**

Erik Nygaard

#### **Egypt (2)**

Hasssan Helmy  
(*replacing Baber Kaliouby*)

#### **Estonia (2)**

Täht Krista  
Mall Orru

#### **Finland (3)**

Elias Ekdahl  
Juha Karhu  
Sinikka Roos  
(*Kai Nenonen on 10th*)

#### **France (7)**

Denis Vaslet  
Jean Dercourt  
Alain Blicck  
Jacques Charvet  
Patrick Weaver  
Alain-Yves Huc  
Dominique Janjou



**Gambia (1)**

Sospeter Muhongo

**Germany (7)**

Alan B. Woodland

Bettina Reichenbacher

Hans-Joachim Kuempel

**Greece (2)**

Nikolas Avantidis

**Hungary (3)**

Tamás Weiszbürg

**Iceland (1)**

Kristinn J Albertsson

**India (5)**

Ashok Kumar Singhvi

Vijay Prasad Dimri

Rajender Kumar Chadha

Harsh Gupta

Arun Kumar

*Om Prakash Pandey (alternate)***Iran (3)**

Abdolazim Haghipour

*(replacing Mohamed Reza Ghassen)*

Hamid Nazari

Seyed Hadi Mirmohammad Meyguni

**Ireland (4)**

Peadar McArdle

**Israel (2)**

Zvi Ben-Avraham

**Italy (7)**

Gian Battista Vai

Giuseppe Cavarretta

William Cavazza

Forese Carlo Wezel

Gian Gaspare Zuffa

Luca Demicheli *(replacing L. Serva)***Japan (8)**

Yasuji Saito

Ryo Matsumoto

Yujiro Ogawa

Eikichi Tsukuda

Niichi Nishiwaki

Hiroshi Kitazato

Koji Okumura

Hirokazu Kato

**Kazakhstan (3)**

Ginayat Bekzhanov

Bulat Uzhkenov

Zaure Bekmukhametova

**Kenya (1)**

Lojomon Kipsang Biwott

**Lebanon (1)**

Mustapha Mroueh

**Lithuania (1)**

Petras Sinkunas

**Malaysia (1)**

Yunus Abdul Razak

**Mongolia (1)**

Gerel Ochir

**Morocco (2)**

Abdelaziz Charik

Abdellah Mouttaqi

**Mozambique (1)**

Felix Toteu

*(approved by Elias Xavier Felix Daudi)***Namibia (1)**

Gabi Schneider

**New Zealand (3)**

Ian Graham

Mark Rattenbury

Desmond Darby *(repl. Alex Malaboff)***Norway (3)**

Anders Elverhøi

Richard Sinding-Larsen

Tore Vorren

**Pakistan (1)**

Zulfiqar Ahmed

**Poland (2)**

Andrzej Zelazniewicz

Wlaszczyk Ireneusz

**Portugal (2)**

Eduardo Ferreira Da Silva

**Romania (3)**

Mircea Ioan Sandulescu

Victor Mocanu

Crisan Demetrescu

**Russia (8)**

Nikolay Laverov

Mikhail Fedonkin

Alexander Gliko

Nikolay Bortnikov

Robert Nigmatulin

Victor Osipov

Vladimer Pavlenko

Julius Zetzer

**Serbia, Rep. of (1)**

Aleksandra Maran

*(replaced on 10.08 by  
Dragan Milovanovic)***Slovakia (2)**

Dusan Plasienka

**South Africa (4)**

Sharad Master

Susan Frost Killian

Geoff Grantham

Wayne Colliston





**Spain (4)**

José Pedro Calvo-Sorando  
Carmen Antón-Pacheco Bravo  
Antoni Roca-Adrover  
Cecilio Quesada-Ochoa

**Sweden (3)**

Lars Persson  
Olle Selinus  
Pär Weihed  
(*David Gee, repl. 10<sup>th</sup> only*)

**Switzerland (4)**

Karl Föllmi

**Taipei, China (3)**

Sheng-Rong Song

**Tanzania (1)**

Sospeter Mohongo  
(rep. Pascal Dr. Semkiwa)

**Thailand (1)**

Apichai Chvajarernpun  
(plus two observers)

**Turkey (3)**

Orhan Tatar  
A.M.Celal Sengor

**Ukraine (3)**

Mykola A. Yakymchuk  
Aleksander A. Kitchka  
Oleksandr Lukin

**United Kingdom (8)**

Edmund Nickless  
Richard Fortey  
Peter Styles

**United States (8)**

Farouk El-Baz  
Rich Calnan  
Jonathan Fink  
Priscilla Grew  
Grant Heiken  
Suzette Kimball  
Patrick Leahy  
Eldridge Moores

**Uzbekistan (2)**

Narimon Mavlyanov  
Otabek Yuldashev

**Vietnam (1)**

Nguyen Thanh Van

**Yemen (1)**

Ismail N. Al-Ganad

**INACTIVE MEMBERS AND  
APPLYING COUNTRIES****Colombia (1)**

Jorge Gomez

**Iraq (1)**

Saffa Fouad  
(*replacing Sarmad Mahmood*)

**Kosovo (1)**

Gani Maliqi

**Tajikistan (1)**

Azim Ibrohim

**Observers*****Representatives from IUGS Affiliated Organisations:***

Jerry Brown, International Permafrost Association  
Richard Calnan, Circum-Pacific Council  
Nicola Casagli, International Consortium on Landslides  
Hee-Young Chun, CCOP  
Ezzoura Errami, Association of African Women Geoscientists  
Saverio Fiore, Association Internationale Pour l'Etude des Argiles  
Monique Fort, International Association of Geomorphologists  
John W. Hess, Geological Society of America  
Wesley Hill, Geological Society of America (and COGE)  
Ole Humlum, International Permafrost Association  
Chan-Jong Kim, International Geoscience Education Organisation  
Kari Kojonen, International Mineralogical Association  
Shrikant Limaye, Association of Geoscientists for International Development  
Stephen Ragone, National Ground Water Association  
Phillipe Rossi, Commission for the Geological Map of the World  
Wilhelm Struckmeier, International Association of Hydrogeologists  
Neil Williams, Society of Economic Geologists, Inc.  
R Shankar, Geological Society of India



***IUGS Commission and Task Group Representatives:***

Kristine Asch, Commission on the Management & Application of Geoscience Info.  
Barry Cooper, International Commission on the History of Geological Sciences  
Ian Jackson, Commission on the Management & Application of Geoscience Info.  
Joy Pereira, Geoscience for Environmental Management  
Hermann Lebit, Task Group on Tectonics and Structural Geology

***Geounion Representatives:***

Tom Beer, International Union of Geodesy and Geophysics  
Allan Chivas, International Union for Quaternary Research  
Tom de Beer, International Union of Geodesy and Geophysics  
Ian Downman, International Society for Photogrammetry and Remote Sensing  
Alik Ismail-Zadeh, International Union of Geodesy and Geophysics

***Representatives from other IUGS Partners:***

Thomas Rosswall, International Council for Science  
Tim Badman, International Union for Conservation of Nature  
Stuart Marsh, IUGS/UNESCO Program on Geological Application of Remote Sensing  
Robert Missotten, UNESCO  
Wolfgang Eder, International Year of Planet Earth  
Nickolas Zouros, European Geopark Networks

***General Observers***

Moutaz Al-Dabbas, IYPE NC for Iraq  
Orhan Altan, International Society for Photogrammetry and Remote Sensing  
Mahfood Ali Ba-Bttat, Kuwait University  
Murat Bekzhanov, The Kazak Geological Society  
Niran Chaimanee, CCOP  
Pol Chaodumrong, Department of Mineral Resources, Thailand  
Marthinus Cloete, Geoscience Council for South Africa  
Ismael Cooradia, South Africa's Ambassador to Norway  
Frik Hartzler, Geoscience Council for South Africa  
Allah Kausar, Geological Survey of Pakistan  
Gudmund Løvø, NGU Communications  
Abdourahamane Konare, University of Ggdy (Abidjan)  
Aberra Mogessie, University of Graz (Vienna)  
Hamide Muhammadi, Geological Survey of Iran  
Jacqueline Numbem Tchakounte, University of Yaounde  
Nhtombikayise Mdluli Jacha, South African Bid Delegation  
Martin Lekotoko, South African Bid Delegation  
Phuti Ngoepe, South African Bid Delegation  
Hong Minh Nguyen, Coastal Committee for Offshore and Geoscience in East and South East Asia  
Lebogang Nhleko, South African Committee for IUGS and IGCP  
Emmanuel Njonfang, Ecole Normale Supérieure (Cameroon)  
Ratanajaruraks Phitaks, Department of Mineral Resources, Thailand  
Thibedi Ramontja, South African Bid Delegation  
Gerhard Von Gruenewaldt, South African Bid Delegation  
Ester Sztein, The National Academies (USA)  
Per Wessel, NECE, Norway  
Peter Zawada, South African Bid Delegation

***Secretariat:***

Rognvald Boyd, Elena Dantec, David Huntley, Anne Liinamaa-Dehls, and Ioanna Proptosali.



## BUSINESS MEETINGS OF THE IUGS, AFFILIATED BODIES AND OTHER SCIENTIFIC ORGANISATIONS

### International Year of Planet Earth (IYPE)

#### **BM-03 Meeting of the IYPE Board**

7 August, 09.00-17.00, Contact: Ed De Mulder (e.demulder@planet.nl)

#### **BM-04 Meeting of the SIT leaders**

9 August, 09.00-18.00, Contact: Ed De Mulder (e.demulder@planet.nl)

#### **BM-05 Meeting of the Outreach Programme Committee**

9 August, 09.00-12.00, Contact: Ed De Mulder (e.demulder@planet.nl)

#### **BM-06 Meeting of the IYPE National Committees**

9 August, 13.00-16.00, Contact: Ed De Mulder (e.demulder@planet.nl)

### Commission for the Geological Map of the World (CGMW)

#### **BM-07 Bureau meeting**

7 August, 09.30-17.30, Contact: Philippe Rossi (ccgm@club-internet.fr)

#### **BM-08 General Assembly**

9 August, 12.30-21.00, Contact: Philippe Rossi (ccgm@club-internet.fr)

#### **BM-66 Meeting for the World Gravity Mapping Program**

8 August, 18.00-20.30, Contact: Philippe Rossi (ccgm@club-internet.fr)

### International Commission on Stratigraphy (ICS)

#### **BM-09 General business meeting**

7 August, 17.30-18.30, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-10 Subcommission on Quaternary**

6 August, 18.30-19.30, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-11 Subcommission on Jurassic and Subcommission on Cretaceous**

6 August, 17.30-20.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-12 Subcommission on Cambrian and Subcommission on Ordovician**

6 August, 17.30-20.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-13 Subcommission on Neogene and Subcommission on Paleogene**

6 August, 17.30-20.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-15 Subcommission on Triassic**

8 August, 17.30-19.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-16 Subcommission on Silurian and Subcommission on Devonian**

8 August, 17.30-20.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-17 Subcommission on Carboniferous and Subcommission on Permian**

8 August, 17.30-20.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-18 Subcommission on Precambrian and Subcommission on Cryogenian-Ediacaran**

8 August, 17.30-20.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

#### **BM-19 Open meeting on Redefinition of the Quaternary and Pleistocene: Open Discussion**

9 August, 17.30-20.00, Contact: Stan Finney (scfinney@csulb.edu)



**BM-59 Subcommittee on Stratigraphic Classification (ISSC business meeting)**

10 August, 18.00-20.30, Contact: Maria Bianca Cita (maria.cita@unimi.it)

**International Union of Geological Sciences (IUGS)**

**BM-21 IUGS Executive Committee**

4 August, 09.00-17.00, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**BM-22 1<sup>st</sup> IGC Committee (Outgoing) Meeting**

5 August, 14.00-17.00, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**BM-23 59<sup>th</sup> IUGS Executive Committee (Outgoing) Meeting**

5 August, 09.00-13.00, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**BM-24 2<sup>nd</sup> IUGS-IGC Council Meeting (Registration starts at 08.30)**

6 August, 10.00-14.00 and 14.00-17.00, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**BM-79 2<sup>nd</sup> Informal Meeting of incoming and outgoing Executive Committee**

6 August, 17.00-17.30, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**BM-26 IUGS Executive Committee Meeting with Affiliated Organisations**

8 August, 16.30-18.00, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**BM-28 2<sup>nd</sup> IUGS-IGC Council Meeting continued**

10 August, 10.00-18.00, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**BM-32 2<sup>nd</sup> IGC Committee (Incoming) Meeting**

13 August, 16.00-17.30, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**BM-36 Committee (Incoming) Meeting**

13 August, 09.00-12.00, Contact: Anne Dehls (IUGS.Secretariat@ngu.no)

**The International Association on the Genesis of Ore Deposits (IAGOD):**

**BM-37 IAGOD council meeting**

9 August, 14.30-16.30, Contact: Nigel Cook (n.j.cook@nhm.uio.no)

**BM-38 IAGOD General Assembly**

9 August, 16.30-18.30, Contact: Nigel Cook (n.j.cook@nhm.uio.no)

**BM-39 Northern Europe Geochemistry Project (NEG) steering committee**

10 August, 09.00-10.30, Contact: Pasi Eilu (pasi.eilu@gtk.fi)

**BM-40 Fennoscandian Ore Deposit Database project (FODD) steering committee**

10 August, 10.30-12.00, Contact: Pasi Eilu (pasi.eilu@gtk.fi)

**BM-41 IGCP Project 510 (A-type Granites and Related Rocks through time)**

8 August, 18.00-20.00, Contact: Tapani Rämö (tapani.ramo@helsinki.fi)

**OneGeology**

**BM-43 Launching of the OneGeology portal**

7 August, 11.00-14.00, Contact: Jenny Forster (jforster@bgs.ac.uk)

**BM-69 OneGeology session**

6 August, 16.30-17.00, Contact: Jenny Forster (jforster@bgs.ac.uk)

**BM-44 Technical group meeting**

6 August, 08.00-14.00, Contact: Jenny Forster (forster@bgs.ac.uk)





**BM-45 Press conference**

6 August, 08.30-16.00, Contact: Jenny Forster (jforster@bgs.ac.uk)

**BM-46 Steering group meeting**

12 August, 13.00-20.00, Contact: Jenny Forster (jforster@bgs.ac.uk)

**BM-47 Management group meeting**

13 August, 14.00-18.00, Contact: Jenny Forster (jforster@bgs.ac.uk)

**International Association for Mathematical Geology (IAMG)**

**BM-48 General Assembly**

9 August, 16.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

**BM-49 Krumbein Medal and John Cedric Griffiths Teaching Award**

11 August, 18.00-20.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

**BM-50 George Matheron lecture**

7 August, 18.00-19.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

**BM-51 Council meeting**

8 August, 12.00-13.30, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

**BM-52 Editorial board meeting: Mathematical Geosciences (formerly Mathematical Geology)**

6 August, 12.00-13.30, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

**BM-53 Editorial board meeting: Computers & Geosciences**

7 August, 12.00-13.30, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

**BM-54 Editorial board meeting: Natural Resources Research**

11 August, 12.00-13.30, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

**BM-55 Publications Committee**

7 August, 19.00-20.00, Contact: Felix Gradstein f.m.gradstein@nhm.uio.no

**BM-56 Student Affairs Committee**

6 August, 19.00-20.00, Contact: Felix Gradstein (f.m.gradstein@nhm.uio.no)

**International Lithosphere Program (ILP):**

**BM-61 Bureau meeting**

8 August, 18.00-20.00, Contacts: Sierd Cloetingh (sierd.cloetingh@falw.vu.nl), Jörg Negendank (neg@gfz-potsdam.de)

**BM-62 Author meeting (Springer book)**

9 August, 18.00-20.00, Contacts: Sierd Cloetingh (sierd.cloetingh@falw.vu.nl), Jörg Negendank (neg@gfz-potsdam.de)

**BM-63 Task Force IV members meeting**

7 August, 18.00-19.00, Contact: Larissa Dobrzhinetskaya (larissa@ucr.edu)

**Other business meetings:**

**BM-01 International Medical Geology Association, IMGA**

12 August, 18.00-20.00, Contact: Olle Selinus (olle.selinus@sgu.se)

**BM-20 AGID (Association of Geoscientists for International Development)**

12 August, 18.00-20.00, Contact: Shrikant D Limaye (limaye@vsnl.com)

**BM-42 ICOGS**

11 August, 12.00-14.00 and 15.00-18.00, 12 August, 10.00-14.00, Contact: Arne Bjørlykke (Arne.Bjorlykke@ngu.no)



**BM-57 Joint meeting: Italian Association “Geologia e Turismo”, “Geomorphosites” WG of the IAG, and European Geoparks of UNESCO**

8 August, 18.00-20.00, Contact: Mario Panizza (mario.panizza@unimore.it)

**BM-58 INHIGEO board meeting**

7 August, 18.00-20.00, Contact: Ken Bork (bork@denison.edu)

**BM-60 AAB-02 and AAN-02 social evening**

12 August, 19.00-22.00, Contact: Ross Powell (ross@geol.niu.edu)

**BM-64 International Mineralogical Association Commission on Ore Mineralogy**

10 August, 16.00-18.00, Contact: Nigel Cook (n.j.cook@nhm.uio.no)

**BM-65 Young Earth Scientists Congress 2009 - Meeting of the International Organising Committee**

10 August, 09.00-18.00, Contact: David Govoni (david.govoni@giovanigeologi.it)

**BM-67 Meeting for additional discussion GDP-01 (passive margin uplift)**

13 August, 18.00-20.00, Contact: Peter Japsen (pj@geus.dk)

**BM-70 International Association for GeoChemistry**

10 August, 14.30-17.30, Contact: Attila Demeny (demeny@geochem.hu)

**BM-71 Via Geoalpina Management Committee**

7 August, 13.00-17.30, Contact: Luca Demicheli (luca.demicheli@apat.it)

**BM-72 International Palaeontological Association (information meeting)**

10 August, 14.00-17.30, Contact: David A.T. Harper (Dharper@snm.ku.dk)

**BM-74 IGEO International Council Meeting**

13 August, 15.30-18.00, Contact: Chan-Jong Kim (chajokim@gmail.com)

**BM-75 SPBA Technical Meeting**

12 August, 12.00-15.00, Contact: Hans Doornenbal (hans.doornenbal@tno.nl)

**BM-77 IUGS/IAGC Task Group on Global Geochemical Baselines**

8 August, 14.00-17.00, Contact: David B. Smith (dsmith@usgs.gov)

**BM-78 CGI Council Meeting**

10 August, 08.30-18.00, Contact: Jennifer Forster (jforster@bgs.ac.uk)

**BM-80 GSL Editors' Reception (by invitation only)**

7 August, 17.30-20.00, Contact: Angharad Hills (angharad.hills@geolsoc.org.uk)

**BM-81 Introduction to ‘A Night at the Opera’**

8 August, 10.00-12.00, Contact: Asgeir Kndusen (asgeir@congrex.no)



## COMMITTEE REPORTS

### 33IGC CONGRESS COMMITTEES

#### The 33IGC Organising Committee

Arne Bjørlykke	President	Geological Survey of Norway
Anders Solheim	Secretary General	Norwegian Geotechnical Institute
Richard Sinding-Larsen	VP Int. Relations	Norwegian Univ. of Science and Technology
Finn Roar Aamodt	VP Finances	StatoilHydro ASA, Norway
David Gee	VP Science Programme	Uppsala University, Sweden
Øivind R. Lie	PCO Rep.	Congress-Conference AS, Norway
Ellen Ramberg	VP Operations	Ramberg Consulting AS, Norway
Berit Forbord Moen	VP Communication	Geological Survey of Norway
Martin Ghisler	VP for Denmark (until 2007)	Geological Survey of Denmark and Greenland
Johnny Fredericia	VP for Denmark (from 2007)	Geological Survey of Denmark and Greenland
Olle Selinus	VP for Sweden	Geological Survey of Sweden
Elias Ekdahl	VP for Finland	Geological Survey of Finland
Ólafur Ingólfsson	VP for Iceland (until 2007)	University of Reykjavik, Iceland
Kristinn J. Albertsson	VP for Iceland (from 2007)	Natturufraedistofnun Islands, Iceland

#### Special coordinators for the Organising Committee:

Björn Sundquist	Sci. Programme Coordinator	Uppsala University, Sweden
Asgeir Knudsen	Project Coordinator	Congress-Conference AS, Norway



*The 33IGC Organising Committee. From left to right: Aamodt, Fredericia, Moen, Solheim, Lie, Bjørlykke, Ekdahl, Albertsson, Ramberg, Gee (Sinding-Larsen and Selinus were not present). (Photo: Gudmund Løvø)*



## Nordic IGC Foundation Board

**Prof. Anders Elverhøi** (Chairman), University of Oslo, Norway  
**Dr. Lars Persson**, Geological Survey of Sweden, Sweden  
**Prof. Reijo Salminen**, Geological Survey of Finland, Finland  
**Prof. Finn Surlyk**, University of Copenhagen, Denmark  
**Dr. Helgi Torfason**, Icelandic Institute of Natural History, Iceland

## Science Committee

**Prof. David Gee** (Chairman), Uppsala University, Sweden  
**Dr. Harald Brekke**, Excursions, Norwegian Petroleum Directorate, Norway  
**Prof. David L. Bruton**, University of Oslo, Norway  
**Prof. Edward Derbyshire**, University of London, UK  
**Prof. Else Marie Friis**, Swedish Museum of Natural History, Sweden  
**Prof. Sveinn Jakobsson**, Icelandic Institute of Natural History, Iceland  
**Dr. Martin V. Heinesen**, Jarðfeingi, Faroe Islands  
**Dr. Suzanne Lacasse**, Norwegian Geotechnical Institute, Norway  
**Prof. Raimo Lahtinen**, Geological Survey of Finland, Finland  
**Prof. Martin Landrø**, Norwegian University of Science and Technology, Norway  
**Dr. Simon Passey**, Jarðfeingi, Faroe Islands  
**Prof. Kirsti Loukola-Ruskeeniemi**, Helsinki University of Technology, Finland  
**Prof. Ivar B. Ramberg**, Ramberg Consulting AS, Norway  
**Prof. Birger Schmitz**, Lund University, Sweden  
**Director Freysteinn Sigmundsson**, University of Iceland, Iceland  
**Prof. Haraldur Sigurðsson**, University of Rhode Island, USA  
**Dr. Anthony Spencer**, StatoilHydro, Norway  
**Dr. Björn Sundquist** (Science Programme Coordinator), Uppsala University, Sweden  
**Prof. Jörn Thiede**, Alfred-Wegener-Institute, Bremerhaven, Germany  
**Prof. Hans Thybo**, University of Copenhagen, Denmark  
**Prof. Pär Weihed**, Luleå University of Technology, Sweden

## Advisory Board

**Mr. Gunnar Berge** (Chairman), former Norwegian Minister of Finance, former Managing Director of the Norwegian Petroleum Directorate and Chair of the board of PETORO AS, Norway  
**Director Lars-Eric Aaro**, LKAB, Sweden  
**Director Jens Hagen**, StatoilHydro ASA, Norway  
**Vice President Lars Nydahl Jørgensen**, Mærsk Oil and Gas Ltd., Denmark  
**Prof. John Korstgård**, Aarhus University, Denmark  
**Rector Lauri Lajunen**, University of Oulu, Finland  
**Sir Mark Moody-Stuart**, Chairman Anglo American, UK

**Dr. Anatoly Ledovskikh**, Federal Subsurface Resources Agency, Moscow, Russian Federation  
**Director Pierre Heeroma**, Boliden AB, Finland and Sweden  
**Director Tim Dodson**, StatoilHydro ASA, Norway  
**Mr. Carl Sommerholt**, SKB, Sweden  
**Prof. Yuri Leonov**, Russian Academy of Sciences, Moscow, Russian Federation

## International Panel

**Prof. Jörn Thiede** (Chairman), Alfred-Wegener-Institute, Bremerhaven, Germany  
**Prof. José Achache**, Intergov. Group on Earth Observations (GEO)-Secretariat, Geneva, Switzerland  
**Prof. Enric Banda**, Catalan Foundation for Research and Innovation, Barcelona, Spain  
**Prof. Sierd Cloetingh**, Vrije Universiteit, Amsterdam, Netherlands  
**Prof. Umberto Cordani**, University of Sao Paulo, Sao Paulo, Brazil  
**Prof. Edward Derbyshire**, Royal Holloway University, London, UK  
**Prof. Rolf Emmerman**, Geo Research Centre (GFZ), Potsdam, Germany  
**Prof. Harsh K. Gupta**, National Geophysical Research Institute, Hyderabad, India  
**Prof. Zhang Hongren**, International Union of Geological Sciences, Beijing, China  
**Dr. Tim Killeen**, The National Centre for Atmospheric Research, Boulder, USA  
**Dir. John Ludden**, British Geological Survey, Nottingham, UK  
**Prof. Paul Marinos**, National Technical University of Athens, Athens, Greece  
**Dr. Brian Marker**, Independent consultant, London, UK  
**Prof. Judith McKenzie**, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland  
**Prof. Sospeter M. Muhongo**, Regional Office for Africa, International Council for Science, Pretoria, South Africa  
**Dr. Joy Jacqueline Pereira**, Universiti Kebangsaan, Bangi, Malaysia  
**Dir. Oleg Petrov**, Russian Research Geological Institute (VSEGEI), St Petersburg, Russia  
**Prof. Jane Plant**, Imperial College, London, UK  
**Dr. Gabriele Schneider**, Geological Survey of Namibia, Windhoek, Namibia  
**Prof. R. Stephen J. Sparks**, University of Bristol, Bristol, UK  
**Prof. Philip Weinstein**, School of Population Health, University of Western Australia, Perth, Australia  
**Dr. Neil Williams**, Geoscience Australia, Canberra, Australia  
**Prof. Marjorie Wilson**, University of Leeds, Leeds, UK

## Arctic Consortium

**Prof. David Gee** (Chairman), Uppsala University, Sweden  
**Prof. Krzysztof Birkenmajer**, Polish Academy of Sciences, Poland





**Prof. Jean-Pierre Brun**, Institut Universitaire de France, France

**Prof. Julian Dowdeswell**, Scott Polar Research Institute, UK

**Dr. Ashton Embry**, Geological Survey of Canada, Canada

**Prof. Áslaug Geirsdóttir**, University of Iceland, Iceland

**Dr. Arthur Grantz**, United States Geological Survey, USA

**Prof. Yngve Kristoffersen**, University of Oslo, Norway

**Academician Yuri G. Leonov**, Geological Institute (Moscow), Russian Federation

**Prof. Johannes Oerlemans**, Utrecht University, Netherlands

**Prof. Byong-Kwon Park**, Korea Research Council of Public Science and Technology, Korea

**Prof. Vladimir Pavlenko**, Arctic Research Centre, Russian Academy of Sciences, Moscow, Russian Federation

**Prof. Carlo Alberto Ricci**, University of Siena, Italy

**Prof. Christian Schlüchter**, University of Bern, Switzerland

**Dr. Robert Scott**, University of Cambridge, UK

**Dr. Kazuyuki Shiraishi**, National Institute of Polar Research, Japan

**Prof. Lars Stemmerik**, Geological Survey of Denmark and Greenland, Denmark

**Prof. Jörn Thiede**, Alfred-Wegener- Institute, Bremerhaven, Germany

**Prof. Zhanhai Zhang**, Polar Research Institute of China, China

**Dr. Olga Bogolepova** (Coordinator), Uppsala University, Sweden, SciComIGC@geo.uu.se

## Communication Sub-Committee

**Mrs. Berit Forbord Moen**, Geological Survey of Norway, Norway

**Mr. Henrik Højmark Thomsen**, Geological Survey of Denmark and Greenland GEUS, Denmark

**Mr. Halfdan Carstens**, GeoPublishing, Norway

**Ms. Anna Kim-Andersson**, Qi-Media, Sweden

**Mr. Arild Foss**, Web editor, UK

## Geohost Sub-Committee

**Prof. Richard Sinding-Larsen** (Chairman), Norwegian University of Science and Technology, Norway

**Mrs. Marianne Draugsvoll** (Secretary), Congress-Conference AS, Norway

**Dr. Kristinn J. Albertsson**, Icelandic Institute of Natural History, Iceland

**Mr. Bengt Hope**, Petrad Foundation, Norway

**Dr. Erik Nygaard**, Geological Survey of Denmark and Greenland GEUS, Denmark

**Prof. Reijo Salminen**, Geological Survey of Finland, Finland

**Dr. Olle Selinus**, Geological Survey of Sweden, Sweden

## Excursions Sub-Committee

**Dr. Stig Schack Pedersen**, Geological Survey of Denmark and Greenland GEUS, Denmark

**Dr. Raimo Lahtinen**, Geological Survey of Finland, Finland

**Dr. Hreggviður Norðdahl**, University of Iceland, Iceland

**Mr. Harald Brekke**, Norwegian Petroleum Directorate, Norway

**Mr. Jan Stenløkk**, Norwegian Petroleum Directorate, Norway

**Dr. Pär Weihed**, University of Technology, Sweden

## GeoExpo Committee

**Prof. Anders Solheim**, Secretary General, 33IGC

**Mrs. Marianne Graff Nesse**, Congress-Conference AS (PCO representative)

**Mrs. Ellen Ramberg**, Ramberg Consulting AS

**Mr. Asgeir Knudsen**, Project Coordinator, 33IGC Organising Committee

## Business Meetings and Workshop Committee

**Mr. Asgeir Knudsen**, Project Coordinator, 33IGC Organising Committee

**Dr. Björn Sundquist**, Science Coordinator, 33IGC

**Prof. Anders Solheim**, 33IGC Secretary General

**Mr. Jose Cepeda**, International Centre for Geohazards, Oslo, Norway

## National Working Groups in the Nordic countries

### *Danish Working Group*

**Dr. Lise Holm** (Chairman), Skov- og Naturstyrelsen, lho@sns.dk

**Dr. Martin Ghisler** (Contact), Geological Survey of Denmark and Greenland (GEUS), mg@geus.dk

**Prof. Hans Thybo**, University of Copenhagen, thybo@geol.ku.dk

**Prof. Finn Surlyk**, University of Copenhagen, finns@geol.ku.dk

**Prof. John A. Korstgård**, University of Aarhus, john.korstgard@geo.au.dk

**Dr. Erik Nygaard**, Geological Survey of Denmark and Greenland (GEUS), eny@geus.dk

**Dr. Johnny Fredericia**, Geological Survey of Denmark and Greenland (GEUS), jfr@geus.dk

### *Finnish Working Group*

**Prof. Raimo Lahtinen** (Chairman), Geological Survey of Finland, raimo.lahtinen@gtk.fi

**Prof. Eero Hanski**, University of Oulu, eero.hanski@oulu.fi

**Prof. Juha Karhu**, University of Helsinki, juha.karhu@helsinki.fi

**Prof. Martti Lehtinen**, University of Helsinki, martti.lehtinen@helsinki.fi

**Prof. Kirsti Loukola-Ruskeeniemi**, Helsinki University of Technology, kirsti.loukola-ruskeeniemi@tkk.fi



**Prof. Lauri Pesonen**, University of Helsinki,  
lauri.pesonen@helsinki.fi

**Prof. Matti Saarnisto**, Geological Survey of Finland,  
matti.saarnisto@gtk.fi

**Prof. Reijo Salminen**, Geological Survey of Finland,  
reijo.salminen@gtk.fi

**Prof. Veli-Pekka Salonen**, University of Helsinki,  
veli-pekka.salonen@helsinki.fi

**Prof. Krister Sundblad**, University of Turku,  
krister.sundblad@utu.fi

### *Icelandic Working Group*

**Dr. Helgi Torfason** (Chairman), Icelandic Institute of Natural History, heto@ni.is

**Prof. Ólafur Ingólfsson**, University of Iceland, oi@hi.is

**Prof. Helgi Björnsson**, University of Iceland,  
hb@raunvis.hi.is

**M.Sc. Sigurrós Friðriksdóttir**, Environment & Food Agency, sigurros@ust.is

**Dr. Sigurður Gíslason**, University of Iceland,  
sigrg@raunvis.hi.is

**Dr. Jórunn Harðardóttir**, National Energy Authority,  
jha@os.is

**Dr. Grétar Ívarsson**, Reykjavik Energy,  
gretar.ivarsson@or.is

**Dr. Sveinn Jacobsson**, Icelandic Institute of Natural History, sjak@ni.is

**Dr. Hreggviður Norðdahl**, University of Iceland,  
hreggi@raunvis.hi.is

**M.Sc. Ragnheiður Ólafsdóttir**, Landsvirkjun,  
ragnheidur@lv.is

**M.Sc. Bjarni Richter**, Iceland GeoSurvey, br@isor.is

**Dr. Olgeir Sigmarsson**, University of Iceland,  
olgeir@raunvis.hi.is

**Dr. Freysteinn Sigmundsson**, University of Iceland,  
fs@hi.is

**Prof. Haraldur Sigurðsson**, University of Rhode Island, USA, haraldur@gso.uri.edu

**Prof. Leifur Símonarson**, University of Iceland,  
leifuras@raunvis.hi.is

**Dr. Árný Sveinbjörnsdóttir**, University of Iceland,  
arny@raunvis.hi.is

### *Norwegian Working Group*

**Prof. Henning Dypvik** (Chairman), University of Oslo,  
henning.dypvik@geo.uio.no

**William Helland-Hansen**, University of Bergen,  
william.helland-hansen@geo.uib.no

**Geoffrey D. Corner**, University of Tromsø,  
geoff.corner@ig.uit.no

**Prof. May Britt Mørk**, Norwegian University of Science and Technology, mai.britt.mork@geo.ntnu.no

**Prof. Jon Landvik**, Norwegian University of Life Sciences, jon.landvik@umb.no

**Ass. Prof. Hanne H. Christiansen**, University Centre in Svalbard, hanne.christiansen@unis.no

**Prof. Anders Elverhøi**, International Union of Geological Sciences, anders.elverhoi@geo.uio.no

**Terje Thorsnes**, Geological Survey of Norway,  
terje.thorsnes@ngu.no

**Anthony Spencer**, StatoilHydro ASA, ams@statoil.com

**Dr. Willy Fjeldskaar**, University of Stavanger,  
willy.fjeldskaar@irisresearch.no

**Eivind S. Aarseth**, StatoilHydro ASA,  
eivind.swensson.aarseth@hydro.com

**Erling Kvadsheim**, Norwegian Petroleum Directorate,  
erling.kvadsheim@npd.no

**Dr. Anders Solheim**, Organising Committee, as@ngi.no

**Tor Løken**, Norwegian Geotechnical Institute, tl@ngi.no

### *Swedish Working Group*

**Dr. Lars Persson** (Chairman), Geological Survey of Sweden, lars.persson@sgu.se

**Prof. Stefan Claesson**, Swedish Museum of Natural History, stefan.claesson@nrm.se

**Prof. Else-Marie Friis**, Swedish Museum of Natural History, else.marie.friis@nrm.se

**Prof. David Gee**, Uppsala University,  
SciComIGC@geo.uu.se

**Dr. Kennert Röshoff**, BergByggKonsult AB,  
kennert.roshoff@bergbyggkonsult.se

**Prof. Birger Schmitz**, Lund University,  
birger.schmitz@geol.lu.se

**Dr. Olle Selinus**, Geological Survey of Sweden,  
olle.selinus@sgu.se

**Prof. Pär Weihed**, Luleå University of Technology,  
par.weihed@ltu.se

## ORGANISING COMMITTEE REPORT

A Nordic Organising Committee (OrgCom) was established immediately after the 32<sup>nd</sup> Congress in Florence, during which the Nordic countries were awarded the next Congress. From 2005, a monthly meeting schedule was set up. An Executive Committee (ExCom) was comprised of the committee members with the exception of the four national VPs for Denmark, Sweden, Finland, and Iceland. A monthly meeting schedule was initiated in spring 2005, in which roughly every fourth meeting involved the full OrgCom, and the remaining were ExCom meetings. Most meetings were held in Oslo at the premises of the Norwegian Geotechnical Institute. In addition to the monthly meetings, a number of additional meetings were held on an ad hoc basis involving only parts of the committee, when issues had to be dealt with quickly. Some of the meetings were also held at the Congress venue, the Norway Convention Centre, where inspection of the venue and discussion of various logistical aspects were important issues on the agenda. Once every year an OrgCom meeting was combined with a meeting of the Nordic IGC Foundation board, where OrgCom reported to the board on overall issues such as economy, venue logistics and the outline of the scientific programme. From April 2008, the ExCom meeting frequency was increased to roughly every two weeks.

In total 44 committee meetings were held after OrgCom had been established in 2005. Of these 14 were full



## SCIENCE COMMITTEE REPORT

OrgCom meetings. One meeting, 2008/14, was held post-Congress in December 2008, to sum up all aspects of the Congress including post-Congress feedback from participants.

The meetings mostly followed a fixed agenda, where all ExCom VPs reported on status for their area of responsibility and from the work done in different sub-committees. In the full OrgCom meetings the national VPs also reported on the activity in each of the Nordic countries. External participants, typically representatives from sub-contracted companies, were invited to the meetings when needed. All meetings were led by the President, and detailed minutes were recorded by the Secretary General for each meeting. The minutes also included an action list in which responsibility and deadlines were detailed. These documents are all available on request from IUGS.

Although details of the many parts of the programme were made in different sub-committees, the Organising Committee defined the overall guidelines and made all important decisions. Issues such as the overall science programme, deadlines for submission and registration, participation fees, choice of subcontractors, content of circulars and flyers etc. were all decided in ExCom and OrgCom meetings.

Committee members were active in communicating plans for the Congress to the wider scientific community, and participated with presentations and exhibitions in various international and national conferences. Important venues for these activities were large international conferences such as AGU, EGU, AAPG Gen. Assembly, GSA, etc., as well as the assemblies of the national geological societies of the Nordic countries. The bi-annual joint Nordic geosciences “winter conference” was obviously an important venue for informing about this huge joint Nordic effort. A dedicated 33IGC stand was present at the most important conferences.

The Organising Committee benefited greatly from communication with previous IGC organizers. In particular we made use of the recent experiences from the Italian organizers of the 32<sup>nd</sup> IGC in Florence. Some of the ExCom members had a meeting with key persons in the Italian committee in Italy as early as 2005. In addition, two meetings with the International IGC Committee (IGCC) were also very useful in discussing planning details and learning from the experiences of past IGCs.

The committee that organized the science programme for the 33<sup>rd</sup> IGC (the Science Committee - SciCom) was established in 2005 and held its first meeting in October of that year. It was composed of representatives of all the Nordic countries and expanded during the following year to 21 members, including expertise in most of the main geoscience disciplines and a colleague from both Germany and the UK. The SciCom meetings were usually held in Oslo at the Norwegian Geotechnical Institute and often attended by the 33IGC President and Secretary General.

The main theme of the 33<sup>rd</sup> IGC, “Earth System Science – Foundation for Sustainable Development”, emphasized the importance of resources, the environment and the challenge of improving the living standards of all people on the planet. The science programme highlighted these priorities within the traditional IGC framework of Topical, Special and General symposia; these were characterized at the 33<sup>rd</sup> IGC as Inter(multi)disciplinary, Regional and Disciplinary, respectively. The Special Symposia were designed initially to focus on Nordic geoscience and particularly the Arctic region, and an Arctic Consortium was established to promote Polar symposia. Subsequently, in response to proposals from the international community, the Special Symposia were expanded regionally to encompass most of the Earth.

Symposia were also encouraged for the major international programmes and organisations, with particular emphasis on the International Year of Planet Earth (IYPE) and the International Polar Year (IPY). The main themes of IYPE were incorporated in the IGC programme and some were adopted for Plenary lectures. These lectures were held during the lunch intervals to promote maximum attendance and avoid collision with other parts of the science programme. They were given greater emphasis and visibility by the arrangement of complementary science symposia in the morning before the lunch-time lectures, and afternoon sessions when the focus was placed on societal implications and outreach, including panel debates and information for the media.

Worldwide participation in the construction of the science programme was encouraged. The IGC First Circular was published in spring 2006, outlining the programme priorities and inviting proposals - “Participate in the Planning of the Programme”. It resulted in a flood of proposals (nearly 600) of variable quality, some very professional, others inadequate, most of which reached the Uppsala secretariat in autumn 2006. Some complementary symposia were encouraged and a framework programme was developed (see following pages). Responsibility for promotion and coordination of each of the main groups of symposia was divided within SciCom (and a few colleagues from other committees).



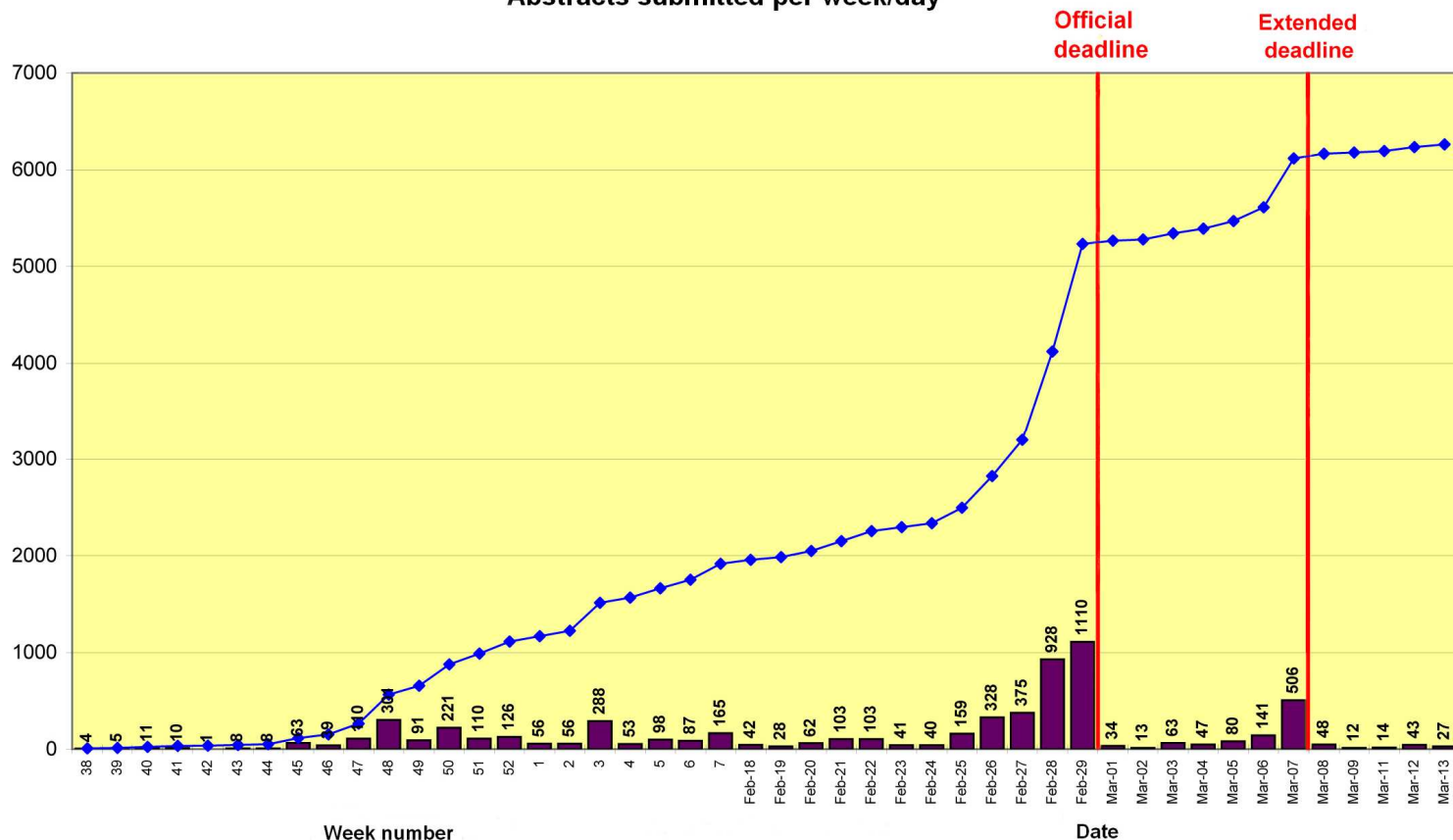
For the eight “Themes of the Day” (“Global Geology”, “Early life”, “Climate change”, “Geohazards”, “Water”, “Mineral Resources”, “Energy” and “Earth and Beyond”), responsibility was divided between SciCom and the Organising Committee, with the former concentrating on the morning science programme and plenary lectures.

By the autumn of 2007, after a long process of cancelling inadequate proposals and merging those that were similar, c. 470 symposia, workshops and short courses were accepted and advertised on the Congress website. Not all were accompanied by suitable summaries and, to promote these, it proved advantageous to include Nordic conveners in many symposia. SciCom received repeated requests from

conveners for support of keynote speakers (e.g. waiving of registration fees); in most cases this proved impossible.

Submission of abstracts was initially required by the end of January 2008, but the deadline was moved forward five weeks to allow for further incoming contributions. Abstracts submitted after 7<sup>th</sup> of March were accepted if supported by the convener of the related symposium. Thereafter, further merging of some of the symposia was necessary. The final programme with 337 symposia is summarised below. This includes a list of the main groups of symposia in each major subject area and the number of symposia in each group.

**Abstracts submitted per week/day**



**33<sup>rd</sup> IGC Symposia programme**

Title	Code	No of symp.
<i>Themes of the Day</i>		<b>8</b>
<i>Major Geoscience Programmes</i>		<b>11</b>
International Year of Planet Earth (IYPE)	PE	7
International Consortium of Geological Surveys (ICOGS)	IC	1
International Science Drilling Programs (IODP, ICDP)	SD	1
Contribution of Geochemistry to the Study of the Planet (IAGC)	GC	2
<i>Interdisciplinary Symposia (Topical)</i>		<b>46</b>
United Nations Convention on the Law of the Sea (UNCLOS)	UN	4
Changing Climates	CC	3
CO <sub>2</sub> Capture, Storage and Usage	CO	2





Title	Code	No of symp.
<b><i>Interdisciplinary Symposia (Topical) cont.</i></b>		
Earth System Management	EM	3
Gas Hydrates	GA	2
Geodynamics and Plate Motions	GD	6
Geohazards	GH	12
Geoscience and Nuclear Waste Disposal	NW	2
Mathematical Geology	MA	4
Medical Geology	MG	3
Ultra-High Pressure Metamorphism	UH	5
<b><i>Regional Symposia (Special)</i></b>		<b>43</b>
Arctic, Antarctic and Bi-polar relationships (IPY)	AA	12
Africa	AF	4
Americas	AM	6
Asia	AS	6
Europe	EU	13
Oceania	OC	1
World Maps	WM	1
Title		
<b><i>Disciplinary Symposia (General)</i></b>		<b>229</b>
Biogeosciences	BG	3
Climate, Glaciology	CG	12
Earth Interior, Exploration Geophysics	EI	20
Environmental Geoscience	EG	7
Geo-energy	GE	21
Geomorphology, Soil Science	GS	4
Geotechnology, Remote Sensing	GT	9
Historical Geology, Paleontology	HP	27
Hydrogeology	HY	7
Information, Education, Ethics, History	IE	35
Mineralogy, Petrology, Isotope Geology, Volcanology	MP	31
Mineral Resources	MR	22
Ocean Sciences	OS	6
Planetary Sciences, Impact Structures	PI	5
Sedimentology	SE	5
Structural Geology, Tectonics	ST	15

**Total 337**

With regard to the Congress publications, conveners were encouraged by SciCom to make their own arrangements for publishing Symposium Proceedings. Many were in contact with journal editors and made arrangements for special volumes. SciCom took responsibility for one major publication dedicated to Nordic Geoscience and published in *Episodes (Earth System Science: Foundation for Sustainable Development. Special Issue for the 33<sup>rd</sup> International Geological Congress, Oslo, Norway, 6-14 August 2008. Episodes, Vol. 31, nr 1, March 2008)*. Excursion guides were prepared by the excursion leaders and made available on the website at the time of the Congress (see Excursion Subcommittee Report). At the time of publishing this General Proceedings, one special volume has been printed: B.S. Paliwal (Editor), 2010: *Global Groundwater Resources and Management*, Scientific Publishers, Jodhpur, India, ([www.scientificpub.com](http://www.scientificpub.com)). The book is a compilation of papers from the Hydrogeology symposium HYH-02.

#### SUBMITTED ABSTRACTS PER COUNTRY (based on first author)

(Invited abstracts for the Themes of the Day symposia are not included)

Country	Submitted	Lectures	Posters	Country	Submitted	Lectures	Posters
Russian Federation	678	273	404	Japan	193	97	96
Norway	528	378	150	Australia	187	160	28
United States	442	373	67	Brazil	184	61	123
China	434	222	211	Sweden	173	145	28
Italy	319	170	149	France	149	117	31
United Kingdom	278	227	51	Canada	136	118	18
Germany	261	188	73	India	136	92	44



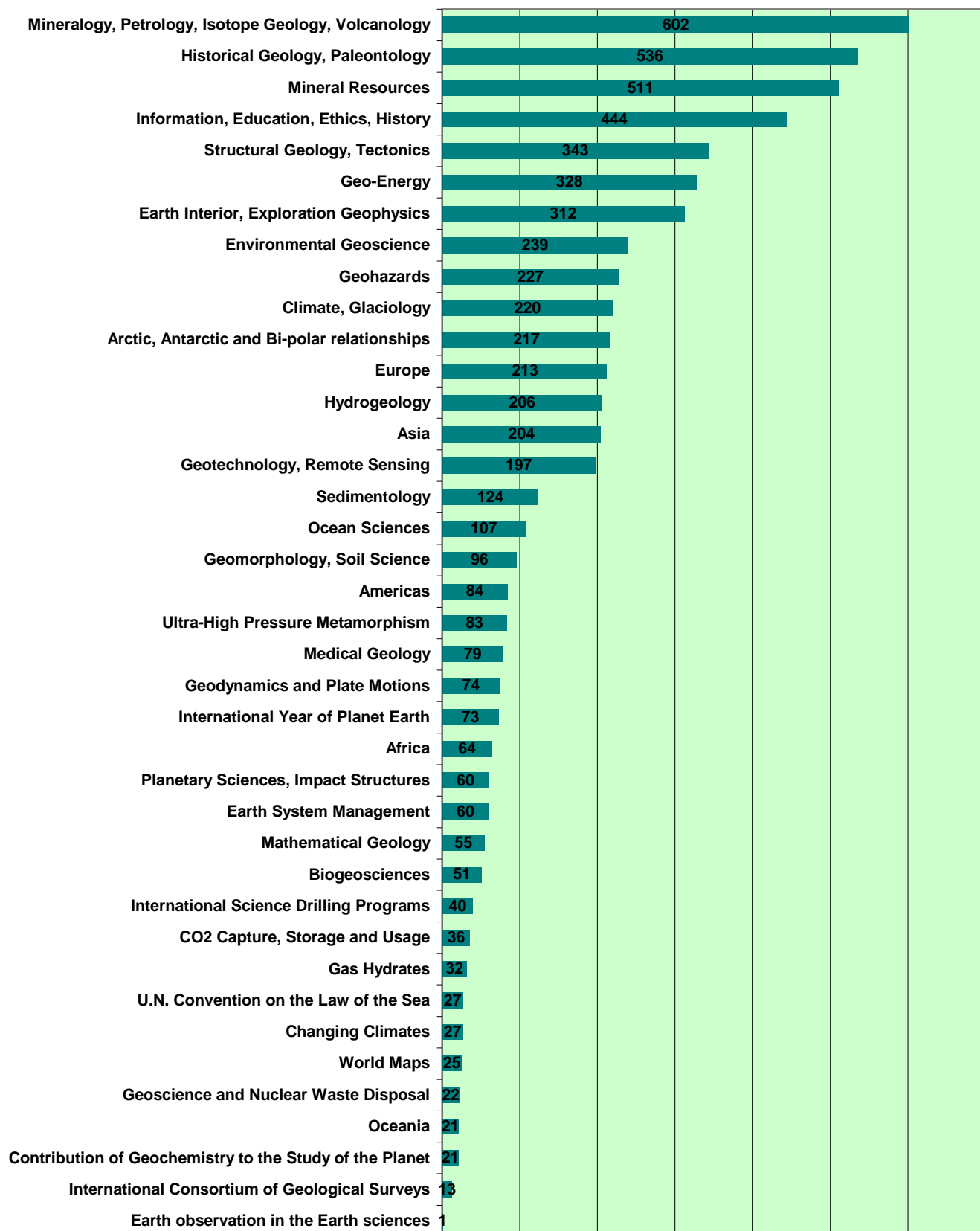
**SUBMITTED ABSTRACTS PER COUNTRY (based on first author)**

(Invited abstracts for the Themes of the Day symposia are not included)

<b>Country</b>	<b>Submitted</b>	<b>Lectures</b>	<b>Posters</b>	<b>Country</b>	<b>Submitted</b>	<b>Lectures</b>	<b>Posters</b>
Spain	132	54	78	Vietnam	9	4	5
Islamic Republic of Iran	128	47	81	Cameroon	8	7	1
Finland	118	84	34	Albania	7	3	4
Switzerland	104	83	21	Latvia	7	1	6
Denmark	100	80	20	Mongolia	7	3	4
Poland	93	43	50	Peru	7	2	5
Republic of Korea	86	24	62	Faroe Islands	6	4	2
Turkey	83	36	47	Georgia	6	2	4
Netherlands	77	64	13	Thailand	6	5	1
Romania	67	14	53	United Arab Emirates	6	4	2
Portugal	60	24	36	Ethiopia	5	5	0
Kazakhstan	51	13	38	Malaysia	5	4	1
Czech Republic	49	35	14	Namibia	5	2	3
Ukraine	49	19	30	Saudi Arabia	5	2	3
Argentina	47	31	15	Sri Lanka	5	5	0
Uzbekistan	47	9	38	Hong Kong	4	3	1
Austria	44	24	20	Indonesia	4	3	1
Ireland	37	28	9	Jordan	4	1	3
New Zealand	37	31	6	Kuwait	4	3	1
Greece	34	17	17	Mozambique	4	0	4
Belgium	29	20	9	Tanzania	4	3	1
Hungary	28	13	15	Uruguay	4	4	0
Serbia and Montenegro	26	12	14	Botswana	3	2	1
Iceland	25	20	5	Lebanon	3	3	0
Mexico	25	11	14	Nepal	3	3	0
Pakistan	23	10	13	Syrian Arab Republic	3	3	0
Slovenia	22	9	13	Armenia	2	0	2
Colombia	21	9	12	Cuba	2	2	0
Egypt	19	5	13	Ghana	2	2	0
Croatia	18	6	12	Macedonia, FYROM	2	0	2
Morocco	18	2	15	Afghanistan	1	1	0
South Africa	18	13	5	Belarus	1	1	0
Taiwan	17	5	12	Bolivia	1	0	1
Lithuania	16	8	8	Congo, the	1	0	1
Tunisia	16	4	12	Democrati Republic	1	0	1
Iraq	14	3	11	Costa Rica	1	0	1
Azerbaijan	13	5	8	Cote d' Ivoire	1	1	0
Slovakia	13	6	7	Democratic Peoples	1	1	0
Kyrgyzstan	12	4	8	Republic of Korea	1	1	0
Nigeria	12	8	4	Dominica	1	1	0
Bangladesh	11	9	2	Jamaica	1	1	0
Chile	11	7	4	Libyan Arab	1	0	1
Yemen	11	5	6	Jamahiriya	1	0	1
Algeria	10	0	10	Oman	1	0	1
Israel	10	9	1	Panama	1	1	0
Philippines	10	9	1	Sudan	1	1	0
Venezuela	10	3	7	Svalbard and	1	1	0
Bulgaria	9	4	5	Jan Mayen	1	1	0
Estonia	9	5	4	Trinidad and Tobago	1	1	0
				Yugoslavia	1	0	1



**Number of submitted abstracts per topic**  
(Included abstracts for the Themes of the Day symposia are not included)



## EXCURSION COMMITTEE REPORT

### The Excursion Subcommittee and its tasks

The Excursion Subcommittee was established by the Science Committee in August 2006. The task of the Subcommittee was to

- review all excursion proposals
- establish contact with all potential excursion leaders in the respective countries
- organize and communicate circulars concerning all standard excursion logistics, formats of excursion guides and budgetary procedures
- provide, compile and edit the necessary excursion information for the Congress website
- be the responsible communicator with the excursion leaders

- receive and handle the excursion guides and review their layout for presentation on the website
- assist the Congress secretariat regarding registration of excursion participants, excursion fees and liaison with the excursion leaders
- decide on the final excursion programme in communication with the excursion leaders and the Science Committee.

Due to the cost of travel within the Nordic countries, the Excursion Subcommittee did not hold separate meetings but communicated online. The major part of the work of Subcommittee members was to communicate actively with excursion leaders in their respective countries and assist them in following up the work and requirements of the Subcommittee.

### Record of procedure

March 2006	First circular, invitation to submit excursion proposals to the Science Committee
August 2006	Establishment of Excursion Subcommittee
August – September 2006	Consideration of proposals submitted
October 2006	Circulation of guidelines to excursion leaders (see Attachment 1)
November 2006	Deadline for excursion descriptions in standardised format
January – May 2007	Review of descriptions and preparations for second circular and website publication
June 2007	Excursion descriptions published on website and made available for registration
November 2007	Website upgraded with interactive excursion map for registration
December 2007	Circulation of guidelines and format for excursion guides
March 2008	Starting to cancel excursions with fewer than stipulated minimum registrations
January – June 2008	Receiving and making excursion guides available through website in PDF format
May 2008	Circulating insurance waiver documents and accounting agreements
June 2008	Transferring registration fees to excursion leaders
July – August 2008	Assisting excursion leaders in final preparations
September – November 2008	Assist in final settling of accounts between Secretariat and excursion leaders

### Excursion proposals

All excursions were proposed and organized by interested academic and government institutions as well as private companies. Invitations for proposals were already issued by the Nordic Bidding Committee which had started its promotion work in 2001, aiming at making its bid at the 32<sup>nd</sup> IGC in Florence in 2004. In its bidding document, this committee was able to present 33 excursion abstracts with photos, and an additional list of 31 preliminary excursion proposals, from all five Nordic countries. Many of these early excursion proposals made their way to the final excursion programme.

In its first circular, the Science Committee of the 33<sup>rd</sup> IGC invited all interested organisations to submit proposals for excursions, on the understanding that the proponent would be responsible for the scientific and logistic organisation in each case. The members of the Excursion Subcommittee engaged in encouraging the geoscience societies in their respective countries to produce such proposals and to have them submitted within October 2006. By end of October

2006, the Excursion Subcommittee had received proposals for 102 pre- and post-Congress excursions.

After having registered all initial excursion proposals following the call in first circular, the Excursion Subcommittee circulated its guidelines for standard excursion descriptions to be posted on the website (circular included as Attachment 1). Individual members had the responsibility to follow up this work in their respective countries. During this work, the Subcommittee was able to present to the Science Committee an updated list of excursions with standard descriptions at the end of 2006. This list was included in the second circular of the Congress in March 2007, and was placed on the website in June 2007. These were opened for registration through the website in August 2007.

Following the review by the Excursion Subcommittee and its circulation of further requirements for the preparations of the excursions the number of excursion proposals that was included on the website by end of February 2007 was



51 pre- and post-Congress excursions and 7 one day mid-Congress excursions. By December 2007 the final number of excursions available for registration through the website had grown to 56 pre- and post-Congress excursions and 8 one day mid-Congress excursions.

A modest sum was made available through the Excursion Subcommittee for excursion leaders that wanted to apply for economic support to do “dry runs” of their excursions during the summer of 2007. The Subcommittee received 5 such applications.

#### **Final adjustments of the excursion program**

Participants to the Congress were notified that they would have to register for the excursions by the end of February 2008, after which date a decision would be taken as to which excursions would be cancelled due to lack of interest. Those participants that at that stage had their choice cancelled would be offered alternative excursions. Accordingly, in consultation with the excursion leaders many excursions were cancelled in early March. However, in several cases where the stipulated minimum number of participants had not been reached, excursion leaders chose to keep their excursions open for registration and made an extra effort to promote the excursions through their network and the IGC website. Many of these succeeded in acquiring enough participants, while others failed. The last cancellations were made in May 2008. In the end, a total of 38 excursions were run; 14 pre-Congress, 16 post-Congress and 8 mid-Congress.

The excursions were closed in consultation with the individual excursion leader when a sufficient number of participants had been reached. In several cases the excursion leaders preferred to have their excursions open for further registration right up to the start date even when a sufficient number had been secured, as long as they felt that they might accommodate more participants.

#### **Website information**

All information regarding the excursions, i.e. abstract descriptions, photos, names of organizers, prices, dates, minimum and maximum numbers of participants, and start and end locations were posted on the Congress website in early June 2007. After this, the excursion leaders had the opportunity, through the Excursion Subcommittee, to update and expand information about their excursions on the Congress website at any time up to the start of the excursion. All important logistic messages and updates regarding the excursions were put on the website, and frequently the website was used for advertising campaigns for specific excursions in order to help them to reach the minimum limit of participants.

From January 2008 field excursions in PDF format were made available through the website as soon as they were received and checked by the Subcommittee.

All information and updates were published through

frequent communication between the Chairman of the Subcommittee and the website editor.

The website solution proved to be an extremely efficient way to handle all the dynamic information (updates, cancellations and logistics) regarding the excursions. The introduction in October 2007 of an interactive excursion map, enabling access to the whole range of excursion information, was very successful.

#### **Registrations, budgets, contracts and insurance issues**

All excursion leaders had to produce a budget and a cost estimate for participation based on a minimum number of participants as defined by the excursion leaders themselves. The excursion fee quoted on the website reflected this cost estimate plus 5 % to meet the risks of currency and unforeseen cost increases. In August 2007 the excursions were opened for registrations through the website by an automatic link to the registration software of the Congress Secretariat. The Secretariat collected the excursion fees and, for each excursion, kept updated lists of the numbers of registrations and the names and contact information for each participant registered. This was an absolute must in order to handle transfer to alternative excursions after cancellations and to establish contact between the excursion leaders and the individual participant in due time before the excursion started.

During May and June 2008, subsequent to the closing of the individual excursion for further registration, the Subcommittee Chairman assisted the Congress Secretariat in transferring the total registration fee to the individual excursion leader. The excursion leaders were expected to carry out all payments for the costs of their own excursion. In some cases, the Secretariat, in consultation with the Subcommittee Chairman, allowed individual invoices to be sent to the Secretariat for payment. In these cases no money transfer was made to the excursion leader up front.

With respect of the money transfer, each excursion leader was asked to sign a contract with the Secretariat to cover the formalities involved (see Attachment 2).

Special attention was paid to the question of insurance of excursion participants. The participants came from many countries with different national systems for insurance of accidents, thefts and illness. The Excursion Subcommittee therefore decided that one should make sure that each participant was responsible for his or hers own insurance in this respect. To achieve this, the Excursion Subcommittee circulated a “Statement of understanding” document that had to be signed by each participant no later than at the start of the excursion. By doing so, the participant agreed to follow the leadership of the excursion leader and waived all rights to claim any insurance cover by the 33<sup>rd</sup> IGC or any institution involved in arranging the excursion, and that arranging a personal insurance was the participant’s own responsibility (see Attachment 3). The “Statement of understanding” document was also made available in due





time on the website for everybody to download, sign and deliver to the excursion leader upon arrival.

### Excursion guides

During October and November 2007, the Excursion Subcommittee, in consultation with the Science Committee, prepared the instructions to authors regarding the standards of the excursion guides. These guidelines were circulated in early December 2007 with a requested deadline for submission of guides in January 2008. This deadline proved far too short for most of the excursion leaders and authors. The Excursion Subcommittee then relaxed this requirement since the Organising Committee had decided that the excursion guides should not be printed, but only be made available for downloading in PDF format from the website. The Excursion Subcommittee therefore agreed with the excursion leaders that they should submit as soon as possible but no later than within June 2008, in order for all registered participants to have a chance to download a copy before

leaving for the Congress. This worked satisfactorily, with the majority of the excursion guides available by the beginning of June 2008.

The Subcommittee had the responsibility to receive, register and store the excursion guides. The excursion guides were submitted in Word or PDF formats, and all files were checked and reviewed in accordance with the prescribed layout and content. Some editing regarding the layout proved to be necessary before they were stored for reference and put on the website. Not all authors gave permission to have their excursion guides published on the website, but were willing to consider to have them formally published later under the auspices of the Congress. These authors distributed their guides only to the excursion participants separately from the copy submitted to the Excursion Subcommittee. The work involved in handling and considering the excursion guides was basically carried out by the Chairman of the Subcommittee with the assistance of two external geologists.

## Attachment 1

### IGC 2008 Excursions - Memorandum 2006-10-10

(1) General information about IGC Excursions is to be found in the 1st Circular (pp. 22–23):

“The Nordic countries will organise a wide range of excursions. These will take place before, during and after the congress and be well integrated with the congress themes. The preliminary excursion targets include the high Arctic environments of Svalbard and Greenland, classical orogens and basins, world-class mineralizations, volcanism, divergent plate boundaries, impact structures and new Geoparks. Oslo itself is a superb location for oneday trips to the Precambrian, Caledonides, Upper Paleozoic graben with related igneous rocks, glacial features and post-glacial landscapes. In addition, our close neighbours, Russia and the Baltic States, will provide outstanding excursion targets. Some of the excursions will cross from one country to another by road and/or ferry.

**Excursion guides will be produced for all excursions and will be available on CD at the congress. However, some may be cancelled immediately after the excursion deadline in February 2008, if not enough participants have registered. If you plan to join an excursion, register early in response to the 2nd Circular.**

A selection of 35 preliminary proposals for excursions are presented below. The selected excursions highlighted are organised geographically as shown in the index map on p. 24. The excursions are also sorted by theme in the diagram accompanying the map on p. 24. The final programme will include a set of pre- and postcongress excursions of up to 10 days duration, as well as a set of mid-congress excursions of 1–2 days duration. There will also be daily excursions, throughout the congress, in the vicinity of Oslo.

We wish to gauge the interest for these excursions and we invite proposals for others. In the case of new proposals, send details on the excursion route, scientific theme, logistics and minimum number of participants required. You must be willing to take responsibility for the planning and execution of your proposed excursion and preparation of the excursion guide. The guides will follow a standard format and will all be made available on CD at the time of the congress, whether or not the excursions attract the necessary minimum participation.”

**Note** that there should be a symposium at IGC that provides the geological context for the excursion.

(2) We need NOW (October 2006), for all excursion proposals, the following information (see Annex 1):

- a) Title
- b) Leader(s)



- c) Purpose, etc. (10-15 line summary)
- d) Other items (timing, logistics, accommodation, meals, transport and budget)
- e) Day-by-day stops (1-2 page summary)
- f) Indicate a minimum and maximum limit of participants for the excursion

(3) The IGC Excursions Sub-Committee (Chairman Harald Brekke, Norway, Hans Thybo, Denmark, Raimo Lahtinen, Finland, Helgi Torfason, Iceland, Pär Weihed, Sweden, David Gee, SciCom Chairman, Björn Sundquist, Science Programme Coordinator) needs NOW (October 2006) to promote (2) above. National representatives in this committee should immediately to be in contact with all potential excursion leaders (see 1st Circular) in their respective countries with regard to (2) above.

(4) During October - November, the Excursions Sub-Committee should review all proposals for excursions and propose necessary action.

(5) In November 2006, we will need, for 2nd Circular (January 2007), a concise excursion description, i.e., an updated (2) above, incl. a, b, c (<100 words), and cost estimate in 2006 prices.

(6) During 2007 it will be possible to expand the details about excursion proposals on the IGC web site. Leaders should use the web to increase the attraction of their excursion.

(7) Final preparation of all aspects (scientific and logistic) for the excursions will be necessary in the summer 2007 (including full cost estimate in 2007 prices). A “Dry-run” will be necessary for fixing the exact steps. This will also provide an opportunity for illustrating the www edition of your excursion guide with photographs and videos. The latter are encouraged.

(8) The “standard” format for publication (hard copy) of all excursion guides will be agreed by December 2006. This will be the edition that is published at the time of the conference on a CD (see 1 above). By December 2007, all excursion guides in standard format should reach the Excursions Sub-Committee (for review, modification and editing). The IGC web edition of the excursion guides can be more expansive than the “standard” format in terms of illustrations, and details of stops (7 above). Hard copies will be available at the time of the conference for excursion participants.

(9) Some funding is being solicited to support excursion preparation (see 7 above) if absolutely necessary.

(10) Excursion leaders should encourage participation in their excursion. By end of January 2008, excursion registration will have been completed and excursion leaders will be informed of the total number of registered participants. They will then have ten days to decide if it is possible to run their excursion with this number of participants (and if too few, to get more participants).

(11) In mid February 2008, all registered participants will be informed whether or not their excursion will run. If their excursion has been cancelled they will be told to which excursion they have been transferred (in general, their second choice).

(12) By 1<sup>st</sup> March 2008, the excursion programme will be finalised and included in the 3<sup>rd</sup> Circular (web presentation only).

(13) By May 2008, all excursion guides in “standard” format should be finalised (i.e., editing completed) and prepared for the Congress CD.

(14) June 2008. Printing (≈100 copies per excursion) of hard copies: 2 copies per excursion participant, 10 copies for excursion leaders, spare copies in the IGC Excursion booth for last minute registration (if this is favoured by leaders).



## Attachment 2



## 33 IGC, The Nordic Countries



Date and place

2008

**Grant contract on gratuitous services (Excursions 33IGC)**

A)

Name of the institution or the excursion leader responsible: ..... will receive funding in total amount (Euro) from The 33<sup>rd</sup> International Geological Congress to carry out a excursion within the bounds of 33 International Geological Congress (Oslo, 2008).

B)

Please fill in the bank form and send it to us together with the signed contract. According to account law in Norway we need a signed contract for your excursion before payment.

C)

After the excursion (within 10 days) the responsible leader send the secretariat an account of the expenses (including invoices and a bank statement). A successful excursion (with many more participants than the minimum number) may be able to cover all the leader's costs.

D)

Excursion responsible (name, email, telephone number).....

Other Leaders:.....

The excursion leader is responsible to get a written statement from all the participants before the excursion starts. This statement must be deposited in a safe place until the excursion is finished. The statement is delivered by the 33IGC as an attachment to this contract.

E)

**Details of the excursion**

Excursion No .....description:

Duration: days; Time:

Start and end:

Number of participants:

Price per participant:

Total cost;

.....  
Responsible excursion leader

.....  
Harald Brekke

Excursion responsible 33IGC

33<sup>RD</sup> INTERNATIONAL GEOLOGICAL CONGRESS, Oslo, August 2008

Postal address: P.O.Box 2694 Solli

Street address: Thomas Heftyegate 2, NO-0204 Oslo

Telephone: [+47] 22 56 19 30

Telefax: [+47] 22 56 05 41

E-mail: [secretariat@33igc.org](mailto:secretariat@33igc.org)

Bank account: 5081 06 71162

Business NO: 989 596 829

Internet: [www.33igc.org](http://www.33igc.org)

**StatoilHydro**  
Main Sponsor



## Attachment 3



## 33 IGC, The Nordic Countries

**STATEMENT OF UNDERSTANDING for participating in an Excursion**

(to be signed by participants participating in a excursion during the 33IGC 2008)

The undersigned hereby acknowledge(s) and agree(s) that:

- A. \_\_\_\_\_ (herein referred to as "Participant") expects and intends to participate in the following activity organized by the 33<sup>rd</sup> IGC following the execution of this Statement of Understanding: **Excursion (Title of excursion)**

---

- B. In consideration of the 33IGCs direction of such field trip(s), participant hereby states that he/she has read and understands the terms and conditions of this statement and specifically agrees to be bound thereby.
- C. Participant further agrees and understands that during each such field trip he/she will be under the direction and control of Excursion leader approved by the 33IGC and specifically agrees to comply with all reasonable directions and instructions by Excursion leader during the course thereof.
- D. Participant understands and acknowledges that there are specific risks of injury to person and/or property that are associated with excursions, including risks related to travel hazards, terrain, weather, eating and sleeping arrangements, and other circumstances. Risks specific to this trip may include:
- 
- E. Participant specifically agrees to and voluntarily assumes the risk of such injuries, and hereby certifies and represents that participant will arrange for appropriate valid insurance protection to cover illness, accidents, property and third party liability. Such insurance can conveniently be arranged by special travelling insurance or by suitable addition to home insurance for the duration of the excursion trip.
- F. Participant understands and acknowledges that the 33IGC, and the organizations with which the excursion leaders are affiliated, and/or persons for whom such organizations and/or 33IGC are responsible, and independent contractors, assumes no liability with regard to participant or to any other person, company or organisation on account of loss of life, personal injuries or property damages to participants or to third persons arising out of excursions, even if created by fault or negligence of 33IGC or the organizations with which the excursion leaders are affiliated, and/or persons for whom such organizations and/or 33IGC are responsible, and independent contractors, except to the extent that such liability is imposed by law. Participant agrees to indemnify and to save the 33IGC, and the organizations with which the excursion leaders are affiliated, and/or persons for whom such organizations and/or 33IGC are responsible, and independent contractors harmless from any liability arising out of the acts or omissions of participant during any such field trip, subject to any limitations or restrictions against such indemnification that are imposed by law.
- G. Any action arising out of the Excursion and/or this Statement of Understanding will be governed by Norwegian law. This agreement signed by both parties constitutes a final written expression of all the terms of this agreement and is a complete and exclusive statement of the terms and any and all representations, promises; warranties or statements that differ in any way from the terms of the written agreement shall be given no force or effect. In the event a court having jurisdiction finds any portion of this agreement unenforceable, that portion shall not be effective and the remainder of the agreement shall remain effective.

Date: \_\_\_\_\_ 20\_\_\_\_. Signed: \_\_\_\_\_

Date: \_\_\_\_\_ 20\_\_\_\_. Signed: \_\_\_\_\_

33<sup>RD</sup> INTERNATIONAL GEOLOGICAL CONGRESS, Oslo, August 2008  
 Postal address: P.O.Box 2694 Solli  
 Street address: Thomas Heftyesgate 2, NO-0204 Oslo  
 Telephone: [+47] 22 56 19 30  
 Telefax: [+47] 22 56 05 41

E-mail: secretariat@33igc.org  
 Bank account: 5081 06 71162  
 Business NO: 989 596 829  
 Internet: www.33igc.org

**StatoilHydro**  
 Main Sponsor



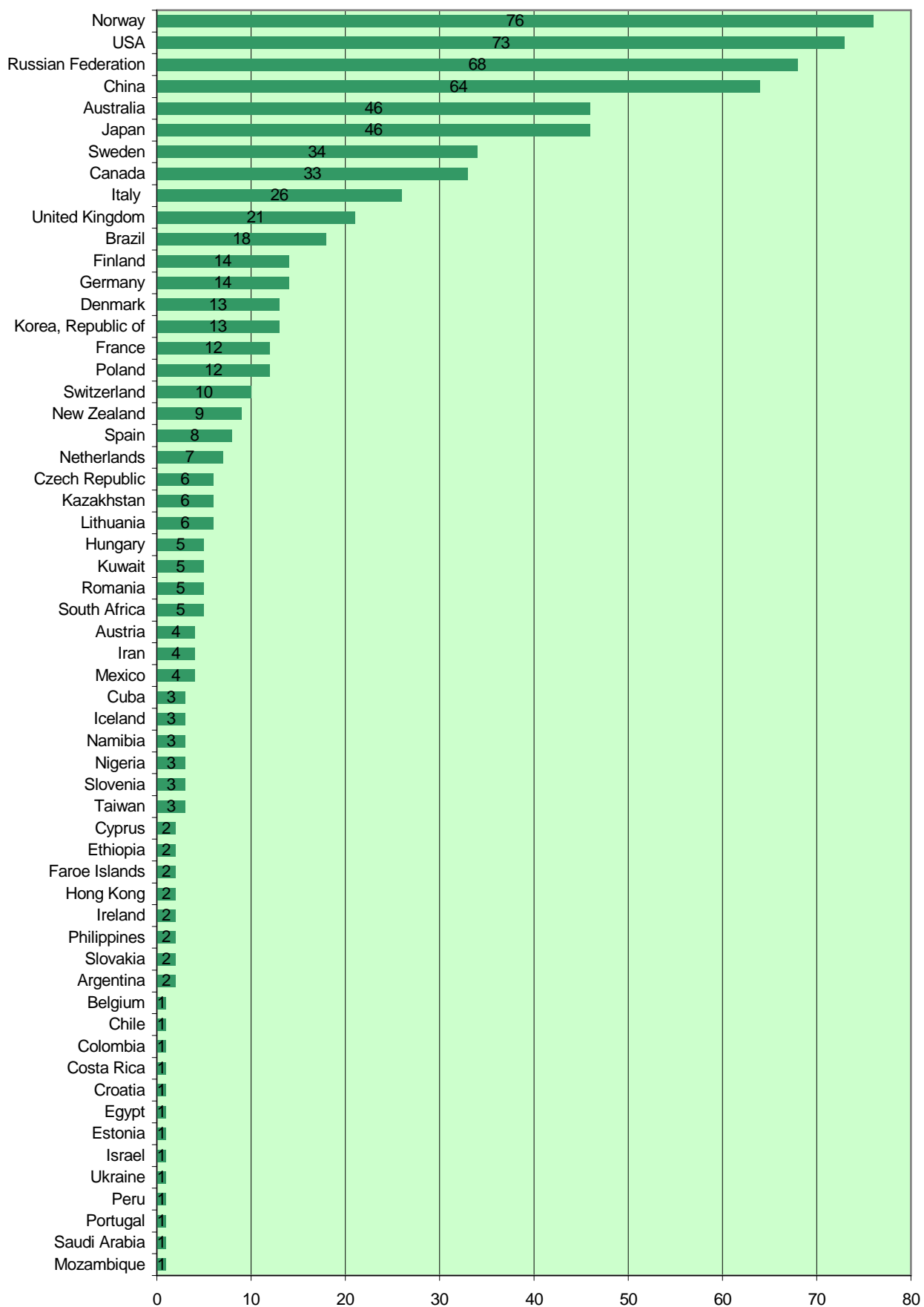
### Number of participants per excursion

Exc. No.	Excursion	Participants
3	Jameson Land, East Greenland - a petroleum geology analogue for the Norwegian continental shelf	8
5a	The geology of Iceland (pre-Congress)	32
5b	The geology of Iceland (post-Congress)	44
6	Faroe Islands - The volcanic and sedimentary evolution of the Palaeogene Faroe Islands Basalt Group	20
7	Faroe Islands - The oceanic glaciation of the Faroe Islands	20
9	Mesozoic Palaeontology and sedimentology of Sweden	9
10	Palaeozoic impact craters	8
11a	Paleoseismicity and uplift of Sweden (pre-Congress)	11
11b	Paleoseismicity and uplift of Sweden (post-Congress)	7
12	Paleoproterozoic volcanic- and limestone-hosted massive sulphide deposits in Bergslagen, Sweden: Character and geological setting	25
15	Metallogeny and tectonic evolution of the Northern Fennoscandian Shield	29
16	100 years of migmatite - In Sederholm's footprints	18
18	Karelian Craton transect: Precambrian greenstone belts, ophiolites and eclogites	12
21	Gea Norvegica, UNESCO European Geopark	15
23	The Carboniferous-Permian Oslo Rift	9
24	From Epicontinental Sea to Foreland Basin - the Early Palaeozoic of the Oslo Region	10
25a	The Palaeozoic geology of the Oslo Region - the Outer Oslo Fjord area	20
25b	The Palaeozoic geology of the Oslo Region - the Inner Oslo Fjord area	35
26	Magma Geopark - The Rogaland Anorthosite Province	12
28	Structural geology and tectonic evolution of the Sognefjord transect, Caledonian Orogen	11
29	The Caledonian infrastructure and evolution in western Norway	24
31	UNESCO FJORDS: From Nærøyfjord to Geirangerfjord: Surface processes and landscape development in the fjord area of western Norway	20
34	A Tectono-stratigraphic transect across the Scandinavian Caledonides in the Mid-Norden Region	32
39	Karst and landform development of North Norway	8
40	Raised beaches, falling-stage deltas, river terraces and postglacial fjord-valley fill, Arctic Norway	15
42	Glacial Stratigraphy of the Neoproterozoic in the northernmost Scandinavian Caledonides	10
44	Svalbard (Spitsbergen) Round Trip - Post Caledonian Tectonostratigraphic and Paleo-geographic Development	16
47	Khibina and Lovozero alkaline massifs: geology and unique mineralization	4
48	The Cu-Ni-PGE and Cr deposits of the Monchegorsk area, Kola Peninsula, Russia	6
51	The Sveconorwegian Orogen of Southern Scandinavia: P-T-t-evolution of polymetamorphic high-grade domains	12
52	Geology, Radiological Age, Metallogeny of Greenstone Complexes in the Ukrainian Shield	6
56	Bjørnøya, an Upper Palaeozoic-Triassic window into the Barents Shelf	5
57	Geothermal energy and energy storage	32
58	Radon geology excursion in the Oslo area	52
101	Neoproterozoic Moelv Tillite and the Hedmark Basin, the Mjøsa area, South Norway	31
102	The Gardnos meteorite crater	48
103	Urban geochemistry in Oslo	12
104	Classical fossil localities in the Oslo area	26





## Excursions - Participants per country



## GEOHOST COMMITTEE REPORT

The 33<sup>rd</sup> IGC Geohost Stipend Programme was developed in accordance with the principles originally outlined by the Organising Committee of the 28<sup>th</sup> IGC, giving priority to young scientists with academic Earth Science qualifications. A Geohost Committee was established, including representatives of the five Nordic countries as well as the non-profit Norwegian government foundation Petrad. The funds were provided by the Norwegian Ministry of Foreign Affairs, the Swedish and Finnish Development Agencies and the 33<sup>rd</sup> IGC Organising Committee. The Geohost Committee was also in charge of the selection of recipients for a separate fund provided by the European Science Foundation (ESF).

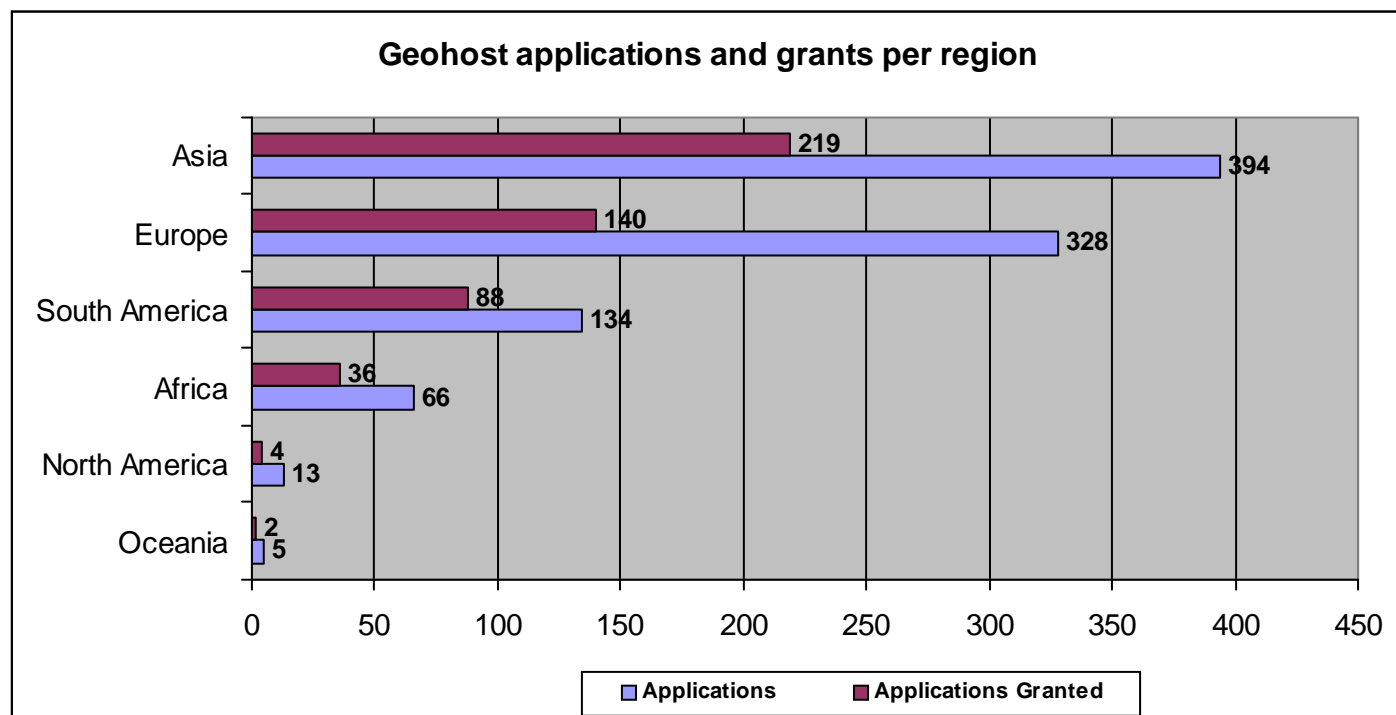
The Geohost Committee developed an application form and procedure designed to give the Committee a basis on which to evaluate applicants. Each applicant to the Geohost Programme had to request a subsidy for one or more of the following:

1. - waiver of the registration fee for the Congress
2. - waiver of the registration fee for a Workshop or a Short Course
3. - subsidised lodging and subsistence during the Congress
4. - waiver of the fee for a Field Trip

In addition to filling out the form, which was included in the Second Circular with details of the Programme, applicants were requested to also enclose a letter of reference from their supervisors supporting their

applications. The deadline for applying to the Geohost Programme was set for November 30, 2007, to allow awardees sufficient time to arrange for the remainder of their needs and the necessary documents for attending the Congress. A total of 940 application forms from 86 countries were received, with a majority from the Asian, European and South American regions. A first selection stage was carried out by the Organising Committee to eliminate all the illegible forms and incomplete documents, although the final decision was left entirely to the Geohost Committee.

The Geohost Committee met in Oslo on 14 February 2008 to undertake the selection procedure. The aim of the Geohost Committee was to satisfy the greatest possible number of applications from the greatest number of countries. The selection of applications was made on the basis of the documents submitted by applicants and selection criteria were: nationality, age, gender, role in congress, and qualifications/position. A weighting scheme was applied taking into account the demand from less developed countries, but seeking also an adequate geographic balance; some preference was given to applicants engaged in special activities of the Congress, as was the case for the conveners, the invited speakers, etc. The Committee decided to select extra applicants to be placed on a "waiting list" for financial assistance, in case some of the awards were refused or not utilized. All the applicants were notified of the decision taken by the Geohost Committee by 28 February 2008 and were requested to express their acceptance no later than 15 March 2008. Detailed confirmation letters regarding attendance preferences and accommodation were sent by 2 April 2008.



*Number of applications and grants per region prior to the congress. (On-site applications and grants are not included.)*



Nearly 10% of the recipients initially selected declined or did not respond. After the meeting of the Geohost Committee about 370 late requests arrived, mainly from applicants closely involved in the Congress. Less than 20% of the awarded grants were cancelled due to refusal by the applicants or failure to respond. With the newly available funds it was possible to give some support to all the applicants included by the Committee on the waiting list, and to offer some grants to a few more late applicants, selected on the basis of their scientific contribution to the Congress. Due to a limited number of no-shows during the Congress as well as supplementary funds from the Organising Committee, it was possible to accept 73 on-site requests, and to offer all the Geohost participants free access to the Conference Barbeque.

In total there were 562 stipends allocated, 342 to men and 220 to women from 76 countries in total. This represented 61% of the total number of applications. All 571 were

granted waiver of the registration fee, 439 received free accommodation in Oslo for the duration of their stay during the Congress. No travel grants were awarded, as travel money in most cases could be obtained from national sources once registration and accommodation were granted.

The Geohost committee is most grateful for the separate Hutchinson funding to 20 candidates selected by the International Union of Geological Sciences (IUGS).

### GEOHOST APPLICATIONS AND GRANTS PER COUNTRY

Country	Submitted	Granted	Country	Submitted	Granted
Albania	3	2	Hungary	6	1
Algeria	5	1	India	97	76
Argentina	33	25	Indonesia	1	1
Armenia	4	2	Islamic Republic		
Australia	5	2	of Iran	96	47
Azerbaijan	7	4	Iraq	10	3
Bangladesh	7	5	Israel	2	1
Belarus	1		Italy	15	3
Belgium	1	1	Ivory Coast		
Bolivia	1	1	(Cote D'Ivoire)	1	1
Botswana	3		Japan	4	
Brazil	61	41	Jordan	5	1
Bulgaria	6	2	Kazakhstan	9	5
Cameroon	6	5	Korea, Republic of	2	1
Canada	2	1	Kyrgyzstan	9	8
Chile	9	4	Latvia	3	1
China	37	14	Lebanon	1	1
Colombia	16	9	Libyan Arab		
Costa Rica	1	1	Jamahiriya	1	
Croatia	7	3	Lithuania	2	1
Cuba	2	1	Macedonia, Fyrom	1	1
Czech Republic	2	2	Malaysia	1	1
Egypt	14	6	Mexico	3	1
Estonia	3	1	Mongolia	4	3
Ethiopia	4	2	Morocco	14	6
Finland	1		Nepal	5	1
France	4	1	Netherlands	1	
Georgia	2		Nigeria	8	4
Germany	2		Norway	1	5
Ghana	2	2	Pakistan	16	5
Greece	1		Peru	3	1



GEOHOST APPLICATIONS AND GRANTS PER COUNTRY *cont.*

Country	Submitted	Granted	Country	Submitted	Granted
Philippines	1	1	Turkey	34	11
Poland	15	2	Ukraine	22	14
Portugal	4	1	United Kingdom	2	1
Romania	6	3	United States	11	3
Russian Federation	185	78	Uruguay	1	1
Saudi Arabia	1		Uzbekistan	31	26
Serbia and Montenegro	8	2	Venezuela	4	1
Slovakia	1	1	Vietnam	9	7
South Africa	2	1	Yemen	1	
Spain	5	3			
Sri Lanka	3	2			
Sudan	1	1			
Sweden	1				
Switzerland	1				
Syrian Arab Republic	3	2			
Tanzania	4	4			
Thailand	1	1			
Tunisia	11	6			



33IGC Poster presentations.



## REPORT OF THE FINANCES AND SPONSORSHIP WORK

The Congress PCO, Congress-Conference AS, was responsible for the continuous follow-up of the expenditure and income of the 33IGC, and thereby to regularly update the budget. The budgetary situation was an agenda item in all meetings of the Executive and Organising Committees. The level of cost in Norway is high, and in order to keep the participant fees at an acceptable level it was necessary to attract sponsors to support roughly half of the estimated costs. Therefore, several members of the Organising Committee, and in particular the VP Finances, were heavily involved in the sponsorship work. As can be seen from the overview table of income (below) this work turned out quite successful, as slightly more than 50% of the total budget of 51,748,790 came from external sponsors. The list of sponsors is shown below, but the Congress could not have been held without the generous support of the main industry sponsor, StatoilHydro (now Statoil), and from the Norwegian Government. The Geohost Programme was possible only through the contribution of NOK 3 million from the Norwegian Ministry of Foreign Affairs.

The table of income and expenditure (following page) is relatively self-explanatory, but a few items should be mentioned in particular. The high cost of the Congress venue is partly caused by the need to hire and build extra auditoriums in the main halls of the centre. Large resources were spent on promotion, and this included establishing and maintaining the website, as well as running a campaign on Google for a long period before the abstract deadline. In addition, this budget item also covers the hire of a professional media company to assist in promoting the Congress to the national and international media before and during the Congress, an effort that proved successful. The high cost of running committees also covers the cost of running the Science Secretariat in Uppsala, Sweden; hence this item includes a large amount of work on the scientific programme as well as salaries. The agreement with the Norwegian State Railways (NSB) to provide transportation between the city and the venue as part of the registration fee was very valuable, and NSB is greatly acknowledged for their efforts to provide an efficient and reliable service. The Lunches and coffee item was costly because all catering at the venue was regulated through an agreement between the venue and the hotel, which prevented us from receiving bids through an open competition among potential caterers in order to lower the cost. The committee decided at an early stage to hold an opening ceremony “out of the ordinary”, and the relatively high expenses were according to the original budget for this event. The idea of using students from all Nordic countries as staff during the Congress was a success. The costs of travel, food, accommodation and a per diem for the students are included in the Congress staff item. The actual costs of the Geohost programme are higher than

shown in the table, as explained in the notes. Regarding the PCO fees, the actual costs of hiring the PCO are considerably higher, as a fee on all invoices are included in all the other items on the list of expenditures. Roughly half of the items on miscellaneous and unforeseen costs are also costs of the PCO’s work related to sponsors.

Not included in the budget items listed below are expenses related to the production of the General Proceedings and additional work during the period after the closing of the 33<sup>rd</sup> IGC. These expenses are covered by the Nordic Foundation for the 33<sup>rd</sup> IGC.

## LIST OF SPONSORS

### Main sponsor:

Statoil (NOK 8 mill.)

### Sponsors NOK 1-3 million

Norske Shell  
Norwegian Ministry of Foreign Affairs  
Norwegian Ministry of Petroleum and Energy  
Norwegian Ministry of Trade and Industry  
Norwegian Petroleum Directorate  
The Research Council of Norway  
Nordic Council of Ministers  
Norwegian Geotechnical Institute  
Geological Survey of Norway

### Sponsors NOK 0.5-1.0 million

Saudi Aramco  
Norwegian Ministry of Education and Research  
Petroleum Geo-Services  
Boliden AB  
Store Norske Spitsbergen Grubekompani  
Det Norske Oljeselskap  
Dong Energy

### Sponsors < NOK 500,000

Maersk  
The Swedish Research Council  
Oslo Municipality  
Swedish International Development Co-operation Agency  
Geological Survey of Finland  
European Science Foundation  
International Union of Geological Sciences  
Det Norske Veritas  
Altinex Oil  
Lundin Norway  
RWE Dea Norway  
Omya  
  
Elkem Solar  
Intex Resources  
Crew Minerals  
Nordic Mining  
Petro-Canada  
Talvivaara Mining Company  
NunnaUuni  
Areva





Agnico-Eagle Mines Limited  
Fugro-Geoteam  
Mondo Minerals

International Research Institute of Stavanger  
Aker Restaurantene

## INCOME AND EXPENDITURE

INCOME	NOK	EURO
Main sponsor StatoilHydro (now Statoil)	8,000,000	1,012,658
2 <sup>nd</sup> sponsor SHELL	2,000,000	253,165
Other industry sponsors	4,785,800	605,797
Research Council of Norway (RCN)	1,500,000	189,873
Nordic Council of Ministers	1,067,619	135,142
Norwegian government (Ministries of Foreign Affairs, Oil & Energy, Commerce and Trade, Research and Higher Education)	8,200,000	1,037,975
Oslo Municipality	200,000	25,316
From other Nordic countries, IUGS, and ESF for the Geohost Programme (see Geohost report)	363,861	46,058
<b>Total Sponsorship</b>	<b>26,117,280</b>	<b>3,305,985</b>
Delegate fee	15,466,354	1,957,766
Accompanying persons	421,190	53,315
Youth Congress	18,480	2,339
Abstract fee	1,551,690	196,416
GeoExpo	2,351,728	297,687
Field trips	4,215,019	533,547
Opera and BBQ tickets	553,597	70,076
Financial income / expenses (interest, exchange rates, etc.)	1,053,441	133,347
<b>Total income</b>	<b>51,748,779</b>	<b>6,550,478</b>
<b>EXPENDITURES</b>		
Congress venue, (all AV and ICT facilities, poster boards, security, cleaning, etc.)	12,001,698	1,519,202
Printed material (Programme, circulars, <i>Episodes</i> issue, etc.)	2,042,692	258,569
Promotion, outreach, and communication	4,445,553	562,728
Committees, science secretariat, secretary general, 33IGC Nordic Foundation (all running costs, travel, etc.)	7,161,119	906,471
Invited speakers (mainly "Themes of the Day")	652,706	82,621
Abstract handling	2,235,097	282,924
Transport pass between Oslo and the Congress Centre	1,253,772	158,705
Lunches and coffee	4,214,402	533,469
Social events (Icebreaker, BBQ, Opera, Sightseeing trip)	2,795,536	353,865
Opening Ceremony	1,101,348	139,411
Congress staff, incl. 100 Nordic student helpers	2,147,625	271,851
Signs, banners and flowers	379,328	48,016
Geohost costs - accommodation, on-site payout, secretariat expenses <sup>1)</sup>	2,113,351	267,513
Field trips	4,952,067	626,844
Misc. Costs and unforeseen	687,268	86,996
Bank and credit card costs	593,399	75,114
PCO direct fees and office expenses	2,535,239	320,916
IUGS fee	436,590	55,265
<b>Total expenditures</b>	<b>51,748,790</b>	<b>6,550,480</b>
Deficit	-11	-1

<sup>1)</sup> Other Geohost expenditures, such as transport pass, icebreaker party, BBQ dinner, lunches and coffee, etc. were part of the participation fee which were covered through the Geohost stipend and are included in other items in the list of expenditures. Total Geohost Programme cost is NOK 3,530,000 (EUR 446,835 using an exchange rate of 7.90).



## ADVISORY BOARD REPORT

### Mandate

The Advisory Board was composed of representatives from a wide range of sectors; industry, science organisations, geoscience associations, management, etc. The members were all senior representatives within organisations that are relevant for geoscience, with the majority coming from the Nordic countries. The Chairman was Gunnar Berge, Director (since 2008 Former Director) of the Norwegian Petroleum Directorate and former Norwegian Minister of finance.

The main objectives for the Board were to provide advice to the 33IGC Organising Committee in order to ensure that the “Geoscience World Congress 2008” (IGC-33) in the best possible way addressed themes that are important for society at large. Board members were welcome to promote themes or symposia within the programme.

The Advisory Board supported in emphasising the important role of Earth Sciences in a modern sustainable society. The Board comprised of about 20 members, and was scheduled to meet once per year in 2006, 2007 and 2008.

### Meetings of the Board

The 33IGC Advisory Board met twice; on October 20 2006, at NGI, Oslo, Norway, and October 19 2007, at the Norway Convention Centre (the Congress venue). A Board meeting planned for spring 2008 was decided unnecessary, as necessary communication with Board members was maintained through email.

The Board consisted of key persons from industry and academia in the Nordic countries, Russia and the UK. The 33IGC President, Secretary General, VP Science Programme and VP Finances participated in both meetings. All Board members were invited to attend the Congress.

The Organising Committee benefited hugely from the discussions with the Advisory Board and the suggestions and recommendations provided by the Board. All aspects of the Congress were discussed in the Board meetings, and particularly important input included:

#### *Science Programme:*

All aspects of the programme were discussed, but particular emphasis was placed on the “Themes of the Day”. The Board was instrumental in suggesting several of the themes and to suggest topics and speakers under each theme.

#### *Finances:*

The Board provided very useful advice on Nordic and international sponsorship possibilities related to the main scientific themes of the Congress. The Board also provided

quality assurance on parts of the Congress budget.

#### *Communication:*

Various communication issues and how to approach media were discussed in the Board meetings. The Board first suggested webcasting of the Themes of the Day. This was the first time IGC provided webcasts, which proved to be very successful.

#### *Geohost Programme:*

As several of the Board members represented companies with international activity, the Board also had many useful suggestions which were put into place to improve the Geohost Stipend Programme.

The 33IGC Advisory Board differed somewhat from previous similar boards in its composition and focus. The idea behind it, as stated in the mandate, was to ensure adequate societal relevance of the Congress. While strictly scientific matters were handled by the Science Secretariat and the Science Committee, the Advisory Board acted more as “guard dogs” ensuring that the science programme as well as other parts of the Congress reflected relevance for society. This approach worked very well, and similar arrangements can definitely be recommended to future IGC organizers.

## COMMUNICATION COMMITTEE REPORT

### Communication sub-committee

33IGC decided in September 2006 to form a communication subcommittee, with the following remit:

- \* To define communication needs for important communication phases before and during the congress
- \* To define goals and target groups, and recommend cost effective communication channels

The subcommittee included Ms Berit Forbord Moen, VP Communication representative of the 33IGC Organising Committee from August 2006); Mr Henrik Højmark Thomsen (GEUS - Geological Survey of Denmark); Mr Halfdan Carstens (Geo Publishing, Norway) and later Ms Anna Kim-Andersson (Qi-Media, Sweden) and Mr Arild Foss (Web Editor, UK).

Objectives for the communications activity were defined, and a communications strategy with concrete tasks developed. The initial September 2006 version was discussed in 33IGC OrgCom and ExCom, and revised several times.

It was agreed that [www.33igc.org](http://www.33igc.org) would be the primary channel of communication. An operational media strategy was formulated June 2008, in order to work strategically with press and media outlets domestically and abroad in the phase prior to and during the congress.



The following key values for the congress were agreed in OrgCom autumn 2007, and also fed into communications activities:

- \* Professional and innovative approach
- \* Friendly and inclusive atmosphere
- \* Environmental focus and transparency in all activities

### Brand and identity

33IGC commissioned marketing agency Bennett, Trondheim, to develop design and corporate branding for the congress, in addition to providing support in developing communications material.

Development of the design programme was initiated August 2006 and finalised October 2006.

### Publications

The First Circular, published May 2006, was the first publication incorporating the new IGC design. The process proved relatively labour intensive and costly. The First Circular was produced as an A4 format 52-page publication, with a circulation of 20,000 copies.

Two revised versions were subsequently issued - the first printed in 5,000 copies April 2007 and 2,000 amended copies October 2007, and the second published online at [www.33igc.org](http://www.33igc.org).

### Initial publicity material

- \* An A4 format poster was produced and published online as a downloadable PDF file April 2006, with revised versions published online in March and December 2007.
- \* A six page 10x21 cm-format leaflet was produced for general issue.

First print March 2006 (10,000 copies) - updated April 2007 (5,000 copies), May 2007 (20,000 copies), August 2007 (5,000 copies, sent to Australia), February 2008 (2,000 copies), April 2008 (2,000 copies). Total printed: 34,000.

### Marketing

The strategic marketing challenges were:

- \* To advertise the congress in order to encourage maximum amount of bookings as early as possible
- \* To communicate key information both to those who already knew about the congress, and those who were unfamiliar with IGC. Crucial information to be communicated included registration deadlines, abstract submission, excursion participation, hotel and plane bookings, and social events
- \* To develop a congress website, which would function as an effective communication channel both in terms of time, impact, and information output in relation to cost. To use the website proactively as a marketing tool and communication channel.

### Event marketing

A large banner and roll-up were produced to promote 33IGC at conferences and events. The final year before the congress 33IGC was promoted in this way at five major

international conferences and three Nordic events. The promotional impact in numbers of IGC participants is difficult to assess, however it was essential to be represented - particularly in terms of recruiting exhibitors, where personal contact is valuable. The stands also offered an opportunity to give updated information about 33IGC.

Another popular stand element was a bowl of sweets, which attracted a number of visitors. A continuous Flash animation on a computer screen on the stand served as an informative and attractive visual element.

500 green pens with the text "Welcome to Oslo 2008", 2,500 small wing clips with 33IGC logo, and 8,000 logo pins were produced as promotional giveaway items. The wing clips proved particularly popular.

Attracting participants to a congress held only every four years is challenging, and event marketing is especially important to reach potential exhibitors and participants.

### Website

A dedicated website with the URL [www.33igc.org](http://www.33igc.org) was developed and launched April 2006. Marketing and web media agency Bennett developed and managed the web content management system including design and functionality. Content was delivered by the IGC Organising Committee, which also held responsibility for publishing content on the website. It became necessary to hire a dedicated web editor from November 2006. The web editor, based in the UK, worked online for an hourly fee.

The website was the core communication channel before, during and after the congress, offering the opportunity to steer relevant information to different target audiences. Significant efforts were made in optimising content and phraseology to ensure visibility and maximize hits from search engines.

During the congress the website was integrated with a separate Scientific Programme search facility for display and search functions, which proved very popular. A sample of the lectures were made available as webcasts, with several lectures accessible in an online archive.

Main figures and statistics for [www.33igc.org](http://www.33igc.org) 29/3/2007 - 14/8/2008:

Total amount of visits: 510,387

Total amount of page hits: 6,078,972

Average viewing time: 5.28 mins

This is considered a high rate of visits and a long viewing time, indicating that many visitors found relevant content.

### Online marketing

Paid advertising in print publications was not part of the congress promotion, as it was deemed too costly and would only reach a limited readership. Instead a search engine advertising test was carried out to measure the impact of advertising on Google, and the effect on traffic



and activity on the 33IGC website. The Nordic countries, Russia and other selected European countries were targeted for maximum exposure to the advertisements, which were displayed when selected IGC-relevant key words were searched.

The test was run throughout a month and proved so successful that web advertising was carried forward and expanded to global coverage. A strategy was developed for creating targeted key word advertisements for the different congress themes, in addition to focusing on the Geohost Stipend Programme in relevant countries.

Results from key word advertising on Google 29/3/2007 - 14/8/2008:

93,273,676 advertisement displays

114,472 clicked on our search word advertisements

3,151 of these clicks went to the registration section

### Email newsletter

The web management system provided by Bennett included an option to sign up for newsletters. Ten newsletters were produced and issued via email to 9,500 registered recipients. The last newsletter was issued 24/7/2008. This activity resulted in 14,000 visits.

### Website development and content

The structure of the website was developed in cooperation with Bennett. The website used a frame structure, where the topmost part of the web page displayed the IGC banner and link buttons to key sections Scientific Programme, Excursions, General Information, Registration and Contact (shortly before the congress buttons for Press room and Webcast were added). Due to the frame solution this information was displayed on all pages.

The link menu in the left hand margin featured more dynamic links and reflected changing priorities; the registration link on the front page was for instance moved toward the top when important deadlines approached. This combination of static (but crucial) links on the top and dynamic linking in the margin flagging important links proved very useful.

### Navigation

A particular challenge was to create an intuitive structure and easy navigation for the Scientific programme and Excursion sections, which included a wealth of detail about symposia, workshops, abstracts, excursions and field guides.

The most practical solution we settled on for the Scientific Programme was to use the link menu in the left margin to link to different programme section, with a further "drill down" menu in the right margin combined with an overview page linking to details for specific symposia. For the excursion section a similar structure was used. However the excursion front page displayed a clickable map providing an alternative direct link to each excursion, an option which also proved popular.

### Web contact liaison

Content updates on the website depended on liaison between the webmaster, three main OrgCom contacts (communications, scientific programme, excursions), event organizer Congress-Conference (registration, hotel bookings, social programme) and website provider Bennett (banner frame, Flash animations, sponsor logos). These multiple contacts meant that clear and efficient communication was crucial to avoid confusion and overlap. The process went well, which is largely due to clearly defined areas of responsibility, clear deadlines for gathering/submitting material, and close liaison at all times.

### Webcast

As part of the communication activities a webcast team was active throughout the IGC congress. The team consisted of staff members from a web media company and media students. Their main task was to cover lectures from the plenary hall. Most of the plenary hall speeches, "Themes of the day" lectures and the closing ceremony were broadcast, in addition to other IGC events. A webcast studio was centrally situated in the venue, attracting significant attention from the participants.

It is difficult to measure audience numbers for webcast transmissions, but some polls indicated approximately 200 viewers. After the IGC there have been a number of comments, mainly queries about why some lectures weren't streamed, or others looking for particular lectures. We believe we reached many people outside IGC with webcasting, in addition to offering participants the option to watch interesting lectures after the congress.

Webcasts could increase the value of attending the IGC, and has a significant value as an archive for 33IGC. Webcasting represents a cost effective opportunity for global mass communication, enabling live presentations to be broadcast over the internet to a large audience. Our experience is that webcasting was a great success, with a very positive feedback to GeoTV.

### Scope for website improvement

The web strategy has confirmed that a website with appropriate functionality and content can be very useful for the congress. The website could be developed further with a "my page" function to encourage repeated visits and make it more attractive for users to register. The web solution for registering at 33IGC did not have this option, which only became apparent late in the process. This functionality should be a priority for subsequent IGCs.



## AN EVALUATION OF COMMUNICATION, MEDIA RELATIONS AND RESULTS

### Background

The communications agency Gambit Hill & Knowlton (Gambit H&K) in Oslo was commissioned for IGC media relations support at Oslo/Lillestrøm 6 – 14 August 2008. The objective was to create attention about the congress in the media. The IGC aimed to have editorial coverage in local, national, Nordic and international media. Norwegian media was the most important channel for the IGC. It was essential for our sponsors that the congress was covered in the media.

A media team was established medio June, consisting of 33IGC Director of Communications Berit Forbord Moen (NGU, Norway), Senior Press Officer Anna Kim Andersson (Qi-media, Sweden), and a press team including Marie Louise Wiklund (GTK, Finland), Gudmund Løvø (NGU, Norway), Tove Aune (NGU, Norway), Halvdan Carstens (GeoPublishing, Norway) and Arild Foss (UK); five of the team members were professional journalists. Layout of "Daily News": Ulla Vibeke Hjuler (GeologiskNyt, Denmark). Webcast: Asgeir Knudsen (project coordinator, 33IGC). The media team worked in shifts around the clock in the IGC press centre during the congress. In addition we had two geology students and two media students in the press centre, and four media students working with webcast together with a team manager.

### Process

Gambit H&K assisted the IGC on communication and media relations from 16 May to 1 September 2008, liaising with IGC through meetings and correspondence via email and telephone. The media relations activity was organized in three phases. Phase 1 from 1 Mai to the middle of June: Planning of the communication strategy and media plan. Phase 2 from middle of June to the start of the conference: Proactive media relations, operative work and preparing media pitches. Phase 3: Operative press centre, press releases, media relations and news surveillance. After the conference there was an evaluation of the media process.

### Pre-Congress activities

Gambit H&K developed a media plan and strategy with input and feedback from the 33IGC ExCom and OrgCom. The media plan outlined the target, topic groups, key messages, partners and spokespersons, media pitches and media outlets.

Media pitches were developed in cooperation with scientists. A range of media and journalists were approached based on the background information.

A meeting was held with *Aftenposten*, one of the major Norwegian newspapers, where a range of themes and news angles were suggested. The newspaper published four articles during the congress.



*IGC banners in Oslo.*

A list of media liaison activities was developed. The list included specific media outlets and journalists to be contacted, news angles for media pitches, responsibility for follow-up, and spokesperson. Status was frequently reviewed and communicated with IGC (Press Officer and Director of Communications).

### Mid-congress activities

A press centre was established with dedicated workspace for journalists including PC, printer, secretary function, and simple refreshment facilities providing coffee, tea and fruit. The press centre was manned at all times, and the journalists were given tips on stories and assistance in arranging interviews. The journalists were accredited through the press section on [www.33igc.org](http://www.33igc.org) or by registering at the IGC venue.

In total 63 accredited journalists attended from 14 countries, including 31 from Norway, 4 from other Nordic countries, 7 from Germany and 6 from China.

The press centre included a production room for the media team responsible for Daily News and press releases, and informal press gatherings and one-to-one interviews as more traditional press conferences after the panel debate attracted little interest. To launch OneGeology the British Geological Survey (BGS) arranged a press conference in cooperation with the media team, and it was highly successful. There was also a high demand for running updates to accredited journalists, and queries from other media both domestically and from abroad.

In total eight "Daily News" were produced, consisting of a two-page information sheet with interviews and news about lectures, excursions, social programme, exhibitions and sponsors. The "Themes of the Day" programme was presented each day, with Themes highlights covered the next day. The Daily News were printed at the site and handed out by the entrance. It was easily accessible both as print copy and through the website, and became a popular publication during the congress.





During IGC Gambit H&K drafted a daily press release based on the theme of the day. 25 press releases were produced, five in Norwegian. These were signed off by the media team before they were published on the web. Media pitches to editors and journalists were made by Gambit H&K, while the distribution of press releases was divided evenly between Gambit H&K and the press centre.

Gambit H&K assisted the press centre with additional staff during the congress when it was needed. There was close daily liaison and cooperation between the press officer and Gambit H&K, with the latter providing advice for a range of communication matters during the congress.

Each day Gambit H&K scanned Norwegian and international media for news related to the congress. The results were summed up and reported to the press centre and to the web editor in order to publish media coverage links on the website.

### Post-Congress activities

News monitoring and reporting to the web editor continued several weeks after the congress. The evaluation of results regarding media coverage about IGC or specific themes from the congress was initiated. An evaluation meeting with Gambit H&K and 33IGC was held on 2 October 2008, concluding with recommendations for 34IGC.

### Media coverage

Impact on media coverage, both national and international, has been very good.

#### Press coverage

News monitoring of print media in Norway shows a count of 24 articles about the 33IGC or some of the topics from the media pitches based on themes or abstracts from the congress. Non-Norwegian print articles have not been registered.

#### Web coverage

There were 54 articles from 33IGC on the web, 23 from Norwegian websites. The search criteria were different versions of the phrase “International geology congress”. However non-English websites were not tracked.

#### Broadcast coverage

The IGC opening ceremony was covered on Norwegian national television and radio.

TV2 *Nyhetskanalen* broadcast a debate the morning of the IGC launch day with the President of the IGC, Arne Bjørlykke, and the Minister of Higher Education in Norway, Mrs Tora Aasland, discussing research and recruitment in the context of the biggest science conference ever held in Norway. This emphasised one of the key messages of the media strategy - highlighting geoscience, importance in the future and recruitment.

NRK *Dagsrevyen* and NRK *Kveldsnytt* covered the opening ceremony with the arrival of HM King Harald of Norway

and footage of the exhibition venue. The news angle was geohazards and the risk of rockslides and tsunamis in Norway. Spokesperson was the IGC General Secretary Anders Solheim. This was followed up by VG, the largest Norwegian newspaper, a few days later. TV Romerike/TV Norge covered the opening ceremony in the plenary hall and King Harald inflating the 15 metre long Plesiosaur replica (a replica of fossils found in Svalbard by paleontology professor Jørn H. Hurum).

NRK regional broadcaster NRK Telemark had coverage of one of the IGC excursions, to Gea Norvegica. NRK *Ut i Naturen* included extensive interviews with Professor Hurum (on paleontology and sponsoring) and Anders Solheim (on geology for society and the IGC). NRK *Verden på lørdag* covered the energy theme day and interviewed three of the speakers, eg. Charles Hall.

International broadcasters were represented by Canadian, Chinese and German TV crews. They interviewed several IGC participants and speakers. A German radio station broadcast telephone interviews with three of the speakers on the topic of water and human health.

### News clippings and value

There are different methods for calculating news clippings and value. Gambit H&K has a moderate approach for calculating value, i.e. a 1:1 ratio of costs connected to advertisement for equivalent broadcast time or columns in print magazines. Estimated news clippings value for media coverage (print and broadcast media) of 33IGC is NOK 1-1.4 million. As an example, the two minute segment on NRK *Kveldsnytt* was worth NOK 364,900.

Coverage online or in international media is not included in this calculation.

### Recommendations for future IGCs

These are some areas of improvement for future IGCs. Suggestions include:

- Start planning a communications strategy early in the process.
- If a communications agency will be involved in media relations support, involve the agency early in the process.
- Close liaison between the scientific committee and the communications department, in order to source interesting and newsworthy abstracts or special symposia from the scientific programme for media pitches.
- Choose themes of great importance. Identify degree of newsworthiness and media angles.
- If possible try to pre-produce press releases before the congress starts. This will save time when activity levels rise and free up resources for more operational activities, such as personal telephone follow-ups to editors and journalists, and assisting accredited members of the press room.
- Ensure the press centre has sufficient staff. Organise



staff shift rotas with regular breaks. Nine days (eleven including preparation days prior to congress launch) and long hours will be a hard schedule without properly organised shifts.

- Test the sponsors' expectations regarding profiling and media coverage in advance to make sure their expectations can be fulfilled. This strategy might help avoiding discussions with the sponsors when the workload is high.
- Ensure that some major news items are presented during the congress, eg. the launch of OneGeology, the USGC special symposium and their new report on oil and gas resources in the Arctic. These events were regarded as particularly newsworthy by both Norwegian and international news media.

*The report "An evaluation of Communications, Media relations and Results" is available upon request.*

## YOUTH CONGRESS REPORT

The Youth Congress was organised by Bodil and Jan Evensen, and arranged in cooperation with the Natural History Museum of the University of Oslo. This initiative was meant to offer young people an opportunity to gain a first acquaintance with Earth's history and past life as well as extending their knowledge in history and natural sciences.

Thursday 7 August, the first day of the Youth Congress, was spent at the Natural History Museum where the exhibition 'Messel on tour' was displayed. This exhibition shows well preserved fossils from the rainforest covering Europe 47 million years ago, including bats, crocodiles, turtles and prehistoric horses. The participants also learned the history of the newly discovered Plesiosaurus and Ichthyosaurus from Svalbard, and met the huge dinosaur exhibit 'Stan'.

Friday 8 August the youngsters spent the day at Hovedøya, an idyllic island in the Oslo Fjord where the participants could explore the ruins of a medieval monastery and go hiking in secret tunnels. The island is also a popular area to explore a unique flora of plants originally imported and cultivated at the monastery, and to go fossil hunting.

On Saturday 9 August the plan was to hike the impressive Kolsås geological profile and learn the history of the Oslo Rift and its ancient volcanic activity, however this was cancelled due to heavy rain. Instead the participants enjoyed a visit to the famous Holmenkollen ski jump and the Vigeland Sculpture Park in Frognerparken, where an impressive set of sculptures made from bronze and Iddefjord granite shows different expressions of human life.

Monday 11 August the group travelled to Røverkollen

("Robber's Hill") where they could go treasure hunting. It is still possible to find sparkling garnets and rock crystals as well as copper minerals in the old mines, and there are also some bats living there. The site includes burial mounds from the Bronze Age as well as a spectacular view of Oslo, the Oslo Fjord and the surrounding forests.

Tuesday 12 August started with a boat trip to the peninsula Bygdøy and to the Viking Ship Museum, where the unique Oseberg and Gokstad longboats, representing the largest finds ever made in Norway, are displayed. The excavated household items also show how people lived in the 9<sup>th</sup> century. Next stop was at Thor Heyerdahl's Kon-Tiki Museum with its famous "Kon-Tiki" raft on display along with the papyrus boat RA-II and other items pertaining to Heyerdahl's many expeditions.

On the final day, Wednesday 13 August, participants took a bus tour to the old Kongsberg silver mines, where they boarded a 'mining train' taking them deep into the mountain. Inside the mine the children could participate in a treasure hunt, and outside the mine entrance there were activities like "find your own silver" and "find your own minerals". The participants could also make their own silver coins.

We highly recommend arranging a Youth Congress for subsequent IGCs. It offers an inspiring introduction to science, culture and history for young people who are attending the main congress with their parents and/or grandparents. After a few days "in the field" it also develops into a stimulating meeting place for young minds where they make new friendships across global cultural divides. This is a very important aspect and was certainly reflected at the gathering in Oslo.

However, the age group 7-16 years is too wide and represents an almost impossible challenge both for the organizer and the participants with regard to language barriers, individual maturity and mindset. It is therefore strongly recommended to divide the program into two groups - i.e. *Teenagers 12-16 years* and *Children 7-11 years*. This would enable the program content to be suitably tailored to the age groups involved.

## GEOEXPO COMMITTEE REPORT

The GeoExpo committee consisted of Marianne Graff Nesse (PCO Rep. Committee chair), Anders Solheim (Secretary General) and Ellen Ramberg (VP Operations).

An area of 1700 m<sup>2</sup> was assigned for the exhibition, and invitations were sent out for exhibition stand allocations on a 'first come first served' basis, following a broad allotment into 'courts' for different categories of exhibitors (for instance Petroleum companies, Mineral industries, Geological surveys, Publishers etc.) This type of allotment



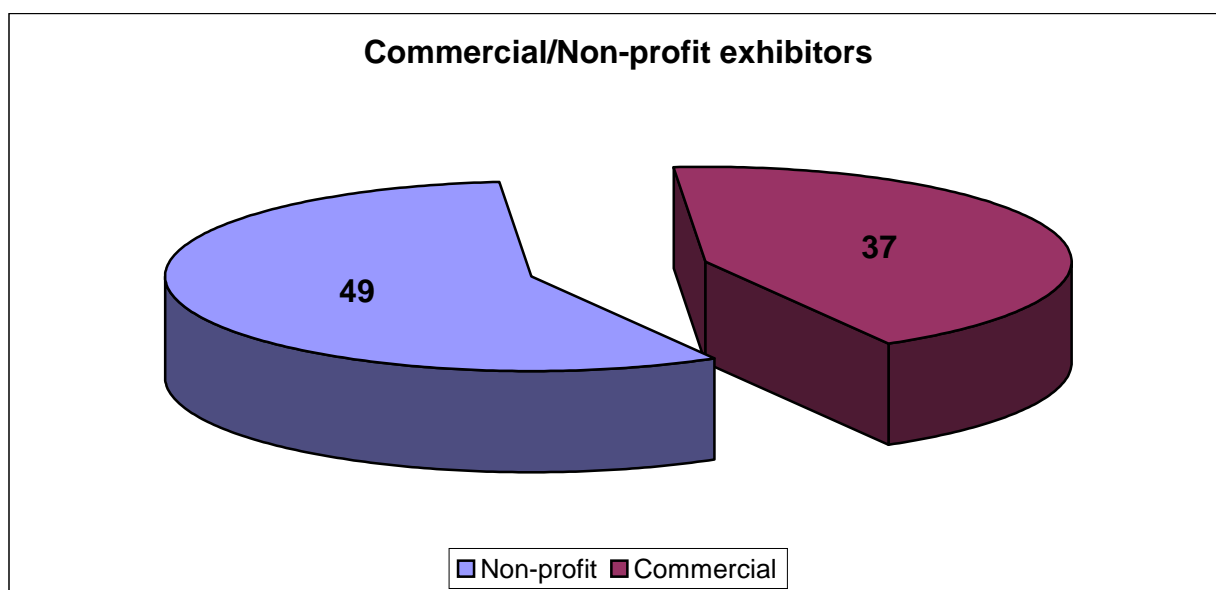
gave the exhibition a good structure and made it more easily accessible.

The exhibition opened on 6 August and closed on 14 August, and attracted great interest from the audience. Exhibitors from 30 countries from all over the world participated in GeoExpo 2008, with 86 exhibition areas composed by one or more stands, representing a varied mix of industry, geoscience associations and societies, publishers and various governmental organisations. Norway was the largest country with 17 exhibitors, followed by USA, Germany, United Kingdom, Denmark and Italy. Non-profit bodies comprised 58% of the total number of exhibitors, while 42% were profit-making organisations.

The exhibition became a favoured meeting place for the congress participants, and the exhibitors were very pleased with the number of visitors and the interest they were showing. Several of the industry exhibitors were particularly interested in the many geology students present at the Congress and, we believe, a number of new employees were recruited during these days.



*The GeoExpo 2008 exhibition, with the Chinese stand.*



## LIST OF GEOEXPO 2008 EXHIBITORS

Company	Country
<b>Main Sponsors</b>	
Boliden Mineral	Sweden
Det Norske	Norway
Dong Energy AS	Denmark
Elkem	Norway
Intex Resources ASA (tidl Crew)	Norway
IRIS - International Reserach Institute of Stavanger	Norway
IUGS - International Union of Geological Sciences	Norway
Maersk Olie og Gas AS	Denmark
NGF - Norsk Geologisk Forening	Norway
NGI - Norges Geotekniske Institutt	Norway
NGU - Norges Geologiske Undersøkelser	Norway
Nordisk Ministerråd	Denmark
Norske Shell	Norway
OMYA	Switzerland
PGS - Petroleum Geo-Services	Norway
StatoilHydro	Norway
Store Norske Spitsbergen Kulkompani AS	Norway
<b>Other Exhibitors</b>	
Australia 2012 - 34th International Geological Congress	Australia
AAPG - American Ass of Petroleum Geologists	USA
Activation Laboratories Ltd	Canada
American Geological Institute	USA
Asociacion de los Servicios de Geologia y Minería Iberoamericanos, ASGMI	Brazil
Beta Analytics Inc	USA
BRGM	France
British Geological Survey	United Kingdom
Bundesanstalt für Geowissenschaften und Rohstoffe	Germany
Cambridge University Press	United Kingdom
CGMW - Commission for the Geological Map of the World	France
Committee of Geology and Suboil Use of the Ministry of Energy and Mineral Resources, Republ. of Kazakhstan	Kazakhstan
Copernicus org Meeting & Open Access Publications	Germany
Council for Geoscience	South Africa
C.S.G.S.r.l.- Centro Servizi di Geoingegneria	Italy
Czech Geological Survey	Czech Republic
DOSECC - Drilling, Observation and Sampling of the Earths Continental Crust	USA
Elsevier	The Netherlands
EuroGeoSurveys	Belgium
European Regions for Earth Sciences, IT, DE, ES	Italy
F.W.Breithaupt & Sohn	Germany
FLSMIDTH Automation	Denmark
Geobrugg AG, Protection Systems	Switzerland
Geocap AS	Norway



**LIST OF GEOEXPO 2008 EXHIBITORS cont.*****Other Exhibitors continued***

Geoforschungs Zentrum Potsdam	Germany
Geoinformation Center Geol Survey of Japan	Japan
Geological Delegation of China	China
Geological Society of America	USA
Geological Society of Yemen	Yemen
Geological Survey of Denmark and Greenland, GEUS	Denmark
Geological Survey of Finland	Finland
Geological survey of Iran	Iran
Geological Survey of Morocco	Morocco
Geotechnologien	Germany
HyVista - GeoModeller	Australia
IAMG - International Association for Mathematical Geology	Canada
IDS - Ingegneria dei Sistemi Spa	Italy
IMA - International Mineralogical Association	France
Indian Bid - IGC 2016	India
Instituto Geologico y Minero de Espana, IGME	Spain
Intergrated Ocean Drilling Program	USA
International Continental Scientific Drilling Program	Germany
Italian Geological Survey	Italy
IYPE - International Year of Planet Earth	Norway
Jacques Whitford Ltd	Canada
Jardfeingi (Faroese Earth and Energy Directorate)	Faroe Islands
Korea Institute of Geoscience and Mineral Resources (KIGAM)	Korea
Leica Microsystems CMS GmbH	Germany
Litografia Artistica Cartografica	Italy
Mosambique: Mineral Resources Capacity Building Project	Mosambique
Norsk Elektro Optikk AS	Norway
Norsar Innovation AS	Norway
Onegeology	United Kingdom
Oxford University Press	United Kingdom
PANalytical B.V. Branch Norway	Norway
Polish Geological Institute	Poland
Russia Geological Research Inst, VSEGEI	Russia
Selfrag AG	Switzerland
Society of Economic Geologists, SEG	USA
Springer Verlag GmbH	Germany
Sveriges Geologiske Undersökning, SGU	Sweden
Swedish Museum of Natural History and Stockholm University	Sweden
Taylor & Francis	United Kingdom
The Geological Society of London, Publishing House	United Kingdom
The Geological Society of Sweden & Swedish Ass of Scientists	Sweden
UNESCO	France
US Geological Survey	USA
Wiley -Blackwell	USA
2iC Australia Pty Ltd	Australia





## BUSINESS MEETINGS, WORKSHOPS AND SHORT COURSES COMMITTEE REPORT

The committee did not hold formal meetings, but worked on a continuous basis, particularly during the last year leading up to the Congress. A few main working principles were:

- Participants had to be registered for the Congress.
- 33IGC offered rooms for business meetings, workshops and short courses free of charge. Expenses for teachers, equipment etc. were to be covered by the course or workshop itself, through a fee.
- Registration to the events took place through the Congress website, as part of the Congress registration. All organising and communication with participants were handled by the organizers of the courses, workshops or business meetings.

- Most of these events were to be held on Sunday 10 August, when there were no other Congress symposia and most of the lecture rooms were available.
- Those who needed rooms for meetings or workshops but had not booked this prior to the Congress were offered rooms for rent. Rooms of various sizes were available from the venue or from the hotel attached to the convention centre.

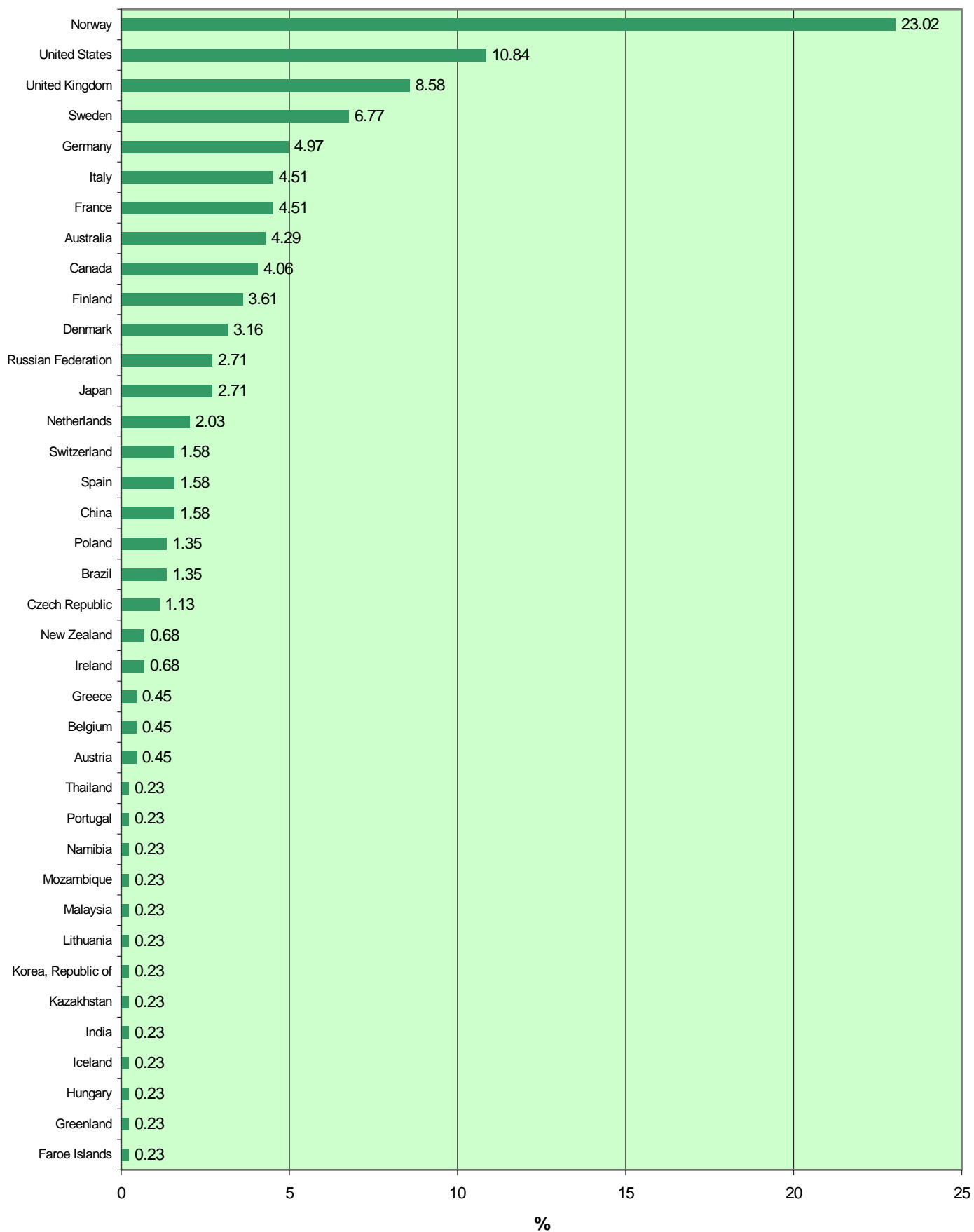
These principles worked reasonably well. Most meetings, workshops and short courses took place on Sunday 10 August, and the committee was able to accommodate those with needs of having their meeting at another time. The biggest problem was that some of the workshop or short course organizers did not show up. This was very inconvenient for the committee and, not the least, to the participants. A total of 96 business meetings and 20 workshops and short courses were held during the Congress.



*33IGC Opening day in the Congress Centre.*



**Conveners per country (%)**  
(those registered as conveners at the Congress only)



## THEMES OF THE DAY

### Themes of the Day - a new feature of the IGC

A new feature of the 33<sup>rd</sup> IGC were the “Themes of the Day” sessions. Aspects of geoscience of particular importance for society were chosen for seven of the Congress days. A lunchtime plenary lecture (as in Florence 2004 at the 32IGC) was promoted by the Congress main sponsor StatoilHydro, and termed the “StatoilHydro Lecture”. It was supported by a morning session of invited lectures focusing on the science and afternoon lectures on aspects of societal importance. Each day ended with a panel debate which also included input from the audience and questions from the press.

The themes of each day were:

*Wednesday 6 August:* Global geology (afternoon lectures only)

*Thursday 7 August:* Early life, evolution and biodiversity

*Friday 8 August:* Climate Change, past, present, future: How much is anthropogenic

*Saturday 9 August:* Geohazards: Can society cope?

*Monday 11 August:* Water, Human health, and the environment.

*Tuesday 12 August:* Mineral resources in a fast growing global economy: Are there any natural limits?

*Wednesday 13 August:* The energy race: What will be the future energy mix?

*Thursday 14 August:* Earth and beyond - a cosmic perspective (no afternoon session)

For the afternoon sessions key speakers included high level politicians such as the Danish Minister for Climate and Energy, the Icelandic Minister for Environment, and the Ethiopian Minister for Water Resources, who gave excellent presentations at the Climate Day, the Geohazards Day, and the Water Day, respectively. The “Themes of the Day” sessions attracted large audiences and were also attended by numerous single-day registrants. The sessions were streamed as online webcasts and could be followed through the congress website. Most of the webcast presentations have been archived and are still available on the 33IGC website ([www.33igc.org](http://www.33igc.org)).

### The Programme

#### Wednesday 6 August: Global Geology

Convener: **Arne Bjørlykke**, Geological Survey of Norway (Norway)

The importance of Earth Sciences in addressing global challenges is increasing, and new organisations such as the International Year of Planet Earth and OneGeology have been established to disseminate information and support increased visibility. Traditionally the UN and its organisations have been seen as the most important bodies in this context. There is, however, an increasing commercial market for geoscientific knowledge provided by web based companies, such as Google and others.

16:00-16:30 Global geology: past, present and future? **Eduardo de Mulder** International Year of Planet Earth, IYPE, (The Netherlands)

16:30-17:00: Formal launch of the OneGeology Project:

A 21st century map to change the world? **Simon Winchester** British Geological Survey, BGS (UK)

Local knowledge, globally accessible **Ian Jackson** British Geological Survey, BGS (UK)

#### Thursday 7 August: Early life, evolution and biodiversity

Convener: **Stefan Bengtsson**, Swedish Museum of Natural History (Sweden)

The symposium assesses important steps in the evolution of life and biodiversity on Earth and what we know from fossil records, 150 years after the publication of Darwin’s “The Origin of Species”. Darwin was a naturalist and covered many different disciplines. The importance of combining different natural sciences today is demonstrated in presentations on management and mapping of marine resources, as well as the deep biosphere where a significant amount of the Earth’s biomass is present.



- 08:30-08:33 Introduction **Stefan Bengtson**
- 08:33-09:00 The establishment of life on Earth **Minik Rosing** Copenhagen University (Denmark)
- 09:00-09:30 The great divide: life on Earth before and after the Ediacaran transition **Nicholas Butterfield** University of Cambridge (UK)
- 09:30-10:00 The evolution of reefs **Rachel Wood** University of Edinburgh (UK)
- 10:00-10:30 Coffee
- 10:30-11:00 Biodiversity through time **Douglas H. Erwin** National Museum of Natural History (USA)
- 11:00-11:30 Hominin evolution and environmental change **Lars Werdelin** Swedish Museum of Natural History (Sweden)
- 11:30-12:00 Darwin's "abominable mystery" **Else Marie Friis** Swedish Museum of Natural History (Sweden)
- 13:00-13:45 **(StatoilHydro Lecture)** The fossil record since Darwin: what do we know and what remains to be discovered? **Richard A. Fortey** Natural History Museum (UK)
- 14:00-14:30 Evolution, education and outreach – learning from the Jurassic reptiles **Jørn Hurum** Natural History Museum of the University of Oslo (Norway)
- 14:30-15:00 The deep biosphere; background, news, and implications **Ingunn Thorseth** Centre for Bio-Geology, University of Bergen (Norway)
- 15:00-15:30 The management of seabed resources; Actions of the International Seabed Authority **Satya Nandan** International Seabed Authority (Jamaica)
- 15:30-16:00 Coffee
- 16:00-16:30 Synergies of science at the U.S. Geological Survey **Suzette Kimball** United States Geological Survey (USA)
- 16:30-17:00 Ireland's mapping and management of seabed resources **Paedar McArdle** Irish Geological Survey (Ireland)
- 17:15-18:15 Panel debate
- 18:30 Press conference

### Friday 8 August: Climate Change: Past, Present, Future - How much is anthropogenic?

Convener: **Jörn Thiede**, Alfred Wegener Institute for Polar Research (Denmark) and University of Copenhagen (Denmark)

The climate has changed constantly throughout Earth history, but the rate of recent climatic change is causing much concern. The symposium looks at the paleoclimatic records and assesses various climate forcing factors, asking how much of the total change is anthropogenic. As the energy industry is one of the main CO<sub>2</sub> emitters, carbon capture and storage is an important issue addressed in the symposium. Other topics covered are the reliability of climate predictions, impacts of the present change, and the need for action to reduce impact.

- 08.30-08.35 Introduction **Jörn Thiede**
- 08.35-09.00 Paleoclimate: the deep and modern time perspective **Eystein Jansen** University of Bergen (Norway)
- 09.00-09.30 Cenozoic paleoclimates: greenhouse to icehouse **Peter Barrett** University of Wellington (Australia)
- 09.30-10.00 Ice cores and their paleoclimatic records **Hubertus Fischer** AWI (Germany)
- 10.00-10.30 Coffee
- 10.30-11.00 Ocean-atmosphere interaction and climate change **Peter Schlosser** Lamont-Doherty Earth Observatory (USA)
- 11.00-11.30 Solar variability **Willie Wie-Hock Soon** Harvard-Smithsonian Center for Astrophysics (USA)
- 11.30-12.00 Cosmic rays and climate change **Henrik Svensmark** Danish National Space Center (Denmark)
- 12.00-13.00 Lunch
- 13.00-13.45 **(StatoilHydro Lecture)** Links between late cenozoic paleoclimates and human history **Gerald Haug** ETH, Zürich (Switzerland)
- 14.00-14.30 How reliable are climate predictions? **Lennart Bengtsson** Max Planck Institute for Meteorology, (Germany); University of Reading (UK)
- 14.30-15.00 Climate concerns: carbon capture and storage **Olav Kaarstad** StatoilHydro (Norway)
- 15.00-15.30 Global change science in China: past, present and future **Xiaoping Yang** Institute of Geology and Geophysics, Chinese Academy of Sciences (China)
- 15.30-16.00 Coffee
- 16.00-16.30 Arctic climate: present and future perspective **Ola M. Johannessen** Nansen Centre for Climate Research (Norway)
- 16.30-17.00 Climate science and the need for action **Connie Hedegard** Danish Minister of Climate and Energy, (Denmark)
- 17.30-18.30 Panel debate
- 18:30 Press conference



**Saturday 9 August: Geohazards: can society cope?**Convener: **Suzanne Lacasse** Norwegian Geotechnical Institute, NGI, (Norway)

Landslides, sea level rise, subsidence in deltas, violent storms, earthquakes, floods and tsunamis hit our communities, causing loss of life and huge damage. Can we protect these communities, and should we build in areas threatened by natural hazards? Can we develop effective warning and emergency preparedness systems?

- 08:30-08:33 Introduction **Suzanne Lacasse**  
 08:33-09:00 Rock slide hazards: detection, assessment and warning **D. Jean Hutchinson** Queen's University (Canada)  
 09:00-09:30 Earthquake vulnerability: an engineer's perspective with a difference **Tiziana Rossetto** University College London (UK)  
 09:30-10:00 Tsunamis **Costas Synolakis** University of Southern California Los Angeles (USA)  
 10:00-10:30 Coffee  
 10:30-11:00 Volcanoes and their impact on human society **Stephen Sparks** University of Bristol (UK)  
 11:00-11:30 Geological considerations in quantitative offshore geohazards risk assessment **Philippe Jeanjean** BP Corporation (USA)  
 11:30-12:00 Early warning systems for landslides **Farrokh Nadim** University of Oslo, International Centre for Geohazards (ICG) and NGI (Norway)  
 12:00-13:00 Lunch  
 13:00-13:45 **(StatoilHydro Lecture)** Reducing the risks associated with natural threats **Herbert H. Einstein** MIT (USA)  
 14:00-14:30 A global approach to slope safety in Hong Kong **Raymond Chan** GEO Civil Engineering and development Department (Hong Kong)  
 14:30-15:00 Geophysical risks and society **Tom Beer** CSIRO (Australia)  
 15:00-15:30 Geo-risks: global trends, losses and risk management **Anselm Smolka** Geo Risks Research, Munich Reinsurance Company (Germany)  
 15:30-16:00 Coffee  
 16:00-16:15 The Ms 8.0 Wenchuan earthquake of May 12th, 2008, Sichuan, China **Shuwen Dong, Yueqiao Zhang, Zhenhan Wu, Non Yang, Zhengle Chen and Wei Shi, Meijian An** Institute of Geomechanics, Chinese Academy of Geological Sciences, Beijing, (China)  
 16:15-16:30 Social vulnerability and resilience to geohazards **Carsten Felgentreff** University Osnabrück (Germany)  
 16:30-16:45 Global patterns of disaster risk **Bob Chen** The Earth Institute, Columbia University (USA)  
 16:45-17:15 Hazard and risk mapping for landslides in quick clay **Kjell Karlsrud** ICG, NGI (Norway)  
 17:15-17:30 Geohazards in Iceland **Thorunn Sveinbjarnardottir** Icelandic Minister for the Environment, (Iceland)  
 17:30-18:30 Panel debate: Policy-making for prevention and mitigation of risks associated with geohazards  
 18:30 Press conference

**Monday 11 August 2008: Water, Human health and the Environment**Convener: **Olle Selinus** Geological Survey of Sweden, SGU, (Sweden)

People's lives depend on water, and the demand for clean water increases in line with population growth. Groundwater is an important and traditionally clean source for water, but urbanisation, industrialisation, and changes in land use cause problems and challenges related to pollution as well as political issues, since ground water reservoirs cross regional boundaries. The symposium covers many of these issues, presented by speakers from a variety of fields.

- 08.30 Introduction: **Olle Selinus**  
 08.30-09.00 Groundwater - principles and perspectives **Bo Olofsson** Swedish Royal University of Technology, KTH, (Sweden)  
 09.00-09.30 Cultural evolution and water-borne exposure pathways **Philip Weinstein** School of Population Health, University of Western Australia (Australia)  
 09.30-10.00 Health effects of arsenic in drinking water **Jose Centeno** Armed Forces Institute of Pathology, Washington DC (USA)  
 10.00-10.30 Coffee  
 10.30-11.00 Fluorine: water-rock-human interactions - a global overview **Mike Edmunds** Oxford University Centre for Water Research (UK)  
 11.00-11.30 Radon and health risks of radon in groundwater **Don Appleton, Jon Miles** BGS and UK Health Protection Agency, (UK)  
 11.30-12.00 Natural organic pollutants in groundwater: potential health implications **Robert B Finkelman, William H Orem** University of Texas, Dallas (USA)  
 12.00-13.00 Lunch





- 13.00-14.00 **(StatoilHydro Lecture)** A changing world: will there be enough water for all? **Ghislain de Marsily** University Paris VI, (France)
- 14.00-14.30 Climate change adaptation and water - examples of facing multiple challenges from sea level rise to water scarcity from a planning perspective **Philippe Schmidt-Thome** Geological Survey of Finland (Finland)
- 14.30-15.00 Risk management of groundwater contamination in the context of water safety plans **Roger Aertgeerts** Regional Adviser Water and Sanitation, WHO Regional Office for Europe (Switzerland)
- 15.00-15.30 Coffee
- 15.30-16.00 Why is groundwater neglected in water management discussions? **Anders Berntell** Stockholm International Water Institute SIWI, Stockholm (Sweden)
- 16.00-16.30 Global changes, an accelerating water cycle, adaptation strategies: can we cope? **Dr Roisin Rooney** World Health Organization (WHO) Regional Office for Europe, Rome (Italy)
- 16.30-17.00 Ethiopian groundwater resource management **Asfaw Dingamo** Ethiopian Minister for Water Resources (Ethiopia)
- 17.15-18.30 Panel debate
- 18:30 Press conference

## **Tuesday 12 August 2008: Mineral resources in a fast growing global economy - are there any natural limits?**

Conveners: **Pär Weihed** University of Luleå (Sweden), **Pierre Heeroma** Boliden AB (Sweden)

The world's mineral resources have been said to be a limit to growth. At present, metal prices are high and new resources of minerals are explored and exploited, using new technologies. Estimates of reserves always seem to be too low. The symposium looks closely at some mineral resources in particular and assesses the challenges facing the mining industry - and therefore important parts of society - in the years to come. China, as one of the largest and fastest growing economies, presents its views on the resource situation.

- 08.30-08.35 Introduction **Pierre Heeroma/Pär Weihed**
- 08.35-09.00 Advances in genetic studies of base metal deposits **Ross Large**, CODES (Australia)
- 09.00-09.30 Tomorrow's gold resources: where will we find them? **Rich Goldfarb** U.S.Geological Survey (USA)
- 09.30-10.00 Rare earth elements: a new scope of mining for saving energy and environment **Yasushi Watanabe** (AIST)
- 10.00-10.30 Uranium resources: today and tomorrow **Thimothy Gitzel**, Cameco, (Canada)
- 10.30-11.00 Coffee
- 11.00-11.30 Ocean floor mining **Steve Scott**, University of Toronto (Canada)
- 11.30-12.00 Global assessment of undiscovered mineral resources: opportunities and challenges **Michael L. Zientek**, U.S.Geological Survey (USA)
- 12.00-13.00 Lunch
- 13.00-13.45 **(StatoilHydro Lecture)** Mineral resources and reservoirs - why prognoses of reserves are always wrong **Neil Williams**, Geoscience Australia, (Australia)
- 14.00-14.30 Geology and mineral resources of China, **Meng Xianlai**, Geological Survey of China, (China)
- 14.30-15.00 Metal markets: A new corporate landscape emerging **Magnus Eriksson**, RMG, (Sweden)
- 15.00-15.30 Supply of mineral resources: mining in the European context **Lennart Evrell** New Boliden AB, (Sweden)
- 15.30-16.00 Coffee
- 16.00-16.30 Challenges of the European mining industry in the years to come **Corina Hebestreit**, Euromines (Belgium)
- 16.30-17.00 The European Union's view on the supply of mineral resources in the 21<sup>st</sup> century **Hans Sierd Pietersen**, European Union, GD Enterprise, Brussels (Belgium)
- 17.00-18.00 Panel debate
- 18:00 Press conference

## **Wednesday 13 August 2008: The energy race: what will be the future energy mix?**

Conveners: **Stig Bergseth**, **Kjell Arne Oppebøen**, **Anthony M. Spencer** StatoilHydro ASA (Norway)

The energy situation is a critical question in our modern society. Our dependency on fossil fuels also raises serious climate concerns. The symposium addresses the present situation regarding various energy sources, their potential, their impact, and their economy. Several important questions are raised on how the increasing energy demand can be met, and at what price.

- 08.30-08.35 Introduction **Stig Bergseth / Kjell Arne Oppebøen**
- 08.35-09.00 Conventional oil and gas: the global endowment **Ken Chew** IHS (Scotland)
- 09.00-09.30 Unconventional oil: 'tomorrow's oil' today **Robert Skinner** StatoilHydro Canada (Canada)



- 09.30-10.00 Unconventional gas: tight gas sands, shale gas, coal bed gas **Brenda Pierce** U. S. Geological Survey (USA)  
 10.00-10.30 Coffee  
 10.30-11.00 Hydrocarbon exploration in Europe: can we meet the energy demand? **Rien Herber** Shell (The Netherlands)  
 11.00-11.30 Coal: an energy source for future world needs? **Thomas Thielemann** RWE Power (Germany)  
 11.30-12.00 Geothermal energy and the energy race **Gudmundur Fridleifsson**, Hitaveita Suðurnesja hf (Iceland)  
 13.00-14.00 **(StatoilHydro Lecture)** The future energy mix - probabilities and policies **Mark Moody-Stuart**, Anglo American (UK)  
 14.00-14.30 Nuclear energy options **Sven Kullander**, Royal Swedish Academy of Sciences, (Sweden)  
 14.30-15.00 Renewable energy, innovation and peak oil **Jeremy Leggett** Solarcentury (UK)  
 15.00-15.30 The economic and environmental credentials of biofuels and fossil fuels **Marian Radetzki** Luleå University (Sweden)  
 15.30-16.00 Coffee  
 16.00-16.30 Energy return on investment and our economic future **Charles Hall** State University of New York (USA)  
 16.30-17.00 A sustainable energy future **Gunnar Gjerde**, Norwegian Ministry of Petroleum and Energy (Norway)  
 17.00-18.00 Panel debate  
 18.00 Press conference

#### Thursday 14 August 2008: Earth and Beyond - A cosmic perspective

Convener: **Birger Schmitz** Lund University (Sweden)

Some of the world's most renowned scientists highlight recent developments in planetary research, providing a new understanding of our place in the universe. Topics include the search for Earth-like planets in other solar systems, the role of asteroids and comets for the evolution of life on Earth, water on Mars and its possible significance for extraterrestrial life, the meteoritic perspective on the condensation of the solar nebula, volcanism and impact cratering in our solar system, and the ultimate question: How might Earth's habitability come to an end, making it no longer Earth-like?

- 08.30-08.33 Introduction **Birger Schmitz**  
 08.33-09.00 From gaseous giants to rocky planets: Search for extrasolar planets **Michel Mayor** University of Geneva (Switzerland)  
 09.00-09.30 A meteoritic perspective on the formation and early evolution of asteroids and terrestrial planets **Thorsten Kleine** ETH-Zürich (Switzerland)  
 09.30-10.00 Volcanism in the Solar System **Alfred McEwen** University of Arizona (USA)  
 10.00-10.30 Coffee  
 10.30-11.00 Impact cratering on Earth and other planets **Christian Koeberl** University of Vienna (Austria)  
 11.00-11.30 Asteroids, comets and the evolution of life **Walter Alvarez** University of California, Berkeley (USA)  
 11.30-12.00 How rare are Earth-like planets - and how might the Earth's habitability come to an end - making it no longer Earth-like? **Peter Ward** University of Washington (USA)  
 12.00-12.45 **(StatoilHydro Lecture)** Water on Mars: past and present **Maria Zuber** Massachusetts Institute of Technology (USA)



## THEMES OF THE DAY ABSTRACTS

**TL: EARLY LIFE, EVOLUTION AND BIODIVERSITY****The impact of life on the young Earth**

**Minik T. Rosing**, Nordic Center for Earth Evolution, Natural History Museum of Denmark, Denmark

Earth's stratigraphic record reaches 3800 million years back in time and covers more than one fourth of the history of our Universe. Throughout this expanse of time, we find traces of the presence of life in Earth's surface environments. Most of this record is in the form of morphological traces of the organisms themselves. However, the rock record gets increasingly fragmented and the few preserved rocks get increasingly deformed and metamorphosed as we go back in time. The presence of life during deposition of the oldest sedimentary rocks cannot be documented by preserved organic morphologies but must be inferred from metabolic impacts of life on the depositional environments. One of the most robust signatures of biologic activity is the fractionation of carbon isotopes during autotrophic carbon fixation, which leads to a depletion in  $^{13}\text{C}$  in biogenic carbon compounds relative to the ultimate source of carbon in Earth's mantle. It is important to notice however, that the presence of  $^{13}\text{C}$  depleted carbon in a rock is not in itself a sign that life was present when the rock formed. A reliable biological signature is the presence of carbon that can be unambiguously attributed to a specific sedimentary environment and that has a systematic fractionation of the carbon isotopes that is consistent with the type of organisms that could operate in that type of environment. Carbon that meets these criteria can be identified throughout Earth's 3800 Ma stratigraphic record and document the antiquity of life on Earth.

The magnitude of biologic impact on Earth's environments is limited by the availability of energy for metabolic activity. Before the advent of photosynthesis, life activity was low due to a limited supply of chemical free energy from geologic sources. For this reason, pre-photosynthetic life must be expected to have left only local geochemical impacts. After the evolution of photosynthetic energy harvesting strategies, life gained control over many of Earth's surface geochemical cycles. Signs of biologic impact on global geochemical cycles can therefore be taken as indications of photosynthetic activity. Such signs are present in the 3800 Ma Isua metasediments which indicates that life had evolved photosynthetic biochemical pathways at that time. Given the high level of sophistication of such pathways, Darwinian evolution must have operated for considerable geologic time prior to 3800 million years ago. This means that the geologic record leaves us no

opportunity to study the pre-biotic environments in which life emerged and first evolved.

**The great divide: Life on Earth before and after the Ediacaran transition**

**Nicholas Butterfield**, University of Cambridge, Earth Sciences, Cambridge, UK

The Earth has supported an active biosphere for at least the past 3500 million years, but the obvious fossil record is limited to just the last ca. 530 my. This Phanerozoic record documents a wealth of large scale (macro)evolutionary patterns and sheds important light on the functioning and potential fate of the modern biosphere: not only is the present the key to the past, but the past can be the key to the present. In this seemingly uniformitarian light, the evolutionary "rules" of the Phanerozoic have commonly been extrapolated into the much deeper, pre-Cambrian record.

Pre-Cambrian strata preserve an abundance of prokaryotic and eukaryotic fossils, but the emerging patterns differ fundamentally from those of the Phanerozoic. Prior to the Ediacaran Period (ca. 635-543 Ma), not only were most organisms microscopic, but diversity appears to have been fundamentally lower and evolutionary turnover fundamentally slower than at any subsequent time. The principal signature is of profound evolutionary stasis with no measurable extinction documented over hundreds of millions of years.

All this changed at the onset of the Ediacaran, which begins with a conspicuous radiation of microfossils, followed by the appearance and relatively rapid turnover of the first diverse macrofossils, the first sedimentary trace fossils and the first biologically controlled biomineralization. Around 530 Ma there was a further radiation - the Cambrian explosion - which marks the onset of the modern marine biosphere.

There is no shortage of hypotheses to explain the shift in evolutionary dynamics (e.g., Snowball Earth, meteorite impact, global oxygen increase), but most lack a proximal explanation for the accompanying biological phenomena. I will argue here that the key innovation was the appearance of animals with a differentiated gut and nervous system. Unlike all other types of organisms, Eumetazoa are capable of building multi-tiered trophic structures, and driving the co-evolutionary arms races that give the Phanerozoic biosphere its peculiar character - not least large organismal size, complex behaviour, biomineralization, high diversity, high standing biomass, rapid evolutionary turnover, dynamic (in)stability, mass extinctions, biogeographic partitioning, and eukaryote-dominated primary



productivity. As such, the history of life on Earth can be divided into two more-or-less mutually exclusive phases, separated by the Ediacaran Period. It was during this critical 100 million-year transition that the three billion-year hegemony of microbes finally gave way to the peculiarly uniformitarian world of the Phanerozoic.

### The evolution of reefs

**Rachel Wood**, University of Edinburgh, School of GeoSciences, Edinburgh, UK

Reefs have long fascinated natural historians and geologists for their unearthly beauty as well as their ability to produce prodigious amounts of carbonate sediment. Darwin recognised that reefs offered more than their share of paradoxes: How do coral reef islands seemingly grow from great depths in the middle of the oceans? What controls the production of all this limestone? And why do so many of these reefs form necklaces strung across the Pacific? Darwin used his formulation of the accumulation of slow and gradual phenomena to account for the complex patterns of reef growth he observed from the Beagle. Indeed he solved the 'coral reef problem' long before final proof of the origin of reefs was forthcoming with the deep drilling of atolls in the 1950s.

We now know that the 3 billion year history of reefs is closely tied with the history of the oceans: changing sea water chemistry has dictated the mineralogy of reef organisms, mass extinctions creating global perturbations in the carbon cycle have caused reef growth to cease, and evolutionary innovations such as increasingly novel methods of predation and symbioses have allowed reef organisms to exploit new ecological niches. For example, there has been a proliferation of traits with proven anti-predatory benefits since the Mesozoic, and some forms, such as branching corals appear not only to thrive, but actually require conditions of considerable disturbance for their survival in shallow tropical seas.

Coral reefs worldwide are now undergoing dramatic and far-reaching change, and many of these changes are historically recent phenomena. Most notable are the increase of soft-bodied algal cover and biomass, and the decline of corals in the Caribbean. This phase-shift from coral to algae dominance has also led to reduced coral biodiversity and a precipitous decline in rates of calcification. That these changes are taking place is unequivocal; but the causes and controls are far less clear. They have all been variously attributed to anthropogenic impacts, either directly as a result of changing land use, overfishing and pollution, or to a multitude of indirect effects caused by global warming and ocean acidification. With the likelihood of accelerated degradation as a result of synergies between these causes, reefs clearly face an uncertain future.

### Biodiversity through time

**Douglas H. Erwin**, National Museum of Natural History, Dept of Paleobiology, USA

Biodiversity, calculated as the number of taxa, has increased greatly through deep time, interrupted occasionally by mass extinctions and smaller biodiversity crises, with broadly similar patterns observed from the fossil records of terrestrial plants and vertebrates, and marine animals. But this bland truism hides ongoing debates among paleontologists about the rate, pattern and driving mechanisms of this increase. Many paleontologists have been concerned that the apparent post-Cretaceous increase in marine biodiversity reflects a sampling artifact associated with more available rocks to study, and some have suggested marine diversity may have been roughly constant since the Ordovician.

Over the past decade a number of sophisticated statistical approaches have been applied to new datasets of the published fossil record in an attempt to refine our knowledge of the pattern of diversity. These debates over the pattern of diversity have obscured a more fundamental controversy over the mechanisms underlying changes in diversity. The conceptual models paleontologists apply to this question generally involve either logistic models and the assumption of global carrying capacities, or exponential increases in diversity modulated by occasional diversity crises. Any theoretically maximal diversity varies with plate tectonic configuration, latitudinal thermal gradients and climate, with the redox state of the oceans and atmosphere, and with the adaptations available to acquire resources, among other factors. Thus the assumption of global carrying capacities is unsupportable either empirically or theoretically and thus logistic models, despite their mathematical tractability are of little use in understanding large scale patterns of taxonomic diversity. One aspect that has been missing from models of long-term biodiversity is inclusion of positive feedback processes in which biodiversity begets biodiversity. Examples of such positive feedback includes niche construction, where the fitness of a species is increased by an extended phenotype of activities such as nests or burrows, and ecosystem engineering, where species modify the resources available not only for themselves but also for other species. Identifying niche construction requires recognizing selection pressures, which can be difficult in the fossil record. More compelling evidence for increases in ecosystem engineering are available through the Phanerozoic, including increased bioturbation and reef-building. Establishing the network of positive and negative interactions which control taxic diversity, and the timescales over which they operate, will greatly increase our understanding of the nature of biodiversity through time.



## Hominin evolution and environmental change

**Lars Werdelin (1); Christopher J. Campisano (2)**

1) Swedish Museum of Natural History, Department of Palaeozoology, Stockholm, Sweden;

2) Arizona State University, Institute of Human Origins, Tempe, USA

Knowledge about human evolution has expanded enormously in the past 20 years. This information explosion is not solely due to an increased database of fossil human ancestors. It is as much, or even more, due to increased focus on climate and environmental change over the relevant time periods, as recorded in geological and biological proxies. Such proxies include, but are not limited to, global climate records including the expansion of C4 plants and isotopic and terrigenous dust records from ocean cores, and local proxies such as paleosol carbonates and associated fauna from the hominin sites. With this increased understanding of climatically mediated environmental change in the geographic region occupied by our early ancestors has also come the temptation to associate evolutionary change in the hominin (human ancestors evolved after the split with chimpanzees some 5-7 million years ago) with climatic variation.

Indeed, for almost every major event in hominin evolution, there is at least one climatic forcing hypothesis. In this presentation, a selected set of such events: 1) the origin of bipedalism, 2) the origin of *Homo ergaster/erectus*, and 3) the so-called "out-of-Africa 1" hypothesis (the first hominin movement out of Africa) will be critically evaluated following a set of consistent guidelines, including A) a highly resolved temporal scale to define "synchronous" events, B) a causal mechanism that ties a climatic event to the purported biological result, C) input from multiple lines of proxy evidence that consistently support the timing and/or direction of an expected response, and D) the ability to confidently rule out other potential environmental or non-environmental forces of change. By these criteria, the results are a mixed bag, where the climatic forcing hypothesis for 1) is inconclusive, for 2) supported by current evidence, and for 3) possible but inconclusive. "Out-of-Africa 1" (3) will be selected for detailed discussion, as it offers particular insights into both geological and biological proxies. It also offers an opportunity to reflect on the important interplay between theory and interpretation when dealing with faunal movement.

## Darwin's abominable mystery: A palaeontological perspective

**E.M. Friis, K.R. Pedersen & P.R. Crane**

Swedish Museum of Natural History, Stockholm, Sweden

The angiosperms or flowering plants exhibit an overwhelming diversity that is expressed in their habit and reproductive biology as well as in their tremendous ecological range. Perhaps more than 400,000 species of angiosperms inhabit the Earth today, but in a geological

perspective the group is young with the earliest well-documented occurrences in the Early Cretaceous. The origin and rapid rise to ecological dominance during the Cretaceous has long been a puzzle to botanists and evolutionary biologists, and is often expressed as Darwin's "abominable mystery" based on a famous quotation ("The rapid development as far as we can judge of all the higher plants within recent geological times is an abominable mystery") included in a letter from Darwin to J. D. Hooker dated 22 July 1879, as a comment to an essay by John Ball on the origin of the flora of the European Alps.

Over the last 50 years an increasingly convincing and coherent picture of early angiosperm diversification has begun to emerge through concerted efforts at several frontiers of plant science. The discovery and study of new exquisitely well-preserved fossil flowers have contributed important knowledge on angiosperm diversity and biology through the first 50 million years of their evolution. However, important questions regarding angiosperm origin still remain unsolved, and in particular we still lack a well-corroborated hypothesis of the phylogenetic position of angiosperms to other seed plants. A key problem is that current models of seed plant phylogeny are mainly based on molecular analyses of living plants, but the five living groups of seed plants provide only poor representation of the full diversity of the group that existed in the past. Improved resolution of this persistent mystery will require an improved understanding of the extensive extinct diversity of seed plants. New fossils that may help to solve some of these questions have already been identified. They emphasize the point that the fossil record is far from exhausted and still has much new data to contribute to understanding important aspects of angiosperm evolution.

## The fossil record since Darwin: what do we know and what remains to be discovered?

**Richard Fortey**, Natural History Museum, London, UK

Darwin was acutely aware of the imperfections of the fossil record. When he wrote *The Origin* many of the crucial 'intermediates' that Darwin predicted by the theory of evolution had not yet been discovered. This apparent lack was used by contemporary critics to support other narratives of creation. Now some of the most significant of these stumbling blocks have been removed: I will use the example of the colonisation of land by plants and the evolution of the tetrapod limb as examples. Creationists first, and now 'intelligent designers', have moved on to other areas of which Darwin was aware which still remain controversial - in the sense that they are the subject of scientific debate. I shall discuss this in the context of the Cambrian evolutionary 'explosion', and, briefly, the origin of life. The influence of mass extinctions in 're-setting' the history of life is something that has largely been investigated last century: controversies remain on the causes of mass extinction and the relative role of extraterrestrial events. We now know much better the pattern of evolution, but recently attention has again been





focused on the influence of the rock record itself on some of the curves of changing diversity - a return to Darwin's preoccupation with the imperfections of the record.

### **Evolution, education and outreach - learning from the Jurassic reptiles**

**Jørn Harald Hurum**, Natural History Museum, University of Oslo, Norway

In 2001 university teachers and students from the University Centre in Svalbard (UNIS) found a hind limb and parts of the neck of a plesiosaur at Janusfjellet mountain, Svalbard. Two years later they contacted Jørn H. Hurum and suggested that the specimen should be excavated for professional conservation. In 2004 a group of paleontologists and assistants, joined by two journalists from the Norwegian Broadcasting Corporation (NRK), carried out a one week excavation at Janusfjellet. During the fieldwork the group discovered nine additional marine reptile specimens. The media interest was enormous when the group returned to the mainland, the whole world wanted to know more about the project. A small website with pictures, e-mail addresses and phone numbers were made. Six short television programs and several radio programs were broadcast in the autumn and helped to generate even more interest.

The team, together with NRK, returned to the area in 2006 for 11 days of mapping. 28 skeletons were documented, nine of which are believed to be significant discoveries. This tally, which includes 21 long-necked plesiosaurs, six ichthyosaurs and one short-necked plesiosaur, ranks Svalbard as one of the most productive sites for marine reptiles in the world. The most remarkable discovery made during the expedition in 2006 was that of a gigantic plesiosaur. Based on the fossilized remains of its skull, limbs, and backbone found weathering out of a steep hillside, the skeleton promised to be one of the largest plesiosaurs ever discovered. This was immediately recognized as the find to focus on in the hunt for sponsors. When the crew returned to the mainland, work with a large website in Norwegian and English was started immediately. The website included all the information the journalists asked for in 2004 - location map, field pictures, reconstruction of the marine reptiles, historical background, and also a downloadable leaflet for potential sponsors. An embargo date for the news release was set in agreement with NRK. When the news of the large plesiosaur broke 5th October 2006 it made headlines all over the world. Our main purpose of this large media coverage was to attract sponsors for the large dig in 2007, and it worked.

The large scale excavation at Knerten, south of Diabasodden (Svalbard), took place over three weeks in August 2007, again followed by NRK and several national newspapers. Due to the fragmented nature of the fossils 1,200 hours of stabilizing and careful preparation was needed before the next press release in February 2008. The television series was broadcast in January and February

2008. Again, this was to attract sponsors and show the slow and painstaking work that is being made in the basement of the Natural History Museum in Oslo. The fossils attracted 1,500 visitors over three hours one Sunday in February, and the web site is still visited by several thousands every month.

### **The deep biosphere; background, news and implications**

**Ingunn H. Thorseth**, Centre for Geobiology, Department of Earth Science, University of Bergen, Norway

During the last two decades increasing evidence for the existence of a deep biosphere in the terrestrial and marine subsurface environments has been reported. The detection of microbial populations or traces of microbial life in sediment deposits, formation water from oil wells, groundwater and hydrothermal fluids from continental springs and deep-sea vents, and continental and oceanic crustal rocks suggests that the subsurface biosphere is extensive with a biomass potentially similar to that of the surface biosphere. The wide range of geophysical and geochemical conditions in the subsurface environment opens for a large microbial diversity. The microbial activity may, on the other hand, have major influence on subsurface geochemical processes important for the chemical exchange between the lithosphere and the hydrosphere. While the predominately biogenic energy sources present in sediments give rise to a variety of chemoorganotrophic organisms, microbial life in crustal rocks where organic compounds are scarce may be based on chemolithotrophic organisms retrieving energy from reduced inorganic compounds from the lithosphere, such as hydrogen, reduced metals (e.g. iron/manganese) and sulfur compounds, while carbon dioxide serve as the main carbon source. This implies that our planet may harbour two biospheres, one that is sun driven and one that is earth driven. The continuing exploration of these extreme environments constantly expands the magnitude and conditions of the deep biosphere. Thus, the record of active microbial life in marine sediments was lately extended from 842m to a depth of 1626m. Similarly, evidence for microbial growth in a deep-sea hydrothermal venting area at significant higher temperatures than the currently known limit to life has recently also been reported. Documentation of microorganisms in altered seafloor and subseafloor basaltic and ultramafic rocks and fluids indicates moreover that water-rock reactions in the oceanic lithosphere support microbial life, even if it is uncertain to what extent these communities may be linked to the surface biosphere. The deep biosphere has clear implications for geochemical processes involving groundwater quality, carbon cycling and climate, and other global geochemical cycles. The biotechnological potential may be high, since many of the subsurface microbes are unknown and live in extreme environments defining the limits of life. The deep biosphere also raises fundamental questions concerning the origin and evolution of life, and



the possibility for life on other planets.

### **The management of seabed resources; actions of the International Seabed Authority**

**Satya N. Nandan**, International Seabed Authority, Kingston, Jamaica

The International Seabed Authority is an autonomous international organization established under the 1982 United Nations Convention on the Law of the Sea and the 1994 Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea. The Authority is the organization through which States Parties to the Convention, in accordance with the regime for the seabed and ocean floor and subsoil thereof beyond the limits of national jurisdiction (the Area), organize and control activities in the Area, particularly with a view to administering the resources of the Area. The Area and its resources are the common heritage of mankind, and all rights in the resources of the Area are vested in mankind as a whole. The Authority acts on behalf of the mankind to administer the resources. The Authority, which has its headquarters in Kingston, Jamaica, came into existence on 16 November 1994, upon the entry into force of the 1982 Convention. The principal organs of the Authority are the Assembly (154 States Parties plus the European Community are the members), Council (with 36 elected members) and the Secretariat. The Assembly and the Council are assisted by the Legal and Technical Commission (25 expert members) and the Finance Committee (15 expert members.)

The main functions of the International Seabed Authority are to adopt rules, regulations and procedures for conduct of the activities in the Area, to promote and encourage marine scientific research in the Area, and to protect and conserve the natural resources of the Area and prevent damage to the flora and fauna of the marine environment. In addition, the Authority organizes workshops on the scientific and technical issues relating to the deep seabed mining of minerals, the environmental impacts of such exploration, and how the data and information collected by the various scientific institutions can be standardized and shared with its member states. The Authority also brings out regularly publications of the proceedings of these workshops, decisions taken by the sessions of the Authority, and on other relevant matters. The Authority also maintains an up to date repository of the data on resources of the Area (Central Data Repository).

The Area is endowed with rich non-living resources, like polymetallic nodules (source for Manganese, Nickel, Cobalt and Copper), polymetallic sulfides (Source for zinc, copper lead, gold, silver and cadmium) and cobalt rich ferromanganese crusts (source for cobalt, platinum etc). Other potential resources in the Area are gas hydrates and petroleum and natural gas.

The Authority has adopted the mining code for

polymetallic nodules which provides a comprehensive legal frame work for prospecting and exploration of these resources. Applications in the form of Plans of Work for Exploration for polymetallic nodules are approved by the Council upon the recommendation of the Legal and Technical Commission and contracts are issued to eight entities (seven contractors in the Clarion-Clipperton zone of the Pacific Ocean and one in the Central Indian Ocean Basin) for exploration in the Area. The Mining code consists of 40 regulations and 4 annexes, including a model contract document. The code stipulates that, the contractors should take necessary measure to prevent, reduce and control pollution, they should establish baseline data and information and develop environmental monitoring program and provide periodic reports to the Authority. The exploration contractors are required to reserve areas for reference and impact zones. The Authority has also joined hands with the Kaplan project to study the distribution of organisms on the seabed in order to facilitate the establishment of environmental guidelines. This project also aims to determine the number of different faunal groups at a number of locations in the Clarion-Clipperton zone using modern molecular methods to facilitate standardization and to use state-of-the-art molecular and morphological techniques to evaluate levels of species overlap and rates of gene flow for key faunal compositions. The Authority is undertaking an exercise on geological modeling of polymetallic nodule deposits in the Clarion-Clipperton Fracture zone. This program is in its final stages of completion.

As regards the other two types of resources in the Area (the polymetallic sulfides and the cobalt rich ferromanganese crusts), the Authority is in the process of adopting the mining codes. The draft codes are being considered by the Council and are likely to be adopted in the coming sessions of the Authority in 2009.

### **Synergies of science at the US Geological Survey**

**Suzette Kimball**, U.S. Geological Survey, Reston, Virginia, USA

The US Geological Survey (USGS) is unusual among national geoscience organizations in that it conducts its basic research program with a multidisciplinary staff of, primarily, biologists, geographers, geologists, and hydrologists. Although each scientist tends to have an individual perspective on geoscience or environmental inquiries based on his or her training, the USGS provides organizational opportunities and incentives to encourage a multidisciplinary approach to scientific research. The opportunity for interdisciplinary teams to combine their perspectives has produced a rich cross-fertilization of ideas and generated a multiplier effect in dealing with complex issues. For example, USGS ecosystem studies are now based on watershed boundaries where multidisciplinary science is used to assess ground water and soil systems, to examine the impact of human activity on flora and fauna, and to study the interaction of ecosystems within the



watershed. This institutional approach enables the USGS to carry out complex, multifaceted research on issues of scientific and societal concern at large spatial scales and long temporal scales while conducting systematic scientific observations that range from electron-beam microscopy to data collected by remote-sensing satellites.

### Mapping Ireland's seabed

**Paedar McArdle**, Irish Geological Survey, Ireland

Ireland is a relatively small island on the continental shelf of the northeast Atlantic Ocean which has a considerable strategic importance in a European context. Its long-standing maritime tradition has been substantially enhanced by the Government's commitment to a comprehensive survey of its seabed resources. Its seabed area covers in excess of 80 percent of Ireland's territory and this reflects its national importance.

Starting in 1999, seabed mapping of deeper waters was completed in 2005 under the direction of the Geological Survey of Ireland (GSI). Since 2006 an effective partnership between GSI and the Marine Institute is tackling the nearshore seabed. This presentation will outline the results of the survey to date and the benefits which have accrued, both in terms of the increased skills base and the added value for specific sectors.

### TC: CLIMATE CHANGE: PAST, PRESENT, FUTURE—HOW MUCH IS ANTHROPOGENIC?

#### Paleoclimate: The deep and modern time perspective

**Eystein Jansen**, Bjerknes Centre for Climate Research and Dept. of Earth Science, University of Bergen, Norway

The ongoing global warming and the increasing content of atmospheric greenhouse gases which will give continued warming of our planet call for knowledge about the operation of the climate system on a number of timescales. We need to identify the true sensitivity of the climate system to forcings, we need to identify mechanisms and feedbacks through which climate forcing is transformed into climate change, and we need to understand how natural and man-made changes interact. Improved projections of the future state of our planet will hinge on better understanding of the climate system and its interactions, but also from how climates changed in the past unrelated to human forcings. Thus paleoclimate knowledge is clearly relevant for climate policy, but there are also restrictions to the relevance as stated in the 4th Assessment Report of the IPCC. Climate change is both driven by internal processes of the climate system, but also originate to a large extent from external forcings such as atmospheric trace gas content, solar variability, volcanism, changes in the Earth's orbit and on longer time scale tectonic changes and orogeny. In terms of deep time perspectives, it is difficult to quantify and model past

changes, yet there appear to be a clear correspondence between major changes in the mean state of the climate and changes in forcings such as atmospheric greenhouse gas content. The orbital parameters are major drivers of climate change, and enable us to identify both forcings and critical aspects of the feedbacks of the system that translate small changes in radiative forcings into major changes such as growth and demise of ice sheets. The background state of the climate system has great importance for these factors, exemplified by the emergence of an active cryosphere on the planet in the form of snow and ice, which sets into operation powerful feedback mechanisms. The background state also appears to be important for the possibility for abrupt changes to occur. Abrupt changes appear mostly to have regional and hemispheric extent and can be triggered in situations when the climate system operates in situations which are unstable, often intermediate between warm and cold states during ice ages. The recent millennia provide the most detailed information of climate change under boundary conditions akin to those that prevail now, except for the fact that the current level of greenhouse gas forcing probably is unprecedented for the last million years. The recent millennia tell us a story of regional and hemispheric changes that to a large extent were a response to a combination of stochastic process and volcanic and solar forcing, creating multidecadal to century scale changes. The knowledge we have from the past supports our understanding of an ongoing man-made global warming. Thus there is little conflict between the perspective and understanding we have from the past, and the projections we have for the future.

#### Cenozoic paleoclimate: from the Greenhouse to the icehouse world

**Peter Barrett** (1); **Thomas Crowley** (2); **Kenneth Miller** (3)

1) Victoria University of Wellington, Antarctic Research Centre, Wellington, New Zealand;

2) University of Edinburgh, SAGES, Edinburgh, United Kingdom;

3) Rutgers, The State University of New Jersey, Department of Earth & Planetary Sciences, Piscataway, United States

Geography of the Late Cretaceous-early Cenozoic Greenhouse world is well known from plate-tectonics reconstructions. It was similar to the present in that the shapes of modern continents and oceans are clearly recognizable and latitudinal positions known. However it differed in two major aspects: 1) the Southern Ocean had yet to develop through the separation of Australia-South America from Antarctica in the mid-Cenozoic; and 2) the Norwegian Greenland sea did not begin to open and develop a high-latitude connection to the north until ca. 55 Ma.

The Greenhouse world was significantly warmer than today. Any ice sheets were small-moderate sized (8-12 million cubic km), restricted to the Antarctic interior, and



ephemeral (lasting < 200 kyr in a quasi-3 myr cycle). Global temperature estimates from oxygen isotopic data average around 6-7°C warmer than the present 15°C and with a much lower latitudinal gradient between poles and equator. Both plant paleoecology and geochemical proxies indicate atmospheric CO<sub>2</sub> levels were several times higher than modern. Climate modelling experiments indicate this is consistent with the high average temperatures of this period.

Two transient events disturbed the Earth's Greenhouse climate: the Cretaceous/Paleogene impact event (65 Ma) and a massive methane discharge (55 Ma), the latter increasing global temperature by 5°C. However, neither of these remarkable events resulted in a permanent shift in the climate system from its existing state.

Early Cenozoic temperatures declined from 50 to ~34 Ma, when a significant shift in deep-sea oxygen isotope values occurred. This, along with physical evidence of a continental ice sheet on Antarctica extending beyond the present-day ice margin, marked the shift to the icehouse world of today. This was also a period of both variably declining atmospheric CO<sub>2</sub> levels and the final separation of Australia-South America from Antarctica that brought about a profound change in ocean circulation. Modelling suggests both influenced Antarctic ice sheet development but the former more so.

Antarctica's early ice sheets were dynamic, changing climate and sea level (magnitude tens of m) on earth's orbital and myr periods, but these fluctuations diminished around 14 Ma with further cooling and the development of a persistent ice sheet on East Antarctica. Timing of first Northern Hemisphere ice sheets is debated but ice extends at least to 7 Ma. A major expansion occurred at ~2.6 Ma resulting in increasingly extreme oscillations in climate and sea level, culminating in the 100 kyr cycles of the past 800 kyr.

Antarctic ice core records show a close association between CO<sub>2</sub> and temperature over the past 650,000 years. Anthropogenic CO<sub>2</sub> emissions have increased atmospheric levels well beyond the envelope for this period. From a geological perspective it seems that without concerted intervention there is a credible risk of Earth's climate reverting to a greenhouse state by the end of the century.

Climate and global biogeochemical cycles in the ice core paleoperspective

Hubertus Fischer (1); Peter Köhler (2); Thomas Stocker (1); Jerome Chappellaz (3); Eric Wolff (4); and the EPICA community (5)

1) University of Bern, Climate and Environmental Physics, Bern, Switzerland;

2) Alfred-Wegener-Institute for Polar and Marine Research, Glaciology, Bremerhaven, Germany;

3) CNRS, LGGE, Grenoble, France;

4) British Antarctic Survey, Cambridge, United Kingdom;

5) University of Bern, Bern, Germany

Polar ice cores provide not only climate records from both hemispheres in high resolution but also records of the most important climate forcing parameters: greenhouse gases, atmospheric aerosol, solar activity and more. The EPICA records from Dome C (75° S, 123° E, 3,233 meters above sea level.) and Dronning Maud Land (75° S, 0° E, 2,892 meters above sea level) allow us to extend these records from the Holocene back in time to Marine Isotope Stage 20, and to study their variability in higher resolution during the last glacial period. Latest results on these atmospheric ice core records are presented, extending the CO<sub>2</sub>, CH<sub>4</sub>, and mineral dust records back in time to approximately 800,000 years before present and allow for studying their coupling to millennial climate variations in more detail. These long-term records enable us to estimate the changes in the radiative forcing of these parameters over glacial/interglacial cycles.

In addition recent advances in the interpretation of those records in terms of glacial/interglacial changes in biogeochemical cycles and the bipolar coupling of climate variations are discussed.

### **Ocean-atmosphere interaction and climate change from an Arctic perspective**

**Peter Schlosser**, Lamont-Doherty Earth Observatory, Columbia University, New York, USA

There is broad consensus that anthropogenic forcing has led to significant climate change and that under reasonable scenarios further climate change will occur in the near- and long-term future. Global projections have suggested early on that in the Arctic such changes would be visible early on through amplified signals. Indeed observations conducted in many of the Arctic subsystems are now showing environmental change of unprecedented scope. In this contribution, the recent observations of climate change in the Arctic ocean/sea ice/atmosphere system are reviewed and likely future scenarios are discussed. The expected changes in the climate system are placed into the context of interlinked changes in the other domains of the Arctic including the anthrosphere. Known and possible future impacts of the observed changes on the Arctic system itself and on lower latitudes are presented.

### **Solar and climate variability: past, present and future**

**Willie Soon**, Harvard - Smithsonian Centre for Astrophysics, USA

In this lecture, we will take a brief tour through some of the latest understanding in the studies of solar-stellar-galactic astronomy, intrinsic variability of the Sun's magnetism, the weather-climate continuum as well as proxies of climate variability and shift from geological archives. Empirical evidence and interpretation for solar climatic responses on a wide range of spatial and temporal scales will be presented. Related challenges and implications will be discussed.



Additional evidence and technical questions will be comprehensively covered in the CGC-03 Sun-Climate Connection and Stratigraphy Session.

### **Cosmoclimatology: the influence of cosmic rays on climate**

**Henrik Svensmark**, Solar System Physics, Danish National Space Centre, Copenhagen, Denmark

Changes in the intensity of galactic cosmic rays alter the Earth's cloudiness. A recent experiment has shown how charges liberated by cosmic rays assist in making aerosols, the building blocks of cloud condensation nuclei. Variations in the cosmic-ray influx due to solar magnetic activity account well for climatic fluctuations on decadal, centennial and millennial timescales. Over longer intervals, the changing galactic environment of the solar system has had dramatic consequences, including Snowball Earth episodes.

### **Links between Late Cenozoic paleoclimates and human history**

**Gerald H. Haug**, Geological Institute, ETH Zürich, Switzerland

**Larry C. Peterson**, RSMAS Miami, USA

**Gergana Yancheva, Jens Mingram**, GFZ Potsdam, Germany

**Daniel M. Sigman**, Princeton University, USA

**Ralf Tiedemann**, AWI Bremerhaven, Germany

A unifying theme in paleoclimate research is well summarized by a piece of advice that I once heard the late Sir Nicolas Shackleton give to an audience of paleoceanographers: "Whatever you do, do it in high resolution." The underlying message, I believe, is that much 'noise' in geologic records is actually composed of meaningful environmental signals. A central goal is to use new approaches and techniques that do justice to the complexity of geologic records, in order to allow previously hidden signals to emerge.

On the millennial to subdecadal timescale, climate archives with an appropriate memory are anoxic marine basins and lakes. In the anoxic Cariaco Basin off northern Venezuela, millimeter to micrometer-scale geochemical data in the laminated sediments of the Cariaco Basin have been interpreted to reflect variations in the hydrological cycle and the mean annual position of the Intertropical Convergence Zone (ITCZ) over tropical South America during the past millennia. These data with decadal to (sub) annual resolution show that the Terminal Collapse of the Classic Maya civilization occurred during an extended dry period from 700 to 900 AD. Data of comparable quality and resolution have been extracted from sediments of lake Huguang Maar in coastal southeast China. The record indicates a stronger winter monsoon prior to the Bølling-Allerød warming, during the Younger Dryas, and during the middle and late Holocene, when cave stalagmite oxygen

isotope data indicate a weaker summer monsoon. A remarkable similarity in the records of ITCZ migration in East Asia and the Americas from 700 to 900 AD raises the possibility that the coincident declines of the Tang Dynasty in China and the Classic Maya in Central America were catalyzed by the same ITCZ migrations. Comparison of our records with the Chinese dynastic history suggests that drought played a role in the terminations of Dynasties during the past 4,000 years.

On the Cenozoic timescale, the Ocean Drilling Program (ODP) has provided key archives for detailed paleoclimate reconstructions. The Pliocene warm interval, from 4.6 to 2.73 Ma, is the most recent time in Earth's history when the world was 2-3 degree C warmer than the Holocene, the last 10,000 years during which human population has flourished. We report that a major climate-related change in high-latitude ocean productivity, which occurred 2.7 million of years ago and has persisted to today, had a surprisingly rapid onset. Anthropogenic warming that returns temperatures to those of the warm Pliocene should be expected to return the high North Pacific diatom flux of that time, with unknown consequences for regional climate, fisheries, and ocean/atmosphere carbon flux. And the data reported here indicate no reason that this could not happen within the 21<sup>st</sup> century.

### **How reliable are climate predictions?**

**Lennart Bengtsson**, Max Planck Institute for Meteorology, Hamburg, Germany and Environmental System Science Centre, University of Reading, UK

A critical assessment of recent work on climate change will be presented. This will include a discussion on the question of climate predictability, aspects on the role of internal climate variability and the relation between the forcing from greenhouse gases (and aerosols) and the way the climate system is responding to such forcing.

Climate change is a slow process which requires reliable statistics over a period covering 30-100 years. We are just at the borderline to detect such changes against a background of natural variability. However, all indications are that the warming trend during the last 50 years is consistent with the increase in greenhouse gases. In view of the apparent long residence time of greenhouse gases in the atmosphere we cannot exclude that we have to face a major aberration of anthropogenic nature in the Earth's climate during the next hundred years or so, which will be too risky to ignore. Precisely how it will evolve is not possible to outline, but regional drought problems are expected to be among the most serious consequences. And in the longer perspective we may see changes similar to the large changes in the climate of the Earth that have evolved over time scales of tenth- to hundred thousand years.

Unfortunately, it will be significantly more difficult to solve than the successful outcome of the stratospheric ozone issue, although the excessive political focus on carbon





dioxide in this respect is surprising. Presently we need more knowledge before drastic measures are taken as these might cause more harm than help. The ethanol production is here a warning example. Not only is more energy needed for its production, but the increased emission of nitric oxide will more than offset the reduction of carbon dioxide. Finally, any political decisions must include the repercussions of an energy-starving world.

### **Global change science in China: past, present and future**

**Xiaoping Yang**, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China

Around thirty years after the first publication about the four Quaternary glacial events in the Alps of Europe, Chinese scientists studied the sedimentary sequences in four mountains of southern China, which were suggested to be individually correlated to each of the four glacials in Europe. This marked the beginning of the Past Global Change Science in China. In the 1950s and 1960s investigating Quaternary geology and environment was an integral part of the national geological and geographical surveys. Through several generations' endeavors, particularly during the past three decades, China has been able to emerge as one of the major components in the world community of the Past Global Change Science. Great progress has been achieved in China in understanding the processes and mechanisms of past regional and global changes using various records like loess-paleosol sequences, ice cores, deep ocean deposits, aeolian, lacustrine and fluvial as well as coastal landforms and deposits, speleothemes, tree rings, historical documents as well as numerical simulations. A distinct improvement in more recent years has been the increase in resolution for both spatial and temporal scales. The Past Global Change Science has contributed considerably to our knowledge about the processes of various spheres/layers in the Earth System and their linkages and interactions. As the Earth System Science is envisaged to be the future of earth sciences, the Past Global Change Science will play an even greater role in the new development of the earth sciences. The purpose of this talk is to review some of the key progresses and prospects in studying past global changes in China, with a special reference to the work that has been undertaken in drylands.

### **Arctic climate, present and future perspective**

**Ola M. Johannessen**, Nansen Centre for Climate Research, Bergen, Norway

Global warming is enhanced in the Arctic regions. The air temperature has increased to double that of the global average over the last 100 years, the ice cover is decreasing at a rate of 3-5 percent per decade while the thicker multi-year ice is decreasing at a rate of 7-10 percent per decade, the river discharge from Russia is increasing, the tundra-permafrost is thawing and the snow cover on land is

decreasing. Furthermore, in the past few years the Greenland ice sheet has lost mass along its edges - more than the accumulation increase in the interior. The Greenland ice sheet is a "wild card" in the global climate system with significant impact on the global sea level rise and a potentially strong impact on the thermohaline circulation (Gulf Stream decrease). However, it should be pointed out that strong natural variability at the interannual time scale takes place in the Arctic region and also causes strong regional variability.

The prediction for the Arctic region is a strong increase in the air temperature and a significant decrease in the ice cover. A blue Arctic Ocean is predicted during the summer time at the end of this century or earlier. However, the many recent IPCC-coupled climate models also indicate a strong wide spread in the result. Recent studies also indicate that most of the annual decrease in ice extent can be "explained" by the increase of CO<sub>2</sub> in the atmosphere and that the ice extent is reduced faster than the IPCC models predict.

If the predictions turn out to be valid, then global warming will have a strong impact on the ecosystem and fisheries, living conditions for humans and animals, offshore and onshore oil and gas exploration and production, ship transportation along the Northern Sea Route and North West Passage, on society, economy and energy supply (25 percent of the remaining oil and gas reserves is estimated to be in the Arctic region). However, it should be pointed out that the IPCC models have not taken into account the potential impact of the increased melting and discharge of fresh water from the Greenland ice sheet - giving increased uncertainty to the predictions. Another important issue which has not been taken into account is the potential increasing uptake of CO<sub>2</sub> by a "blue Arctic Ocean".

Global warming in the Arctic region can have both positive and negative effects. It is easy to understand that a retreating ice cover will make offshore oil and gas production easier in the future. On the other hand, the thawing of the tundra and permafrost will cause problems for the onshore gas and oil industry. Furthermore, the thawing permafrost will cause a lot of infrastructure problems for the population living in this region. Another big question is what will happen with the huge methane reservoirs which at present are frozen in the permafrost - also located offshore.

These climate changes and the projection of future climate change also have significance in the politics of international relations, in regard to security questions in both the narrow sense and in that of wider human security. The shrinking of the ice cover may allow navigation through Arctic waters and will make for easier access to seabed resources. This in turn is already leading to competing claims of sovereignty. Environmental change will also have a profound effect on the livelihoods of indigenous peoples, both directly and through its implications for the militarization of the region.



**Climate concerns: carbon capture and storage****Olav Kårstad**, StatoilHydro, Norway

Mitigating CO<sub>2</sub> emissions at the necessary pace will require quite drastic changes in the energy system. A large scale transition from fossil fuels to other energy sources looks impossible in the short and medium time frame. In this picture there will be a need for transitional technologies to handle short to mid term energy demand. The International Energy Agency (IEA) energy outlook scenarios indicate that for the next decades, CO<sub>2</sub> capture and geo-storage (CCS) will play an important role in combating climate change together with end-use efficiency and other options. The technologies of the CCS-chain have been proven to a certain extent, but should still be considered to be in their infancy.

Norway was one of the very first countries in the world to recognise and act against global warming. The UN Report of 1987, "Our Common Future" (the so-called "Brundtland Report") was an early warning on the climate change challenge. Mrs. Brundtland later became Norwegian Prime Minister, and in 1991 the administration introduced the world's first CO<sub>2</sub> tax, currently at above \$60/ton, for the offshore industry and some other sectors.

The Sleipner CO<sub>2</sub>-injection became the world's first large scale CCS project for climate change reasons when it started operating in 1996. By now, a decade later, about 10 million tonnes CO<sub>2</sub> has been stored in the so-called Utsira sandstone formation.

Over the years a few other CO<sub>2</sub> geo-storage projects have emerged: The In Salah injection in Algeria, the Weyburn project in Canada and the Snøhvit CO<sub>2</sub>-project in the Norwegian part of the Barents Sea, all of them in the order of 1 mill tonnes of CO<sub>2</sub> per year. In addition a few smaller scale pilot injection schemes have been operated by research organisations on several continents.

The US and to a lesser extent a few other countries have a long and successful history of increasing oil recovery from old fields by injection of CO<sub>2</sub>. Today over 80 such EOR-projects are in operation in the US alone.

The main challenges for wide deployment of CCS are the economics, the immature technology as well as public acceptance. The cost of mitigating one tonne of CO<sub>2</sub> varies with type of source, distance to a CO<sub>2</sub> storage opportunity, onshore or offshore storage, the market value of CO<sub>2</sub>, policy, offset possibilities and so forth. As a rule of thumb, CO<sub>2</sub> capture costs amounts to about 70 percent of the total while transportation and storage to the remaining 30 percent.

A key element to a successful CCS policy is to acknowledge that one tonne of stored CO<sub>2</sub> is equivalent to one tonne of CO<sub>2</sub> not emitted. Viewed globally, this is far from the regulatory reality today.

Accepting CCS is accepting a low risk that a small fraction of geologically stored CO<sub>2</sub> might seep to the atmosphere

in the long time frame. The other side of the coin is that today the world is accepting the risk associated with 100 percent of the anthropogenic CO<sub>2</sub> emissions entering the atmosphere through smoke stacks.

World-wide there are some 5,000 power plants, 600 refineries and other large facilities adding up to about 8,000 large (>0,1 mill tonnes/yr) point sources of CO<sub>2</sub>. These plants emit nearly 60 percent of the world's fossil fuel derived CO<sub>2</sub> that today ends up in the atmosphere. This is the context in which geo-storage of CO<sub>2</sub> will play a crucial role to tackle climate change in the 21<sup>st</sup> century.

**Climate science and the need for action****Connie Hedegaard**, Danish Minister of Climate and Energy, Denmark

(No abstract received)

**TG: GEOHAZARDS: CAN SOCIETY COPE?****Rock slide hazards: detection, assessment and warning****D. Jean Hutchinson**, Geological Sciences and Geological Engineering, Queen's University, Kingston, ON, Canada

Rock slope hazards impact life and infrastructure all over the world, with many examples of events causing loss of life occurring during the last few years and decades. Individual rock slides can be catastrophic events, destroying everything in their path, but with an impact over a relatively local area.

Rock slides can be classified according to their mechanism of failure, requiring an understanding of the geological environment and rock material characteristics. Analysis of rock slides on the basis of type allows consideration of the probable conditioning and triggering events required to initiate the slide, as well as pre-cursor events that might be observed and would give warning of the impending event. Back analysis of past events allows for development of hazard measures, such as magnitude and frequency analysis, and the logic for susceptibility mapping.

New earth observation tools have supplied a much enhanced ability to detect potential rock slide hazards. Analysis of sequential InSAR and LiDAR data provides a very valuable regional view of slope movement. Once potential landslide areas have been identified, assessment can be carried out at the local and site specific scale, to determine the probable extent and displacement rate of the sliding mass. In some circumstances, pre-cursors, such as the development of tension cracks, smaller scale rockfall events, and deforming ground surface, have been identified locally, generating a focused investigation. The outcome of a rock slide hazard analysis should include estimation of the rock slide volume, the conditioning events that cause accelerated movement and may eventually lead to failure,



the probable rate of movement should failure occur, and the probable run out distance.

Once potential rock slides have been identified and assessed, the reduction of consequence to the surrounding area requires that people and infrastructure are protected from the rock slide event. The best protection is prevention of development in high hazard areas, but this is a spatial luxury not available in many countries. This also requires the identification of the hazard before building has begun, and there are many cases where existing infrastructure is in place. In these cases, the landslide hazard may be reduced by physical monitoring systems, designed to provide warning and thereby to reduce vulnerability. In cases where the risk is high, mitigation efforts can be implemented to reduce the probability of the event's occurrence.

While rock slides do not generally have the same regional level of impact as other natural hazards, they generally do result in complete devastation of the area over which they run, and often leave a scarp that may generate further landslide activity in the future. It is therefore very important that the potential for a rock slide is detected as soon as possible so that risk analysis, control and decision making can be undertaken.

#### **Earthquake vulnerability: an engineer's perspective with a difference**

**Tiziana Rossetto**, Earthquake and People Interaction Centre (EPICENTRE), Department of Civil, Environmental and Geomatic Engineering, University College London, UK

In engineering, earthquake vulnerability is traditionally thought of as the likelihood of damage (or collapse) occurring in the built environment under earthquake loading. Human losses, in terms of deaths and injuries, are assumed to be linked to the vulnerability of the built environment and are derived from the latter through fairly simplistic approaches. Societal impact is practically never assessed, nor is societal composition or factors of resilience included in the majority of human loss calculations. The author advocates that the traditional barriers between disciplines (such as engineering and social sciences) need to be overcome in order to advance the state-of-the-art in earthquake vulnerability assessment.

This talk presents some of the author's work on building earthquake vulnerability prediction, the influence on the prediction of using different parameters to represent the ground motion and how earthquake variability is accounted for in this work. A brief overview of human vulnerability models developed in earthquake engineering and social sciences is presented and a case study is used to illustrate the differences in prediction that these models give. Gaps in knowledge are highlighted, as well as areas where a multidisciplinary approach would benefit the vulnerability prediction. Finally, some preliminary work on gauging the

psychological drivers behind the adoption (by individuals) of protective behaviour in anticipation of earthquakes is presented.

#### **Tsunamis**

**Costas Synolakis**, University of Southern California, Los Angeles, USA

(No abstract received)

#### **Volcanoes and their impact on human society**

**Stephen Sparks**, Department of Earth Sciences, University of Bristol, Bristol, UK

Volcanism is the most spectacular manifestation of the dynamic nature of the Earth. However over 500 million people live close enough to active volcanoes to be affected when they erupt. When a volcano shows signs of unrest one of the most important roles of the scientist is to forecast whether an eruption will happen, when it will happen and what kind of eruption it will be. Once an eruption starts a key task is to predict hazardous phenomena, their effects and attendant risks to society. Eruptions are complex natural phenomena and involve the movement of magma to the Earth's surface and interactions with the surrounding crust during ascent and with the surface environment. Magma changes its properties profoundly during ascent and eruption and many of the underlying processes of heat and mass transfer and physical property changes that govern volcanic flows and magmatic interactions with the environment are highly non-linear. There are both epistemic and aleatory uncertainties, which can be large, making precise prediction a formidable objective. Indeed in certain respects volcanic systems may be intrinsically unpredictable. As with other natural phenomena, predictions and hazards inevitably have to be expressed in probabilistic terms that take account of these uncertainties. Despite these limitations significant progress is being made in the ability to anticipate volcanic activity and, in favourable circumstances, make robust hazards assessments and predictions. Improvements in monitoring ground deformation, gas emissions and seismicity are being combined with more advanced models of volcanic flows and their interactions with the environment. In addition more structured and systematic methods for assessing hazards and risk are emerging that allow impartial advice to be given to authorities during volcanic crises.

#### **Geological considerations in quantitative offshore geohazards risk assessment**

**Philippe Jeanjean**, BP America Inc., Houston, TX, USA

Over the last fifteen years, offshore oil and gas production in the Gulf of Mexico has moved from the relatively geohazard-free areas of the Gulf of Mexico continental shelf (except for seabed instabilities in the Mississippi delta) to the deepwater continental slope and the Sigsbee



escarpment where geohazards are much more ubiquitous. As a result, seabed geohazard studies are now a routine part of an overall offshore project risk assessment.

The paper describes typical geohazards studies as they are carried out to assess the risks posed to an offshore field development. Such studies usually include the analysis of the risk induced by shallow water flows, slope instability, turbidity currents, fault movements, mud volcano eruptions, and soil liquefaction. The presentation will describe the geotechnical and geophysical data available to the geologist and geotechnical engineers along with their interpretation, the deterministic and probabilistic engineering analyses performed and how annual probability of occurrences are estimated.

The paper will highlight the required input for geologist in these studies and will emphasize the importance of forming a multi-discipline team for these studies (with the involvement of geophysicists, geologists, geotechnical engineers, oceanographer, reliability experts). The importance of the ultimate objective, which is to provide a quantitative assessment of the risks posed by geohazards, will be reinforced with case histories.

Most of the discussion will focus on examples from the Gulf of Mexico but other areas such as the Caspian Sea and the Nile Delta will also be described. Examples of geohazards from onshore field development will also be presented.

### **Early warning systems for landslides**

**Farrokh Nadim**, International Centre for Geohazards (ICG), NGI, Oslo, Norway

Early warning systems mitigate risk by reducing consequences, giving sufficient lead time to implement actions to protect persons and/or property. Monitoring and early warning systems are more than an implementation of a technological solution. The human factors, social elements and information communication are essential parts.

An early warning system also includes decision-making authorities (e.g. government agencies, local authorities, police/fire), the development of the form and content of warnings issued (how are these understood and relayed in the protected populations), social aspects of how a population responds, the implementation of emergency plans and services to assist the population when it responds, and plans for reconstruction/recovery when the emergency is over. Installing the technology part of an early warning system without considering the social aspects, in particular the response to the system, results in an incomplete system, which may simply create a new type of emergency. Although geologists and engineers are not directly involved in the "human factor" part of the system development, they cannot ignore the human aspect.

Early warning systems are by definition critical systems, and as such it is absolutely necessary that the system remains in operation at all times. The system requires a chain of functional components: monitoring of key parameters - raw data transmission - data processing, interpretation and modelling - decision making - issuing of warnings - reaction of protected population and emergency services. A breakdown at any point in this chain renders the system out of service.

In general, good measurement solutions in critical systems employ both alternative measurement technologies (e.g. different ways to measure a quantity) as well as redundancy in the sensors themselves. To issue an alarm, one must make a prediction of what is about to happen. It is also necessary that sufficient lead time is available to be able to take an effective action. Making a prediction requires an understanding of the physical process being evaluated (a quantitative understanding allowing modelling) or sufficient experience to make correlations (qualitative understanding allowing statistical methods).

The main challenge of designing the threshold values for an early warning system is to balance the conflicting requirements of capturing the critical events with a sufficient margin while avoiding false alarms. A population subjected to false alarms reacts the first time, the second time, and maybe a third time; but quickly becomes tired of the alarm, and the value of the alarm loses credibility. Initially an implicit trust exists between the affected population and the "experts", or at least an acknowledgment of the system can exist, which can eventually lead to trust. However, that initial trust is quickly destroyed by system failure (false alarms), and the trust will be difficult (or impossible) to win completely back.

### **Reducing the risks associated with natural hazards**

**Herbert. H. Einstein, K. Karam, R. L. Sousa**

Massachusetts Institute of Technology, Boston, USA

Natural hazards, or better, the risk caused by natural threats, can be managed by reducing the hazard (probability of the threat), by reducing the vulnerability (probability of consequences), or by a combination. For many natural threats, such as earthquakes or hurricanes and associated secondary threats (tsunamis, coastal flooding) it is usually not possible to reduce the hazard but only the vulnerability. For other natural threats (landslides, avalanches, river floods) the hazard itself can be reduced, as can the vulnerability. Hence, countermeasures can be distinguished correspondingly - active countermeasures reduce the hazard, passive countermeasures and warning systems reduce the vulnerability. Decision-makers and their engineering and scientific advisors need to have tools with which the effect of countermeasures can be compared to their cost and impact on the social and natural environment. Methods associated with decision-making under uncertainty provide such tools.



This presentation will first illustrate several natural threats and the countermeasures which range from physical to regulatory. It will also be shown to what extent observations can be used in managing the risk.

The emphasis of this paper is on a discussion and demonstration of decision-making under uncertainty when evaluating the risk and the countermeasures. This will be done with calculated examples using Bayesian updating in a decision tree process and through Bayesian networks. The latter, which have been applied only recently in this context, offer advantages when many interrelated factors have to be considered and many decisions have to be made.

Specifically, the hazards associated with selected natural threats will be expressed showing which factors contribute to what extent to the uncertainty and thus the probability of the threat (hazard). Analogous expressions will be shown for the vulnerability. Following this will be the formal consideration of countermeasures through updating leading to modified hazard, vulnerability and risk.

While these countermeasures intend to reduce the probability of a threat or its consequences, they can be made more effective through observations which reduce the uncertainty. In this context, two issues/problem areas will be discussed and further studied. Obvious is the use of observation to provide new information and update the originally available information (again with a Bayesian process). An aspect that is often overlooked, however, is the assessment of the decision to observe (collect more information) or not. Since observations have costs (and other impacts) the decision-maker has to know if it is actually worthwhile to conduct such observations.

When discussing the decision-making process as just indicated, the initially shown examples will be recalled to relate analysis to reality. The authors hope that, in this manner, natural events that appear to be and often are inevitable can be dealt with in a rational manner.

### **Global patterns of disaster risk**

**Robert S. Chen**, CIESIN, The Earth Institute, Columbia University, New York, USA

Reducing the risks of natural hazards requires translation of a diverse set of scientific data and information into forms useful for decision-making and associated hazard mitigation and response activities. It is now widely recognized that such data and information must encompass not only knowledge generated by the Earth sciences on the characteristics of natural hazards, but also detailed understanding of human exposure and vulnerability to hazards, including both physical processes related to natural and built environments and their interactions with the human systems that govern human settlement, livelihood, movement, and risk management. Integrating such diverse information into usable knowledge

for managing disaster risks is therefore a critical challenge for interdisciplinary, problem-focused research. Since 2002, an international, interdisciplinary team drawn from both the academic and disaster risk management communities has endeavored to study global-scale patterns of disaster risk, developing comparable quantitative measures of relative risk to improve overall awareness of the complexity of disaster risks faced by different world regions and provide a framework for large-scale disaster risk mitigation and planning. The initial assessment, published in 2005, demonstrated the value of assessing both the humanitarian and economic impacts of natural hazards at a sub-national scale and served as a major input into World Bank efforts to improve management of reconstruction and development projects in hazard-prone regions. Efforts are now under way to update and expand the analysis to include additional hazards and recent hazard data and to address other humanitarian concerns such as conflict. Preliminary results indicate the need for improved assessment of patterns and trends in human exposure and vulnerability, as well as in the hazards themselves, and for efforts to better understand the implications of climate change - and climate change mitigation and adaptation - for disaster risk management and humanitarian response planning.

### **Geophysical risks and society**

**Tom Beer**, CSIRO, Aspendale, Australia

'Hazards - minimising risk, maximising awareness' is one of ten broad themes that make up the Science programme of the International Year of Planet Earth. This theme will focus on key research questions such as the role of humankind in increasing geohazards, ways and means of assessing the vulnerability to geohazards of human communities, our current and future ability to monitor, predict and mitigate the impact of geohazards, and the impediments standing in the way of governments making full use of readily available scientific information in planning to reduce risk and vulnerability.

In developing any program to examine such research question the geological record needs to be examined so as to determine the occurrence and the effects of past geohazards. Present-day natural hazards (the main geohazards that have been systematically studied to date) need to be monitored and measured to assess the risks faced by vulnerable populations lest the effects of an extreme natural hazard are such as to transform a hazard into a disaster. In addition, new methods have been developed to deal with environmental hazards and with the new risks and vulnerabilities that global climate change may introduce.

The research programs of the International Year of Planet Earth, The GeoUnions Consortium of the International Council for Science (ICSU), and the ICSU program on Integrated Research on Disaster Risk will all provide scientific input. In order to reduce disasters, the scientific





input needs to mesh with the societal interactions of the Hyogo Framework for Action, and with the processes driven by the Intergovernmental Panel on Climate Change.

### **Geo-risks: global trends, losses and risk management**

**Anselm Smolka**, Geo Risks Research, Munich  
Reinsurance Company, Munich, Germany

Loss statistics for natural disasters demonstrate, also after correction for inflation, a dramatic increase of the loss burden since 1950, which was well confirmed by disasters like Hurricane Katrina and the Kashmir earthquake 2005, the South Asian tsunami 2004, and more recently by surprise events like the winter catastrophe in China 2008 and Cyclone Gonu in Oman 2007. This increase is driven by a concentration of population and values in urban areas, the development of highly exposed coastal and valley regions and the complexity of modern societies and technologies. Probably, early effects of global warming are also contributing to this phenomenon, whose ultimate causes are often the lack or the inadequacy of land-use planning, and deficient building practices. The trend to increasing losses will unavoidably continue unless remedial action will be taken. Coping with future loss burdens represents a formidable challenge to all stakeholders and requires a holistic approach to risk management. Such an approach comprises the steps of risk identification, risk evaluation, risk control and risk financing.

Risk consists of three components: the hazard, the vulnerability of objects exposed to a hazard, and the value of the exposed objects. The hazard is usually defined as the exceedance probability of an event of a specified minimum size, e.g. the wind velocity in the case of windstorms or the ground shaking in the case of earthquakes. The vulnerability is expressed as the expected average loss as a percentage of the replacement value and depends on the hazard. For disaster prevention, planning and response in general this financial definition of vulnerability should be supplemented by loss of life. Probabilistic computer models have been developed for the proper assessment of risks since the late 1980s. The final steps are controlling and financing future losses. Natural disaster insurance plays a key role in this context, but also private parties and governments have to share a part of the risk. A main responsibility of governments is to formulate regulations for building construction and land use. The insurance sector and the state have to act together in order to create incentives for building and business owners to take loss prevention measures. A further challenge is to transfer a portion of the risk to the capital markets, and to serve better the needs of the poor. Catastrophe bonds, other financial products and microinsurance are the answer to such challenges. The mechanisms described above have been developed to cope with well-known disasters like earthquakes, windstorms and floods. They can be applied, in principle, also to less well investigated and less frequent extreme disasters: submarine slides, great volcanic eruptions, meteorite impacts and tsunamis which may arise

from all these hazards. There is an urgent need to improve the state of knowledge on these more "exotic" hazards as well as on the more common perils in order to reduce the high uncertainty in actual risk evaluation to an acceptable level.

### **Tectonics of the Ms 8 Wenchuan Earthquake of May 12th 2008, Sichuan, China**

**Shuwen Dong, Yueqiao Zhang**, Institute of Geomechanics, Chinese Academy of Geological Sciences, Beijing, China

An earthquake of Ms 8 struck Wenchuan County, western Sichuan, China, on May 12<sup>th</sup> 2008. This devastating earthquake (more than 60,000 people were killed and nearly 300,000 people were injured) also had many severe aftershocks and resulted in long surface ruptures (>300 km). On May 16<sup>th</sup> we went to the worst-hit areas of Yingxiu, Beichuan and Qingchuan and investigated the surface ruptures. Observations of the ruptures ascertained that the causative structure of the earthquake was the Yingxiu-Beichuan fault in the north-central segment of the Longmenshan tectonic belt. Along the Yingxiu-Beichuan segment, rupture structures included road arching, mole tracks, push ridges and tensional fractures, which indicate eastward thrusting of the Yingxiu-Beichuan fault with vertical displacements of 2.5-3m, accompanied by a dextral strike-slip component. The co-seismic vertical displacements measured at Yingxiu Township and the seat of Beichuan County show the same order of magnitude. The surface rupture strength was reduced markedly from north of Beichuan to Qingchuan County. The Wenchuan thrust-faulting earthquake is a manifestation of eastward growth of the Tibetan Plateau under the action of continuous convergence of the Indian and Eurasian continents.

The question of whether or not society can cope with geohazards such as earthquakes, volcanoes or tsunamis is closely related to societal dimensions: which level of risk is reasonable for whom, and who is responsible for risk reduction?

The goal of this presentation is to highlight some strengths of the concepts of social vulnerability and resilience. Both terms are heavily contested because they have many different meanings. Nevertheless, risk management would benefit from integrated approaches taking into account social and cultural aspects of geohazards.

### **Hazard and risk mapping for landslides**

**Kjell Karlsrud**, International Centre for Geohazards (ICG), NGI, Oslo, Norway

Landslides in quick clays represent a serious natural hazard in Norway. The largest historic slide involved a volume of 55 million m<sup>3</sup> and covered areas up to about 1.5 km<sup>2</sup>. Landslide statistics show that slides greater than 1 million



m<sup>3</sup> occurs on average about every fourth year, and most recently in May 2007. Slides of the order 100,000 m<sup>3</sup> occur almost every year.

Post-glacial marine clay deposits cover about 5,000 km<sup>2</sup> of Norway. The clays were originally deposited in the sea following the retreat of the glaciers. The clay deposits were brought up to their present level, up to 200 m above sea level, by the post-glacial isostatic uplift of the earth crust. During deposition in the salt sea water environment, the clay minerals, mostly illite and chlorite, tended to flocculate and create an open card-house type structure or clay matrix. When the clay deposits were brought up above sea level, percolation of non-saline fresh groundwater has gradually removed the salt ions from the pore fluid in the clay matrix. This has the effect of greatly reducing the electro-chemical bonding between the clay minerals, giving the clay matrix a highly brittle and unstable structure. Thus, when disturbed or subjected to loads surpassing its strength, the clay structure collapses completely and the clay deposit turns into a heavy liquid. This type of clay is therefore called quick clay. For the clay to become quick, the salt level in the pore fluid must have dropped to about 1g/l, as compared to 30-35 g/l as typical for seawater.

An overview will be given of the main triggering causes and mechanisms involved in quick-clay landslides, and how the landslide hazard can be analysed and quantified. In 1986 a nationwide program for mapping of quick-clay landslide prone areas was initiated. Starting in 2000 the nationwide program was further extended to more specifically address the landslide risk, defined as the product of hazard and consequence to life and property. The procedures developed and used for undertaking this systematic risk mapping will be discussed in some detail. The risk-mapping program is presently followed up by a program for reducing the landslide hazard in areas with the highest risk, which mainly involves measures to improve the stability of quick clay slopes. Statistical data suggest that implementation of these mapping programs has already reduced the quick-clay landslide frequency.

### Geohazards in Iceland

**Þórunn Sveinbjarnardóttir**, Icelandic Minister for the Environment, Iceland

Geohazards in Iceland are of geological, meteorological and climatological origin. Hazards of geological origin include volcanic eruptions with lava flows and explosive activity, earthquakes, jökulhlaups (glacier outburst floods), landslides and even tsunamis. Hazards of meteorological origin include violent storms, sea and river floods and snow avalanches, while hazards of climatological origin include expanding glaciers and frequent sea ice during cold periods, and retreating glaciers as a result of climate warming.

Most of these natural hazards can be viewed as a constant threat to the Icelandic society, but during the last 100 years

or so, vulnerability has changed significantly. Through the ages violent storms have killed thousands of fishermen and volcanic hazards and sea ice have often lead to crop failure and bad fisheries resulting in death of livestock, famine and diseases. In extreme cases this resulted in the loss of up to one third of the population. The present society with modern knowledge of science and technology has developed mitigation measures against most of these threats, e.g. better ships and harbors, fairly accurate weather forecasts and a good transportation system. Economic and medical advances have largely eliminated the threat of famine and diseases. Today other natural hazards like jökulhlaups and lava flows have become a threat to the terrestrial transportation system, which in earlier times was primitive and of minor importance. Jökulhlaups and explosive volcanism are also a major threat to many of the hydroelectric power stations in glacial rivers, and volcanism is a threat to geothermal power stations within volcanic areas. Soil erosion caused by violent storms is still a problem, while the threat of snow avalanches has been reduced during the last two decades by mitigating measures such as dams, support structures, restrictive zoning and more effective evacuation during critical situations. Within the next 100-200 years global warming might lead to the melting of the Icelandic glaciers, resulting in local landrise and major changes in the nature of the glacial rivers. A reduction of their suspended load will lead to coastal inequilibrium which, along with rising sea level, might dramatically change the sandy coast of south Iceland.

## TW: WATER, HUMAN HEALTH AND THE ENVIRONMENT

### Groundwater - principles and perspectives

**Bo Olofsson**, Royal Institute of Technology, Land and Water Resources Engineering, Stockholm, Sweden

Freshwater makes up only about 3 percent of the earth's water resources. Most of the freshwater (70 percent) is found in glaciers and snow cover. Surface water bodies account only for 0.3 percent of the freshwater resources and the water in the atmosphere even less (0.04 percent), whereas the major part of freshwater consists of groundwater. Therefore, many countries in the world almost totally rely on groundwater resources for drinking supply and agricultural irrigation. Hence, groundwater resources are assumed to be the basis for human development in many areas. Groundwater recharge is, however, usually a slow and highly varying process both in time and space and the groundwater resources can in some areas be assumed as almost non-renewable. Overextraction of groundwater may lead to quantitative as well as qualitative problems. The groundwater levels have dropped more than 50 m locally due to overexploitation of the water resources. Inadequate use of groundwater e.g. for irrigation, has at the same time lead to salinization of soils



and decreased crop productivity. More than half of the world's population lives within a 60 km wide coastal zone where intrusion of seawater into the freshwater aquifers is common. Recirculation of treated sewage water has therefore locally been tested in order to mitigate further depletion of the groundwater resources.

The quality of groundwater depends mainly on the geological conditions, but human actions influence the local quality due to the lowering of groundwater levels or spreading of pollutants from agriculture, industry and inadequate sanitation systems.

The occurrence of groundwater and its quality is highly varying in all scales and depends mainly on the geological conditions and the local climate, but is also affected by human actions. Porous aquifers, karstic and fracture systems and combinations between these aquifer types are predominant. The systems are also usually characterized by a strong hydraulic heterogeneity and anisotropy. This leads to difficulties for correct estimations of groundwater resources and difficulties for the prediction of how various human actions may affect the resources and the water quality.

This presentation gives an overview of the major groundwater resources in the world, the various predominant aquifer types and the principles of groundwater recharge, flow and interaction with the matrix material. Some of the major problems with groundwater occurrence and quality will also be discussed as an introduction to the thematic presentations in this symposium.

### **Cultural evolution and water-borne exposure pathways**

**Philip Weinstein**, University of Western Australia, Perth, Australia

Toxins of geological origin have contaminated human water sources since well before the first modern humans appeared over 200,000 years ago, but the nature and intensity of the resultant disease burden has changed dramatically with cultural evolution. Early *Homo sapiens* were hunter-gatherers, and directly dependent on resources in their immediate environment: Exposures therefore included toxins like fluoride in the only surface water sources available, leading to acute and chronic toxicity. After the advent of agriculture, this disease pattern changed dramatically to one of trace element deficiencies: For example, where meltwater leached valley soils heavily, iodine deficiency was chronic, and cretinism became endemic in entire agricultural communities.

Finally, following the industrial revolution, a new set of water-borne exposures became possible, this time anthropogenic: Mercury in Minamata bay is one well known example, and more recently, the poisoning of millions through wells driven into arsenic laden rock strata in

Bangladesh. From this historical perspective it is clear that water has always provided an exposure pathway through which the geological environment has affected human health. However, the global disease burden from such exposures is now greater than at any time in human history, highlighting the urgent need for a Medical Geology approach to solving these multidisciplinary problems.

### **Arsenic and medical geology: A role for the earth scientist in the assessment and prevention of health risk**

**Jose A. Centeno**, U.S. Armed Forces Institute of Pathology, Environmental & Infectious Disease Sciences, Washington, DC, USA

Arsenic is one of the oldest poisons known to men and examples of intentional human poisoning are abundant in history. Throughout the years a body of knowledge has been built up on the clinical and forensic toxicology of arsenic compounds.

To date, the industrial use and manufacture of arsenic compounds are significantly developed and therefore the anthropogenic (man-made) sources of arsenic exposure include a.o. arsenic-based biocides, arsenic-based wood preservatives, arsenic-based food supplements and arsenic-based medicines. However, industrial poisoning is far from the most significant arsenic health issue.

Over the last decades geological sources of arsenic exposure have also been recognized to contribute to human exposure. Arsenic is a ubiquitous element and it is the 20th most abundant element in the earth crust. Therefore - at the interface of geology and human activities - human arsenic exposure from groundwater, soils and coal burning is considered to pose a serious public health risk.

As yet, worldwide environmental chronic poisoning with arsenic exceeds the scope of any industrial or other arsenic poisoning and victimizes millions of people in many areas of the world (e.g. arsenic in drinking water in Bangladesh, arsenic in coal in China). The continuous environmental exposure to very low levels of arsenic has opened a whole new array of syndromes. Many people suffer from irreversible health effects.

To protect populations at risk prospectively, health scientists may focus on the early recognition of arsenic exposure and health effects. Biological monitoring of arsenic in urine, blood and hair, and biological-effect monitoring of skin alterations may provide this information. However, earth scientists may find an important role in the environmental monitoring; not only by analyzing arsenic levels in ground water or soil but also by mapping areas of arsenic containing strata. The prospective use of these data would provide an important contribution to evaluation and prevention of the public health risk.



## Fluorine - water, rock, human interactions: a global overview

**W Michael Edmunds**, Oxford University, Oxford Centre for the Environment, Oxford, UK

Fluorine excess is an endemic global health problem, affecting notably the active alkaline volcanic province of the East African Rift Valley and other geothermal areas, ancient crystalline basement rocks of large parts of India, Sri Lanka and Africa, as well as groundwater from some sedimentary aquifers. In these areas, concentrations can often exceed national and international standards for fluoride in drinking water. Low fluoride concentrations, prevalent especially in high rainfall areas, also pose health problems and give rise to controversy in relation to the need for fluoridation of water supplies. Thus, both deficiency and excess of fluoride in the human diet can have detrimental health effects and the optimal doses lie within a relatively narrow range. Drinking water still constitutes an important component of the dietary intake in many regions.

The behaviour and distribution of fluoride in water are controlled by a number of factors, the most important being geology, hydrology and climate. The element, fluorine, is present in a number of minerals and where these occur in abundance, high-fluorine provinces can be anticipated. The upper limits of fluoride concentration attained in water are controlled by mineral solubility, mainly of fluorite. Hence, dissolved fluoride concentrations may build up where calcium is deficient or in soft waters where Ca has been removed by ion exchange processes. In groundwater, residence time is also an important factor. All chemical reactions are time-dependent and progressive changes may occur with distance along the flow line. Evolution of groundwater has often taken place over centuries or millennia and older waters are more likely to have high fluoride concentrations resulting from water-rock interaction. Climatic controls on fluoride mobilisation have been demonstrated in many areas. In areas with similar rock types, high rainfall typically gives rise to fluoride-deficient waters through leaching losses and dilution, while in areas of low rainfall, concentrations of fluoride and other solutes may build up through intense water-rock interaction and evapotranspiration. In general, high fluoride concentrations in groundwater are associated with conditions of neutral to alkaline pH (7-9), high alkalinity and where sodium is the dominant cation.

An understanding of the occurrence of fluoride in water and the environment is the most important first step in the management of fluoride-related health problems, since geology, hydrology and climate can cause considerable variations in concentrations found in water at both regional and local scales. Awareness of likely at-risk (high-fluoride) aquifers allows more effective testing and monitoring of groundwater for fluoride and may also serve to identify water resources with acceptable fluoride concentrations that occur locally within fluoride endemic areas.

## Radon and health risks of radon in groundwater

**Donald Appleton (1); Jon Miles (2)**

1) British Geological Survey, Nottingham, U. K.;

2) Health Protection Agency, Radiation Protection Division, Didcot, UK

Radon is produced by the radioactive decay of radium, which in turn is derived from the radioactive decay of uranium. Radon in water supplies can result in radiation exposure of people in two ways: by ingestion of the water or by release of radon into the air during showering, bathing and washing dishes, allowing radon and its decay products to be inhaled. 1000 Bq L<sup>-1</sup> of radon in the domestic water supply contributes about 100 Bq m<sup>-3</sup> to the indoor air of a home. Radon in the ground under homes is the biggest source of radon in indoor air, and presents a greater risk of cancer than radon in drinking water. Breathing radon in the indoor air of homes contributes to about 20,000 lung cancer deaths each year in the USA, whereas radon in drinking water causes only about 170 cancer deaths per year; about 90 percent from lung cancer are caused by breathing radon released from water, and 10 percent from stomach cancer are caused by drinking radon-containing water. Geology is the most important factor controlling the source and distribution of radon. Relatively high levels of radon are associated with some granites, phosphatic rocks, ironstones and aluminous shales. In some granites, much of the uranium is found in uraninite, which is relatively easily weathered to radium from which radon can escape into groundwater with high efficiency. Uranium in zircon, monazite and apatite liberate less radon. The fraction of radon that escapes from rock depends on the openness of and imperfections in the internal structure of the minerals and on the surface area of the source material. Water flow below the water table is generally slow so hydraulically transported radon will travel only a short distance before decay. Radon in solution will migrate more quickly in areas of permeable, fractured and fissured rocks. Radon in some domestic water wells exceeds 80 000 Bq L<sup>-1</sup> and 12 percent of private well water supplies in Sweden exceed 1000 Bq L<sup>-1</sup>, which is the EC action level for public and commercial water supplies. The US Environmental Protection Agency recommends that radon in community drinking water supplies should be reduced to 150 Bq L<sup>-1</sup> or lower. Water processing in large municipal systems aerates the water which allows radon to escape, and also delays the use of water until most of the remaining radon has decayed. Small public water works and private domestic wells often have closed systems and short transit times that do not remove radon from the water or permit it to decay. Radon gas may be removed from high radon groundwater by aeration or by granular activated carbon (GAC) although <sup>238</sup>U decay products are absorbed onto the GAC, which produces a disposal problem.



### Natural organic pollutants in groundwater: potential health implications

**Robert Finkelman (1); William Orem (2); Calin Tatu (3); Nikola Pavlovic (4); Joseph Bunnell (2)**

1) University of Texas at Dallas, Department of Geosciences, Richardson, USA;

2) U.S. Geological Survey, Mail Stop 956, Reston, USA;

3) University of Medicine and Pharmacy, Timisoara, Romania;

4) University of Nis, Institute of Biomedical Research, Nis, Serbia and Montenegro

Most studies of the health impacts of contaminants in water supplies have focused on pathogens, organic and inorganic pollutants derived from anthropogenic activities, or toxic elements such as arsenic derived from the sediments in contact with the water. One additional class of pollutants that may have adverse impacts on human health is naturally occurring (geogenic) organic pollutants. The sources of these organic substances are fossil carbonaceous deposits (coal, petroleum) or organic-rich sediments in contact with the water. Coal, petroleum, and shale are known to contain many organic compound classes that may be toxic (e.g. polycyclic aromatic hydrocarbons, aliphatic hydrocarbons, terpenoids, heterocyclic compounds, aromatic amines, etc.). Because of the relatively low solubilities of these organic compounds in natural waters, health impacts may result from chronic, long-term exposure to low levels of toxicants. Few studies of the human health implications of exposure to toxic organic compounds derived from fossil carbonaceous deposits in drinking water supplies have been conducted.

One example in which coal-derived organic pollutants leached into drinking water has been hypothesized to be linked to human disease is the case of Balkan endemic nephropathy (BEN). BEN is a debilitating and most often fatal kidney disease resulting in chronic renal failure and with a high co-incidence of cancer of the renal pelvis. BEN is known to occur only in clusters of rural villages located in alluvial valleys of tributaries of the Danube River in Bosnia, Bulgaria, Croatia, Romania, and Serbia. A common factor among BEN villages is that the primary source of drinking water is groundwater from lignite aquifers. The concentration and number of toxic organic compounds (e.g. terpenoids, aromatic amines, and heterocyclic compounds) was higher in well water from BEN villages compared to water from non-BEN villages. Similar suites of compounds have been water-leached from BEN-area lignites in the laboratory. Toxicological studies have shown that organic substances isolated from water supplies in BEN villages have a concentration dependent impact on human kidney cell cultures (relative to controls): excessive cell proliferation at low dose, and cell death at higher dose.

Since the 1950s, as many as 100,000 people in BEN villages are believed to have died from kidney failure and related health problems. Recent studies have demonstrated a possible similar relationship between coal-derived organic substances in drinking water supplies and kidney disease in

the western and southern USA (Wyoming and Louisiana), and in northern Portugal where a region of former lignite mining coincides with the highest incidence of kidney disease in the country. Ongoing studies are continuing to examine links between coal-derived toxic organic substances in drinking water and BEN, as well as BEN-like diseases (Panendemic Nephropathy) from other areas of the world.

### A changing world: will there be enough water for all, including the ecosystems?

**Ghislain de Marsily**, University Pierre et Marie Curie, Paris Cedex 05, France

The French Academy of Sciences published in October 2006 a "Science and Technology Report" entitled "Continental Waters", which was prepared for the French Government to examine some of the major water problems that the world may face in the second half of the present century. The aim of this report was to examine the risk of major crises occurring in the world due to water-related problems, and to suggest possible actions to anticipate such crises. The perceived risks were linked to the consequences of climate change, to the increase of the world's population, to the impact of society on water ecosystems, to potentially deteriorating drinking-water quality and to the increasing number of mega-cities (with more than ten million inhabitants) mostly in the developing world.

The talk will first examine the likely consequences of climate change, for both average and extreme events, taking also into account the latest IPCC report. Situations of water scarcity and droughts, as well as water resources increase, will be considered.

The global water needs for food production, both by rain-fed agriculture and by irrigated land, will then be discussed, given the predicted demographic growth, the changes in diet due to economic growth and the potential competition between food production and bio-energy production. Arable land availability will also be discussed. The potential for major food shortages in case of severe global droughts (e.g. during very strong El Niño events) will be examined.

But mankind is not the only user of water on earth. Natural ecosystems also depend on water to survive. Land-based ecosystems mostly use rainwater and water stored in the soil for their development; aquatic continental ecosystems use water in streams, lakes and wetlands, which can be affected by any changes to the hydrologic regime of these water courses, e.g. by climate change or by agricultural development. Land and water for agriculture will thus be in direct competition with land and water for natural ecosystems and biodiversity. Maintaining biodiversity may thus be the major challenge.





### Climate change adaptation and water - examples of facing multiple challenges from sea level rise to water scarcity from a planning perspective

**Philipp Schmidt-Thomé**, Geological Survey of Finland, Espoo, Finland

Adaptation measures to climate change effects on water can be managed successfully, e.g. by integrating spatial planning into the development of strategies. Spatial planning is certainly not the only tool relevant for climate change adaptation, but it is a firm background as it acts on future territorial development. The examples presented here are derived from EU projects on the impacts of climate change on regional development, which have led to the formulation and implementation of adaptation strategies in close cooperation with stakeholders. The projects were led by the Geological Survey of Finland (GTK) and were co-financed by the European Region Development Fund (ERDF) of the Baltic Sea Region's INTERREG IIIB area. The project "Sea Level Change Affecting the Spatial Development of the Baltic Sea Region" (SEAREG), which operated from 2002 to 2005, aimed at raising awareness of climate change to planners and decision-makers. The main focus was to start a science-stakeholder communication process on the development of adaptation strategies, based on global climate change scenarios reported by the International Panel on Climate Change (IPCC). The stakeholder communication was endorsed by the project's Decision Support Frame (DSF). The development of the DSF in several case study areas around the Baltic Sea Region showed that such a communication-based support system can be applied in day to day decision-making processes (<http://www.gtk.fi/slr>).

The award-winning Baltic Sea Region INTERREG IIIB project "Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region" (ASTRA) was a follow-up of the SEAREG project and operated from 2005 to 2007, studying the impacts of climate change on territorial development. The analyzed effects of climate change comprised increasing storm events, sea level rise, the salinization of aquifers in coastal regions, the change of flood prone areas (coastal and terrestrial), the potential effects of droughts on groundwater availability, and the effects of rising mean temperatures on water quality. The project developed scenarios, maps and other tools to support decision-making, e.g. on future land use. The ASTRA project has been very successful in communicating climate change impacts to planners and other stakeholders. The project conferences included a high number of stakeholder participants, and many local workshops have attracted a large number of planners and decision makers. Several cities in the Baltic Sea Region have already taken project results into account in their decision-making processes, e.g. land use plans have been adapted to results of the project (<http://www.astra-project.org/>).

### Risk management of groundwater contamination in the context of water safety plans

**Roger Aertgeerts**, WHO Regional office for Europe, Rome, Italy

Groundwater has considerable importance as prime resource for the production of safe drinking water. In the European region this resource is under considerable stress. Demand projections vary across the European region; changes in population numbers need to be weighted against increase in living standard. Climate change may create considerable water scarcity in certain regions, leading to increased stress on groundwater. To preserve the resources as a basis for safe and healthy water, it will become more and more important to develop and put in place water safety plans. Such water safety plans need to include a correct risk assessment - risk management approach, particularly taking into account the protection of groundwater resources. A comparative study of a number of European water suppliers allowed a first assessment on how far the concept of water safety plans has already penetrated daily operations. The 21 European countries that have ratified the Protocol on Water and Health likewise pay attention to the setting of targets and the monitoring of progress towards such targets, including the protection of aquatic resources particularly in a transboundary context.

### Why is groundwater neglected in water management discussions?

**Anders Berntell**, Stockholm International Water Institute (SIWI), Stockholm, Sweden

On a global level groundwater is estimated to provide about 50 percent of household use of water, 40 percent of the water demand of industry and 20 percent of water use in irrigated agriculture.

In many regions of the world, we see an overexploitation of the groundwater resource, resulting in dropping groundwater tables or salt-intrusion. We also see pollution of the resource due to contamination of soils, spreading of waste and discharges of untreated effluents from industries, cities and households. Other regions have however not yet utilised the resource to its full potential, primarily due to lack of funding and/or capacity.

Groundwater use has increased substantially over the last decades, the main reasons being its widespread occurrence, overall high quality, relative reliability during drought seasons, and modest development costs.

The potential of groundwater for water storage is in general nowhere explored fully; the building of large or small scale dams remains the most common practice for storing water globally.

In spite of its importance, groundwater remains however by and large neglected in water resource management



discussions, compared to the attention that is given to surface water in many parts of the world.

This paper will discuss why - the simple answer being a tragic combination of "the tragedy of the commons" and "what we cannot see we cannot manage".

Capacity development of groundwater management is urgently needed to strengthen human resources. Financial restraints and lack of knowledge about groundwater resources hinder effective management. More widespread understanding of groundwater issues is necessary for increased inclusion of groundwater issues into general water management. Excellent research exists on many aquifers in many countries, but the existing governance structure has in most cases neither assumed its responsibility to monitor nor to manage the resource.

### **Ethiopian groundwater resource management**

**Asfaw Dingamo**, Ethiopian Minister of Water Resources, Ethiopia

In Ethiopia groundwater is of paramount importance. It is a supplement to available surface water resources, providing drinking water to its population and providing the basis for economic development in agriculture, livestock, industry and tourism. Groundwater is especially important in regions with limited or polluted surface water and in areas affected by recurrent droughts. Unlike surface water resources, which are limited in occurrence, groundwater is found throughout the country.

Groundwater development in Ethiopia is, however, hampered by low investments in infrastructure, inadequate well designs, the wrong choice of well locations and poor drilling practices, all of which have led to low or declining production rates and water quality deterioration. According to recent estimates, 50 percent of the wells drilled for some rural water supplies have suffered from serious yield reduction within five years.

While the groundwater potential of Ethiopia is estimated to be 2.6-13.5BM<sup>3</sup>/year, very little has been explored and developed. The recurring droughts in Ethiopia have reduced surface water resources and groundwater tables, drying up wells and springs. In highly drought-affected areas, groundwater from deep underground sources has been the sole source of water supply. Most of the current water supply sources of the country are from different hydrogeological settings, and much work is needed in the future to increase population coverage from the current 52 percent to the goal of over 90 percent by the year 2012.

The Ethiopian Ministry of Water Resources is currently working on strengthening the national capacity for the establishment of a comprehensive knowledge base on groundwater resources, promoting all national efforts towards an effective and optimum development and sustainable management of these resources. The

knowledge base aims at organizing a national database and designing a national development master plan for implementation both at federal and regional levels.

Development and management of national groundwater resources are high on the agenda of the Government of Ethiopia (GoE). The GoE launched a national groundwater assessment program (EGRAP) in 2000 with support from the IAEA. EGRAP is designed to address the urgency of improving the knowledge of groundwater resources and to make this information available for groundwater development and management. On the planning and management level there is a need for coordination between the federal agencies (ministries, national institutions) and the regional agencies (regional bureaus, regional government).

For groundwater assessment studies and investigations, EGRAP will link groundwater assessment studies and related investigations with research programs at Ethiopian universities. The Regional Bureaus and their Zonal Hydrogeologists will play a key role in these assessment studies with support from the Geological Survey of Ethiopia (GSE) and other consultants.

### **TM: MINERAL RESOURCES IN A FAST GROWING GLOBAL ECONOMY—ARE THERE ANY NATURAL LIMITS?**

#### **Advances in genetic understanding of sediment-hosted base metal and gold deposits**

**Ross R Large, Stuart Bull, David Cooke, Peter McGoldrick, Rob Scott and Dave Selley** CODES, ARC Centre of Excellence, School of Earth Sciences, University of Tasmania, Australia

Continental margin and intra-continental basins are hosts to the major global resources of sediment-hosted base metal and gold deposits. Research in the last ten years has greatly improved our understanding of basin scale fluid flow and fluid chemical processes involved in the transport and deposition of copper, zinc-lead-silver and gold in ore deposits within these sedimentary basins. The presence or absence of evaporitic strata, and its position within the stratigraphy, is critical to the development of basinal brines, their fluid flow patterns and their capacity to transport particular metals.

At the early stages of basinal development, in shallow clastic and evaporitic-carbonate dominated rift basins, circulation of oxidised saline marine fluids, below a cap rock of evaporites, is the ideal regime for the formation of stratiform copper deposits such as those in Zambia and the Kupferschiefer. Oxidised saline fluids sink into the basement along rift faults, leach copper and cobalt from the basement lithologies, and recirculate under convective flow, driven by the geothermal gradient, to deposit



stratiform copper sulfides due to fluid mixing and reduction. Ore deposition occurs by syn-diagenetic replacement of organic-rich shales and mixing with organic rich fluids trapped within footwall clastic packages, particular at pinch out positions.

At later times in sedimentary basin development (several tens of million years later), within the tectonically quiet sag phase of siltstone, shale and carbonate deposition, overlying the clastic rift package, stratiform zinc-lead-silver deposits may form adjacent to deep penetrating basin-scale rift faults. Saline marine fluids sink into the basin along a system of recharge faults to depths of 2 to 7 km. During episodes of tectonic activity, the saline fluids move laterally through the basin along clastic aquifer and/or permeable volcanic units leaching zinc, lead and silver to become powerful ore-forming fluids. These fluids rise to the surface along deep penetrating discharge faults, and exhale metal-rich brines into the basin waters, or into porous sediments below the basin floor. Two types of fluids may be generated in this way, depending on the lithological composition of the sedimentary basin. Oxidised metalliferous basinal fluids ( $\text{SO}_4 > \text{H}_2\text{S}$ ) are generated in basins dominated by clastics, carbonates and volcanics, whereas reduced metalliferous basinal brines ( $\text{H}_2\text{S} > \text{SO}_4$ ) are generated in basins dominated by shales and quartzites. Oxidised fluids deposit Zn-Pb due to reduction on the seafloor by mixing and reaction with organic-rich seawater and bottom muds. Reduced fluids deposit Zn-Pb due to mixing with seawater and rapid cooling. Distal or proximal SEDEX deposits result from these processes, depending on the fluid type.

Sedimentary basins that are dominated by organic-rich shales, siltstones and carbonates, but contain no oxidised evaporitic sequences, generate basinal fluids that are excessively reduced ( $\text{H}_2\text{S}$  and organic-C rich), with moderate to low salinity. Such fluids do not have the capacity to transport significant Zn, Pb, Cu or Ag (due to their low salinity and high  $\text{H}_2\text{S}$  content), but can transport Au and As as bisulfide complexes. Basin fluid convection and related exhalation of these strongly reduced, organic-C and  $\text{H}_2\text{S}$ -rich fluids, leads to concentrations of stratiform gold, arsenic and other trace elements (Zn, Mo, Se, Ag, Pb, V, Ni) within black mudstone facies, by adsorption and organo-metallic complexation in the basin-floor muds. Formation of world-class basin-hosted gold deposits is commonly a two-stage process, which involves syngenetic concentration of Au-As in organic-rich sediments as described above, followed by basin inversion, leading to metamorphic re-concentration and up-grading of gold in structural sites such as anticlinal cores, shear zones and breccia zones.

#### **Tomorrow's gold resources: where will we find them?**

**Richard J Goldfarb (1); Jeffrey Hedenquist (2)**

1) U.S. Geological Survey, Denver, CO, USA;

2) University of Ottawa, Earth Sciences, Ottawa, Canada

The price of gold is at an all time high and the demand for the precious metal has never been greater. Emerging wealth in China, India, and Russia implies that increased consumption will continue. Yet global gold production is slowly decreasing; after a peak of 2604 t Au in 2001, production has declined to 2444 t in 2007. Some of the decline reflects the decrease from the unique Witwatersrand orebodies, as deeper operations become less economic; thus, for the first time in more than 100 years, South Africa lost its status as the world's leading gold producer in 2007. The decline also reflects the relatively few recent world-class discoveries, partly due to the low gold price at the end of the 1990s having discouraged exploration. As prices recovered, the trend was for major companies to increase resources through acquisition and merger rather than exploration. However, demand now requires discovery of new resources, both by improving exploration skills in heavily explored countries and under cover, and through green-fields exploration in under-explored regions. Because discoveries commonly require 10 years to come on-line, it is unlikely that global production will exceed 2500 t Au for at least another decade.

Where will the resources to meet demand be found? Approximately 90 percent of the world's 100 largest known gold deposits formed from (1) deep fluid discharge along major crustal faults in metamorphic belts or (2) advective flow related to shallow igneous intrusion within magmatic arcs or zones of extension. Thus, the bulk of future gold resources are likely to be found in these orogenic and epithermal/porphyry systems respectively, rather than in rarer deposit types such as the Carlin-style or giant paleoplacers.

Slate belts of central Asia, eastern Russia, and the Eastern Cordillera of South America are among the most favourable areas to find new Phanerozoic gold ores. Hundreds of small operations are responsible for China becoming the world's leading gold producer in 2007. But with no deposit yet recognized to contain more than 200 t Au, it is probable that brown-fields exploration in China will identify new Phanerozoic giant gold deposits. NW Africa and NE South America will continue to be targets for giant Proterozoic orogenic systems. Under-explored Archean metamorphic belts of India and Tanzania could become the next Yilgarn and Superior gold provinces. As for magmatic arcs (and backarcs) and their porphyry/epithermal deposits, the entire American Cordillera remains the premier region in the world for these Mesozoic-Cenozoic gold-rich ores. The under-explored arcs of the world, particularly in the young regions of the SW Pacific, as well as parts of the Cretaceous Tethyan and Paleozoic central Asian belts, will doubtless be locations of new large discoveries. Older arcs, typically deformed and metamorphosed and thus poorly understood, may yield as-yet unrecognized Proterozoic belts of deposits, where the upper few km have been preserved from erosion.



### Rare earth elements: a new scope of mining for saving energy and environment

**Yasushi Watanabe**, Geological Survey of Japan, AIST, Institute for Geo-Resources & Environment, Tsukuba, Japan

The dissemination of hybrid and electric vehicles is important for the reduction of hydrocarbon fuel consumption, which can contribute to the decrease of CO<sub>2</sub> dispersion as well as NO<sub>x</sub> and SO<sub>x</sub> dispersion into the atmosphere. Production of hybrid vehicles is enabled by installing a motor with Dy-bearing NdBF<sub>e</sub> magnets (rare earth magnets) in the engine. NdBF<sub>e</sub> magnets are also equipped in many other parts of a modern vehicle, in addition to the use of light rare earth elements (REEs) in the nickel-hydrogen battery. Thus, REEs are indispensable for the production of environment-friendly vehicles as well as other modern energy-saving electric products. For this reason, the demand of REEs is increasing year by year, resulting in the increase of REEs prices and shortage of some REEs such as Dy and Nd. Now rare earth mining has an important role to realize the energy-saving society by supplying REEs, and presents a new scope for the mining industry, which is generally regarded as "anti-environment".

The total production of REEs since 1900 is only about 2.2 million tons as rare earth oxides, but the demand of REEs is expected to increase dramatically up to 8-10 million tons in the next 30 years. The production of REEs has been nearly monopolized by China since late 1990s due to low REE production costs and the presence of REE smelting and utilization industries, despite an estimation of huge REE reserves in many other countries in the world. The present major sources of light REEs are bastnäsite and monazite from the Bayan Obo iron oxide-REE deposit in Inner Mongolia and bastnäsite from the carbonatite and/or alkaline rock deposits in Sichuan. Heavy REEs are mainly supplied from ion-adsorption deposits related to weathering of reduced-type granites in southern China. However, the production of REEs in China, especially that from the ion-adsorption deposits, will be limited for the preservation of natural environment and protection of mineral resources.

To respond to the increasing demand of REEs, the development of rare earth deposits in other parts of the world, such as high-grade carbonatites at Mountain Pass in the USA and Mount Weld in Australia, is indispensable, although these deposits are depleted in heavy REEs. Possible sources of heavy REEs are 1) magmatic-hydrothermal apatite, 2) xenotime in placer deposits, 3) ion-adsorption and laterite deposits, and 4) REE-enriched peralkaline igneous complex. Among these four types, the first two types may supply REEs in a shorter period, because they can produce REEs as the byproduct of other minerals. Peralkaline igneous complex may become the ultimate source for REEs in future, because of their huge potential.

### Uranium: the world's energy mineral

**James McIntyre**, Cameco Corporation, Saskatoon, Saskatchewan, Canada

Uranium averages about 2.8 parts per million in the earth's crust, making it one of the more common elements. Traces of it occur almost everywhere. It is more common than tin, about 40 times more common than silver and 500 times more common than gold. Vast amounts of uranium also occur in the world's oceans, but in much lower concentrations. In the last 50 years uranium has become one of the world's most important energy minerals. It is used almost entirely for making electricity, though a small proportion is used for the important task of producing medical isotopes. Still, the uranium industry remains a mystery to many in the general public and often even to industry analysts. There are many uranium mines operating around the world, in some twenty countries, though more than two thirds of world production come from just ten mines. Generally speaking, uranium mining is no different from other kinds of mining. But because of the high variability in uranium ore grades and geological settings in which these deposits occur, innovative and advanced technologies are necessary to extract the mineral safely and economically.

This presentation will provide an overview of the uranium mining industry, its major players, and describe how uranium fits into the nuclear fuel cycle. The presenter will also discuss the current state of the world's nuclear industry and what developments are occurring. He will explore how nuclear energy compares to other forms of electrical power generation and its relative importance as the world moves toward a more carbon-constrained energy profile. The presenter will take you into the world of ultra high-grade uranium mining at Cameco Corporation, the world's largest uranium supplier. He will provide an overview of Cameco's uranium operations, with particular focus on the technologies required to mine the company's extraordinarily rich deposits safely and with high regard for environmental protection. Finally, the presenter will take you into the world of low-grade uranium mining and discuss how innovative in-situ recovery technologies are being deployed by Cameco to recover uranium from very low-grade deposits in the US and Kazakhstan.

### Ocean floor mining

**Steven Scott**, University of Toronto, Toronto, Canada

Oceans and seas cover 71 percent of Earth's surface, most of which are deep ocean basins beyond the continental slope at water depths typically in excess of 2000 metres. Both the shallow continental margins and the ocean basins harbour mineral resources, many of whose economic potential, especially those in the deep basins, we are only beginning to appreciate.

Mining the ocean floor is not new. Throughout much of the past century and even earlier, there has been placer



mining of heavy minerals, diamonds and aggregates from beaches and contiguous shallow waters. Present-day recovery of gem quality diamonds from the seabed off the Atlantic coast of southern Africa to water depths of about 100 m, with exploration extending to 250 m, represents a multi-billion dollar industry utilizing advanced marine technologies. Yet to be recovered from relatively shallow waters of continental shelves and oceanic plateaus are extensive deposits of phosphorites.

On the deep ocean floor, there is untapped potential for mining vast deposits of ferromanganese crusts, manganese nodules and massive sulfides. Ferromanganese crusts form pavements up to 25 cm thick over hard substrates. The iron and manganese are themselves of little value but they contain cobalt on the order of 1 percent, and a variety of other elements at lesser concentrations may be economic in the distant future.

Manganese nodules are cm- to dm-size lumps of manganese and iron oxides that litter much of the ocean floor at about 5,500 m water depth. These are in sufficient quantities in some international waters under the jurisdiction of the International Seabed Authority (ISA) to be considered potentially economic. The better deposits average about 2.4 percent combined copper, nickel and cobalt, a grade similar to that of terrestrial sulfide ores. Between 1974 and 1982 several consortia spent in the order of \$US 1 billion in failed ventures to mine nodules. Eight groups presently have exploration contracts with the ISA. Mining may be anticipated within a decade.

Hot springs ("black smokers") on the deep ocean floor are accumulating economic concentrations of copper, zinc, lead and silver sulfides, together with gold. Mining of these deposits is on the verge of becoming a reality, driven by the ever-increasing need for raw resources, especially copper, and the high metal content of some deposits greatly in excess of those in analogous ores on land. Two entrepreneurial companies based in Australia, Nautilus Minerals and Neptune Minerals, have exploration licenses covering vast areas of the seabed, primarily in the western Pacific, targeting these massive seafloor sulfide deposits. A third Australian company, Bluewater Metals, is being organized. Technological and financial challenges for recovery of seafloor sulfide deposits are manageable, and mining these may be less environmentally deleterious than mining on land. Nautilus Minerals expects to begin mining a site at 1,600 m water depth offshore eastern Papua New Guinea in 2010.

### **Global assessment of undiscovered mineral resources: opportunities and challenges**

**Michael L. Zientek**, U.S. Geological Survey, Spokane, USA

An assessment is any effort to express an opinion or make an estimate using sound and reasonable evaluation. Mineral assessments, particularly of undiscovered resources,

provide important opportunities and challenges for earth scientists. Assessments create the opportunity to communicate with people outside our area of expertise and to engage in discussions about global issues that affect the future well-being of people around the planet. These studies are challenging because they require us to forecast the future, an uncomfortable task for most scientists. An additional challenge is to report our findings in ways that can be considered in relation to the diverse values, goals, and interests of a large population.

To meet these challenges, resource assessments conducted by the U.S. Geological Survey (USGS) are guided by several principles (Singer, 1993; Charpentier and Klett, 2005): 1) the process must be designed to minimize bias; 2) the degree of uncertainty associated with the assessment should be explicitly expressed; 3) the methodology and course of the assessment should be consistent and documented as transparently as possible, within the limits imposed by the inevitable use of subjective judgment; and 4) the multiple uses for an assessment requires a continuing effort to provide the documentation in such ways as to increase utility to the many types of users.

The USGS currently is conducting a cooperative international study to: (1) outline permissive areas (tracts) and estimate the probable amounts of the world's undiscovered resources of copper, platinum-group elements (PGE) and potash, and (2) provide a consistent and globally comprehensive analysis of these undiscovered non-fuel mineral resources. Our form of assessment uses deposit models to delineate permissive tracts for undiscovered deposits and grade-tonnage models to describe ore characteristics for each deposit type. Probabilistic estimates of numbers of undiscovered deposits are combined with grade-tonnage models by Monte Carlo simulation to calculate probable amounts of undiscovered resources.

Like most assessments, our study will be incomplete because we are focusing on only a few aspects of mineral resources. However in the process we are identifying areas where more information is needed and new research is required. Even so, we will provide an assessment with geologically based results in a format that permits economic analysis and integration into decision-support systems.

### **References:**

- Charpentier, R.R., and Klett, T.R., 2005, Guiding principles of USGS methodology for assessment of undiscovered conventional oil and gas resources: *Natural Resources Research*, v. 14, no. 3, p. 175-186.
- Singer, D.A., 1993, Basic concepts in three-part quantitative assessments of undiscovered mineral resources: *Nonrenewable Resources*, v. 2, no. 2, p. 69-81.





### **The exhaustion of mineral resources - a truism or a state of mind?**

**Neil Williams**, President of the Society of Economic Geologists, CEO Geoscience Australia

Since the Industrial Revolution there have been concerns about the exhaustion of non-renewable mineral resources. The concerns are serious because modern society depends on a variety of metals, such as copper, lead, zinc, silver and gold which are widely used but geochemically scarce.

Determining if and when the supplies of a particular metal will run out is difficult. The problem is bound up in the different disciplines of geology and economics. Geologists approach the problem from the perspective of the nature and distribution of mineral deposits, whereas economists approach the problem from the perspective of the roles played by metals and their relative importance in the economy.

In the mineral resource world geology and economics come together most visibly in the mineral reserve and resource estimates that are published by governments and resource companies. While definitions of reserves and resources vary, the key elements are a degree of certainty that a body of mineralization occurs and a degree of certainty that the mineralization can be profitably mined and processed. The two elements are not mutually exclusive. The calculation of a mineral reserve figure must take into account the price of the commodity being considered, as well as the cost of mining and processing. If a commodity price rises but all other costs remain constant, material of a lower grade can be profitably extracted and a lower cut-off grade would be used in the reserve calculation, thereby increasing the tonnage of the reserve. A new technology that lowers the cost of mining would have the same effect.

Reserve and resource figures are therefore nothing more than a snapshot in time of the inventory of a commodity, and they are in no way a measure of the future availability of that commodity. Unfortunately some do use the figures to predict future scarcity and resource exhaustion, and not surprisingly these predictions invariably turn out to be wrong.

Based on our present understanding of the Earth's endowment of mineral resources, the main limit to the supply of minerals will not be their exhaustion. Rather, it will be our ability to effectively manage the environmental impacts of mining and mineral use. Based on past experience it is anticipated that technological innovation will continue to improve our ability to find new mineral resources, to mine and beneficiate them more efficiently and effectively, to lessen the environmental impact of these activities, to improve the way mineral products are used, to better recycle mineral products, and to develop new materials that will permit the substitution of more abundant metals for scarcer ones. The exhaustion of mineral resources is unlikely to be a major concern in the

future; rather the concern will be the exhaustion of innovation.

### **Geology and mineral resources of China.**

**Meng Xianlai**, Geological Survey of China, Beijing, China

(No abstract received).

### **The metal markets: a new corporate landscape emerging**

**Magnus Ericsson**, Raw Materials Group, Sweden

During the establishment of the present extended mining boom, global mining TNCs are meeting increased competition from new participants from China, India, CIS and other developing economies, and from junior companies. Society's expectations of exploration and the mining industry are quickly growing, and the industry is increasingly receiving political attention:

\* In the industrialised countries metal and mineral supply is becoming a concern.

\* Developing countries want a larger share of profits.

In this situation the global mining industry faces one main challenge: To deliver sufficient volumes of metals and minerals at reasonable prices, while ploughing an acceptable share of profits back into host economies.

When meeting this challenge a few points should be highlighted: Firstly, exploration and mining remains a cyclical business. Mine output will increase and gradually catch up with demand. Secondly, the industry, new players included, needs to consolidate to create corporate entities, while proper checks and balances must be in place to ensure that monopolistic powers are not created. Larger companies are necessary to fund increasing volumes of R&D and exploration. Thirdly, there is a need for a new type of international cooperation to facilitate the use of minerals as a lever for economic and social development in developing countries. This is necessary to ensure that mistakes of the past are not repeated.

Governance and transparency remain key concepts for all participants, both new and old, in this process. Positive experiences from countries that have successfully developed, economically and socially, based on natural resources should be systematically transferred to weak governments. The same strict demands on transparency, conduct and operational practices from reporting standards to health and safety routines should be put on all exploration and mining companies in principle regardless of origin or size.



### Metals for a sustainable modern society

**Lennart Evrell**, President and CEO, Boliden AB, Sweden

Demand for base metals is growing strongly, with per capita GDP ranging from UDS 5,000 to UDS 15,000 as nations progress from agricultural to industrial societies. For several decades in the past, the world's countries could be divided into two categories, with the West above this range and the rest of the world below. We are now in a situation where important countries, such as China, are in the range of fast demand growth. These countries are undergoing intense development and modernization, and this requires large quantities of metals.

Together with our industrial colleagues we have a task to meet society's demand for metals. This must be done, however by simultaneously contributing to long-term sustainable development by acting ethically and responsibly in dealing with people, the environment and society alike.

Boliden, as most other metal companies, has to deal with numerous different stakeholder groups. We are a major supplier of important base metals that are used via our customers and our customers' customers in a variety of applications.

Environmental impact is an unavoidable consequence of mining and metal refining, and there is no doubt that the poor reputation of our industry often has been deserved. Going beyond legislative and regulatory requirements must be a given. The environmental initiatives should be as much about reducing our environmental impact, by introducing new and more efficient techniques, as about saving resources, by for example increased metal recycling.

More and more investors and investment fund managers are choosing to invest in companies that operate in a responsible way. It is currently estimated that between 10 and 15 per cent of European investment fund management is conducted within the framework of so-called Socially Responsible Investments or SRI.

The metals industry is categorized by most ethical fund managers as belonging to a high-risk class sector. By continuously improving the impact of our operations, both socially and environmentally, we have a great opportunity to both create long-term financial values and to become the first sustainable link in the metal value chain. This is a worthy challenge.

### Challenges of the European mining industry in the years to come

**Corina Hebestreit**, Euromines, Brussels, Belgium

The presentation will highlight the short and medium term challenges that the European industry will have to face with regard to its right to operate and its cost to operate in Europe. The presentation will show ways forward and steps to take in order to ensure that the European

extractive industry will be able to satisfy a potential growing percentage of the demand in Europe.

The new EU Communication expected for autumn 2008 will be a milestone and starting block for the development of the sector in Europe.

### Commission Raw Materials Initiative

**Hans S. Pietersen**, European Commission, DG Enterprise, Brussels, Belgium

The availability and efficient use of raw materials is a key factor for sustainable growth in industrialised, emerging and developing countries. Sustainable development, both globally and at European level, raises important challenges associated with access and efficient use of raw materials. However, the unprecedented demand for raw materials due to a rapidly increasing and continuous high level of world demand, in particular from emerging economies such as China and India, is resulting in sharp upward movements in prices, posing competitiveness challenges to the EU manufacturing industry generally. Since this trend is generally expected to consolidate in the near future it also raises longer term issues related to security of supply of (specific) raw materials. Since key challenges related to energy and agricultural raw materials have been addressed extensively at different policy areas at Community level, the forthcoming communication of the Commission will focus on the non-energy raw materials, both primary (mined or quarried) and secondary materials.

This Communication, due to be adopted in autumn 2008, aims to raise the political awareness within the EU and will propose a coherent strategy on the sustainable supply of non-energy raw materials for the EU industry. It is also the response to a Council of Ministers' (Competitiveness) request to the Commission on 21 May 2007 to 'develop a coherent political approach with regard to raw materials supplies for industry, including all relevant areas of policy (foreign affairs, trade, environmental, development and research and innovation policy) and to identify appropriate measures for cost-effective, reliable and environmentally friendly access to and exploitation of natural resources, secondary raw materials and recyclable waste, especially concerning third-country markets'.

The international dimension of the raw materials question was recognised at the G8 Summit in Heiligendamm on 6-8 June 2007 which adopted a declaration on 'Responsibility for raw materials: transparency and sustainable growth, focusing in particular on the important role of the extractive sector.

A wide range of non-energy raw materials, including metallic ores, clays and aggregates are needed to build infrastructure, such as roads, homes, schools and hospitals, and to produce innovative industrial and consumer products essential for our future economy, such as IT equipment, means of transport, and household appliances.



This often seems to be taken for granted.

But although the EU is self-sufficient with respect to construction raw materials and remains one of the world's leading producer of some industrial minerals, the EU is highly dependent on imports of metal raw materials. In 2004, it imported more than 175 million tonnes of metallic minerals, with a total value of € 10.5 billion, compared to a domestic production of only 30 million tonnes. The import dependency rate for these minerals ranges from 74 percent for copper ore, 80 percent for zinc ore and bauxite, 86 percent for nickel to almost 100 percent for "high-tech" metals such as cobalt, platinum, titanium and vanadium, or REE.

With regard to domestic supply there is the question of how to improve sustainable access to raw materials from European sources. This raises specific challenges in the area of exploration, better regulation and the permitting process, research and innovation, skills shortages, and the health and safety performance of the extractive industry. This issue has also been addressed in the Commission's staff working document on the competitiveness of the non-energy extractive industry in the EU whose principal focus was on means to improve the EU domestic supply situation<sup>1</sup>. The pressure on raw materials supply, together with the need for greater eco-efficiency, also raises the question of how to improve the efficient use of raw materials.

With the exception of some minerals, improving the possibilities of exploitation in the EU will not significantly reduce reliance on imports from third countries. However, the competitiveness of our economies requires a stable and steady flow of raw materials, without major disruptions in the supply chain. Against this background, the proliferation of measures introduced by third countries and the absence of full transparency in the production and trade of raw materials is causing concern.

There is also the question of how best to support developing countries in the sustainable management of the extraction of their own raw materials. This could include actions, in conjunction with ongoing international initiatives, which aim to increase transparency in the extractive industry worldwide. Building (geological) capacity to ensure good governance of mineral resources is obviously important.

Finally, there is the need to build knowledge of raw materials. Policy-makers at different levels require adequate, reliable and timely information on raw materials. As the sources of such knowledge in the EU tend to be fragmented and incomplete, action will be required in this area.

## TE: THE ENERGY RACE: WHAT WILL BE THE FUTURE ENERGY MIX?

### Conventional oil and gas: the global endowment

**Ken Chew**, IHS Inc, Scotland

Neither of the earliest significant commercial production operations for natural gas (shale gas, New York State, 1821) or oil (shale oil, Scotland, 1851) came from what we today consider to be conventional hydrocarbon accumulations. Despite these unusual beginnings, oil and gas production from conventional hydrocarbon accumulations limited by downdip water contacts has a history going back some 150 years.

While production of hydrocarbon liquids and natural gas continues to increase, the rate of discovery of new accumulations appears to have peaked in the early 1960s for oil and early 1970s for gas, giving rise to concerns that production may also peak in the not-too-distant future.

Discovered hydrocarbon liquids amount to some 6.5 trillion barrels in-place, some 1.1 trillion barrels of which have already been produced, while a further 1.2 trillion barrels are currently estimated to be recoverable. These remaining recoverable resources, currently concentrated in the Middle East but with significant volumes also in the Former Soviet Union, could be further enhanced by additional exploration in a number of key geological provinces and by increasing the recovery factor from existing fields.

Discovered gas resources are more evenly distributed around the world with the Middle East, Former Soviet Union and Asia-Pacific regions being the dominant resource holders. To date, over 10,000 trillion cubic feet has been discovered while less than 3,200 trillion cubic feet has been produced, leaving a substantial endowment. Nevertheless it should be noted that in oil-equivalent terms, remaining discovered resources of natural gas (1.15 trillion barrels oil equivalent) are less than those for conventional liquid hydrocarbons noted above. Considerable potential still exists for future natural gas discovery but often in relatively hostile environments, such as Arctic Russia.

In addition to future discoveries and additional recovery from existing fields, future production growth will also come from less conventional accumulations of oil and natural gas. These will be discussed in detail in subsequent presentations but their likely contribution to global resources relative to that of conventional hydrocarbon accumulations will be indicated in this talk.



## The future energy mix? “Unconventional oil - ‘tomorrow’s oil’ today”

**Robert Skinner**, StatoilHydro Canada Ltd., Canada

Unconventional oil comes from three sources. First, the base of the petroleum resource pyramid - comprising extra-heavy oil and bitumen - represents an estimated four to five trillion barrels of liquid resource in-place. Current production of such hydrocarbons totals about 1.9 million b/d (560 kb/d of extra heavy oil from the Faja del Orinoco of Venezuela and 1,350 kb/d from the Alberta oil sands of Canada). Second is shale oil, perhaps another three trillion barrels of resource. This source of hydrocarbon liquids depends largely on converting kerogen in immature shales. Other sources of oil involving conversion processes are coal (CTL) and natural gas (GTL). Current production from these three convertible sources is small: minor volumes are being produced from pilot 'shale oil' projects; GTL production is less than 100 kb/d; South Africa continues to produce around 140 kb/d of CTL oil and China has ambitious plans to extract oil from its coal resources. The third source of unconventional oil is biofuels, currently yielding about 1.5 million b/d. They are certainly not part of the resource pyramid but should be viewed within the same energy service context, as they replace products derived from fossil resources.

The challenge is to extract, upgrade or convert and refine these resources into useful products economically and in environmentally and socially acceptable ways. Transformation amounts to either reversing or accelerating geological processes, which require prodigious inputs of energy, labour, ingenuity, technologies or other resources, especially water. While the price of light sweet crude might exceed \$100/bbl, the cost of producing unconventional liquids continues to rise because of competing demands for, and therefore higher costs of, these essential inputs, some of which are themselves energy-intensive. This conceptual framework for discussing their potential contribution to the future energy mix is illustrated in the case of the Athabasca oil sands. Improving our understanding of the geological setting (biofuels excepted) of these difficult sources of hydrocarbons is just one, albeit important, part of the challenge to allow these resources to play an increasing and sustainable role in meeting future demand. Total supply in 2008 from this suite of unconventional liquids is less than four million barrels per day. In the absence of major technological breakthroughs, unconventional liquids collectively will be hard-pressed to exceed 10 percent of projected world oil supply by 2020.

## Unconventional gas: tight gas sands, shale gas, coal bed gas, and natural gas hydrates

**Brenda Pierce**, U.S. Geological Survey, USA

Unconventional gas resources represent a vast energy potential if they can be determined to be technically and economically recoverable. One excellent example of an unconventional gas resource that is now technically and

economically recoverable is coalbed gas. Coalbed methane, once thought only as a hazard in coal mines, now accounts for almost 10 percent of the natural gas production in the United States. Improved geologic characterization and understanding as well as technological advances has made this once unconventional resource a viable part of the U.S. energy mix. In 1989, 0.1 TCF of coalbed gas was produced in the United States as compared to 1.8 TCF produced in 2006 (Energy Information Administration). Coalbed gas and other nonconventional gas resources such as tight gas sands and shale gas are the fastest growing resource in the United States. One example of the growth of shale gas and its importance in U.S. production is the Barnett Shale. The Barnett Shale Newark East field now ranks second in the United States in terms of annual gas production (EIA, 2005). Gas production in this field was only about 11 BCF in 1993 as compared to 480 BCF in 2005, and cumulative gas production from January 1993 to January 2006 from the Barnett Shale Newark East field was about 1.8 TCF (Texas Railroad Commission, 2006). This same trend can be seen in USGS national assessments of undiscovered, technically recoverable resources. Undiscovered, technically recoverable coalbed gas resources estimated by the USGS in 1995 totalled 49.9 TCF, as compared to 88 TCF as of November 2007. All other non-conventional ("continuous") gas resources (exclusive of coalbed gas) were assessed by the USGS at 2.1 TCF in 1995 as compared to 273 TCF as of November 2007. Natural gas hydrates are another huge potential future gas resource, and current research is being conducted to determine whether hydrates can be added to the world's viable energy portfolio. There are currently no technically recoverable resource estimates of natural gas hydrates, but the potential of these resources dwarfs all other gas resources combined. This talk will discuss recent advances in these resources and their potential to add to our natural gas production.

## Hydrocarbon exploration in Europe: can we meet the energy demand?

**Rien Herber**, Shell Exploration Europe, Netherlands

In Europe, oil and gas have been produced for many decades now and basins such as the North Sea, Pannonian and Permian Basin have been very prolific. However, production is moving off plateau in many of the large fields such as Brent, Oseberg and Statfjord. Although new fields like Ormen Lange are coming on stream, we do see the beginning of a decline in European production which in 2007 still amounted to 1.8 bln bbls of oil and 7.8 Tcf of gas (source Woodmac). European demand for energy is however continuously increasing, with hydrocarbon consumption in 2007 reaching a level of 5.8 bln bbls of oil (source PFC Energy) and 14.4 Tcf of gas (source GasEurope).

An important question therefore is: what will be the role and contribution of domestically produced fossil fuels in the medium term? Will exploration continue to deliver or are we indeed on a creaming curve? Are there unexplored



areas with Big Cat prospectivity? And if so, are they accessible and under what terms? What is the potential of unconventional oil and gas in Europe?

These are just some of the questions which come to mind. Obviously we do not have all the answers, but what we do have is a history of success as an industry, capable of coping with technological, environmental and financial challenges in sometimes adverse conditions. It is that same industry that now needs to prove that it can, also in Europe, identify, find and develop new resources through new technology, adhering to high environmental standards and at competitive cost.

### **Coal: an energy source for future world needs?**

**Thomas Thielemann**, RWE, Germany

For four years now, international hard coal prices have been at rather expensive levels. Some argue that these higher prices might indicate the threat of a physical scarcity of fossil fuels - similar to the situation with oil and gas. This is not true. The supply situations with lignite and hard coal appear to be largely non-critical. In 2007, global hard coal production rose to 5526 Mt (million metric tons), whereas lignite had a production of 972Mt. This equals to 4738 Mt tce or 3318 Mt of oil-equivalent for hard coal. Lignite amounted to 317 Mt tce or 222Mt of oil-equivalent. Adjusted to the rise in global coal consumption, nature can meet the world's coal demand. This is shown for lignite and hard coal in this talk, differentiated in space and time globally and viewed for the years 2005, 2020, 2030, 2050 and 2100. From a geoscientific point of view, there will be no bottleneck in coal supplies on this planet. Thanks to this favourable supply situation, coal will be able to replace some of the oil and gas in the course of this century.

Burning coal releases substantial amounts of CO<sub>2</sub> into the atmosphere - proportionately more CO<sub>2</sub> emissions than other fossil energy carriers. This is likely to change in the foreseeable future. With the deployment of modern, efficient power plants emitting less CO<sub>2</sub>, as well as a long-term alignment towards carbon storage in underground geological structures, coal will meet the requirements of sustainable climate protection.

This talk will review coal geology and reserves and their implications for coal production, as well as short-term and long-term market effects.

### **Geothermal energy and the energy race**

**Gudmundur O. Fridleifsson** (gof@hs.is) and **Albert Albertsson**, Hitaveita Sudurnesja Ltd, Iceland

Geothermal energy is derived from the natural heat of the Earth. A huge amount of thermal energy is generated and stored in the Earth's core, mantle and crust. Temperatures are believed to range from 200 to 1,000°C at the base of the continental crust and 3,500 to 4,500°C in the Earth

core. The heat is mostly transferred from the interior towards the surface by conduction, which makes temperature rise with increasing depth in the crust, averaging 25-30°C/km. Most economic ('conventional') geothermal systems occur in areas where the thermal gradient in the crust is 2-4 times higher, and where fluid convection plays a key role by conveying heated waters from recharge areas to effluent geothermal- or hot spring fields. Exploitable geothermal systems occur in various geological environments, but can broadly be grouped as high-temperature systems (HTS) and low-temperature systems (LTS). The HTS are more or less confined to young volcanic fields, mostly at plate boundaries, whereas the LTS have much wider distribution in the earth's crust. In addition, geothermal energy can be harnessed at shallow depths and low temperatures almost everywhere by using so-called geothermal heat pumps (GHP). During the next few decades, a dramatic increase in the use of geothermal energy for domestic heating and cooling purposes is expected from GHP.

Conventional geothermal resources have been identified in some 90 countries and there are quantified records of geothermal utilization in 72 countries. To date, electricity from geothermal is produced in 24 countries and approaches about 60 TWh/yr, in addition to the direct use of geothermal which is close to 80 TWh/yr worldwide.

Estimating worldwide geothermal potential is difficult without a range of estimations for the conventional systems, and by including potential new technologies, e.g. permeability enhancements, drilling improvements, special Enhanced Geothermal Systems (EGS) technology, low-T electricity production, and the use of supercritical geothermal systems (SGS). Based on such estimations, it appears possible to increase the installed world geothermal electricity capacity from the current 10 GW to 70 GW with present technology, and to 140 GW with enhanced technology. Additionally, vast HT geothermal resources exist along the ocean ridges which may possibly be harnessed for energy and chemicals in the near future? A cascaded use of geothermal energy, from high to low temperatures, could also be used more extensively, possibly with the aid of the CO<sub>2</sub> resource stream from power plants, to produce valuable products such as food and bio-fuel. These and other estimates of the potential and costs of harnessing the environmentally benign and sustainable geothermal energy source will be discussed.

### **The future energy mix - probabilities and policies**

**Mark Moody-Stuart**, Anglo American, London, UK

The rate of increase of future global energy demand will be determined by the interplay between the growth of emerging market economies as they move through the energy intensive phase of economic development and the partially offsetting factor of increased energy efficiency. The impacts on demand from the recent rises in oil and natural gas prices are only just beginning to be seen. On





the supply side, while estimates of the likely growth rate of non-fossil fuel energy sources vary given the low base from which these start, it is likely that fossil fuels will continue to be the most important part of the energy mix for the next three decades. However, the growth rate of hydrocarbon production is also likely to be constrained, at least over the next few years; not by the shortage of hydrocarbon resources, but by the constraints on the rate of increase of production capacity imposed by the need to produce from more challenging physical environments, the shortage of human and project development resources as well as very inflated capital costs. These constraints on capacity increases are present but less serious in the case of coal production. Such constraints will be exacerbated for all fossil fuels should carbon capture and storage become a common requirement.

For all of these reasons global policies to drive energy efficiency are of the highest priority and a no regret option. Quite separately, given the challenges of climate change and the ultimately finite nature of fossil fuel resources, more widespread frameworks to price carbon dioxide and hence accelerate the development of less carbon intensive energy sources are also urgent. Some suggestions as to the most appropriate policy approaches to both energy efficiency and carbon pricing are made. In the absence of effective measures to reduce demand growth by stringent energy efficiency measures, coupled with widespread application of carbon pricing, it is likely that coal production will be the default response to fill any potential energy demand gap.

### **Nuclear energy options**

**Sven Kullander**, Royal Swedish Academy of Sciences, Stockholm, Sweden

According to the reference scenario of the International Energy Agency, the world's primary energy demands are projected to grow by 55 percent between 2005 and 2030. Electricity use increases from 18,000 to 30,000 TWh between now and 2030 which implies that its share of final energy consumption rises from 17 percent to 22 percent.

There are now 439 reactor units in operation producing 16 percent of the world's electricity. The majority of the reactors are located in USA, France, Japan and Russia. In addition to the existing reactors there are 31 units under construction, mainly located in Russia, India and China.

Today, 70 percent of the reactors in the world are more than 20 years old. Most of them were built during the period 1970 to 1990. If the reactor lifetime is assumed to be 60 years, about 100 of the currently operating reactors will be shut down by 2030 as a consequence of ageing.

New reactors being built and planned up to 2030 incorporate improved fuel technology, passive safety systems and standardized design. It is predicted that new reactors and existing reactors still in operation will increase

nuclear electricity from the current 2,600 TWh to 3,600 TWh by 2030.

The next generations of reactors, Generation IV, are a set of nuclear reactors currently being developed by the Generation-IV International Forum (GIF), a joint cooperation of ten countries, the International Atomic Energy Agency and the OECD Nuclear Energy Agency. The six most promising concepts feature increased safety, improved economics for electricity production and new products such as hydrogen for transportation applications, reduced nuclear waste for disposal, increased proliferation resistance and physical protection. These new reactors are not expected to produce electricity before 2030.

From 2050 onwards other nuclear options may become available. One option is the thorium fuel cycle, which is at present developed by India. The opportunities for Norway of thorium as an energy source are described in a recent report by a committee appointed by the Norwegian Ministry of Petroleum and Energy. Another nuclear option is dedicated transmutation systems to shorten the lifetime of radioactive waste. Both critical and sub-critical "burner" reactors are potential candidates for reducing waste radio-toxicity to a few hundred years. A third option is nuclear fusion which according to present plans should be ready for use by 2050 after the design concepts have been verified by ITER, the international thermonuclear experimental reactor.

### **Renewable energy, innovation and peak oil**

**Jeremy Leggett**, Solarcentury, UK

Warnings by oil industry insiders have recently reached a new pitch that should be sounding alarm bells in every capital in the world. As former US Energy Secretary James Schlesinger has put it, "we can't continue to make supply meet demand much longer. It's no longer the case that we have a few voices crying in the wilderness. The battle is over. The peakists have won." Leading peakists put the peak year as somewhere in the range 2010 - 2015, with 2011 being very likely. Growing calls for action like Schlesinger's flag the trend, in my view, that will dominate entrepreneurship and enterprise culture in years to come. We face the mother of all global energy crises. Yet politicians almost everywhere, and too many in government service and industry, remain locked in an increasingly breathtaking process of institutionalised denial. Once we do mobilise on a scale matching the enormity of this and the global warming challenge, design and innovation in renewable and efficient energy will have a lot to do with whether global human civilisation can survive the storm. One major problem is that renewables today provide barely a few percent of world primary energy, and energy efficiency and immense reservoirs of conservation and efficiency go essentially untapped in most countries. On the other hand, the potential of "cleantech" for rapid invasion of traditional energy markets is great, and massive investment has recently begun to flow into this sector.



More than \$100 billion of c. \$1,000 billion total global energy investment in 2007 went into renewables. Silicon Valley venture capitalists identify 50 families of attractive clean energy technologies. The race is on.

### **The economic and environmental credentials of biofuels and fossil fuels**

**Marian Radetzki**, Luleå University, Sweden

The world is currently involved in a frantic effort to substitute biofuels for gasoline and diesel. In 2001 biofuels accounted for less than 0.5 percent of total oil products use; in 2008 replacement is assessed to be 1.7 percent (equal to the crude oil output of Algeria). Originally, the effort was completely dominated by Brazil and the US, but in recent years the European Union has become a leading player. Its global goal for 2020 is a replacement of oil products by 10 percent.

With the exception of Brazil's sugar-based ethanol, the biofuels programs are uneconomical and driven by public support. Ethanol in the US receives subsidies in excess of \$1 per liter of displaced gasoline, while support in Europe is in a range of \$1.60-4.90. These numbers can be compared with a pretax gasoline and diesel price of \$0.50 when crude oil sells at \$70 per barrel, and around \$0.65 with oil at \$100. Overall, the support currently amounts to some \$60 billion in total (more than half of global aid flows to the poor world) and it is growing fast.

The global supply of biomass for biofuels production is limited and is already hitting against constraints, with detrimental effects for food consumers. Wheat prices in early 2008 were 160 percent higher than in 2005, those of corn had gone up by 120 percent, importantly because of rising demand for biofuels. With oil prices rising by "only" 70 percent over this period, biofuels had become even less competitive.

The main purpose of spending money on ethanol and biodiesel is their purported benign impact on climate emissions. A closer look demonstrates that this is fallacious. Out of five recent life cycle studies of ethanol production based on corn in the US, four showed a net increase in CO<sub>2</sub> emissions compared with the use of gasoline; the fifth recorded a 10 percent saving. A 2007 study from the OECD however, shows a 30 percent CO<sub>2</sub>-saving from US and European ethanol.

These results demonstrate that the current biofuels effort in temperate countries is misplaced. The OECD study gauges that subsidies to ethanol, measured per ton avoided carbon emissions, work out at \$1500-2000 in the US, and an incredible \$2100-16000 in Europe. This can be compared with the current European carbon trading price of \$120, or assessments of long run emission avoidance, of less than \$300. There are clearly far cheaper climate stabilization options than support for ethanol and biodiesel in the temperate zone.

If climate stabilization were the major policy concern, then strong preference should have been given to Brazilian sugar-based ethanol, whose emission characteristics are far superior and do not require support. In fact, energetic protection measures suppress Brazilian exports.

The current drive for biofuels cannot be justified, neither on economic nor environmental grounds.

### **Energy return on investment and our economic future**

**Charles A. S. Hall**, State University of New York, USA

Our society is overwhelmingly dependent upon oil, which supplied about 40 percent of US energy use in 2007, and natural gas, which supplied another 25 or so percent. Global values are similar. Society has also been dependent upon oil and gas growth in supply to support additional economic growth, even with some efficiency improvements. There is considerable concern about whether "peak oil" (meaning the point for a region, a nation or the world at which oil production no longer increases year by year but enters a plateau or decline) has occurred for the world or might soon. If this is true then the "end of cheap oil" might be, or might soon be, upon us. Natural gas might not be too far behind, especially in North America.

Issues related to the increasing energy cost of these fuels and their substitutes (EROI) may be even more important. Because of the critical importance of this petroleum for essentially everything we do economically there are major concerns as to what the financial implications might be. Do conventional economics and conventional economic models and tools work only when it was possible to readily expand the petroleum supply? There is a strong view held by myself and others that because our main economic concepts were derived during a period of our expanding ability to do everything - i.e. that more or less regardless of policy we were able to pump more oil out of the ground readily to implement whatever we were trying to do - conventional economic approaches may have much less relevance during times of contracting supplies. In other words, are finances beholden to the laws of physics? I think yes. Thus the question becomes: can we supplement or improve upon our ability to do economics and financial analysis by using procedures that focus more on the energy available (or not) to undertake the activity in question? This presentation will explore the relation of economics and energy with a series of innovative and empirically-based graphical and modeling approaches.

### **A sustainable energy future**

**Gunnar Gjerde**, Norwegian Ministry of Petroleum and Energy, Oslo, Norway

(No abstract received)



## Carbon capture and storage - political, technological and economic constraints

**Elisabeth Heggelund Tørstad**, DNV Energy, Oslo, Norway

Carbon Capture and Storage (CCS) is a large scale solution to climate change, considered to have significant potential for curbing CO<sub>2</sub> emissions. Fossil fuels will continue to be our main energy source for decades to come and CCS can contribute with as much as 55 percent of the emission reductions needed to stabilize climate change at an average of +2°C.

However, CCS is suffering from a lack of maturity in terms of frame conditions, technology, economy, infrastructure and common acceptance criteria. A key factor is development and implementation of a regulatory framework that allows a market and business to emerge, depending on financial incentives through GHG mitigation policies and mechanisms.

The framework for CO<sub>2</sub> storage should require an integrated risk management throughout the life cycle of a CCS project, i.e. from initial site selection, design and construction, operation including monitoring, reporting and verification, up to closure and post-closure requirements. An important aspect is also to address the legal and economic responsibilities and liabilities, and how these are distributed between the involved parties.

An increasing number of demonstration projects are seen as a tool for technology development at competitive cost and to acceptable HSE standards. Demonstration projects may also assist in the establishment of reasonable and cost efficient criteria and increased public acceptance.

The uncertainties and risks involved in CCS range from societal to commercial and technical issues. Understanding and managing risk is a prerequisite for decisions, and the decision basis and risk picture need to be transparent and well understood by all stakeholders. The paper will address these uncertainties and risks in more depth and highlight how common acceptance criteria and qualification methods can assist in clarifying the decision basis and shortening the time span from policy-making to industry implementation.

## TB: EARTH AND BEYOND—A COSMIC PERSPECTIVE

### From gaseous giants to rocky planets: search for extraterrestrial planets

**Michel Mayor**, University of Geneva, Sauverny, Switzerland

In the last 13 years, about 300 exoplanets have been detected. These discoveries have revealed the impressive

diversity of exoplanet orbital properties. Most of these discoveries have been done by precise Doppler spectroscopic measurements, but more recently several dozen of planets have been detected when transiting in front of the disk of their host stars. The photometric signal from the transiting planet combined with radial velocity measurements open a new window to get constraints about the internal structure of exoplanets.

The past years have witnessed a remarkable improvement of the precision of radial velocity measurements with a gain of about a factor of 100. Thanks to the HARPS spectrograph installed in 2003 at La Silla Observatory (Chile), numerous planets with masses as small as a few earth-masses have been detected. Several statistical properties are already emerging and help constraining the formation mechanisms of these systems.

Is it possible to expect further significant progress in Doppler measurements? Such a possibility could be of interest to permit radial velocity follow-up measurements of planetary transit candidates expected from the COROT and KEPLER space missions: the goal being to get a precise determination of mass-radius relations from terrestrial planets to brown dwarfs.

Today, we already have estimations for the mean density of exoplanets and brown dwarfs on a large domain of masses: 22 Earth-masses to 20 Jupiter-masses (a factor of 300 on the mass of these objects). A radial velocity precision at the level of 0.1 m/s does not seem out of reach. With an observing strategy adapted to minimize the influence of the stellar intrinsic variability (magnetic activity, acoustic modes) we should be in position to explore statistical properties of terrestrial planetary systems.

### A meteoritic perspective on the formation and early evolution of asteroids and terrestrial planets

**Thorsten Kleine**, Institute for Isotope Geochemistry and Mineral Resources, Zurich, Switzerland

The formation of asteroids and terrestrial planets started with the coagulation of dust grains and proceeded with their collisional aggregation into increasingly larger objects. Presumably each planetary body began as a relatively homogeneous object, but collisions during accretion and decay of short-lived nuclides caused the planetary interiors to heat up and melt. As a consequence, all major bodies and also many smaller bodies in the solar system are differentiated into a metal core and a silicate mantle. However, some asteroids, the chondrite parent bodies, never melted and contain components - Ca-Al-rich inclusions (CAIs) and chondrules - that formed in the solar nebula prior to accretion. Meteorites, therefore, provide a record of the different stages of planet formation. The application of short-lived chronometers (e.g., <sup>26</sup>Al-<sup>26</sup>Mg, <sup>182</sup>Hf-<sup>182</sup>W) to the various meteoritic and planetary materials allows determining the timescales of planetary accretion and differentiation. These timescales are key for



understanding the planet formation process and for constraining the initial parameters that controlled the subsequent evolution of planets. CAIs are widely accepted to represent the first solids formed in the solar nebula and the most recent determination of their absolute age is  $4568.6 \pm 0.5$  Ma, which is often referred to as the age of the solar system. Most chondrules formed  $\sim 2$ -3 Ma later than CAIs, although there is now evidence that some chondrules formed earlier, at  $\sim 1$  Ma, whereas others might have formed as late as  $\sim 5$  Ma. The chondrule ages provide the earliest time for accretion of the chondrite parent bodies and indicate that these objects formed more than  $\sim 2$  Ma after CAI formation. The late formation of chondrite parent bodies contrasts with the early accretion and differentiation of the parent bodies of magmatic iron meteorites and basaltic achondrites. These objects formed within less than  $\sim 1$  Ma after CAI formation, consistent with predictions from accretion simulations. Thermal modelling combined with these age constraints reveals that the different thermal histories of meteorite parent bodies primarily reflect their initial  $^{26}\text{Al}$  abundance, which is determined by their accretion age.

The formation of larger bodies such as the Earth involved several large collisions, which characterize the late stage of terrestrial planet formation. These collisions were the main heat source for differentiation of terrestrial planets. The timescales for accretion can be constrained using the  $^{182}\text{Hf}$ - $^{182}\text{W}$  system, and the most recent determinations indicate that Mars formed in the first  $\sim 20$  Ma, whereas the last large impact during Earth's accretion, the Moon-forming giant impact, occurred at  $\sim 100$  Ma. The W isotope composition of Earth's mantle does not only constrain the timing of accretion but also provides important insights into the process of core formation. In Earth, chemical and isotopic equilibrium must have been achieved during core formation, suggesting that core formation might have largely occurred by metal rainfall in a magma ocean. Given that Earth most likely accreted from already differentiated objects, the effective metal-silicate equilibration during core formation requires that the metal cores of the impacting bodies were emulsified as they sank through the terrestrial magma ocean.

### Volcanism in the solar system

**Alfred McEwen**, University of Arizona, Planetary Sciences, Tucson, USA

Volcanism is one of the most important processes shaping and modifying planetary surfaces, differentiating their interiors, and modifying their atmospheres. Basaltic volcanism has dominated the terrestrial planets and Jupiter's moon Io, whereas the icy moons of the outer Solar System have experienced volcanic processes involving  $\text{H}_2\text{O}$  and other volatiles. We have samples of the Earth, Moon, Mars and asteroids, and in-situ measurements for Earth, Moon, Venus, and Mars, but otherwise have limited knowledge of compositions and chronology from remote sensing. In the inner Solar System

volcanism has been driven by radioactive decay of chondritic bulk compositions, such that activity has waned over time on the smaller bodies (asteroids, Moon, Mercury, and Mars) but continues to the present day on Earth and probably Venus. Mars has experienced geologically recent volcanism ( $< 200$  Ma) and future eruptions cannot be ruled out.

The correlation between mass and volcanic activity does not extend to the outer Solar System, where tidal heating driven by orbital evolution provides a source of energy that may increase or fluctuate over time, and more volatile species are preserved. Io is covered by hundreds of actively erupting volcanoes and represents a very unique experiment that needs to be monitored more closely. Neighboring Europa also experiences significant tidal heating and may experience silicate volcanism beneath its thin shell of water and ice. Volcanism on Saturn's large moon Titan is poorly understood but may be significant. Meanwhile, tiny Enceladus is actively spewing a plume of  $\text{H}_2\text{O}$  from active fractures in its south polar region, a significant challenge to our understanding of how planets work. Other icy moons of Jupiter, Saturn, and Uranus have relatively young (uncratered) terrains perhaps due to icy volcanism. Triton, the large moon of Neptune, has especially young surfaces with possible volcanic structures, likely produced by tidal heating when this large Kuiper belt object (KBO) was captured into Neptune orbit. Voyager observed active jets erupting from the summertime polar cap of Triton, but these may be seasonal sublimation phenomena (like the jets and dark fans on Mars) rather than volcanism driven by endogenic heat. Other KBOs such as Pluto/Charon may reveal evidence of volcanism once New Horizons captures a glimpse up close.

### Impact cratering on earth and other planets

**Christian Koeberl**, University of Vienna, Center for Earth Sciences, Austria

Craters are a fundamental and common topographic form on the surfaces of planets, satellites and asteroids. On large planetary bodies, of the size of the Moon and larger, craters can form in a variety of processes, including volcanism, impact, subsidence, secondary impact, and collapse. On smaller bodies (e.g., of the size of minor planets), impact may be the only process that can form craters. In the explanation of terrestrial crater-like structures, the interpretation as volcanic features and related structures (such as calderas, maars, cinder cones) has traditionally dominated over impact-related interpretations. The importance of impact cratering on terrestrial planets (Mercury, Venus, Mars), our Moon, and the satellites of the outer planets is obvious from the abundance of craters on their surfaces. On most bodies of the solar system that have a solid surface, impact cratering is the most important surface-modifying process even today.

On Earth, active geological processes rapidly obliterate the cratering record. To date only about 170 impact structures



have been recognized on the Earth's surface. They come in various forms, shapes and sizes, from 300 km to less than 100 m in diameter, from recent to 2 billion years in age. Some of them are fresh and obvious, such as Meteor Crater in Arizona; others are old and deeply eroded, such as the originally 300-km-diameter Vredefort impact structure in South Africa; and others again are not even exposed on the surface of the Earth (they are subsurface structures). Impact craters (before post-impact modification by erosion and other processes) occur on Earth in different morphological forms - simple craters (small bowl-shaped craters) with diameters of up to about 3 km, and larger complex craters, which are characterized by a central uplift.

On the Moon and other planetary bodies that lack an appreciable atmosphere, it is usually easy to recognize impact craters on the basis of morphological characteristics. On the Earth, complications arise as a consequence of the obliteration, deformation, or burial of impact craters. Thus, it is ironical that despite the fact that impact craters on Earth can be studied directly in the field, they may be much more difficult to recognize than on other planets. Thus diagnostic criteria for the identification and confirmation of impact structures on Earth were developed, including: a) crater morphology, b) geophysical anomalies, c) evidence of shock metamorphism, and d) the presence of meteorites or geochemical evidence for traces of the meteoritic projectile - of which only c and d can provide confirming evidence. Remote sensing, including morphological observations as well as geophysical studies, cannot provide confirming evidence; this requires the study of actual rock samples.

Impacts influenced the geological and biological evolution of our own planet; the best known example is the link between the 200-km-diameter Chicxulub impact structure in Mexico and the Cretaceous-Tertiary boundary. Understanding impact structures, their formation processes, and their consequences should be of interest not only to earth and planetary scientists, but also to society in general.

### **Asteroids, comets and the evolution of life**

**Walter Alvarez**, University of California, Department of Earth and Planetary Science, California, USA

There is increasing evidence that the impact of comets and asteroids on Earth has played a major role, both beneficial and detrimental, in the evolution of life. Earth was assembled by impacts of a large number of asteroids and comets, rapidly building it to a size sufficient to hold both water and an atmosphere, thus making it suitable for life. Impact of a Mars-sized impactor produced the Moon, initiating tides which may have encouraged the invasion of the land by animals, but probably stripping off the atmosphere and hydrosphere. This impact may also have been a major contributor to tilting Earth's axis, producing seasonality.

After the Moon-forming event, comet impacts apparently provided a late veneer, renewing the hydrosphere and atmosphere. Very large early impacts, including the Moon-forming event, and especially during the Late Heavy Bombardment  $\sim 3.9$  Ga, may have sterilized Earth repeatedly, depending on whether life originates readily. Life may have initiated at deep-sea vents, protected from all but the largest impacts. This hypothesis is supported by the variety of extremophiles among the Archaeobacteria, but is contradicted by a rooting of the tree of life closer to the Eubacteria. There is tantalizing evidence of impacts triggering a biotic diversification in the Ordovician. A number of meteorites have been found by Birger Schmitz and colleagues at a variety of stratigraphic horizons in an Ordovician limestone quarry in southern Sweden, attesting to an unusually heavy bombardment of the Earth at that time, and confirmed by similar results from China. All these meteorites are L-chondrites, suggesting that the bombardment was due to impact-triggered breakup of the L-chondrite parent body within the asteroid belt. This increase in impactor flux may be correlated with and causally related to a burst in marine biotic diversity, but the existence of that increase still needs confirmation. Six great mass extinctions are documented in the fossil record, but determining their causes is an enduring geological problem.

Little is known about the causes of the first two (Ordovician-Silurian boundary, Frasnian-Famennian in the late Devonian). The other four (end-Middle Permian, Permian-Triassic, Triassic-Jurassic, and Cretaceous-Tertiary) all coincide within a million years or so with a flood basalt, or large igneous province, suggesting that basaltic volcanism can trigger mass extinctions, but it has been hard to identify mechanisms by which this would happen. The most recent mass extinction (Cretaceous-Tertiary) is convincingly tied to the 170-km-diameter Chicxulub impact crater on the Yucatán Peninsula of Mexico, with very tight age correlation. Many killing mechanisms would be triggered by such an impact. The Chicxulub impactor may have resulted from the breakup of the Baptistina-family asteroid parent body by collision at about 160 Ma. So far no convincing link between impacts and flood basalts has been suggested. It remains a mystery why four major extinctions at least roughly correlate with flood basalts, including the one that was surely caused by impact.

### **How rare are Earth-like planets - and how might the Earth's habitability come to an end, making it no longer "Earth-like"?**

**Peter Ward**, University of Washington, Earth and Space Sciences, Seattle, USA

Determining the number of "Earth-like" planets remains a major goal of astrobiology. While "Earth-like" usually refers to a planet with abundant water, long term temperature stability, and the acquisition of life (even to the point of complexity), a major determinant of remaining habitable like our own planet relates to how long





habitability can be maintained on any planet. An important astrobiological question thus concerns the fate of habitable, Earth-like planets. While there has been much work on just what habitability means, and how it might be obtained and then maintained on an Earth-like planet or moon, far less has been written about the end of such habitability - the analogue of death, when all life on a planet ends.

Thus there is indeed important information to be obtained from a study of the past mass extinctions in Earth history. Could any of these events have threatened the end of life on Earth when they occurred, or could such events occur in the future? The well-studied Cretaceous/Paleogene mass extinction was either completely or largely caused by environmental consequences of the Chicxulub impact - that now seems unequivocal and is accepted by all save a fringe group of nay-sayers, whose opposition seems as much about staying in the press's eye as it is about real scientific findings that could falsify either or both of the two-part Alvarez Impact hypotheses - that the Earth was hit by a 10 km body 65 million years ago, and that the effects of that hit caused the mass extinction. But what of the other four of the so-called "Big Five" - and the other 10 or so "minor" mass extinctions of the past 540 million years? In this talk I will discuss the current state of understanding about these other extinctions, and will show evidence now suggesting that only the KP was impact caused. This new work has important implications for the future of life on Earth, and by extension should apply in general fashion to other inhabited planets in the universe.

### **Water on Mars: past and present**

**Maria Zuber**, Massachusetts Institute of Technology,  
Dept. of Earth, Atmospheric and Planetary Sciences,  
Cambridge, USA

Recent observations of Mars from orbiters and rovers have dramatically changed our understanding of the distribution and amount of water on and near the surface throughout the planet's history. The combination of diverse data sets from Mars Global Surveyor, Mars Odyssey, Mars Express, the Mars Reconnaissance Orbiter and the Mars Exploration rovers provide global and regional perspective combined with local context. On the basis of these collective observations there is now definitive evidence from geology and geochemistry for a watery past. For present-day Mars there is observational proof of abundant water ice within a meter of the surface in many areas of the planet. In addition, the volumes of water ice in the polar caps have been accurately measured and it is now believed that water in the liquid state flows in small quantities on the surface in certain places and at certain times. This presentation will summarize the observations that have allowed scientists to reconstruct the history of water on Mars, including the distribution and state of present-day water. The amount and state of water is inexorably tied to climate, and provides insight into how the environment of Mars has changed over the course of planetary evolution. Such observations also bear strongly on the search for past

life. While considerable progress has been made in characterizing the nature of water, many questions remain and a holistic understanding of the water and climate history remains elusive. Observations of Mars' north polar region by the NASA Phoenix lander will aid considerably in understanding the present sub-polar environment. Insight that could be gained from future robotic observations will also be discussed.



# The Symposia Programme: Reports

Code

## Major Geoscience Programmes

International Year of Planet Earth (IYPE).....	PE
International Consortium of Geological Surveys (ICOGS).....	IC
International Science Drilling Programs (IODP, ICDP).....	SD
Contribution of Geochemistry to the study of the Planet (IAGC).....	GC

## Interdisciplinary Symposia (Topical)

United Nations Convention on the Law of the Sea (UNCLOS).....	UN
Changing Climates.....	CC
CO <sub>2</sub> Capture, Storage and Usage.....	CO
Earth System Management.....	EM
Gas Hydrates.....	GA
Geodynamics and Plate Motions.....	GD
Geohazards.....	GH
Geoscience and Nuclear Waste Disposal.....	NW
Mathematical Geology.....	MA
Medical Geology.....	MG
Ultra-High Pressure Metamorphism.....	UH

## Regional Symposia (Special)

Arctic, Antarctic and Bi-polar relationships (International Polar Year).....	AA
Africa.....	AF
Americas.....	AM
Asia.....	AS
Europe.....	EU
Oceania.....	OC
World Maps.....	WM

## Disciplinary Symposia (General)

Biogeosciences.....	BG
Climate, Glaciology.....	CG
Earth Interior, Exploration Geophysics.....	EI
Environmental Geoscience.....	EG
Geo-energy.....	GE
Geomorphology, Soil Science.....	GS
Geotechnology, Remote Sensing.....	GT
Historical Geology, Paleontology.....	HP
Hydrogeology.....	HY
Information, Education, Ethics, History.....	IE
Mineralogy, Petrology, Isotope Geology, Volcanology.....	MP
Mineral Resources.....	MR
Ocean Sciences.....	OS
Planetary Sciences, Impact Structures.....	PI
Sedimentology.....	SE
Structural Geology, Tectonics.....	ST



## SYMPOSIA PROGRAMMES IN ALPHABETICAL ORDER

### Code

AA	Arctic, Antarctic and Bi-polar relationships (RS)
AF	Africa (RS)
AM	Americas (RS)
AS	Asia (RS)
BG	Biogeosciences (DS)
CC	Changing Climates (IS)
CG	Climate, Glaciology (DS)
CO	CO <sub>2</sub> Capture, Storage and Usage (IS)
EG	Environmental Geoscience (DS)
EI	Earth Interior, Exploration Geophysics (DS)
EM	Earth System Management (IS)
EU	Europe (RS)
GA	Gas Hydrates (IS)
GC	Contribution of Geochemistry to the study of the Planet (IAGC) (MGP)
GD	Geodynamics and Plate Motions (IS)
GE	Geo-energy (DS)
GH	Geohazards (IS)
GS	Geomorphology, Soil Science (DS)
GT	Geotechnology, Remote Sensing (DS)
HP	Historical Geology, Paleontology (DS)
HY	Hydrogeology (DS)
IC	International Consortium of Geological Surveys (ICOGS) (MGP)
IE	Information, Education, Ethics, History (DS)
MA	Mathematical Geology (IS)
MG	Medical Geology (IS)
MP	Mineralogy, Petrology, Isotope Geology, Volcanology (DS)
MR	Mineral Resources (DS)
NW	Geoscience and Nuclear Waste Disposal (IS)
OC	Oceania (RS)
OS	Ocean Sciences (DS)
PE	International Year of Planet Earth (IYPE) (MGP)
PI	Planetary Sciences, Impact Structures (DS)
SD	International Science Drilling Programs (IODP, ICDP) (MGP)
SE	Sedimentology (DS)
ST	Structural Geology, Tectonics (DS)
UH	Ultra-High Pressure Metamorphism (IS)
UN	U.N. Convention on the Law of the Sea (UNCLOS) (IS)
WM	World Maps (RS)

### Abbreviations:

DS = Disciplinary Symposia (General)

IS = Interdisciplinary Symposia (Topical)

MGP = Major Geoscience Programme

RS = Regional Symposia (Special)



## MAJOR GEOSCIENCE PROGRAMMES

### INTERNATIONAL YEAR OF PLANET EARTH (IYPE) PE

Topical symposia related to the IYPE are being coordinated by Ed de Mulder and Edward Derbyshire; most are convened by the theme leaders.

#### **PED-01 Deep Earth - from crust to core (ILP)**

*CONVENERS:* Sierd Cloetingh, VU University Amsterdam, Netherlands; Jörg Negendank, GFZ Potsdam, Germany

*NUMBER OF PRESENTATIONS:* 8 oral

*SYMPOSIUM SUMMARY:* New perspectives are evolving in understanding the structure and evolution of the lithosphere. Nature, dynamics, origin and evolution of the lithosphere are elucidated by international multidisciplinary geoscience research projects and coordinating committees. The International Lithosphere Program (ILP) seeks to achieve a fine balance between: "addressing societal needs", e.g. understanding natural catastrophes and other solid earth processes that affect the biosphere, providing information for improved resource exploration and environmental protection; and "satisfying scientific curiosity".

*GENERAL COMMENTS:* The oral presentations were top scientific quality with a significant impact to the present audience.

#### **PEE-01 Earth and Health - building a safer environment**

*CONVENER:* Olle Selinus, Geological Survey of Sweden, Sweden

*NUMBER OF PRESENTATIONS:* 6 oral

*SYMPOSIUM SUMMARY:* Geological factors play key roles in a range of environmental health issues that impact the health and well-being of billions of people worldwide but there is a general lack of understanding of the importance of these factors on animal and human health among the general public, the biomedical/public health community, and even within the geoscience community. Therefore the contributions aim to show the importance of geology and geochemistry on health of humans and animals.

*GENERAL COMMENTS:* 60 people attending. High quality of all presentations. Vivid discussion.

#### **PEG-01 Groundwater - reservoir for a thirsty planet**

*CONVENER:* Tony Jones, Aberystwyth University, UK

*NUMBER OF PRESENTATIONS:* 7 oral

*SYMPOSIUM SUMMARY:* The seven invited speakers highlighted the main issues facing the management of groundwater resources in the coming decades. Papers ranged from over-exploitation of groundwater, arsenic pollution and climate change impacts to methods of mapping and integrated management. President of the

International Groundwater Commission of IAHS, Chunmao Cheng, and Jie Liu presented the problems in the North China Plain, one of the worst cases of overdraft in the world, whilst Professor Sinha concentrated on the problems of arsenic poisoning that are multiplying around the world and especially in West Bengal. Session chair and convener, Tony Jones, pointed out that arsenic pollution appears to be associated with both overdraft (oxidation) and over-irrigation (reduction), each of which represents a mismanagement of water resources. And the problem is a new one: people have been drinking well water in the affected regions for thousands of years, yet there is no medical evidence from archaeology to indicate problems before the 20th century.

Jac van der Gun, Director of IGRAC, and Willi Struckmeier, Director of WHYMAP, both addressed issues of identifying and classifying aquifers, and of communicating information succinctly and meaningfully to the general public and policy-makers. A major hurdle in this work is to establish a common international standard for data collected under many different national schemes and at different scales. Products include maps and an international database that recognises a hierarchy of spatial scales.

João Lobo-Ferreira, Director of the Groundwater Section of the Portuguese National Civil Engineering Lab., described a methodology to assist in artificial recharge of an aquifer in the Algarve. The approach aims to provide a buffer against drought and to improve water quality.

Kevin Hiscock (UK), author of a major textbook on groundwater, focussed largely on the potential effects of future climate change on groundwater. He noted that the 2008 IPCC reports analyse potential changes in overall water availability, but do not specifically relate to groundwater: yet again, groundwater is the Cinderella of hydrology. He also linked oscillations in water tables beneath the American High Plains to climatic oscillations, especially the 10-25 year cycle of the Pacific Decadal Oscillation (PDO), the NAMS, and to a lesser extent ENSO.

Steve Silliman (USA) and colleagues from Benin presented the leading peer-reviewed research project that has been "badged" by the IYPE's Science Implementation Team for Groundwater as the main research contribution. Badging has allowed the group to acquire sufficient resources to continue work for another four years. The research is identifying the threats to groundwater in Benin, especially the spread of saltwater intrusion in coastal aquifers, and testing solutions. It involves a combination of modelling, field research and interaction with the local population. Getting local government to maintain a network of observation wells is a major aim.

*ANNOUNCEMENTS:* All the presenters have agreed to provide chapters for a book in the Springer Legacy series to be published in 2009 as a contribution to the IYPE.



**PEH-01 Hazards - minimising risk, maximising awareness**

*CONVENERS:* Tom Beer, CSIRO, Australia; Kunioshi Takeuchi, ICHARM, Tsukuba, Japan; R.K. Chadha, NGRI, Hyderabad, India

*NUMBER OF PRESENTATIONS:* 24 oral, 3 no-shows

*SYMPOSIUM SUMMARY:* The MegaSymposium was designed to link the four main research questions of the IYPE Hazards Theme with the five action items of the UN-ISDR Hyogo Framework for Action. This was done at both a disciplinary level and at a geographic level.

Dr Harsh Gupta, whose attendance was supported by the Netherlands UNESCO Committee, spoke on the ICSU Regional Offices and noted that each of these has designated Natural Hazards to be a priority research area.

As there was general agreement that the time span of the IYPE (either one or three years) was insufficient time, the proposed ICSU programme on Hazards (now known as Integrated Research on Disaster Risk) is seen as the natural continuation of the IYPE research work.

In addition to the main invited papers, shorter presentations were also made by scientists working on IYPE Hazards projects related to landslides, seismic faults, and major catastrophes over geological time scales.

*GENERAL COMMENTS:* Both days of the MegaSymposium were by invitation, which led to a very high quality of presentations. There were approximately 25 to 30 people present for all of the talks, with an increased audience size for one or two of the speakers.

Unfortunately both of the presenters for the ICSU Regional Office for Africa had travel problems and were unable to show up when scheduled. They were opportunistically slotted into the second day, but it meant that audience members who had specifically come to hear them on the first day were not there to do so on the second day.

*ANNOUNCEMENTS:* Springer has agreed to publish the proceedings as part of the IYPE Book Series.

**PEM-01 Megacities - going deeper, building safer**

*CONVENER:* Keijo Nenonen, Geological Survey of Finland, Finland

*NUMBER OF PRESENTATIONS:* 7 oral, 2 poster

*SYMPOSIUM SUMMARY:* Urban areas, often concentrated on narrow coastal strips, are running out of space and the price of land is sky-high. More and more, architects will wish to switch from building high to building deep. This is more expensive in the short term, but much more sustainable in the long term. A physical change to how an urban landscape develops has many direct impacts (e.g. socialization, emotionally, physically) on those who live within such conurbations. A better understanding of the urban environment and its impact on our species - and indeed other species - has huge implications for society.

*GENERAL COMMENTS:* Keijo Nenonen chaired the first part of the session after the lunch and Brian Marker the second part after the coffee break. At the most we had 22 participants in the audience. Discussions about urban planning issues and decision-making role of geoscientists came forward and discussion of the peculiar problems of

Tokyo Quaternary faulting and the risk they may pose to infrastructure. Two oral presentations were cancelled, one of Gully classification and management from Nigeria and one of Tokyo urban geological problems.

**PER-01 Non-renewable resources - towards their sustainable use**

*CONVENER:* Richard Sinding-Larsen, Norwegian University of Science and Technology, Trondheim, Norway

*NUMBER OF PRESENTATIONS:* 7 oral, 1 poster

*SYMPOSIUM SUMMARY:* Nearly everything we make or build, and nearly all the energy we use, comes out of the Earth. Modern society is increasingly dependent on mineral and fossil energy sources. They are non-renewable; they differ in their availability, in the cost of production, and in their geographical distribution. The Earth is not running out of critical mineral resources or aggregates - at least for the near future - but the ability to explore for, and produce, those resources is being restricted in many regions by competing land use, as well as political and environmental issues. This symposium covered key resource issues associated with the geological, technological, and social constraints related to the sustainable use of non-renewable resources. The possibility to stretch the available non-renewable resources by seeking efficiency was emphasized. A review of worldwide reserves and ultimate resources of uranium underlined the need to preserve the knowledge from past discoveries in order to tap the remaining resources. An outline of the future of metal mining in Europe from a fennoscandian perspective showed the large untapped potential that still exists in Europe. The problem of sustainable management of mineral resources in developed and developing economies was addressed in relation to the need for transfer of knowledge from well-established geoscience universities to the academic community in developing economies. An example using artisanal and small scale mining in India demonstrated in a forceful way that sustainable management of mineral resources is possible if the scale is in harmony with the local level of industrialization.

*GENERAL COMMENTS:* The overall quality of the presentations both oral and poster were good and several issues on sustainable management of mineral resources created lively discussions. 25 people attended the session.

*ANNOUNCEMENTS:* Springer will publish a book in 2009 with manuscripts from the session.

**PES-02 The Earth's Critical Zone and Hydopedology**

*CONVENERS:* Henry Lin, Pennsylvania State University, USA; Alexander Gennadiyev, Moscow State University, Russia;

Michael Sommer, Leibniz-Centre for Agricultural Landscape Research (ZALF), Germany

*NUMBER OF PRESENTATIONS:* 10 oral

*SYMPOSIUM SUMMARY:* The emerging concept of the Earth's Critical Zone (CZ) provides an appealing framework for integrated studies of water with soil, rock, air, and biotic resources in terrestrial ecosystems. The CZ refers to that part of the Earth from the top of vegetation





to the bottom of aquifer, and extends from the near-surface biosphere and atmosphere, through the entire pedosphere, down to the surface and near-surface portion of the hydrosphere and lithosphere. Interactions at these interfaces between the solid earth and its fluid envelopes determine the availability of nearly every life-sustaining resource and provide the foundation for all human activities. Soil is at the central juncture of the CZ, which functions as a living geomembrane through which water, solutes, energy, gases, solids, and living organisms dynamically exchange with the atmosphere, biosphere, hydrosphere, and lithosphere, hence creating a life-sustaining environment. Water is the circulating force and transport agent that drives many of these interactions and the cycling of solutes and nutrients in the CZ. Other transport mechanisms are also important, such as biogenic, aerial, and mechanical migrations. The interaction of soil and water often dictates the interface between the biotic and abiotic in ecosystems. Because of the critical role soil and water play together in diverse ecological and environmental systems, hydropedology has emerged in recent years as a viable new interdisciplinary field that addresses interactive pedologic and hydrologic processes and the landscape-soil-water-ecosystem relationships across space and time, aiming to understand pedologic controls on hydrologic processes and properties, and hydrologic impacts on soil formation, evolution, variability, and functions.

The goal of this symposium was to promote the holistic studies of the CZ and to advance hydropedology through synergistic collaborations across scientific disciplines, including soil science, hydrology, geomorphology, geology, ecology, biogeochemistry, and others. All these components are important for the CZ functioning, but special attention is paid to the role of water and its interaction with soil at various scales. The synergistic integration of hydrology with pedology, geomorphology, and other related bio- and geo-sciences into CZ science and hydropedology encourages a renewed perspective and a more integrated approach to study landscape evolution, water-energy-element cycles, and biogeochemical dynamics, and their relations to climate change, ecosystem sustainability, land use, and contaminant fate in the environment.

**GENERAL COMMENTS:** The symposium was well received. All the talks were of high quality and stimulating. We hope more interactions and synergies can happen between soil science and geosciences communities. The Critical Zone is the right platform for this to happen.

**ANNOUNCEMENTS:** A special issue of Hydrology and Earth System Sciences is being published with selected papers from this symposium. A hydropedology symposium will be held in 2010 at the 19th World Congress of Soil Sciences in Australia.

## INTERNATIONAL CONSORTIUM OF GEOLOGICAL SURVEYS (ICOGS) IC

### ICG-01 International Consortium of Geological Surveys

**CONVENERS:** Jose-Pedro Calvo, Geological Survey of Spain (IGME), Spain; Zdenek Venera, Czech Geological Survey, Czech Republic

**NUMBER OF PRESENTATIONS:** 12 oral, 1 poster

**SYMPOSIUM SUMMARY:** The ICOGS Symposium was an initiative of the Association of European Geological Surveys in order to overview the role played by National Geological Survey organisations (GSOs) throughout the world. The Symposium aimed to place a basis for extending the International Consortium of Geological Surveys (ICOGS). For this purpose, a number of straightforward contributions dealing with general aspects of the activities of GSOs were presented and contributors from different continents were called to participate. A map of World GSOs showing foundation year, staff, budgets, government adscription and main activities was presented by representatives of CPRM (Brazil), BRGM (France), USGS (USA) and NGU (Norway). The role played by GSOs in knowledge and technical strategies facing Global Change and Geohazards was discussed by representatives of GEUS (Denmark) and SGS (Slovenia). The contribution of GSOs to world-class science was outlined by a representative of BGS (UK). Several major projects dealing with large-scale mapping and the relevance of integrated geo-science systems were presented by representatives of Russia, Japan, Germany and UK; in particular, the project OneGeology should generate interest from Symposium participants. A final contribution by the Secretary General of EuroGeoSurveys placed a question mark on the necessity to enlarge the association of GSOs at a global scale, this opening to a Business Meeting on ICOGS.

**GENERAL COMMENTS:** Contributions presented in the Symposium were provided mostly by General Directors of Geological Surveys. Quality was in most cases excellent. Audience attending the Symposium reached up to 80-100 persons. Each presentation received at least 3-4 questions from the audience.

**ANNOUNCEMENTS:** No special publication is expected, but the ICOGS Symposium will contribute to the development of the organisation of the International Consortium of Geological Surveys.

## INTERNATIONAL SCIENTIFIC DRILLING PROGRAMMES (IODP, ICDP) SD

### SDD-01 Scientific drilling

**CONVENERS:** Manik Talwani, Susan Humphris, Ulrich Harms

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.



**SYMPOSIUM SUMMARY:** Scientific drilling provides unprecedented access to deep in situ samples and processes. It is now recognized that this indispensable tool of drilling, sampling and monitoring at depth is, in several cases, the only way to address urgent scientific and societal issues. In order to address key research questions with appropriate funding and drilling tools, two major geoscience programs, the IODP and the ICDP, have been formed. This session will highlight IODP and ICDP projects over the last four years that have made significant contributions to our understanding of earth structure, climate, and environmental evolution. These have required drilling and performing novel experiments in locations such as the Arctic, on coral reefs and meteorite impact craters, in fault zones, and through fast-spreading oceanic crust.

As a contribution to the International Year of Planet Earth, the International Association of GeoChemistry (IAGC) sponsored the Major Geosciences Programme on Contribution of Geochemistry to the Study of the Planet during the 33rd International Geological Congress.

Since the era of modern geochemical analysis began in the 1960s, geochemistry has played an increasingly important role in the study of Planet Earth. Today, highly sophisticated analytical techniques are utilised to determine the elemental, organic, and isotopic compositions of the Earth's cosmological sphere, its atmosphere and surficial skin, and shallow and deep interiors across a wide range of spatial scales.

The proceedings will be published as a book for the geochemistry community in 2010.

Organised and chaired by IAGC President Russell Harmon (USA) and Council Member Andrew Parker (UK), this Major Geosciences Programme consisted of two thematic sessions:

## CONTRIBUTION OF GEOCHEMISTRY TO THE STUDY OF THE PLANET (IAGC) GC

### **GCC-01 Contribution of geochemistry to the study of the Planet: Historical perspectives**

**NUMBER OF PRESENTATIONS:** 9 oral

**SYMPOSIUM SUMMARY:** This session comprised a historical review of geochemistry and its applications. Contributing talks to this first part of the symposium were: Heinrich D. Holland (US); Balz Kamber (Canada) - Geochemistry and Secular Geochemical Evolution of the Earth's Mantle and Lower Crust; Karsten Hasse (Germany) - The Geochemistry of the Earth's Oceanic Crust; Chris Hawkesworth (UK) - Geochemistry and Secular Geochemical Evolution of the Continental Crust; Abraham Lerman - Global Geochemical Cycles and Geochemical Evolution of Earth Surface Environment; Sigurdur Gislason (Iceland) - The Geochemistry of Silicate Rock Weathering; Michel Maybeck (France) - Global Geochemistry of River Systems; Tomas Paces (Czech

Republic) - Geochemistry and Secular Evolution of Ground Water; and Allan Chivas (Australia) - The geochemical Distinction Between Marine and Terrestrial Evaporites.

### **GCC-02 Contribution of geochemistry to the study of the Planet: Today and tomorrow**

**NUMBER OF PRESENTATIONS:** 12 oral

**SYMPOSIUM SUMMARY:** This session considered current and future developments in geochemistry and how the rapidly-evolving analytical tools and approaches used by geochemists may be used to solve emerging environmental and other societal problems. Contributing talks to this second part of the symposium were: Jochen Hoefs (Germany) - Stable Isotope Geochemistry - Past and Present; Thomas Bullen (US) - New Directions in the Stable Isotope Geochemistry of the Metallic Elements; Russell Harmon (US) - Rapid Analysis, Identification, and Discrimination of Geomaterials by Laser-Induced Breakdown Spectroscopy; Philip Bennett (US) - Microbial Geochemistry: The Influence of Microbes on Geochemistry; The Influence of Geology on Microbial Ecology; Yifeng Wang (US) - Nanogeochemistry: Nanophases, Nanostructures and Their Reactivity in Natural Systems; Yousif Kharaka (US) - Geochemistry of Carbon Dioxide Sequestration; Norbert Clauer (France) - Mineralogical, Chemical and Isotopic Tracing of Fluid-Rock Interactions and Mass Transfers in Sedimentary Basins; Morten Jartun (Norway) - Urban Environmental Geochemistry - Sources of Toxic Pollutants and Possible Dispersion Mechanisms; John Farmer (UK) - Metal Contamination Of The Environment In The Anthropocene: Perspectives, Processes and Prognoses; James Kirchner (Switzerland) - The geochemistry of Landscape Dynamics; Wolfgang Muller (UK) - The Neolithic Alpine Iceman's Origin And Beyond: Towards High-Resolution Mobility and Subsistence Reconstructions of Humans and Fauna; and Henry Schwarcz (Canada) - Archaeological and Anthropological Applications of Isotopic and Elemental Geochemistry.



## INTERDISCIPLINARY SYMPOSIA (TOPICAL)

Symposia of interdisciplinary character covering a wide spectrum of subjects that are of particular Earth Science interest today were included in this category. They range from basic geoscience to societal issues and managerial and organizational problems.

### U.N. CONVENTION ON THE LAW OF THE SEA (UNCLOS) UN

The Ultimate Ocean Mapping Challenge - implementation of Part VI of UNCLOS

Coordinated by Ron Macnab, Harald Brekke, Christian Marcussen, Martin Heinesen

The Symposium featured five sessions:

**UNC-01 The ocean floor and the law of the sea**

**UNC-02 Legal and scientific interface issues**

**UNC-03 World wide database, data holders, data management**

**UNC-06 National delineation projects in progress**

**UNC-07 CLCS recommendations, commentaries**

*CONVENERS:* Harald Brekke, Norwegian Petroleum Directorate, Norway; Martin Heinesen, Järdfing, Faroe Islands; Christian Marcussen, Geological Survey of Denmark and Greenland, Denmark; Ron Macnab, Geological Survey of Canada (retired), Canada

*NUMBER OF PRESENTATIONS:* 25 oral, 1 poster

*SYMPOSIUM SUMMARY:* Session highlights included: 1) overviews of the operations and accomplishments of the Commission on the Limits of the Continental Shelf (CLCS); 2) considerations of the Foot of Slope (FOS) in law and in reality; 3) issues in the collection, management, and interpretation of data; 4) descriptions of the ongoing continental shelf projects of nine states; 5) a presentation on the outcome of the Australian submission.

Only twelve out of an anticipated 65-70 submissions have been presented to the UN Secretary-General so far, but these have shed light on several interpretive and procedural issues (e.g. ridge definitions and CLCS workload, respectively) that will likely persist throughout the entire Article 76 process.

*GENERAL COMMENTS:* All papers were well prepared and informative. Attendance at all five sessions ranged between 80 and 100. Questions and discussions followed most presentations. Participants included several young scholars and investigators (both legal and technical), which augurs well for future progress.

*ANNOUNCEMENTS:* Authors have been invited to prepare manuscripts of their presentations. These will be reviewed, and posted by year's end on a website to be determined.

### CHANGING CLIMATES

CC

Coordinated by Jörn Thiede, Ted Moore, Barbara Wohlfarth

#### CCC-01 Climate system: Quo vadis?

*CONVENERS:* Jörn Thiede, Danish Geocenter, Copenhagen, Denmark; Matti Saarnisto, Finnish Academy of Sciences, Helsinki, Finland (absent); Thomas Stocker, University of Bern, Switzerland (absent)

*NUMBER OF PRESENTATIONS:* 2 oral, 1 cancelled, 3 no-shows

*SYMPOSIUM SUMMARY:* This interdisciplinary symposium had been placed into the program of the first day of 33IGC. Surprisingly its exciting theme had only drawn a limited number (very surprising and despite substantial efforts by the convenors) of abstracts which, however, could be combined with a few additional abstracts which had been submitted to IGC without being specifically related to the topic, making up a total of 6 papers to be presented. Probably due to the fact that the symposium occurred during the first day of the congress, we had 3 no-shows and 1 participant who claimed to have been informed to give her paper at a different session. Altogether 2 papers were given, the highlight being the presentation of Professor Jan Harff (given on behalf of 6 co-authors, mainly from eastern countries) on the history of "Late Quaternary climate variations reflected in Baltic Sea sediments". Jan Harff is an excellent speaker, he had clear illustrations and the topic fitted well into the overall theme of this symposium and of the focus of the entire congress on the Arctic s.l. I was the only convener present, and after some lengthy discussion after the second talk and no information on additional presenters present I decided to close the symposium.

#### CCC-03 Focused fluid expulsion in hydrothermal and sedimentary systems: Mechanisms and effect on climate and biosphere

*CONVENERS:* Henrik Svensen, Physics of Geological Processes (PGP), University of Oslo, Norway; Øyvind Hammer, PGP/NHM, University of Oslo, Norway; Sverre Planke, PGP, University of Oslo and Volcanic Basin Petroleum Research, Norway; Aivo Lepland, Geological Survey of Norway, Norway

*NUMBER OF PRESENTATIONS:* 11 oral

*SYMPOSIUM SUMMARY:* Release of fluid and gases to the atmosphere and ocean may have important consequences for global climate and the environment. For instance, degassing of methane from either sediments or oceans is believed to have played a key role in environmental perturbations during the end-Permian, the Early Jurassic, and the Paleocene-Eocene transition. In addition, there has been a renewed interest in how currently active systems (e.g., volcanoes, mud volcanoes)



affect climate and the biosphere. In this session, the contributions ranged from degassing from mud volcanoes and hydrothermal vent complexes to pockmarks and carbonate precipitation from seep systems. Both gas generation, migration and venting were presented, related to petroleum systems and to sedimentary basins. Of special interest to the audience were presentations by the keynote speaker Giuseppe Etiope, and the talk by Adriano Mazzini on the formation of the LUSI mud volcano in Indonesia. Furthermore, new data on pockmarks from the Oslo Fjord initiated a debate about pockmark formation mechanisms.

*GENERAL COMMENTS:* The first part of the session was very well attended, with approximately 80-90 people present. After the coffee break the topics of the talks were more oriented towards metamorphic systems and climate changes, with somewhat fewer people attending. Overall, the session is regarded by the conveners as well attended, with interesting presentations and discussions, and with the broad range of topics as originally intended when advertising the session.

#### **CCC-04 Paleoclimate and climate modelling**

*CONVENERS:* Atle Nesje, University of Bergen/Bjerknes Centre for Climate Research, Norway; Eystein Jansen, University of Bergen/Bjerknes Centre for Climate Research, Norway

*NUMBER OF PRESENTATIONS:* 6 oral, 2 poster

*SYMPOSIUM SUMMARY:* Major improvements in the understanding of how planetary-scale variations in the Earth's orbit (interacting with the ice sheets, sea ice, and atmospheric carbon dioxide content) have shaped global and regional climatic patterns during the Quaternary have arisen from advances in coupled climate modelling at regional and global scales, combined with syntheses of the data on past environmental changes.

The main purposes of this Symposium were to compare climate models driven by natural forcing, in order to better understand the mechanisms of climate change and to test the ability of the models to reproduce past climatic conditions.

Climate model simulations facilitate the inference of global and regional climate, and the identification of relationships between the models and the paleoclimatic evidence. Evaluation of paleoclimatic simulations further provides opportunities for model validation under conditions different from those used in the simulation of current climate, and constitutes an important means of improving levels of confidence in such models. In this sense another aim was to discuss the accuracy of the models designed for paleoclimatic simulations.

Terrestrial and marine paleoclimatologists and climate modellers were invited to give lectures and present posters in order to discuss evidence of past climate change through analysis of different climate proxies and data-model comparisons.

*GENERAL COMMENTS:* The presentations of both marine and terrestrial paleoclimate data (some with data/model comparisons) were in line with the intention of the Symposium and most talks were followed by questions or comments to the presenter. At the beginning of the

symposium (08.30 am) there were less than ten people in the audience. At the end, however, there were approximately 50 people attending.

## **CO<sub>2</sub> CAPTURE, STORAGE AND USAGE CO**

### **COC-02 New frontiers of geological sequestration of greenhouse gases**

*CONVENERS:* Zique Xue, Kyoto University, Japan; Ryo Kouda, AIST, Japan; Toshiyuki Tosha, GREEN and AIST, Japan

*NUMBER OF PRESENTATIONS:* 11 oral, 5 poster

*SYMPOSIUM SUMMARY:* The first paper (by D. Tanasa and T. Yoshimura) briefly summarized and introduced geophysical monitoring carried out in Nagaoka underground CO<sub>2</sub> storage project, which was the world's first onshore CO<sub>2</sub> storage project. The next paper (by L. Stroink et al.) reported the German CCS R&D project GEOTECHNOLOGIEN that promotes laboratory- to field-scale study on safe implementation of CO<sub>2</sub> geological storage. The lecture focused on the status of the Altmark pilot project that was planned to store CO<sub>2</sub> in a depleted gas field in Northern Germany. The following paper (by G. Sigurdur, Iceland) showed the study on storage of CO<sub>2</sub> from geothermal energy production by means of geochemical reaction with basaltic rocks. The fourth paper (prepared by T.F. Xu and K. Pruess but presented by their colleague O. Curtis from USA) introduced the recent advancement of geochemical transport modelling in CO<sub>2</sub> storage research, with particular emphasis on the application of the code TOUGHREACT simulator in the Frio pilot project. The next paper (by Y. Okuyama et al.) briefly summarized geochemical characteristics of Japanese deep groundwater and showed its high potential of CO<sub>2</sub> solubility. The following paper "Deep saline aquifers for sequestration of carbon dioxide" could be an interesting one as it was proposed from an emerging country, India. Unfortunately the author S. Neelam did not arrive and the paper was withdrawn. Thereafter, the paper by T. Tosha et al. introduced a simulation study setting the Tokyo Bay area as a hypothetical storage site and showed successful sequestration of CO<sub>2</sub> in an open aquifer in the model field. The paper by A. Ueda et al. showed the experimental and field study of mineral CO<sub>2</sub> trapping using calcic plagioclase as a reactant. The following paper (by Y. Yamada et al.) presented experimental studies on the CO<sub>2</sub> alteration by casing cements which was one of the possible mechanisms inducing leakage. The paper by M. Sorai et al. also reported an experimental study concerning plagioclase dissolution by CO<sub>2</sub>. Based on the experiments showing non-linear behavior of anorthite feldspar dissolution, he stressed a need of improved geochemical simulator adopting linear rate law of mineral dissolution. The paper presented by X. Zue discussed the trapping mechanisms in CO<sub>2</sub> aquifer storage, based on the Japanese experience from Nagaoka onshore CO<sub>2</sub> storage project. The final paper of this session was an ad hoc one presented by a Danish scientist





from GEUS focusing on the potential of CO<sub>2</sub> storage in sedimentary rocks of land and sea areas in North-Central Europe surrounding the North Sea.

**GENERAL COMMENTS:** The authors of the papers came from Japan, the European countries, and the United States. The oral session gathered over 50 people, indicating an increasing interest concerning CCS and CO<sub>2</sub> geological storage. The atmosphere of the session was active with many discussions mainly on the physico-chemical conditions on experiments and analyses in comparison with the postulated conditions in underground reservoirs of various types.

Five papers from Japan were focused on the open aquifer storage of CO<sub>2</sub>. This method of CO<sub>2</sub> storage is considered to be suitable to Japan with abundant CO<sub>2</sub> emission sources on geologically young and coastal plains. One of the objectives of this session is to demonstrate recent research progress on open aquifer CO<sub>2</sub> storage, thereby showing the scientific basis of this method of CO<sub>2</sub> storage. We consider that the session attracted the attention of many people and ended successfully.

### **COC-03 Risk and vulnerability assessment related to geological storage of CO<sub>2</sub>**

**CONVENERS:** Jens Birkholzer, Lawrence Berkeley National Laboratory, USA; Rainer Helmig, University of Stuttgart, Germany (not present); Kaylene Ritter, Stratus Consulting, USA (not present)

**NUMBER OF PRESENTATIONS:** 16 oral, 3 poster

**SYMPOSIUM SUMMARY:** The intent of geologic carbon dioxide (CO<sub>2</sub>) sequestration is to prevent anthropogenic CO<sub>2</sub> from entering the atmosphere, thereby maintaining acceptable levels of atmospheric CO<sub>2</sub>. Ideally, the CO<sub>2</sub> captured from industrial sources is safely transported to sequestration sites and injected deep underground, where it will be permanently trapped with no negative impact on the terrestrial environment. In practice, carbon sequestration will be neither perfectly effective nor risk-free. Pipelines may breach, CO<sub>2</sub> may leak from geological storage sites back to the surface, shallow subsurface CO<sub>2</sub> may displace large volumes of brines or brackish waters into usable groundwater, or pressure changes may lead to fracturing or seismicity. Thus, there are health and environmental risks associated with geologic carbon sequestration, and evaluation of these risks will be important for making decisions concerning where and how sequestration should be performed. We solicit for this session contributions that help assess the health and environmental risks related to geologic sequestration of CO<sub>2</sub> in a broad sense. All oral and poster presentations provided valuable insight on the session topic.

A first set of seven presentations included contributions on basic approaches and methods for qualitative/quantitative evaluation of geological sequestration risk, or described risk assessment case studies for current or future sequestration sites. Four oral and one poster presentation dealt with determining seal properties and evaluating seal integrity, a fundamental prerequisite for leakage risk assessments. Three presentations analyzed the possible vulnerability of groundwater in response to exposure to CO<sub>2</sub>. Other topics

covered, in oral presentations and one poster, included risk evaluation based on natural analogs, as well as monitoring strategies for CO<sub>2</sub> migration and leakage detection. Overall, the session suggested that the topical choice for this session, i.e. risk and vulnerability assessment related to geological storage of CO<sub>2</sub>, is a relevant and actively pursued research field, evident from the breadth of contributions and the interest in the audience.

**GENERAL COMMENTS:** Overall quality of presentations was very good. Number of attendees is hard to judge; the session room seemed about half full on Day 1, and somewhat less on Day 2. Discussions were lively; having one cancellation gave us more time for extended Q/A sessions.

## **EARTH SYSTEM MANAGEMENT**

**EM**

Coordinated by Joy Jacqueline Pereira, Terje Thorsnes

### **EME-02 Role of geoscience in governance for sustainable development and human security**

**CONVENERS:** Joy Jacqueline Pereira, IUGS Commission on Geoscience for Environmental Management (IUGS-GEM), Malaysia; Chen Shick Pei, Coordinating Committee for Geosciences Programme in East and Southeast Asia (CCOP), Malaysia; Lars Persson, Geological Survey of Sweden, Sweden

**NUMBER OF PRESENTATIONS:** 20 oral, 12 poster

**SYMPOSIUM SUMMARY:** Over the years the term "governance" has become more prominent than "government" to accommodate the growing importance of non-state actors such as non-governmental organisations, community groups, corporations and other interest groups in policy-making. This is particularly pertinent in the pursuit for sustainable development, which is addressed through global programmes of action such as the Millennium Development Goals, Agenda 21 and the Johannesburg Plan of Implementation. Good governance is also critical in the implementation of Multilateral Environmental Agreements (MEAs), such as the UN Framework Convention on Climate Change and Basel Convention on the Control of Transboundary Movements of Hazardous Wastes among others, which provide for actions and initiatives by countries that are parties to these agreements and share their objectives. It is also relevant to human security, which evokes the right of people to live in freedom and dignity, free from poverty, despair and threats, with an equal opportunity to enjoy all their rights and fully develop their human potential. The contribution of geoscience in seeking solutions to global problems is very important and significant, particularly within national boundaries.

The Symposium focused on governance as a point of departure, to authenticate the relevance and significance of geoscience knowledge in addressing issues related to sustainability from the perspectives of environmental, economic and human security. Contributions were sought from several geoscience institutions, to describe their role





and involvement in implementing global programmes of actions and international agreements, using legislative and administrative procedures at the national, provincial and local levels. The aim was to document these contributions and identify common approaches for mainstreaming geoscience contributions into international, regional and national policy and decision-making processes for sustainable development and human security.

The presenters at the Symposium represented a variety of geoscience institutions including national geoscience organisations or geological surveys, academic institutions, scientific bodies, inter-governmental and non-governmental organisations. Clearly, all geoscience institutions play a role in supporting development at the national, provincial and local levels. The majority also support the implementation of international agreements within national boundaries. There was general agreement that the contribution of geoscience in seeking solutions to global problems and achieving sustainable development is very significant. Notwithstanding this, it was noted that the level of awareness among policy and decision-makers on the contribution of geoscience was low. It was suggested that geoscientists are not marketing themselves well. There are barriers, some of which are systemic while others are behavioural in nature.

There are many different approaches to influence policy and decision-making processes and mainstream geoscience for sustainable development and human security. It was agreed that it is impossible to have a prescriptive way to mainstream geoscience and that it is only possible to exchange information, learn from each other and adapt what is suitable to each country. Nevertheless, some generic guiding principles apply. The first course of action would be to identify communication pathways and understand the processes involved so that timely information can be provided for decision-making. In addition to targeted communication, awareness-building is also critical for this purpose.

Multiple types of partnerships were highlighted to build awareness. This varies from traditional partnerships between geoscientists and engineers, land use planners and local authorities etc. to non-traditional partnerships such as that between geoscientists and the community and other groups of non-geoscientists. It was stressed that geoscientists play a bigger role in community service; perhaps pro bono work should be promoted at the community level. A suggestion was made that geoscientists should even run for elections! The potential for transfer of technology in implementing international agreements was also discussed. In this context, the establishment of various types of non-traditional partnerships to strengthen capacity in areas such as climate change adaptation, disaster risk reduction and carbon dioxide storage were highlighted.

**GENERAL COMMENTS:** There were about 50 participants at the oral session and many more visited the posters. The oral session saw active participation during the discussion sessions, with questions, comments and sharing of experiences.

**ANNOUNCEMENTS:** The next step is to document details of the discussion and disseminate the highlights to a

wide audience. For this purpose, the abstracts and report will be published and put on the IUGS-GEM website, so that it can be easily accessed. Clearly, there is need for a programme on "geoscience governance", to develop generic guiding principles and document success stories for mainstreaming geoscience and influencing policy. IUGS-GEM will take the lead and establish an institutional arrangement for this purpose. The outcome of this will be reported at the 34th IGC in 2012 hosted by Australia.

## **EME-06 Geoscience in ocean management**

**CONVENERS:** Terje Thorsnes, Geological Survey of Norway, Norway; Gary Greene, Tombolo Institute, USA; Brian Todd, Geological Survey of Canada, Canada

**NUMBER OF PRESENTATIONS:** 12 oral, 2 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** Geoscience in ocean management is growing in importance. Integration of geological knowledge and methods with other natural sciences, particularly biology, provide critical knowledge and decision support for ecosystem-based management of the oceans and sustainable exploitation of marine non-biological resources. Key words are interdisciplinary research, habitats, GIS-based knowledge and decision support systems, geo-bio interactions, geo-diversity, geology for society, EU Marine strategy, ecosystem based management, and "geology as the floor of the ecosystems". The Norwegian interdisciplinary MAREANO program was planned to underline the Nordic dimension, while important programs and projects in other parts of the world, particularly Canada, the United States, Australia, United Kingdom and Ireland, were included to provide a global overview.

The twelve oral presenters were from institutions in the US, Australia, Ireland, Norway, Finland, Denmark and Germany. Presentations of the role of geosciences in ocean management and the application of the concept globally started the symposium. This was followed up by case studies from the Norwegian MAREANO program, and from projects within the Baltic Sea, Kattegat and the North Sea. Two posters demonstrated how interdisciplinary cooperation, integrating geology and biology, is necessary for habitat mapping and the understanding of important processes and conditions for benthic faunas. The last talk addressed how geoscientists could and should interact with European Union managers, in order to ensure a sustainable and knowledge based management of the European seas.

The symposium was ended with a lively plenary discussion, focusing on how geoscientific knowledge could be further integrated in ocean management, and how sufficient funds could be secured to provide adequate resources. Particularly the full-scale, total area coverage programs like the Seabed Survey in Ireland and the MAREANO program in Norway were mentioned as examples of successful programs, providing basic knowledge for ecosystem based management. Similar programs are under development both in Europe and around the world.

**GENERAL COMMENTS:** The symposium was attended by ca. 60 participants. The presentations, both oral and poster, were of very high quality.



**ANNOUNCEMENTS:** Terje Thorsnes announced that there will be a conference dedicated to habitat mapping and related aspects in Trondheim May 5-7th, 2009. For more info, see [www.geohab.org](http://www.geohab.org).

#### **EME-09 Risks, resources, and record of the past on the continental shelf**

**CONVENERS:** Renée Hetherington, University of Victoria, Canada; Francesco L. Chiocci, University of Rome, Italy; Lindsay Collins, Curtin University, Australia; Michel Michaelovitch de Mahiques, University of S. Paulo, Brazil

**NUMBER OF PRESENTATIONS:** 11 oral, 3 poster, 3 no-shows

**SYMPOSIUM SUMMARY:** IGCP Project 526 "Risks, Resources, and Record of the Past on the Continental Shelf" seeks a better global understanding of continental shelf processes and their influence and relevance to human society. Morphology, stratigraphy, sedimentology, ecology, and human-related issues merge together in the complex continental shelf environment where waves, tides, currents, input from the continent, and humans interplay through time and space. This symposium will focus on three main research topics: 1) Risks: pollutants, neotectonics, tsunamis and other high-energy events, geotechnical hazards, and emergency management; 2) Resources: mineral, aggregates, living, and environmental management; 3) Record: the carbon cycle, paleoanthropology - humans and their relationship with the changing shelf environment, and climate change. We seek improved understanding of the extent of risks and resources on the continental shelf in order to enhance regional capabilities, particularly in developing countries, and future risk mitigation - especially those resulting from economic development and climate change.

**GENERAL COMMENTS:** The session focused on a variety of geological, climatological, anthropological, environmental, and mineralogical research issues related to continental shelves around the world. Questions were posed to presenters and healthy discussion prevailed. An unexpected no-show provided an opportunity for the co-conveners to present a brief summary of the IGCP 526 project and to inform the audience of the upcoming annual general meeting in Brazil in November 2008. It also provided an opportunity for more thorough discussion on issues raised during question period and for participants to make insightful recommendations and research suggestions. For example, suggestions were made about potential geological considerations that should be made during the site selection process for dredged sediment disposal on the New Zealand continental shelf. Collaboration discussions were also instigated, for example in the use of paleoclimate modeling in ascertaining potential explanations for changing river and sedimentation levels during Adra River deltaic formation in the northern margin of the Alboran Sea and in providing insights into the destruction and submergence of ancient Helike, Greece.

## **GAS HYDRATES**

## **GA**

Coordinated by Harsh Gupta, Richard Coffin

#### **GAH-01 Gas hydrates in oceanic and permafrost environments - importance for energy, climate and geohazards**

**CONVENERS:** Juergen Mienert, University of Tromsø, Norway; Charles Paull, Monterey Bay Aquarium Institute (MBARI), USA; Graham Westbrook, University of Birmingham, UK; Hafliði Haflidasson, University of Bergen, Norway

**NUMBER OF PRESENTATIONS:** 11 oral, 12 poster

**SYMPOSIUM SUMMARY:** This session dealt with gas hydrates, a solid ice-like compound in which 1 cubic metre contains approx. 250 cubic metres of methane gas. If it exists in sufficiently large quantities in the pore space of oceanic or permafrost sediments it may be used as an energy source. Geologists speculate that billions of tonnes of methane lie beneath the permafrost and in oceanic hydrates beneath the seafloor. On the other hand, methane is a powerful greenhouse gas and massive methane bursts in times of global warming could accelerate the process. It is therefore important to know: where does the gas hydrate accumulate, what are the volumes of gas hydrates in the various "reservoirs" in the sub-seabed of the ocean and on land, and how stable are the reservoirs under rising global temperatures. Finally, are rising temperatures already causing substantial amounts of methane to be released from beneath the ocean floor and permafrost regions?

No conclusions can be drawn from this session concerning the climate impacts, but the presentations and findings indicate releases of methane from pockmarks in the Norwegian and Arctic regions and in other parts of the world where geophysical or geological expressions of hydrates exist.

The symposium added to a lively discussion that culminated during the well-attended poster sessions.

**GENERAL COMMENTS:** Both the oral and the poster sessions were well attended with approx. 100 participants during oral presentations. It underlined the high interest in this climate and energy related topic. Discussions about technologies for gas hydrate in-situ, laboratory investigations and dissociation processes showed the wide spectrum of knowledge and interest in the audience. Mainly colleagues from Asia, USA, Russia and Europe participated in the session.

**ANNOUNCEMENTS:** Future meetings are planned to focus on the wide Arctic shelves and continental margins to assess the methane reservoirs and their response to climate change.

#### **GAH-03 Exploration and assessment of gas hydrates**

**CONVENERS:** Kalachand Sain, National Geophysical Research Institute, India; Harsh Gupta, National Geophysical Research Institute, India; Richard Coffin, Naval Research Laboratory, USA

**NUMBER OF PRESENTATIONS:** 5 oral, 3 poster, 3 no-shows



**SYMPOSIUM SUMMARY:** Gas hydrates are attracting global attention due to widespread occurrences in coastal oceans, their potential as a future major energy resource and their role in climate change and relation to environmental hazards. Therefore, exploration and assessment of gas hydrates are essential for resource estimation and hazard assessment. Gas hydrates are detected using a suite of geophysical, geological, geochemical and microbial techniques, and quantified mostly by the geophysical tools. The fast consumption of fossil fuel, stagnating production and increasing oil prices have necessitated the search for alternative forms of energy, as economic growth depends heavily on energy security. Gas hydrates seem to be a viable source of non-conventional energy in the 21st century. Abstracts dealing with the characterization and assessing of gas hydrates were invited. The session was chaired by Kalachand Sain and Richard Coffin. Presentations during this session included: B. Pierce provided an overview of the DOE natural gas hydrates programme in the Arctic and Gulf of Mexico. She talked about the key issues related to the production of gas hydrates from varied tectonic/geological settings. This provided useful information to advance our R&D knowledge and practical feasibility of extracting gas from gas hydrates.

D. Mahajan presented the structural properties of methane hydrates formation and dissociation through laboratory experiments with computed microtomography complemented with a new Flexible Integrated Study of Hydrates (FISH) that mimics the hydrate formation at natural conditions. This characteristic study addressed the 3-D growth of hydrates applying a microstructural model and contact angle interpretation of the water host system.

K. Sain presented techniques for the quantitative assessment of gas hydrates based on AVO modelling and A-B crossplot coupled with rock physics modelling. He also showed the application of some seismic attributes for the identification of gas hydrates without any BSR and/or ascertaining whether a BSR is related to gas hydrates.

R. Coffin presented the geochemical evaluation of methane hydrates in the Atwater Valley of the Gulf of Mexico and compared the results with the mid-Chilean Margin, the Hikurangi Margin and Alaminos Canyon of the Gulf of Mexico. Stable and radio carbon isotope analysis of inorganic and organic carbon pools with high pore water chloride concentrations show that the shallow sediment carbon cycling is controlled by the deep sediment methane. The sulfate methane transition zone coupled with high methane concentrations at the shallow level indicate deep sediment hydrate instability that was suspected from the deep sediment salt diapirs.

I. Vargas Cordero presented an iterative approach to determine the velocity field and the migrated seismic section, and related the BSR with the highly tectonised oceanic crust in the Chilean margin. This study was very useful to correlate the gas hydrates occurrences and the accretionary style along the active continental margins. He also showed that the final velocity field can be used for estimating concentrations of gas hydrates and free gas.

Poster presentations were (1) Hydrocarbons in shallow

sediments of the eastern deep-water Ulleung basin, East Sea, by B. Ryo et al., (2) PP and PS wave velocity estimation for gas hydrate area in the Ulleung basin using wide-angle multi-component OBS data, by B. Kim et al. (3) Multi-scaled seismic approaches for gas hydrate exploration in the Ulleung Basin, by N. Koo et al.

**GENERAL COMMENTS:** Though it was the last day of the Congress, the session was attended by more than 50 participants. There were live discussions about the future prospects of this new source of energy. A close interaction between the researchers/scientists from the academia and oil/gas industries took place. The session ended with the summary and thanks to the audience.

## GEODYNAMICS AND PLATE MOTIONS GD

Coordinated by Trond Torsvik, Irina Artemieva, Hans Thybo

### **GDP-01 Elevated, passive continental margins:**

#### **Timing and mechanisms of uplift**

**CONVENERS:** Peter Japsen, Geological Survey of Denmark and Greenland, Denmark; Johan M. Bonow, Geological Survey of Denmark and Greenland, Denmark; Anthony G. Doré, StatoilHydro, USA; Jörg Ebbing, Norwegian Geological Survey, Norway

**NUMBER OF PRESENTATIONS:** 10 oral, 2 poster, 1 no-show

**SYMPOSIUM SUMMARY:** Many passive continental margins around the world are characterized by an elevated plateau, often separated from an adjacent coastal plain by a pronounced escarpment; e.g. on both sides of the Atlantic, south-east Africa, western India and in eastern Australia. In many areas, e.g. Scandinavia, the timing and extent of uplift movements are difficult to determine because the uplifted area consists almost exclusively of ancient metamorphic rocks. However, during recent years evidence has been accumulating that a major component of the relief is of Neogene age. Some offshore sedimentary basins on the passive margins have been exhumed during the Neogene uplift (e.g. around the northern North Atlantic) and petroleum systems can be radically affected by this process. This symposium investigates the uplift history of the passive margins around the world and the mechanism behind these enigmatic movements. The presentations included studies based on geological, geomorphological as well as geophysical observations. Is the mechanism behind the uplift movements a patchwork of different effects, or is there a major underlying lithospheric paradigm behind passive margin uplift?

The session provided a good introduction to the observations pointing towards post-rift formation of many elevated passive continental margins around the world. This provided an excellent background for the more theoretical papers that were focussed on identifying mechanisms that could produce various aspects of the



uplift history of such margins. It was thus possible to identify some mechanisms as being capable of explaining specific observations with various spatial and temporal characteristics.

*GENERAL COMMENTS:* The overall quality of the presentations was very high, and the aspects covered by the presentation were wide-ranging and did thus serve very well as inspiration for future work.

The session was attended by a large number of people, starting with c. 50 persons present at 8.30 and the hall (6) being full during the later part of the morning. The discussions were very lively and followed each of the presentations.

The character of the papers presented and the large audience during the session indicates a great interest in the particular topic and probably also in topical sessions focussed on controversial issues as such.

*ANNOUNCEMENTS:* The session will be followed by a special issue of Tectonophysics with papers on the subject of the session. Guest editors are Cobbold, Japsen, Bonow, Doré and Ebbing.

#### **GDP-02 Paleo- to Mesoproterozoic crustal evolution and continental growth**

*CONVENERS:* David Corrigan, Geological Survey of Canada, Canada; Sally Pehrsson, Geological Survey of Canada, Canada; Karl-Inge Åhäll, Karlstad University, Sweden; Stephen Reddy, Curtin University of Technology, Australia

*NUMBER OF PRESENTATIONS:* 12 oral, 3 poster

*SYMPOSIUM SUMMARY:* The Paleo- to Mesoproterozoic Era (2.5 to 1.0 Ga) witnessed a period of fundamental evolution in the Earth System that ultimately gave rise to tectonic processes similar to those that operate presently, and conditions suitable for the support and diversification of microbial life. This change took place against the backdrop of development of the world's first true supercontinents, with attendant profound effects on atmosphere, biosphere, hydrosphere and geodynamic processes. Its history began with the fragmentation of previously amalgamated Archean continents and evolved through major periods of global accretion and plate dispersal. The amount of juvenile Proterozoic crust and mantle formed - and preserved - during this period is controversial but critical to models of continental growth through time. This time period also witnessed the appearance of new metalotects (e.g., SEDEX, unconformity-type U) and igneous associations (e.g., Anorthosite-Mangerite-Charnockite-Granite (AMCG) complexes). This Topical Session seeks contributions that shed some light on tectonic, magmatic, metallogenic and other fundamental geological processes that reflect the history of Paleo- to Mesoproterozoic Earth and development of its first true Supercontinents.

Overall, the presentations revolved around two main themes, which were: i) Factors contributing to continental growth and craton stabilization, or cratonization, and the role of Archean versus Proterozoic lithosphere in this process, and ii) Various models of Paleoproterozoic continental assembly based on paleomagnetic and detrital

zircon data. It was proposed that crustal growth models are more representative of preservation through time rather than actual episodic growth, with presence of Archean lithosphere highlighted as the most determinant factor in stabilization of younger crust. Paleomagnetic and detrital zircon data as well as new geochemical and geochronological data on arc-derived magmatic suites offered new insights on growth and assembly of Baltica, Eurasia, Laurentia and Amazonia. These reinforced the fact that Laurentia and Amazonia collided during the assembly of Rodinia, but also helped refining these two continents during the final Nuna assembly at 1.80 Ga. New models were also presented on the tectonostratigraphic evolution of western Laurentia and implications for Nuna reconstructions.

*GENERAL COMMENTS:* We were impressed by the quality of presentations and high attendance at the posters. The room was adequate for the symposium, and we estimate that attendance varied between 25 and 40 people throughout the half day session.

*ANNOUNCEMENTS:* We would like to thank IGCP 509 for support for this symposium.

#### **GDP-03 Towards a common reference frame for plate motions and mantle dynamics - a tribute to Kevin Burke**

*CONVENERS:* Bernhard Steinberger, Geological Survey of Norway, Norway; Trond H. Torsvik, Geological Survey of Norway, Norway

*NUMBER OF PRESENTATIONS:* 8 oral, 3 poster

*SYMPOSIUM SUMMARY:* Relative plate motions in the ocean basins are rather well-known, but deformation between and within plates in continental areas, "absolute" plate motions relative to a mantle reference frame and plate motions relative to the magnetic pole are known with much less accuracy. Yet a good knowledge is essential for obtaining a common reference frame for plate motions globally and for making inferences towards plate-mantle interactions. This session brought together experts in several methods that can be used to quantify or model motions between plates and mantle, including (1) geometry and ages of hotspot tracks, (2) geodynamic modelling, (3) relating surface features to mantle tomography. Regarding the first method, John O'Connor discussed new age dates obtained from samples of hotspot seamounts and implications on how scattered eruptions are relative to the presumed mantle plume locations. Pål Wessel showed how this method can be pushed to the limit (145 Ma) for the Pacific by considering tracks of now-extinct hotspots. Bernhard Steinberger argued that plate motions and true polar wander can be distinguished even in the absence of hotspot tracks, by combining paleomagnetic data with geodynamic considerations and the observed characteristics of plate motions relative to hotspots. Regarding the second point, Giampiero Iaffaldano discussed how the growth of the Andes may be related to relative motion between South America and Nazca plates. Wouter Schellart showed how inferred trench migration and subduction-induced viscous dissipation can help to distinguish which reference frame most likely describes true absolute plate motions. Relating



points (2) and (3), Dietmar Mueller showed preliminary results on how matching seismic tomography with predictions based on subduction in plate reconstructions can lead to a common reference frame. Finally, Kevin Burke showed that matching reconstructed Large Igneous Provinces to the margins of Large Low Shear Velocity Provinces (LLSVPs) of the lowermost mantle contributes to a reference frame for the past 300 Ma. Based on a comparison of Earth and Mars he argued that LLSVPs may have been stable for most of the Earth history, a hypothesis that will be challenging but not impossible to test. Trond Torsvik began the session with an honorific speech for Kevin Burke, to whom this session was a tribute.

**GENERAL COMMENTS:** The quality of presentations was overall very high, as some of the key players in the field of absolute reference frames for plate motions and mantle flow contributed presentations. The symposium was rather well attended, beginning with an estimated 50 at the (rather early) start at 08:15, and culminating with about 200 during Kevin Burke's talk. I have no exact count, but there were people standing in the back of room D6.

#### **GDP-04 Palaeozoic-Mesozoic earth geography: Palaeomagnetic, faunal and facies constraints**

**CONVENERS:** Trond H. Torsvik, L. Robin Cocks, Rob Van der Voo

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** The positioning of old terranes can be recognized only by palaeomagnetism and by identifying and discriminating between the distributions of the various faunas and floras in their successive provinces, which can indicate terranes with similar faunas as close to each other or, conversely, indicate their separation. The disposition of key sediments, such as glacial deposits, coals and evaporites, can also be useful, although they are largely latitudinal rather than terrane specific. The history of the various orogenies and the identification and dating of old sutures must also be taken into account, and a paramount factor is the kinematic continuity necessary for plausible successive reconstructions. We invite contributions, preferably reviewing large continents or terrane groups, or on faunal or palaeomagnetic analysis on a global scale over a substantial geological time slice.

#### **GDP-07 Coupling lithosphere and mantle processes**

**CONVENERS:** Susanne Buiter, Geological Survey of Norway, Norway; Bernhard Steinberger, Geological Survey of Norway, Norway

**NUMBER OF PRESENTATIONS:** 9 oral, 6 poster

**SYMPOSIUM SUMMARY:** Deformation processes in the lithosphere and flow in the Earth's mantle have successfully been investigated by considering the lithosphere and mantle as separate domains. However, it is well known that mantle flow drives lithosphere deformation on a large scale, while lithosphere processes such as subduction in turn impact mantle flow. The coupling of mantle and lithosphere processes is one of the

current challenges in geodynamics. To understand interactions between both domains, it is necessary to bridge their differences in scale, while also taking their different material behaviour into account. The contributions in this session discussed progress in coupling lithosphere and mantle processes from the perspective of new developments in computational models and insights from field-based studies.

Several different approaches in coupling tectonic plates with a convecting mantle were presented. Paul Tackley showed how tectonic plate behaviour can arise self-consistently from a mantle convection model with a suitable rheology. Using a different approach, Giampiero Iaffaldano coupled separate models of global lithosphere dynamics and mantle circulation. In yet another approach, Julian Lowman prescribed the initial configuration of freely moving plates on a convecting mantle, and let the geometry evolve self-consistently to study the influence of lower mantle viscosity on plate velocity time dependence. Another important aspect discussed in several presentations was dynamic topography, i.e. vertical plate motions due to mantle convection, and inferences on sea level change in different regions: in the South West Pacific (Lydia diCaprio), in Australia (Christian Heine), on the U.S. east coast (Sonja Spasojevic), and even on Venus (Andre Fahl). Further specific topics discussed included, among others, the work needed to bend subducting plates, and what it tells about the coupling of plates and the mantle (Scott King), sub-lithospheric small-scale convection, and how it relates to seismic anisotropy (Jeroen van Hunen), how slab windows that form through subduction of ridges may facilitate the uprise of hot mantle from beneath the slab, specifically beneath the Canadian Cordillera (Derek Thorkelson), and how plates may at times couple to form megaplates (Thomas Anderson).

**GENERAL COMMENTS:** The oral part of the session was attended by 50 to 80 people, while the poster session was best visited during the lunch break.

#### **GDP-08 Basin subsidence and mantle dynamics**

**CONVENERS:** Sierd Cloetingh (ILP) VU Amsterdam, Netherlands; Magdalena Scheck-Wenderoth, GFZ Potsdam, Germany; François Roure, ILP, France

**NUMBER OF PRESENTATIONS:** 6 oral, 5 poster

**SYMPOSIUM SUMMARY:** This session was organized as an ILP session of the Task Force Sedimentary Basins. Accordingly, the session assembled contributions from the deep and shallow parts of sedimentary basins in order to promote the dialogue between scientists studying processes acting at different depth levels, but which are connected and inter-related. Sedimentary basins evolve in response to lithospheric deformation and store a record of this deformation. Currently, different dynamic concepts compete in explaining the observations in basins of different geo-tectonic settings. On one side the evolution of basins is analysed based on the geometry of the basin fill, the recorded thermal history as well as the generation and evolution of fluids. Especially the search for hydrocarbons yielded remarkable breakthroughs in the understanding of boundary conditions for the generation





and leakage of organic matter and related feed-back with climate. On the other hand deep lithospheric processes are studied to unravel the controlling mechanisms of basin subsidence as magmatic injection, underplating, uniform or differential stretching, flexural or local isostatic compensation. We had invited contributions focussing on the interactions between deep earth and surface processes, i.e. thermicity, phase-transitions, fluid circulations and transfers, interactions between uplift/erosion and subsidence/sedimentation and their spatial variations. We had also welcomed studies presenting geological and geophysical data from different depth levels of basins, and we anticipated the discussion of new conceptual and numerical models of basin evolution.

Three invited speakers gave overview presentations on the current state-of-the-art concerning the deep crustal structure of rifts (H. Thybo, Univ. Copenhagen), forward dynamics models of rift formation (R. Huismans, Univ. Bergen), and on the shallow expression of geodynamic processes such as generation and leakage of petroleum and consequences for gas hydrate formation (B. Horsfield, GFZ Potsdam). The remaining presentations addressed Late Cretaceous foreland basin evolution across Colorado-Wyoming and its linkage with Farallon plate subduction (Li. Shaofeng & D. Nummedal); Dynamic topography and Neogene uplift of Patagonia (Benjamin et al.); The hydrocarbon budget of the Mackenzie Basin (Kroeger et al.); Subsidence of the Gulf of Lion continental margin (Olivet et al.); Deep structures and basin formation in the Barents Sea (Clark et al.); links between the deep structure of the Norwegian continental margin and the location of the Storegga Slide (Maystrenko & Scheck-Wenderoth); and paleo stress fields along the inverted margins of the basins of North Central Europe (Sippel et al.)

**GENERAL COMMENTS:** The oral session took place early and late afternoon August 13, and was well-attended (~80 people, number decreasing towards the end of the session).

**ANNOUNCEMENTS:** As we have been approached by the editorial office of Elsevier, we currently evaluate the option of editing a special volume of Marine and Petroleum Geology where the presentations given at the Oslo IGC can be documented. A follow-up session has been proposed for the EGU 2009 in Vienna.

## GEOHAZARDS

## GH

Coordinated by Farrokh Nadim, Mary Lou Zoback

### GHZ-01 Geo-risk in the 21st century (GSC, IUGS, INQUA)

**CONVENERS:** Peter T. Bobrowsky, David Applegate, John J. Clague, Suzanne Lacasse

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** Earth science has much to contribute to the reduction of risk from hazardous natural

processes. This contribution will be particularly important in the 21st century when global population approaches 10 billion people and climate change begins to affect the health, safety, and well-being of societies. This session will examine the risks and impacts of climate change over the next 100 years. We invite contributions on the current and anticipated effects of a warmer climate on sea level, permafrost, rivers, mass wasting, aeolian activity and desertification, glacier loss, and severe storms. We also welcome papers on risk pertinent to climatically driven changes in surface Earth processes. Speakers should provide clear links between climate change, its physical consequences, and risk implications.

### GHZ-02 Geohazards and risk studies under global environmental change

**CONVENERS:** Olav Slaymaker, The University of British Columbia, Canada; Christine Embleton-Hamann, University of Vienna, Austria; Thomas Glade, University of Vienna, Austria (absent); Kalle Kronholm, Norwegian Geotechnical Institute, Norway (absent); Kari Sletten, Geological Survey of Norway, Norway

**NUMBER OF PRESENTATIONS:** 11 oral, 7 poster, 5 cancelled or no shows

**SYMPOSIUM SUMMARY:** The highlight of the symposium was a series of six presentations on the multi-disciplinary research project "Geoextreme: Norwegian geohazards in a changing climate". Representatives from the Norwegian Geological Survey at Trondheim, the Norwegian Geotechnical Institute in Oslo, the Department of Earth Sciences at the University of Bergen, and CICERO in Oslo presented both physical and social science aspects of this priority issue.

A comparably interdisciplinary presentation on geohazards in Austria was given by Professor Embleton-Hamann, Department of Geography and Regional Research, University of Vienna. Professor Humlum from the University Centre in Svalbard, Longyearbyen presented the impacts of changing climate on trafficability of terrain in Svalbard. Another regional study was presented by Dr. Ghazipour from the Geological Survey of Iran in Tehran, focusing on rockfall hazards. Site specific studies were given by Dr. Zhang from the Chinese Academy of Geological Sciences in Beijing (an ancient landslide dammed lake in Yunnan) and by Dr. Ramaraju from the Department of Civil Engineering, Visweswaraya University College of Engineering, Bangalore (on geohazards in an abandoned gold mining settlement).

**GENERAL COMMENTS:** The symposium was a success, but was marred by the absence of 4 important oral presentations (from Russia, Argentina, Bangladesh and Hungary) and a poster presentation from China. Maximum attendance at the sessions was 42.

### GHZ-03 Integrated studies of tsunamis and other geohazards in coastal regions

**CONVENERS:** Lalit P. Chaudhari, ISDR, India; Shrikant D. Limaye, Ground Water Institute, India; Nils-Axel Möner, Paleogeophysics & Geodynamics, Sweden

**NUMBER OF PRESENTATIONS:** 10 oral, 6 poster



**SYMPOSIUM SUMMARY:** On 26 December 2004 massive waves triggered by an earthquake surged into coastal communities in Asia and East Africa with devastating force. Hitting Indonesia, Sri Lanka, Thailand and India hardest, the deadly waves swept more than 200,000 people to their deaths. Also in other extreme climate change phenomena during 2005 - 2006, causing heavy rain and flooding in the South Asia, Europe and Pacific regions, more than 100 million people witnessed the social, economical and ecological risks and impacts due to climate change and geohazards. The economic losses to coastal ecosystems, agriculture, irrigation, aquaculture, drinking water resources, coastal industries and infrastructure are very high due to extreme geo-disasters linked with global environmental and climate change. The ecosystem and economic systems in these regions are severely affected and need systematic rehabilitation. Scientific knowledge is also needed to mitigate the geo-disasters and marine hazards and stimulate rehabilitation during the post-tsunami period, requiring experienced research communities who can train the local population during tsunami rehabilitation. The session aims to assess the potential risks and hazards, technical issues, problems and damage arising from tsunamis in the Asia-Pacific and Europe region in coastal geology, coastal ecosystems and coastal environmental systems. The recommendations from the experts will be submitted to UNESCO, IUGS, IAHS, governmental organizations and international organizations, and research institutions for capacity building of the local population, scientists and researchers' integration of geohazards studies on vulnerability and risk assessments along coastal regions.

The coastal zones of the globe are especially vulnerable, partly because so many people are living in this zone, and partly because the coastal zone is affected by several processes that may lead to disastrous effects; earthquakes, inundations, storms, tsunamis, etc. In this symposium, we tried to highlight the coastal hazards, not least the effects and threats of tsunamis. In conclusion, we plead for a much better warning system and an improved record of past paleo-tsunamis for better long-term hazard assessments.

**GENERAL COMMENTS:** Several important papers were presented. The discussions were constructive. Some 30 persons attended the symposium. In his opening remarks, Dr. Limaye stressed the need of an efficient tsunami warning system. The Indian Ocean tsunami had struck the Indian naval base in Andaman 90 minutes before it struck the east coast of India and Sri Lanka, but a warning could not be issued. As a tsunami may strike on a holiday or outside the government office timings of 10 am to 5 pm; there is a need to include the NGOs, hospitals and fishermen's cooperatives in the warning system.

#### **GHZ-04 Earthquake hazard assessment and geotechnics**

**CONVENERS:** Amir Kaynia, Norwegian Geotechnical Institute, Norway; Michele Maugeri, University of Catania, Italy

**NUMBER OF PRESENTATIONS:** 17 oral, 27 poster, 2

no-shows

**SYMPOSIUM SUMMARY:** Earthquakes have caused considerable material damage and human loss throughout history. Unfortunately these losses have increased over the years due to increased urbanization and settlement in seismically active regions. Whereas in the past most of the losses were related to structural and building failures, we have witnessed an increased contribution by ground failure to losses in modern history. The ground failures include such phenomena as landslides, rockslides, and soil liquefaction during earthquakes. In addition, the local geology, stratigraphy, and geotechnical soil properties contribute immensely to the amplification of earthquake waves and inflicted damages. To discuss these issues, the symposium focused on the following topics: Assessment of earthquake hazard; Influence of local geology and soil conditions on the amplification of earthquake waves; Characterization of soil properties by field and laboratory testing; Ground failures caused by earthquakes such as landslide and soil liquefaction; Microzonation studies for reduction of earthquake risk; Case histories, observations, numerical simulations, and measures to mitigate earthquake risk.

The papers submitted or designated to this session addressed these subjects well. They included: geological/tectonic studies and fault characterisation, deterministic and probabilistic seismic hazard studies at local and regional scales, simulation of ground motions by earthquakes, site characterization and microzonation studies, case histories and numerical modelling of earthquake-induced landslides, case histories of liquefaction and consequences, and monitoring of geohazards for risk reduction. In addition, Prof. M. Maugeri presented an Invited Lecture on "Seismic microzonation studies and site response analysis in the city of Catania, Sicily, Italy".

**GENERAL COMMENTS:** The presentations had very high standards, both in terms of the scientific content and structure/organisation of the material. All presenters were well prepared and quite engaged in the questions and answers that followed the presentations. The topics of the sessions were interrelated, this brought about several rounds of interesting discussions on the interaction between the various disciplines of earthquake geohazards including importance of site characterisation and simulation of landslides and liquefaction. The number of people attending the session varied during the session from about 10 to about 25.

#### **GHZ-05 Remote sensing and GIS technologies for geohazard monitoring**

**CONVENERS:** [Moutaz Dalati, Farouk El-Baz, Zaher Al Suleimani, Mikhail Mouty, David Stevens, Ahmed El-Hassani, Fares Howari.] Chaired by Linda Hårvik, Norwegian Geotechnical Institute, Norway, when none of the conveners showed up.

**NUMBER OF PRESENTATIONS:** 14 oral, 9 poster, 1 no-show

**SYMPOSIUM SUMMARY:** Many of the geohazards that ever happened on our planet are located in active zones. It is most important to obtain detailed information on



regional structures. Remote sensing has been brought forward for many years, and has applications in many hazard reduction domains. GIS is a way of modelling the world people live in. Remote Sensing and GIS data integration involves combining or merging data from multiple sources to extract better and more information. DEMs/DTMs are also useful for generating three-dimensional perspective views. Using Laser technique in topographic mapping is an accurate method for the quantification of the differences in elevation or relief. In this symposium, effective methodologies were presented in order to identify geohazard zones. The overall objective of the symposium was to increase the awareness of policy-makers, planners and managers of using space technology for preventing and managing disasters. The presentations focused on the following topics: Geohazards: seismic hazards and landslides; Earth resources Satellite and use of space technology for different geohazards monitoring; Applications of Remote Sensing and GIS technology in geohazard risk Modelling; Mapping of Active and fresh faulting zones using Remote Sensing Techniques; Geo-information Modelling in the Hazard Assessment Context; Integrated Concept for GIS in geohazards monitoring.

**GENERAL COMMENTS:** Medium to good presentations: Average attendance of about 20 to 25 during the day. Little discussion, as all authors used all the time they were allotted. It is disturbing that conveners did not send information that they were not to be present. Chair had to be asked on the spur of the moment.

#### **GHZ-06 Landslide risks in fluvial systems**

**CONVENERS:** Nicola Casagli, University of Firenze, Italy; Thomas Glade, University of Vienna, Austria; Margreth Keiler, University of Vienna, Austria; Oliver Korup, Swiss Federal Research Institutes WSL/SLF, Switzerland; Oddvar Kjekstad, Norwegian Geotechnical Institute, Norway

**NUMBER OF PRESENTATIONS:** 9 oral, 21 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** This session has focused on landslide risk reduction in general in relation to the interactions between geomorphic hillslopes and fluvial processes. The wide range of this topic covers the varying underlying causes and triggers, as well as the manifold geomorphic feedbacks between hillslope processes and river systems. This includes, but is not limited to, the formation and failure of landslide dams; impacts on river systems because of excessive hillslope sediment input; influence of weathering and transport limitations; and processes of slope undercutting and knickpoint migration. In this session a particular attention has been given to landslide hazard and risk assessment by means of new technologies and to the progresses on landslide risk reduction. Experiences from different regions of the world have been compared. Scientists, teachers, policy-makers and other stakeholders who regularly deal with the management of ground instability problems have shared their experiences, case studies and best practices. The scientific quality of the contributions has been of a very high level, substantially contributing to the dissemination

of the present knowledge in the field of landslide risks.

**GENERAL COMMENTS:** The session has been very successful. Many people attended and a lively and constructive discussion was raised after each oral presentation. The discussion has formed the basis for future improvements of the research in this topic and possible collaborations.

**ANNOUNCEMENTS:** The session was sponsored by UNESCO, IUGS, IYPE, ICL and ICG. The ICL (International Consortium on Landslides) together with UNESCO will organize the First World Landslide Forum which will be held next November in Tokyo. The Forum will be co-sponsored by IUGS and IYPE.

#### **GHZ-07 Integrating geological hazard assessment into urban planning and management**

**CONVENERS:** Mario Aurelio, University of Manila, Philippines; Bhawani Shanker Paliwal, Jai Narain Vyas University, India; Phillip Schmidt-Thomé, Geological Survey of Finland, Finland; Brian Marker, independent consultant and chairman of the IUGS/GEM Urban Geology Working Group, UK

**NUMBER OF PRESENTATIONS:** 12 oral, 9 poster, 5 cancelled or no-shows

**SYMPOSIUM SUMMARY:** A wide range of hazards were addressed including: rising groundwater, waterlogging and flooding; subsidence associated with fluid withdrawal; compressibility/compaction; soil degradation; gravity opening of ground fissures; waste water pollution; landslides; and seismic and volcanic events. The diversity contrasts with past IGC sessions promoted by the Urban Geology Working Group, which were dominated by papers on the latter 3 hazards. From discussion, the groundwater hazards are clearly a widespread and growing concern internationally and might deserve a special session at IGC2012.

There were strong contributions on the use of Synthetic Aperture Radar in evaluation of ground movements, especially in Italy, and the value of the technique for repeat monitoring was emphasised. Some papers were concerned with more traditional hazard maps, usually now mounted on GIS and generally taking account of more than one type of hazard. It was encouraging to hear about more web-based delivery of products both to the geological community and to administrators and the general public. Inventories of landslides were described that incorporated a wide variety of data in support of geographically referenced sites shown on maps.

Several contributions attempted to step from hazard assessment to risk assessment, which can be more readily used by administrations dealing with planning and development. Good work is being done in both developed and developing countries but, especially in the latter, the amount of unplanned development, poorly enforced planning regulations, and lack of building control frustrate attempts to secure sustainable land use. Other contributors considered the weighting of the significance of hazards and risks as a basis for prioritisation of mitigation and remedial actions. There was clear evidence of efforts by researchers to ensure that findings are used by planning, management



and civil protection authorities, although with varying success.

*GENERAL COMMENTS:* The facilities for review and acceptance/rejection of abstracts were good. The loss of a few presentations/posters seemed to relate to authors not securing Geohost support. The sub-committee kindly awarded Geohost support to co-convenors from India and the Philippines but there were severe difficulties in securing support for their air fares which we were, fortunately, able to overcome. The standard of presentations was high throughout and time keeping was good. Audiences were relatively small, perhaps because a number of geohazards sessions were timetabled in parallel.

*ANNOUNCEMENTS:* All contributors have been asked to submit full papers for publication by the Geological Society Publishing House subject to approval by their editorial committee. It is anticipated that if enough authors respond in good time the proceedings should become available in mid to late 2009.

### **GHZ-08 Volcano flank instability: Causes, precursors and associated hazards (ILP)**

*CONVENERS:* Derek Rust, University of Portsmouth, UK; Federico Pasquare, University of Insubria, Italy

*NUMBER OF PRESENTATIONS:* 7 oral, 2 poster

*SYMPOSIUM SUMMARY:* Volcanic edifices are now recognised as inherently unstable constructions where flank collapse(s) at a range of scales can be expected as a normal part of their life cycles. Moreover, depending on volcano location, such instability can trigger related phenomena, notably debris avalanches, lateral blasts and tsunamis; hazards to which an increasing number of the world's population are exposed. Only fairly recently has research begun to reflect a multidisciplinary approach, including studies of active volcanoes, deeply eroded inactive volcanic systems, as well as laboratory studies and modelling. The symposium aims to bring together structural geologists, volcanologists, petrologists, analogue and numerical modellers, remote sensing specialists, geomorphologists, geophysicists, engineering geologists and hazard mitigation researchers so that their differing viewpoints and insights into these phenomena can be beneficially exchanged. The proposed symposium will be held under the aegis of the International Lithosphere Programme (ILP) project 'New tectonic causes of volcano failure and possible premonitory signals'.

Despite the coincidence of this symposium with a very similar one held at the IAVCEI conference in Iceland nine abstracts were submitted. Presentations in Oslo covered a wide range of instability phenomena, and included both relatively small scale landsliding and extremely large scale sector collapse events. Geographically the talks ranged from central America and the Andes to island arcs in the Mediterranean and Caribbean. This symposium attracted an audience from a wide range of interests, as became clear in the questions during the session. We were also fortunate in occupying one of the smaller rooms at the conference venue as this was conducive to discussion, and at the end of the session we had a very interesting extended plenary debate.

### **GHZ-10 Mountain risks: From prediction to management and governance**

*CONVENERS:* Theo Van Asch, Utrecht University, Netherlands; Nicola Casagli, University of Firenze, Italy; Jean-Philippe Malet, CNRS UMR 7516, France; Giacomo Falorni, University of Firenze, Italy

*NUMBER OF PRESENTATIONS:* 8 oral, 1 poster, 5 no-shows

*SYMPOSIUM SUMMARY:* The session has been organized in the framework of the Mountain Risks (From prediction to management and governance) project in order to disseminate the results of the project itself and increase the knowledge of geohazards in mountainous areas. Mountain Risks is a Marie Curie Research Training Network in the 6th Framework Program of the European Commission. Its focus is research and training in all aspects of mountain hazards and risk assessment and management. Landslides, rockfalls, debris flows, snow avalanches and floods are just a few of the natural hazards to which people, infrastructure, businesses and local communities in mountainous areas are exposed. The most effective approach for coping with these hazards is to implement combined multi-risk-oriented analyses in which investigations focus more on the interdependence of events rather than on single events. In addition, planning and development strategies of mountain areas must now also take into account important variables such as changes in climate, land use and increasing demographic pressure. In the light of these challenges, it is important to hasten the development of methods for assessing quantitative risk, to encourage innovative research and to improve the transfer of knowledge to stakeholders in order to produce comprehensive risk management and prevention policies. The main goal of the Mountain-Risks project is therefore to advance knowledge on mountain hydro-geomorphological processes and to ensure that this knowledge is transferred and applied in order to make long-term cohabitation with natural hazards possible. Within this framework, research is divided into the following themes: (1) mountain hydro-geomorphological hazard analysis; (2) consequences of hazard and quantitative risk assessment; (3) risk management; (4) risk governance. These themes have been addressed during the session thanks to the interesting contributions which have highlighted the scientific improvements in the field of landslide monitoring, susceptibility, hazard and risk assessment, hydrological and geotechnical modelling, and landslide risk mitigation.

*GENERAL COMMENTS:* The scientific quality of the contributions has been of a high level, significantly contributing to the dissemination of the present knowledge of scientific research in the field of natural hazards. The session was very successful. Many people attended and constructive discussions were raised during the session.

*ANNOUNCEMENTS:* In the framework of Mountain Risks project a special session will be organized at the next EGU congress in 2009 which will be held in April in Wien.



### **GHZ-11 Rock slope movements and early warning of catastrophic failure and related tsunamis**

*CONVENERS:* Lars H. Blikra, Geological Survey of Norway/ICG, Norway; Giovanni Crosta, Univ. of Milano-Bicocca, Italy; Steve Evans, University of Waterloo, Canada; Reginald Hermanns, Geological Survey of Canada, Canada; Alexander Strom, Institute of Geospheres Dynamics, Russia

*NUMBER OF PRESENTATIONS:* 16 oral and 3 poster

*SYMPOSIUM SUMMARY:* Landslides resulting from large rock-slope failures are a major hazard in mountainous areas. In the 20th century, disasters caused by rock avalanches have killed more than 50,000 people on a global basis. In Norway, large rock avalanches represent one of the most serious natural hazards, as exemplified by the Tafjord disaster of 1934 when about 3 million m<sup>3</sup> of rock fell into the fjord and generated a destructive tsunami killing 40 people. It is well known that slopes that have not undergone major failure may show movement or surface features that indicate potential for catastrophic failure. Normally, the only method of managing this kind of risk is the development of an effective warning system. Remedial countermeasures are normally not useful when dealing with a large rockslide due to the extremely high kinetic energy involved. Suitable emergency planning is then the only effective tool to reduce the consequences by means of evacuation, road closure and other active measures. The session focused on natural subaerial rock slopes, and had a specially attention to large slope failures along fjords. The session included the following main topics:

1) Monitoring and Early Warning. The presentations were mainly focused to monitoring and early-warning activities in Norway and Italy, with special attention to the monitoring and early-warning of Åknes in Norway and Ancona in Italy. New technologies presented included both in-place monitoring (e.g. subsurface) and remote sensing (e.g. InSAR). Discussions included the challenges related to threshold values in early warning.

2) Models (geology, hydraulics, stability). This part was limited to three presentations on the geological, hydrological and stability models of the large Åknes rockslide in western Norway. The discussion was focused on how we can handle complex groundwater conditions in stability models.

3) Tsunamis. The tsunami part of the session touched both on documentation of historical events and issues related to modelling.

4) Geology and events. The presentations included both large-scale regional geological relationships with rockslide problems and more detailed geological, structural and geomorphological characteristics of potential rockslide areas. The importance of chronological data of rockslide events in hazard analysis was also pointed out.

The final discussion concentrated on some of the fundamental challenges in coping with large events, including how to perform national analysis of rockslide hazard.

*GENERAL COMMENTS:* The presentations were of a very high quality, and with good, lively and important discussions. The location of the session, with a long

distance from the main session area, led to very few people attending the session, in particular Monday morning. Also, since the natural hazard sessions were spread throughout the conference (both weeks), the people attending the natural hazard sessions on the last week were very low. The few people attending the sessions were the most disappointing part of the conference, and may have consequences for future IGC conferences.

### **GHZ-12 Converting geosciences knowledge into action for natural hazard reduction: Lessons from multidisciplinary research**

*CONVENERS:* Roberto F. Page, Servicio Geológico Argentino, SEGEMAR, Argentina; Catherine Hickson, Canadian Geological Survey, Canada

*NUMBER OF PRESENTATIONS:* 5 oral

*SYMPOSIUM SUMMARY:* This symposium brought presentations about the scope, concepts and applications of the methodology developed for geosciences community communication in the context of the Multinational Andean Project: Geosciences for Andean Communities (MAP:GAC). Reginald Hermanns (former MAP:GAC's Scientist in Charge and currently with the Norwegian Geological Survey, NGS) introduced the symposium indicating the project's goals, structure, and participants. Fernando Munoz Carmona presented the concepts and scope of the project's Community Communication methodology (COMCOM). On behalf of the Chilean Geological Survey, he presented an example of the methodology's application in Southern Chile. Based on geoscience information and communication, local authorities and communities developed and applied educational tools to raise awareness about local volcanic hazards and risks. This knowledge together with the articulation of the available resources have allowed several local schools and communities to take actions for risk reduction such as the conformation of parents and students safety brigades, the design and implementation of evacuation signals, and evacuation drills. Eduardo Zappettini from the Argentinean Geological Survey presented the application of the COMCOM methodology in the Mendoza Province (Western Argentina) where local planning and other government authorities together with local communities are applying geosciences knowledge for the relocation of the community of Las Cascadas. The communication exercise has achieved preliminary agreements between inhabitants and authorities which have been traduced in local land use regulations. Zappettini also presented the Andean Hazards Map produced by the seven MAP:GAC countries. The goal with this map is to reach a wide spectrum of users such as school kids, parents and authorities to inform about the different types of hazards the Andean Region is exposed to. Finally Hermanns presented the map of active faults of the Andes based on GeoSemantica. This map was build by the Geological Survey of the Andean countries, the seismological surveys of the Andean countries and several universities. The map is published on CD within the Atlas of active faults of the Andes and on the internet in GeoSemantica. The map is intended for urban and regional planning purposes as well as private companies





working on the construction of lifelines, mining and energy infrastructure, and civil defence.

**GENERAL COMMENTS:** In this symposium were present illustrious representatives of the geological surveys of Chile, Colombia, Germany, Great Britain, Norway, United States, and the Commission for the Geological Map of the World, and discussions focussed mainly on practices of communicating scientific knowledge to a complex user group.

### GHZ-13 Geohazards - a tribute to Kaare Høeg

**CONVENERS:** Suzanne Lacasse, Norwegian Geotechnical Institute, Norway

**NUMBER OF PRESENTATIONS:** 12 oral

**SYMPOSIUM SUMMARY:** The Symposium was a tribute to Kaare Høeg's career and achievements. Lecturers from around the world who have contributed to and benefited from Kaare Høeg's outreach in the geosciences presented keynote lectures on geology and geohazards, including landslides, shallow gas, floods, erosion, early warning systems, safety of dams subjected to erosion, and hazard analysis. Professor R.V. Whitman, of MIT, introduced the session with a retrospective of Kaare Høeg's work in the USA and how his ideas and work influence the profession today.

Dr. Suzanne Lacasse presented a biography of Kaare Høeg and the main areas of influence from his work. Invited lectures included Professor Robert V. Whitman of MIT, Professor Wilson Tang of the Hong Kong University of Science and Technology, Dr. Elmo DiBiagio of the International Centre for Geohazards at NGI, Professor J. Michael Duncan of the Virginia Polytechnic Institute, Dr. Hugh St John of the Geotechnical Consulting Group in the UK, Professor Dr. Michele Jamiolkowski of Politecnico di Torino, Tor Inge Tjelta of StatoilHydro AS, Professor Dr. Jean-Jacques Fry of Electricité de France et Ecole Centrale de Lyon, Professor Anders Elverhøi of University of Oslo, and Professor Dr. Farrokh Nadim of the International Centre for Geohazards at NGI. Professor Kaare Høeg completed the lectures with a Retrospective on his career.

**GENERAL COMMENTS:** Top quality presentations, good attendance from about 09:30 AM. Average of 100 persons at all time after 09:30 M. 08:30 is too early to start when participants need to take a train to come in. Early trains were too crowded and delayed.

**ANNOUNCEMENTS:** Will probably publish all lectures in an NGI publication.

Italy; Frantisek Woller, Radioactive Waste Repository Authority, Czech Republic

**NUMBER OF PRESENTATIONS:** 6 oral, 2 poster, 3 no-shows

**SYMPOSIUM SUMMARY:** Isolation of all types of radioactive waste in rock bodies with suitable properties requires a long-term science and technology programme. The role of the rock body (natural barrier) is crucial for both performance assessment and long-term safety in the case of high-level waste and spent nuclear fuel repositories. The rock body contributes to the safety of disposal by:

providing physical isolation of the waste from the near surface environment and the potentially disruptive processes that occur there;

maintaining a geomechanical, geochemical and hydrogeological environment favourable to the preservation and performance of the engineered barrier system;

restricting the access of water to the waste and migration of mobilized radionuclides.

However, in addition to the host rock, many other factors, such as the regional hydrogeological regime, the tectonics and seismicity of the region, the possibility of volcanic activity, the morphological development and expected climatic changes, affect strongly the ability of the particular rock body to be acceptable for radioactive waste repository siting.

The impact of these and other factors were discussed from different perspectives during the session. Particularly interesting were the series of three presentations from Japanese colleagues on the heat flow, hydrothermal activity, tectonics and seismicity in one of the target areas for high-level waste disposal in northern Japan. Since the conditions described would have excluded areas in Europe from consideration as suitable, there was a long and interesting discussion in a slot provided by a no-show. Another highlight was a half-hour presentation of the main results and future development of the international Mont Terri rock laboratory, in which research teams from 12 countries are studying the geology, hydrogeology, geochemistry and rock mechanics of a clay formation with regard to its possible use as host for a high-level waste repository.

**GENERAL COMMENTS:** All in all, it was an interesting session with wide-ranging contributions, punctuated by sometimes intensive discussions in the 15 minute "holes" in the programme provided by the otherwise disappointingly high proportion of cancelled talks (3 out of 9 talks). The number of attendees varied between 20 and 40.

## GEOSCIENCE AND NUCLEAR WASTE DISPOSAL NW

Coordinated by Alan Geoffrey Milnes

### NWG-01 Geology and disposal of nuclear waste: Global perspectives

**CONVENERS:** Alan Geoffrey Milnes, Geoscience Consultant, Switzerland (session chairman); Steve Sparks, Bristol University, UK; Leonello Serva, Servizio Geologico,

### NWG-02 Geology and disposal of nuclear waste: Nordic approach - special aspects of the disposal in crystalline bedrock

**CONVENERS:** Lars O. Ericsson, Chalmers University of Technology, Göteborg, Sweden; Liisa Wikström, Posiva Oy, Olkiluoto, Finland

**NUMBER OF PRESENTATIONS:** 14 oral, 1 cancelled

**SYMPOSIUM SUMMARY:** Many countries with a programme of nuclear power generation carry out studies for geological disposal of long-lived radioactive waste. The



development and the demonstration of the technology for disposal and the decision/licensing process is progressing. According to national geological options and waste management strategies there are substantial differences in disposal concepts. The Nordic countries Finland and Sweden have developed a multibarrier system with crystalline bedrock as the host media. In Finland, the construction works for a repository for spent nuclear fuel are now finalised and in Sweden site investigations are presently being made.

The engineering and scientific development in Finland and Sweden has been in progress for thirty years and involves geoscientific subjects in a broad sense, e.g. structural geology, rock mechanics, hydrogeology, hydrogeochemistry, thermal aspects and transport of different species in groundwater. In situ experiences have been gained from the Äspö Hard Rock Laboratory and other experimental sites.

The aim of this topical symposium was to highlight general geoscientific progress and understanding in the context of nuclear waste disposal in crystalline bedrock. The content of the session thus related to several geological topics including engineering and investigation issues. Comprehensive presentations of the ongoing site investigations at the Laxemar, Forsmark sites in Sweden and at the Olkiluoto site in Finland were made.

**GENERAL COMMENTS:** The general impression is that the contributions were well prepared and presented with high quality. Ca. 50 participants in the audience followed the session all day.

**ANNOUNCEMENTS:** No special issue journal is planned, but some of the contributions will be elaborated to separate scientific papers.

## MATHEMATICAL GEOLOGY

MA

Coordinated by Richard Sinding-Larsen, Frits Agterberg

### MAG-02 Mathematical and statistical modelling of physical and chemical processes in the Earth sciences

**CONVENERS:** Antonella Buccianti, University of Florence, Italy; Raimon Tolosana-Delgado, Universität Göttingen, Germany

**NUMBER OF PRESENTATIONS:** 6 oral, 8 poster

**SYMPOSIUM SUMMARY:** Earth and environmental systems are complex and dynamic. They are commonly studied and characterised by monitoring several chemical and physical variables, as well as bioecological parameters. Analysing them, while interesting separately, becomes truly fascinating and challenging with a multivariate approach, focusing on their relationships more than on themselves. Indeed, the evolution and spatial distribution of these variables results from the competition of several processes. Modelling both these variables and their controlling processes requires the use of quantitative space-time (such as spatial-sampling methods, time series, pattern identification, cyclicity, regionalised variables) multivariate tools accounting for the particular relations between

variables (e.g. spherical data, compositions and constrained data, mass balances and mixing processes, etc). Session MAG-02 on Mathematical and statistical modelling of physical and chemical processes in the Earth Sciences has represented a focus for discussion on this matter at the 33rd IGC.

**GENERAL COMMENTS:** Scientific works presented as oral or poster in the MAG-02 session have allowed all the participants to discuss the application of mathematical, stochastic or statistical tools to model physical and chemical processes in geology and environmental sciences. Several people who are working with numbers to model processes have presented their results as oral or posters, discussing theoretical aspects as well as applicative case studies. The session was sponsored by the International Association for Mathematical Geosciences. On the whole the scientific level of the presentations was good with approximately 20-30 people attending the session.

### MAG-03 Uncertainty in spatial prediction modelling: From natural risk to resources

**CONVENERS:** Andrea G. Fabbri, Univ. of Milano-Bicocca, Milan, Italy; Chang-Jo Chung, Univ. of Ottawa, Ottawa, Canada

**NUMBER OF PRESENTATIONS:** 8 oral, 2 poster

**SYMPOSIUM SUMMARY:** The proposed background position was that: to perform hazard and risk analysis and mineral potential prediction using spatial databases, the various levels of predicted values should be represented as continuous functions for later classification according to different criteria including the degrees of uncertainty of support, of robustness etc., as required by the specific use in decision-making. This proposed session has focused on the various techniques to estimate and represent the uncertainties associated with the spatial data, with the mathematical models and with the scenarios used to predict natural hazard, risk and resource potential.

Applications of different prediction models have been exposed and lively discussed. One was of the "Alternating Conditional Expectation to construct functional relationships between dependent variables in investment decisions in resource exploration. Another was the spatial interpolation of magnetic intensity data via Artificial Neural Networks. Critical issues in natural hazard mapping were considered the uncertainty of prediction patterns and that of the hazard levels of the prediction classes. They can be estimated by empirical cross-validation procedures based on blind tests. GIS-based landslide susceptibility mapping using Machine Learning Methods and Logistic Regression models was discussed with applications where study areas were subdivided in calibration and validation areas to obtain probabilities of spatial occurrence of landslides. The direct estimation of variograms was proposed using the variogram cloud itself. An Empirical Likelihood Ratio function was used to establish relationships between the locations of 300 water wells with nitrate levels clearly above or below a 20 mg/l, and a number of natural and anthropogenic factor maps. Prediction and validation were obtained via blind tests and the associated uncertainty levels were represented as maps. In one application mineral



resource prediction and assessment uncertainties were related to complexity and variability of mineral deposit types and geneses, their underground settings and the limited data available. Neural Networks, used to predict mineral resource prospectivity, was seen as helpful to express the uncertainty due to vagueness of classification and the incomplete understanding of the mineralization. Finally, spatial random fields were represented via high-order geostatistics. In addition, two colourful and well designed posters dealt, respectively, with the prospectivity maps of volcanogenic massive sulphide deposits in northern Sweden, via Weight of Evidence modelling, and the effects of different digital elevation model data on landslide susceptibility modelling in northern Spain.

**GENERAL COMMENTS:** Contributions were particularly well presented and questions were put to all speakers. The audience consisted initially of 25 participants and quickly arrived at 45. Novelties in the contributions were in methods to visualize complex constructs and to estimate uncertainties, a topic generally ignored in spatial modelling.

**ANNOUNCEMENTS:** While no specifics were proposed for publication of contributions, it became clear that all issues related to uncertainty of predictions need to be analyzed and exposed in further international meetings.

#### **MAG-04 Scales, scaling, non-linearity and complexity in the geosciences**

**CONVENERS:** Qiuming Cheng, York University, Toronto, Canada and China University of Geosciences, Wuhan, China; Frits Agterberg, Geological Survey of Canada, Ottawa, Canada

**NUMBER OF PRESENTATIONS:** 11 oral, 4 poster, 1 no-show

**SYMPOSIUM SUMMARY:** It is well known that singular physical or chemical processes may result in anomalous amounts of energy release or mass accumulation that, generally, are confined to narrow intervals in space or time. Singularity is a property of different types of non-linear natural processes including flooding, landslides, and earthquakes. The end products of non-linear processes have in common that they can be modelled as fractals or multifractals. It is becoming increasingly clear that various geological bodies including hydrocarbon deposits as well as several types of ore deposits exhibit fractal or multifractal properties such as scale independence and power-law relationships. Likewise, ore-mineral and toxic elements associated with geochemical anomalies in the environment may describe Pareto-type frequency distributions. The aim of this symposium was to bring together scientists concerned with non-linear processes and associated complexity in any field of the earth sciences including geophysics, geochemistry, sedimentology, tectonics, petrology and economic geology.

**GENERAL COMMENTS:** The oral presentations were attended by 20-40 scientists with brief, lively discussions. Paper MAG04104L was not presented. In its place, Qiuming Cheng presented recent results of non-linear modelling with singularity mapping.

**ANNOUNCEMENTS:** Several papers will be published in

journals (Computers & Geosciences; Mathematical Geosciences; and Natural Resources Research) of the International Association for Mathematical Geosciences.

#### **MAG-05 New frontiers of mathematical geology for resources exploration**

**CONVENERS:** Katsuaki Koike, Kumamoto University, Japan; Zhao Pengda, China University of Geosciences, China; Donald A. Singer, U.S. Geological Survey, USA; Ryoichi Kouda, Geological Survey of Japan, Japan

**NUMBER OF PRESENTATIONS:** 9 oral, 9 poster, 4 no-shows

**SYMPOSIUM SUMMARY:** For a sustainable world, the development of new technologies for resource exploration is of the utmost importance. This session aimed at combining state-of-the-art theories and technologies of mathematical geology, geoinformatics, GIS, economic geology, geophysics, and geochemistry for exploring and assessing renewable and nonrenewable resources. The topics contained: Advanced data-analysis and GIS methods for exploring and assessing renewable and nonrenewable resources; Advanced geostatistics for ore grade mapping and for characterizing petroleum, geothermal, natural gas, and methane hydrate reservoirs; Hyper-spectral remote sensing for detecting mineral manifestations; New technologies and data analyses for geophysical and geochemical prospecting; Highly precise methods for modelling geologic structures; New paradigms for resource assessment, risk analysis, and exploration strategies; Reconsideration of genetic mechanisms of ore deposits.

**GENERAL COMMENTS:** The session was successful in meeting scientific expectations and attendance. About 60 people attended the session and the small room was densely packed from the beginning to the end, with standing room only most of the session. Almost all of the oral papers were presented and briefly discussed. Both the oral and poster sessions were bustling with activity. The participants could follow the advances and new trends in mathematical geology for natural resource exploration. The overall quality of oral presentations was high and poster presentations were also at a good level.

**ANNOUNCEMENTS:** We will organize an international symposium in Finland in 2010 with almost the same aims and scopes as this IGC symposium. This will be the 11th International Symposium on Mineral Exploration, sponsored by the Division of Exploration Technology in Mining and Materials Processing Institute of Japan (MMIJ) and the Geological Survey of Finland (GTK).

### **MEDICAL GEOLOGY**

### **MG**

Coordinated by Olle Selinus, Eiliv Steinnes, Anne Kousa

#### **MGH-01 Earth and health - medical geology: In memory of Valentin Lukashev**

**CONVENERS:** Olle Selinus, SGU, Sweden; Eiliv Steinnes, NTNU, Norway; Jane Plant, British Geological Survey, UK; Lucy Hoareau, UNESCO, France; Ben



Mapani, University of Zimbabwe, Zimbabwe; Robert Finkelman, USGS, USA; Theo Davis, Moi University, Kenya; Catherine Skinner, Yale University, USA

*NUMBER OF PRESENTATIONS:* 31 oral, 10 poster, 3 no-shows

*SYMPOSIUM SUMMARY:* This symposium was in memory of Valentin Lukashev, Head of Department of Geochemistry and Geophysics, Academy of Sciences of Belarus, Minsk, who died during an international workshop on medical geology at Uppsala, Sweden on June 8, 1998, shortly after having given his paper on medical geology research in Belarus and the former Soviet Union, as member of the International Working Group on Medical Geology. Valentin K. Lukashev was among the pioneers of developing medical geology, urban geochemistry and ecological geochemical mapping. He carried out investigations on thorium as catalyst in geochemical processes, chemical compositions of sapropel used as fertilizers, geological and geochemical aspects of cancer and ecological and geochemical problems of the Chernobyl accident.

Geological factors play key roles in a range of environmental health issues that impact the health and well-being of billions of people worldwide, but there is a general lack of understanding of the importance of these factors on animal and human health among the general public, the biomedical/public health community, and even within the geoscience community. Therefore the contributions of this symposium aim to show the importance of geology and geochemistry on the health of humans and animals. Themes are: General aspects on medical geology/geomedicine. Geological processes and health. Veterinary or animal health and geology. Health aspects of elements in groundwater. Chronic diseases (e.g. cardiovascular disease, diabetes etc.) and the natural environment. Deficiency/toxicity problems and beneficial effects of certain elements.

*GENERAL COMMENTS:* About 60 people attending. Varying quality of presentations, the majority of a very high quality. Quite lively discussions after almost all presentations.

## **MGH-02 Groundwater - Geopollution, contamination and health aspects**

*CONVENERS:* Jonas Satkunas, Lithuanian Geological Survey, Lithuania IUGS-GEM; Anne Kousa, Geological Survey of Finland, Finland; Shrikant D. Limaye, Ground Water Institute, Pune, India; Hishasi Nirei, Geopollution Control Agency (NPO), Japan Branch of IUGS-GEM, Japan; Kunio Furuno, Research Institute of Environmental Geology, Chiba, Japan Branch of IUGS-GEM, Japan

*NUMBER OF PRESENTATIONS:* 11 oral, 16 poster

*SYMPOSIUM SUMMARY:* Examples of geopollution were presented: case of contamination by VOCs such as PCE, TCE (Nirei, Hiyakma, Kusuda & Furuno); a trichloroethylene (TCE) plume identified in unconfined groundwater in the alluvial shallow aquifer of Mobara, Chiba prefecture (Furuno, Takanaka, Satoh, Nirei, Kazaoka & Kusuda); increasing nitrate nitrogen contamination of groundwater in Sawara area, Katori City (Nishikiori, Obara,

Takeshima, Kameyama, Fuse, Nirei & Takamatsu); geo-pollution site in Urabe district, northern Boso Peninsula (Kazaoka, Murakoshi, Kusuda, Nirei, Tanaka, Aoki, Yamaki & Takeuchi); geopollution by organoarsenic compounds (diphenylarsenic acid (DPAA) and phenylarsenic acid (PAA)) Kamisu city, Ibaraki prefecture (Hiyama, Ikeda, Takahata & Nirei).

Kusuda, Kasahara, Yoshida, Nishikawa, Kamura, Kinjo and Nirei reported a case of Yorogawa river water contamination by 4-tertiary butylphenol (a type of environmental pseudo-hormone) in high concentration leaking from a disposal site at Asai Bridge in Chiba prefecture. In addition to ground pollution, polluted emissions (e.g. VOCs gases) rising from contaminated subsurface can result in air pollution (Fujita, Kinjo, Hiyama, & Nirei).

Health problems due to exposure of heavy metals, especially arsenic and lead compounds, are of great concern in many countries in the world. Most cases have occurred due to natural sources of As from typical geological features, such as marine-origin sediments and volcanic activity, as reported by Komai, Kawabe, Takeuchi and Hara.

Yoshida and Nirei reported on arsenic concentrations in Holocene deposits (Yurakuchō Formation) in the Tokyo lowland, Japan. Backman, Luoma, Ruskeenieni and Karttunen reported on arsenic in bedrock groundwater in the Pirkanmaa region of Finland. He and Li reported that coastal land of the Bohai Sea in China has been widely and deeply affected by sea (saline) water intrusion.

Health hazards from nitrate pollution of groundwater in intensified agricultural areas were exemplified by studies from Jaffna peninsula, Northern part of Sri Lanka (Thanabalasingam & Thushyanthy). The problem of high fluoride concentration in groundwater resources has now become one of the most important toxicological and geo-environmental issues in India (Pagadala & Ahmed). Groundwater contamination due to manganese mining and its impact on health of mineworkers - a case study from India was reported by Das and Goswami.

Mathematical models of contaminant transport with groundwater and the systems of groundwater monitoring were discussed by Kochergina (case of storage of liquid radioactive waste, located at the Lake Karachay, Russia), Kagawa, Furuno, Nirei and Kusuda (role of precise groundwater monitoring on geo-pollution sites), Fujisaki (groundwater modelling in assessments of geo-pollution research and remediation). Method of electrokinetic remediation of heavy metals from low-permeability geofomations was presented by Zhang, Ono, Sawada, Komai, Marumo and Sugita. Depositional process of man-made strata was presented by Soma, Nirei and Hirata, and a stratigraphical classification of man-made strata was proposed by Nirei, Maker, Satkunas and Furuno.

*GENERAL COMMENTS:* The symposium was attended by 40 participants (not counting visitors of the poster session), who contributed with questions, comments and discussions.

*ANNOUNCEMENTS:* Papers from the symposium are under preparation for publication in a number of journals.





Conveners proposed to initiate submission of the symposium dealing with geopollution for the 34th IGC. The IUGS-GEM will lead the preparation and submission.

#### **MGH-05 Quantitative aspects of medical mineralogy**

*CONVENERS:* A. Umran Dogan, Ankara University, Turkey & University of Iowa, USA; Meral Dogan, Hacettepe University, Turkey

*NUMBER OF PRESENTATIONS:* 8 oral

*SYMPOSIUM SUMMARY:* Medical mineralogy is a subdiscipline of the medical geology and it deals with quantitatively characterizing health related (hazard/benefit) minerals and elements in rocks, soil, air, and water. These minerals and elements require state-of-the art techniques and must be characterized by certified individuals at the certified laboratories. The World Health Organization classified erionite (a zeolite group mineral with three different species as erionite-K, erionite-Na, and erionite-Ca); chrysotile (a serpentine type asbestos); and tremolite, actinolite, grunerite (amosite), riebeckite (crocidolite), and anthophyllite (amphibole type asbestos); and cristobalite (silica group mineral) as human carcinogens. These minerals and some recently recognized health hazard minerals including edenite, winchite, richterite, magnesio-riebeckite, magnesio-arfvedsonite, etc. (not classified as carcinogens yet) when inhaled, taken orally, or on dermatological contact, may play major roles in a range of human health problems. To assess the potential toxicity of any of these minerals, quantitative parameters including size, shape, aspect ratio, composition, crystal structure, surface area, surface reactivity, solubility, durability, porosity, and permeability are important considerations. Together with the quantitative characterization of minerals, the exposure data is required before any mineral-induced pathogenesis can be determined. Understanding the possible mechanisms that may induce, or could preclude unwanted biological responses, and to suggest and evaluate prevention, cure or remediation from mineral induced diseases is an active area in medical mineralogy. This symposium was specifically devoted to quantitative aspects of medical mineralogy and aimed to bring together interdisciplinary scientists including electron microscopists, mineralogists, geologists, geochemists, soil scientists, medical doctors, veterinarians, toxicologist, biologists, biochemists, pathologists, pharmacists, epidemiologists, criminologists, and lawyers; and provided an interdisciplinary platform to present their results.

*GENERAL COMMENTS:* The symposium was received nicely and there were lively discussions among European and USA groups. We noticed special emphasis given on some species of asbestos group minerals previously not recognized as health hazards, some pharmaceutical industry minerals, corals as food additives, and problems and methods of evaluation of bioapatites. We believe we will soon see some papers on these topics.

*ANNOUNCEMENTS:* Because of the genuine interest in these subjects, we are planning to organize a similar symposium under the same title "Quantitative Aspects of Medical Mineralogy" at the upcoming Uruguay Meeting in 2009.

We would like to mention a new paper accepted for publication in American Mineralogist entitled "Crystal structure and iron topochemistry of erionite-K from Rome, Oregon, USA" by Ballirano, P., Andreozzi, G.B., Dogan, M., and Dogan, A.U.; two invited Encyclopedia Chapters entitled "Water Quality, Occurrences, and Inorganic Contaminants", MS number 283, by Dogan, M. and Dogan, A.U., Elsevier; and "Erionite and its Health Effects", MS number 725, by Dogan, A.U., Dogan, M., and Hoskins, J.A., Elsevier.

### **ULTRA-HIGH PRESSURE METAMORPHISM AND DEEP SUBDUCTION UH**

Coordinated by Larissa Dobrzhinetskaya and the ILP-UHP Group

#### **UHP-02 Collisional orogeny, ultra-high pressure metamorphism and crustal melting**

*CONVENERS:* Yong-Fei Zheng, University of Science and Technology of China, China; Kai Ye, CAS Institute of Geology and Geophysics, China; Lifei Zhang, Peking University, China

*NUMBER OF PRESENTATIONS:* 14 oral and 5 poster

*SYMPOSIUM SUMMARY:* The study of ultrahigh-pressure (UHP) metamorphic rocks has been one of the forefront and core subjects to advance the plate tectonics theory in the twenty-first century. This symposium was focused on geological occurrences and processes due to UHP metamorphism and continental deep-subduction. The 19 presentations addressed a wide spectrum of phenomena, including mineralogical records of UHP metamorphism, dehydration and melting during continental collision, syn- and post-collisional magmatism, and fluid action and element mobility in continental subduction zones. The Dabie-Sulu orogenic belt in China is recognized to crop out the world's largest lithotectonic unit containing UHP terranes. Much of our understanding of the world's most enigmatic processes in continental deep-subduction zones has been deduced from various records in the Dabie-Sulu rocks. The results shed light on the fate of deep-subducted slab and delaminated lower crust, the origin of orogenic igneous rocks, the global circulation of water and other volatiles, and the growth and reworking of continental crust. In particular, dehydration melting of UHP metamorphic rocks has attracted much attention because this process is vital to the understanding of syn-subduction versus syn-exhumation magmatism in oceanic and continental subduction zones. Furthermore, aqueous fluid is recognized to have played a key role in geochemical cycling during subduction of continental crust.

*GENERAL COMMENTS:* This symposium consisted of three sessions, with 70-80 people in the audience during the oral presentations. While the presentations dealt with various aspects concerning mineralogy, petrology, geochronology, geochemistry and tectonics of continental subduction zones, discussion was very active throughout





the symposium. By taking the Dabie-Sulu UHP rocks as the natural laboratory, earth scientists have made seminal contributions to the understanding of UHP metamorphism and continental deep-subduction. Some of the presentations belong to the forefront of this subject, involving the validity of metamorphic phase equilibria, the petrogenesis of ultradeep minerals, the applicability of accessory minerals, the time and duration of UHP metamorphism, the time and scale of fluid action, element and isotope mobilities in continental subduction zones, the scale and magnitude of crustal melting during collision processes, the origin of subducted crust, and orogenic collapse and post-collisional magmatism. Nevertheless, there still remains a lot to be done for individual continental collision zones. These include spatial distribution of UHP metamorphic rocks, the exact time and duration of UHP metamorphism, the protolith nature of deeply subducted crust, subduction erosion and crustal detachment during continental collision, the possible depths of continental subduction, fluid action and element mobility in UHP metamorphic rocks, identification and effect of dehydration melting during continental collision, the recycling of subducted continental crust, the geodynamic mechanism of post-collisional magmatism, and lithospheric architecture of collisional orogens.

**ANNOUNCEMENTS:** Link to Scirus for UHP metamorphism is:

<http://topics.scirus.com/>

Ultrahigh\_pressure\_metamorphism\_and\_Continental\_deep\_subduction.html

Link to Scirus for zirconology is:

<http://topics.scirus.com/>

Zircon\_petrogenesis\_and\_crustal\_growth.html

Link to ScienceWatch for chemical geodynamics of continental subduction is:

<http://sciencewatch.com/ana/st/zir-dat/08febSTzirZheng/>

8th International Eclogite Conference will take place on August 13-19, 2009 in Xining, China

### **UHP-03 Ultra-high pressure metamorphism:**

#### **Minerals, microstructures and nanoscale observations**

**CONVENERS:** Larissa Dobrzhinetskaya, University of California at Riverside, USA; Herman van Roermund, Utrecht University, Netherlands; Harry Green, Institute of Geophysics and Planetary Physics, California, USA

**NUMBER OF PRESENTATIONS:** 15 oral, 5 poster, 1 no-show

**SYMPOSIUM SUMMARY:** The symposium included wide-ranging themes of ultrahigh pressure mineralogy with emphasis on microstructural and structural features of the UHPM rocks/minerals observed in eclogitic and coesite-diamond terranes of the SuLu and Dabie regions of Central Orogenic belt of China, the Kokchetav massif of Kazakhstan, the Polar Ural of Russia, the Bohemian massif of the Central Europe and the Western Gneiss Region of Norway. Some presentations emphasized the important role of the microstructural features of ultra-high pressure mineral phases that are the most powerful witnesses of phase transformations, segregation and collection of

supercritical fluids, incompatible and REE elements, formation of dislocations inside of crystals and at the phase boundaries. Methods of cathodoluminescence analysis, microRaman and Infrared synchrotron assisted spectroscopy, focused ion beam technique and transmission electron microscopy were demonstrated as new technological developments in nanoscale mineralogy and atomic scale geosciences. Several contributions highlighted the connections between geochemical, structural and petrological processes that occur at the atomic level and large-scale transport properties of rocks during continental and continent-ocean collisions, their rate of exhumation and earthquake formation. Strain fabric analyses of the upper mantle rocks and their emplacement into high-pressure granulite in the Kutná hora crystalline complex of the Bohemian massif bridged two important themes related to deep subduction of crustal material and its subsequent exhumation. Fabric kinematics of ultrahigh-pressure metamorphic rocks from the main borehole of the Chinese Continental Scientific Drilling project were discussed in the context of implications for the main understanding of the deep continental subduction and exhumation. Analyses of exsolved pyroxene in garnet and vice versa were proposed as markers of subcratonic mantle evolution and as indicators of ultra-high pressure metamorphic recrystallization. Presentation of studies related to kinetics of diamond nucleation reproduced in laser-heated diamond anvil cell experiments assisted with synchrotron in-situ X-ray measurements was a great contribution to the understanding of diamond formation in ultra-high pressure metamorphic terranes.

Overall, the symposium gathered outstanding scientific presentations, combining new approaches in mineralogical-microstructural studies which extend our knowledge from atomic scale of mineral features to geodynamic processes operating in Earth's deep interior. It was shown that microstructures and nanoscale mineralogy bridge a gap between ultra-high pressure metamorphism, fluid/melt migration and rheological properties of crustal and mantle rocks involved in deep subduction and therefore in plates movement.

**GENERAL COMMENTS:** The overall quality of presentations was very high, all of them representing the "frontier" of UHPM geosciences; the number of people attending this symposium was ~30 -60 people (there were no available seats!); there were lively discussions after each presentation and during poster sessions, with some discussions continuing during the coffee breaks. The participants had a chance to establish new contacts and plan new projects between different countries for joint studies of microstructure and petrology of the deep-seated UHPM rocks.

**ANNOUNCEMENTS:** The related topics will be issued soon (2009) in a Special Volume of *Lithos* devoted to the memory of Tony Carswell; Guest Editors: Larissa Dobrzhinetskaya and Hannes Brueckner.



#### **UHP-04 Ultra-high pressure metamorphism: Mineral reactions, geochemistry, thermobarometry and geochronology**

*CONVENERS:* Simon Cuthbert, University of the West of Scotland, UK; Hans-Peter Schertl, Ruhr-University Bochum, Germany; Alexei Perchuck, Russian Academy of Sciences, Moscow, Russia

*NUMBER OF PRESENTATIONS:* 11 oral, 3 poster

*SYMPOSIUM SUMMARY:* UHP-04 was sponsored by the ILP Task Force IV Ultradeep Subduction of Continental Crust, and focused on ultra-high pressure metamorphism (UHPM) in collisional orogens. We considered the mineralogical and geochemical record of continental subduction. Comprehension of mineral reactions and thermobarometry remains fundamental to determining vertical transport distances and thermal regimes during subduction, and new methods using accessory phases are proving especially exciting. Reaction modelling with application of fractionation to mineral zoning provide more realistic metamorphic P-T-t paths. Application of kinetic principles places constraints on the extent and rates of mineral reactions. Increasing sophistication of mineral chronometers and linkages with mineral reactions allows tighter constraints on rates of motion and timing of reactions. Fluid and melt flux during UHPM influence reactions and reactivity cause metasomatism and have important implications for crust and mantle evolution. We invited contributions on mineral reactions, kinetics, thermobarometry, geochemistry and geochronology relevant to the nature and significance of UHPM.

The presentations nicely covered the range of invited topics. Analysis of garnet zoning and inclusion suites was extended in novel ways by consideration of trace element patterns and melt inclusions. The combination of microbeam analysis of accessory phases, especially when combined with phase equilibrium studies, proved a powerful approach to resolving P-T-t paths and exhumation rates. A return to the "original" Alpine UHP rocks from Dora Maira involving detailed investigation of zoning profiles and inclusions, but also determination of bound water in garnet, gave new insights into P-T evolution and fluid action. Chemographic analysis was applied to corona textures and gave insights into diffusion ranges and the P-T regime. Several presentations dealt with ultramafic rocks having protoliths including sub-lithospheric mantle and sea-floor serpentinite to layered mafic intrusions; an emergent theme was the importance of fluids in their petrogenesis, generated both internally and externally. Finally, two presentations reported new approaches to, and occurrences of UHP metacarbonates, including some intriguing meta-carbonatites.

*GENERAL COMMENTS:* The session was well attended and enlivened by some lively discussions. The breadth of subject matter and valuable insights gained from application of a range of methodologies indicates that UHPM remains a healthy research field that has matured beyond the "record P-T" stage to give valuable insights into metamorphic processes and crust-mantle interactions during continental subduction.

*ANNOUNCEMENTS:* UHP-04 papers will be published

in a special edition of European Journal of Mineralogy - contact Hans-Peter Schertl (hans-peter.schertl@rub.de). Contributions may also be submitted to a special edition of Journal of Metamorphic Geology that will cover the other IGC UHP symposia - contact Larissa Dobrzynetskaya (larissa@ucr.edu). The next International Eclogite Conference will be held in China next summer, and there will be a session on UHPM at the Mineralogical Society of Great Britain annual meeting in Edinburgh, September 2009 (see [www.minersoc.org/pages/meetings/MAPT/MAPT.html](http://www.minersoc.org/pages/meetings/MAPT/MAPT.html)).

#### **UHP-05 General topics of geology, tectonics and petrology of collisional orogenic belts: Implication to UHP-HP metamorphic rocks**

*CONVENERS:* Yang Jingsui, Chinese Academy of Geological Sciences, China; Faryad Waly, Charles University, Prague, Czech Republic; Godar Gaston, CNRS-IPGP, Université Paris VII, France

*NUMBER OF PRESENTATIONS:* 16 oral, 6 poster, 4 no-shows

*SYMPOSIUM SUMMARY:* The session was part of the symposium "ULTRA-HIGH PRESSURE METAMORPHISM" (UHPM), co-sponsored by "Task Force IV -Ultra-deep Continental Crust Subduction, International Lithosphere program".

Ultra-high pressure metamorphic rocks formed during continent-continent collision are recognized in the Caledonian, Variscan, Alpine and Himalayan orogenic belts. The oldest UHPM rocks are known from Late Precambrian and

Neoproterozoic nappes of Mali and Brazil. However, some UHPM terranes are interpreted as deeply subducted oceanic crust sequences. Exhumation of such deeply subducted oceanic slabs is even more difficult to understand than exhumation of the UHPM continental fragments. The processes of tectonic accretion take place under varying physico-chemical and thermo-mechanical conditions during subduction and exhumation. Metamorphic and deformational processes change the densities and mechanical behavior of the rocks moving through the subduction channel. The redistribution of radioactive heat sources by crustal thickening, partial melting and melt transport to the upper crust define metamorphic P-T-t paths and result in thermal stabilization of the lithosphere. Thickened crust may become gravitationally unstable, leading to syn- or post-orogenic extension. Such processes closely related to the exhumation of ultra-high pressure crustal and mantle rocks are some of the most enigmatic questions of UHPM geology. The session discussed; (1) geological and tectonic aspects of deep subduction of both oceanic and continental crust; sequences of ultra-high pressure metamorphism and tectonic events during formation of orogenic belts; (2) fossil subduction complexes and orogens of different ages that contribute, in the long run, to continental growth, magmatic accretion and continental erosion; and (3) how to promote and facilitate new discoveries of UHPM terranes though the accurate knowledge of those that are well established.



**GENERAL COMMENTS:** There were about 100 people in the audience. The 26 presentations can be subdivided into 4 parts as summarized below: 1) Several papers reported new results on HP-UHP metamorphic belts and a new model for the Alps; high- to ultra-high pressure partial melting and the formation of felsic granulites from the Bohemian Massif; omphacite-bearing garnet peridotite and UHP metamorphism of mantle-derived rocks from Pohorje, Eastern Alps; UHP rocks of the Makbal complex, Tien-Shan, Kyrgyzstan; South Altyn Tagh-North Qaidam HP/UHP metamorphic belt, northwestern China; and UHP belt in the Greek Rhodope. 2) Several papers presented new results from the Dabie-Sulu UHPM belt, East China; especially, a series of new results, including petrology, mineralogy, metamorphism, geochronology, structure and tectonic modelling from the Chinese Continental Scientific Drilling Project (CCSD, 5000m-deep Main Hole, 3 Pilot Holes and regional UHPM belt work) were very impressive. 3) Several new HP-UHP belts were reported in the session, including Paleozoic eclogites from the northern margin of the North China Craton; Triassic eclogites and blueschists in central Qiangtang, Tibet, China; the Permian Somdo MORB-type eclogites in the Lhasa Block, Tibet; and an eclogite belt in the Kola Peninsula, Russia. These discoveries are very important contributions to the HP-UHP group and future research. 4) Several presentations reported unusual minerals discovered from the Luobusa ophiolitic mantle rocks and chromitites, Tibet, including UHP minerals, such as diamond and coesite, and many native and alloy metals formed in an extremely reduced environment. This is a very interesting phenomenon and generated much discussion at the session. Many new questions rise from these discoveries and it may open a new window for approaching the study of mantle minerals and mantle dynamics.

on such issues as periodicity of UHP rocks exhumation, overpressure in UHP complexes, origin of Sulu terrain etc. which extended beyond the end of the session.

#### **UHP-06 Numerical modeling of deep subduction and exhumation of UHPM fragments: Implication to Earth's interior**

**CONVENERS:** Taras Gerya, Swiss Federal Institute of Technology (ETH-Zurich), Switzerland; Paul Tackley, Swiss Federal Institute of Technology (ETH-Zurich), Switzerland

**NUMBER OF PRESENTATIONS:** 6 oral, 2 poster

**SYMPOSIUM SUMMARY:** The session presented results of numerical modelling of various aspects of UHP rock origins compared to critical petrological, geochemical and geophysical data, and geodynamic concepts explaining mountain building, mantle convection, subduction, and exhumation of deep-seated mantle and crustal metamorphic rocks in diverse geological situations. Topics presented on this session covered a broad range of numerical modelling studies related to UHP rocks (such as ultra-deep crust subduction, role of surface processes for UHP rocks evolution, cyclic exhumation of UHP rocks, modelling of tectonic origin of controversial Sulu complex in China, overpressure in UHP complexes).

**GENERAL COMMENTS:** The session was very well attended and overall quality of contributions was high. Presented contributions produced very lively discussions



## REGIONAL SYMPOSIA (SPECIAL)

Special symposia were dedicated to Regional Geology and were organised to include all continents - Africa, Asia, Europe, North America, South America and Oceania. At the Oslo Congress, there was a particular focus on the Arctic. Listed below are the coordinators for each of the regions and the symposia.

### ARCTIC, ANTARCTIC AND BI-POLAR RELATIONSHIPS (IPY) AA

Coordinated by David Gee, Jörn Thiede, Anthony Spencer, Art Grantz

#### AAA-01 Paleogeographic and tectonic evolution of the Arctic region during the Phanerozoic

*CONVENERS:* Atle Mørk, IKU, Norway; Ashton Embry, Geological Survey of Canada, Canada; Art Grantz, USGS (ret), USA; Robert Scott, Cambridge University, UK

*NUMBER OF PRESENTATIONS:* 32 oral, 10 poster

*SYMPOSIUM SUMMARY:* Currently many questions remain regarding the paleogeography and tectonic development of the Arctic region during the Phanerozoic. Even the existence, location and extent of major first order elements such as land areas and ocean basins remain controversial. This symposium brought together many well documented, regional interpretations of the tectonics and paleogeography of areas over most of the Arctic. Studies from Russia were especially welcome and provided new data on important new areas such as the Kara Sea and the Laptev Sea to name a few. A number of tectonic models were presented and were very stimulating. Grantz's review of the history of the Amerasia Basin set the tone and Colpron's intriguing hypothesis of blocks from Baltica migrating westward to the Cordillera was mind-expanding. Numerous detailed studies from Alaska, Canadian Arctic, Greenland and the Barents Sea added many new details and new twists to these reasonably well known areas. In summary, exciting new data and concepts on tectonics and depositional history are emerging for the numerous Arctic basins and a new synthesis of the overall development of the Arctic is imminent.

*GENERAL COMMENTS:* The symposium was well attended and the talks were consistently of excellent quality from both scientific and technical points of view.

*ANNOUNCEMENTS:* A number of the papers presented in the symposium will likely be included in a Geological Society of London symposium volume on Arctic Geology being coordinated by Tony Spencer.

#### AAA-04 Arctic petroleum provinces (i): Petroleum geoscience of the Barents Sea

*CONVENERS:* Erik Henriksen, Ørian Birkeland, Antonina Stoupakova, Yuri Matveev

*NOTE:* A post-Congress summary was not received. The

summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* The symposium will cover the petroleum geoscience of the Norwegian and Russian part of the Barents Sea. The area has experienced an interesting exploration history; major hydrocarbon discoveries have been made and future discoveries are expected. The symposium will look at past history, further potential and plans for future exploration in this extensive province, by some expected to be the main future petroleum province for Europe. The symposium will review the regional geological evolution and hydrocarbon potential of the Barents Sea, focussing on: 1. Past and current exploration activity. 2. Integration and compilation of geological information from the Norwegian and Russian databases, including information from offshore as well as onshore investigations. 3. The petroleum systems, hydrocarbon distribution and forecasting of oil and gas, involving basin modelling and analysis of structural, geochemical and temperature parameters.

#### AAA-05 Arctic petroleum provinces (ii): Petroleum geoscience of Russian Arctic basins

*CONVENERS:* Antonina V. Stoupakova, Moscow State University, Russia; Aleksey E. Kontorovich, Russian Academy of Sciences, Russia; Oleg I. Suprunenko, VNIIOKeangeologia, Russia

*NUMBER OF PRESENTATIONS:* 6 oral, 13 poster, 1 no-show

*SYMPOSIUM SUMMARY:* All presentations covered the major aspects of the petroleum geosciences of the Russian Arctic basins, both offshore and onshore acreages. They focused on basin modelling relating to volume and distribution of Arctic petroleum resources. Tectonic structures, stratigraphic successions and characteristics of hydrocarbon distribution in the Arctic basins and adjacent provinces were discussed. Basin modelling, geochemical parameters, temperature and other factors which are important for forecasting of oil and gas accumulations in the Russian Arctic were evaluated during the presentations. Both presentations, given by Academician Kontorovich and Dr. Kaminskiy, showed the potential hydrocarbon resources of Russian Arctic petroleum provinces and main challenges of their exploration and production. There were two regional tectonic presentations dealing with a deep model of the Arctic basins and basin petroleum prospecting. Gazprom's presentation covered the results of exploration in Yamal and offshore Kara Sea. There was discussion about the volume of Arctic petroleum resources, about prospecting of deep basin horizons, as well as all exploration challenges and development programs in Russian Arctic provinces. The poster presentations covered mainly the oil and gas potential of Timan-Pechora basin and some tectonic and structural elements of the Barents Sea and Okhotsk Sea basins. The geochemical basin modelling has been presented for different areas of the Arctic provinces.

*GENERAL COMMENTS:* All presentations were very



interesting despite the limited English of some of the Russian speakers. The symposium was in the afternoon of the 12th August, the second part of the IGC, but there were many people attending, listening and discussing. I have received a lot of positive feedback from participants concerning our Symposium and most of the presentations.

**ANNOUNCEMENTS:** Most of the presentations have been recommended for publications. Some of the authors have been invited for the Arctic meeting in SH, Tromsø University and NPD.

### **AAA-06 Arctic petroleum provinces (iii): Petroleum geoscience of the North American and Greenland basins**

**CONVENERS:** Donald L. Gautier, Kai Sørensen, Kirk Osadetz

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** This symposium concerns the petroleum geoscience of proven and potential petroleum provinces in the Arctic of North America and Greenland, extending from the Chukchi Sea to Jan Mayen and from the Arctic Circle to the Pole. Of the numerous sedimentary basins recognized in the Arctic of North America and Greenland, only a few have been systematically explored for petroleum. In spite of the recent exponential increase in information, many Arctic basins remain untested and uncertainty surrounds even fundamental geologic relationships. This symposium seeks presentations that extend existing knowledge of proven petroleum provinces and solicits recent work concerning sedimentary basins that are unexplored and petroleum systems that remain undiscovered. The following themes are of particular interest: 1) Interpretations of the integrated tectonic history and regional geologic evolution of the Alaskan, Canadian and Greenlandic Arctic and the regional controls exerted on basin geometries, stratigraphic architecture and thermal history. 2) Identification and delineation of Arctic sedimentary basins with emphasis on undrilled sequences with significant petroleum potential. Integrated interpretations of sequence stratigraphic relationships across international boundaries are encouraged. 3) Basin analysis and fluid evolution modelling of major sedimentary successions in the Arctic basins, to better understand the known petroleum accumulations and to predict the properties of yet-to-find hydrocarbon systems. Arctic-wide integrated petroleum source rock studies are also solicited.

### **AAA-07 Russian-Norwegian scientific co-operation in the Barents Sea Region**

**CONVENERS:** Else Ormaasen, Norwegian Petroleum Directorate, Norway; Andrey Morozov, Federal Agency of Mineral Resources, Rosnedra, Russian Federation; Oleg Petrov, Russian Research Geological Institute, VSEGEI, Russian Federation; Erik Henriksen, StatoilHydro, Norway  
**NUMBER OF PRESENTATIONS:** 11 oral, 1 poster, 1 no-show

**SYMPOSIUM SUMMARY:** The background for the symposium was to address the geoscientific cooperation

between Norway and Russia as a connection to the energy dialogue between the Russian and Norwegian authorities, based on the agreement between the Norwegian Prime Minister and the Russian Federation President signed in 2005. Further to inform about the Memorandum of understanding between the Norwegian Petroleum Directorate and the Federal Agency of Mineral Resources, Rosnedra, concerning geoscientific cooperation in the northern seas offshore and the establishment of the Geo Forum as the implementing forum for the agreement activities. The purpose of this symposium was also to illustrate the variety of different geoscientific collaborative projects between Russian and Norwegian authorities, institutions, universities and industries in the northern areas of Russia and Norway.

The plan was to start the symposium with the Norwegian Deputy Minister of Petroleum and Energy to present the opening address and welcome, and the Russian Deputy Minister of Natural Resources to make a keynote speech. Due to the election in Russia and the appointment of a new Vice Minister the very same week as the 33IGC, it became impossible to arrange for the new Vice Minister to come to the symposium. The conveners had to rearrange the opening session of the symposium at the last minute. The opening address and welcome was made by a representative from the Norwegian Ministry of Petroleum and Energy, and a representative from the Russian authorities made the Russian address to this topic.

The rest of the symposium was technical presentations of geoscientific cooperation projects and general cooperation projects for training and education.

The symposium managed to illustrate the variety of the ongoing geoscientific collaborative projects between Norway and Russia in the northern areas.

Some of the comments during the symposium were linked to practical problems encountered by some of the collaborative projects, such as access to data and areas of fieldwork, manpower, vessel, funding etc. It was suggested that the authorities should look into this matters.

**GENERAL COMMENTS:** All the presentations had a very high quality. Numbers of people attending varied through the day; during the morning around 40 - 50, and at the end of the day around 60 - 70. There were some discussions but not lively.

**ANNOUNCEMENTS:** The introduction of the new Geo Forum will be followed up. The next meeting on this matter will be in Moscow in February 2009.

### **AAA-08 Permafrost on a warming planet**

**CONVENERS:** Jerry Brown, International Permafrost Association, USA; Ole Humlum, University of Oslo, Norway

**NUMBER OF PRESENTATIONS:** 14 oral, 3 poster, 3 cancelled or no-shows

**SYMPOSIUM SUMMARY:** Permafrost regions occupy almost one quarter of the land surface of the Northern Hemisphere, considerable portions of the Arctic Ocean shelves, and all of the ice-free areas of Antarctica. Atmospheric warming in the last decades of the 20th century resulted in warming of permafrost, deepening of





seasonal soil thaw, and in some regions of warmer permafrost thawing commenced. A number of new monitoring projects began during the International Polar Year (2007-2009) in order to obtain a snapshot of permafrost conditions (TSP-Thermal State of Permafrost) and the status of carbon in polar soils and peat deposits (CAPP-Carbon Pools in Permafrost Regions). The symposium was organized under the auspices of the International Permafrost Association (IPA) as a contribution to the International Year of Planet Earth, and particularly to the themes related to soil, climate, and hazards.

The majority of the reports concerned the current state of permafrost temperatures, active layer depths and the distribution and mapping of permafrost conditions in Europe, North America and Central Asia. Approximately half of the presentations focused on current activities in the Nordic region. Two reports on sub-sea permafrost discussed its origin, detection by coring and ship-borne geophysics, and potential releases of gas hydrates. Two engineering reports discussed the tunnelling in frozen bedrock of Svalbard for construction of vaults for long-term seed preservation, and Russian designs to protect foundations from the destructive forces of thawing permafrost.

The legacies of the current IPY-IPA permafrost projects are to provide a sustainable database, a network of protected observatories and to foster the development of a new generation of permafrost researchers. Several reports concerned activities of the Permafrost Young Researchers Network (PYRN) including a shallow drilling program to measure temperatures. The new Norwegian TSP database (NORPERM) for permafrost information was presented.

*GENERAL COMMENTS:* The three sessions, starting at 8:30 AM, were attended by between 20 and 25 participants, and a maximum of 27. All presentations were well illustrated and were completed on time. At least one question or comment followed each presentation. Audience participation included non permafrost people, thus providing opportunities to develop new contacts.

*ANNOUNCEMENTS:* Many of the reports were based on papers presented at the Ninth International Conference on Permafrost (NICOP) held earlier this summer in Fairbanks, Alaska. The published proceedings and the extended abstracts contain details of many of the oral and poster reports. Details of the "snapshot" will be presented in Oslo in June 2010 at the final IPY conference, followed by the Third European Permafrost Conference (EUROP III) planned for Svalbard. See the IPA web site for details: [www.ipa-permafrost.org/](http://www.ipa-permafrost.org/)

#### **AAA-10 Arctic paleoclimate and its extremes**

*CONVENERS:* Martin Jakobsson, University of Stockholm, Sweden; Morten Hald, University of Tromsø, Norway; Nalan Koç, Norwegian Polar Institute, Norway; Eiliv Larsen, Geological Survey of Norway, Trondheim, Norway

*NUMBER OF PRESENTATIONS:* 13 oral, 10 poster

*SYMPOSIUM SUMMARY:* Climate models predict that a global warming of 1-5°C will occur during the next century

as a result of projected increases in atmospheric content of greenhouse gases. Warming in the Arctic region is expected to be larger than the global mean. This symposium brought together world leading paleoclimatologists to present up to date results and discussion on past natural climate changes in the Arctic, its causes and effects, and also the importance of paleoclimate data in order to improve climate modelling. The symposium also served an opportunity to report on initial results and plans of the International Polar Year 2007/2008.

*GENERAL COMMENTS:* The session presentations covered marine and terrestrial paleoclimate research from the Paleocene to the Holocene. From the WUN pACE (Worldwide University Networks Paleo Arctic Climates and Environment) initiative results on the early Paleogene Arctic environments were presented. These included initial results from field work carried out in Svalbard during the International Polar Year as well as new analysis of the Integrated Ocean Drilling Program (IODP) Expedition 302 (a.k.a. Arctic Coring Expedition, ACEX) drill core from the Lomonosov Ridge, central Arctic Ocean. The environmental history in relation to the Eurasian Weichselian ice sheets was addressed in several oral and poster presentations as well as the oceanographically critical interaction between the North Atlantic and Arctic Ocean during late glacial and Holocene times.

*ANNOUNCEMENTS:* The Arctic Palaeoclimate and its Extremes (APEX) is a scientific network endorsed by the International Arctic Scientific Committee (IASC). The network aims to understand the magnitude and frequency of past Arctic climate variability and, in particular, the "extremes" versus the "normal" conditions of the climate system ([www.apex.geo.su.se](http://www.apex.geo.su.se)). A special APEX issue (Volume 27, Issue 2) was published in August 2008 in the journal *Polar Research*.

#### **AAA-11 Metallogeny of the Arctic region**

*CONVENERS:* Tom V. Segalstad, University of Oslo, Norway; Ingar F. Walder, SARF Consulting AS & Kjeøy Research and Education Center, Norway

*NUMBER OF PRESENTATIONS:* 6 oral, 1 poster, 3 no-shows

*SYMPOSIUM SUMMARY:* The introduction to the session by Tom V. Segalstad was not included in the official 33IGC program booklet. The introduction was announced in various ways during the first days of the congress, and 16 people showed up for the introduction. The introduction discussed the extent of "The Arctic Region", defined "metallogeny", referred the contents of the invitation to the session, and briefly overviewed the contributions of the session.

The invited speaker Warren J. Nokleberg gave two extraordinary presentations on a metallogenic and tectonic model for the Circum-North Pacific (26 present) and on the tectonic and metallogenic evolution of Northeast Asia (30 present). These talks were accompanied with stunning animations on how the two regions had evolved through geologic time.

15 minutes had been assigned for short (3 minute) presentations of the posters. The 3 posters by the Russian



authors were not presented and the authors did not show up for the oral presentations. This was a pity, as the titles and abstracts were interesting and would have supplemented the other presentations of the session. The one remaining poster had a good turnout in the poster room, and was also presented orally by Ingar F. Walder (~30 present).

After the coffee break Nigel Cook presented new data on the mineralogy and paragenesis of selected base metal deposits on NW Spitsbergen, Svalbard (29 present). Tom V. Segalstad presented, based on field data, stable isotope data and lead isotope data, a talk on the metallogeny of Pb-Zn-Ba vein mineralizations in Svalbard, Norwegian Arctic (30 present). Tom V. Segalstad continued by presenting a talk on the metallogeny of the Kolsvik gold deposit at Bindalen, Northern Norway (30 present). Tom V. Segalstad further presented a talk on thermochemical modelling of the Kongsberg silver ore deposit, Norway (30 present).

The session ended with a discussion and summary of the session, led by Ingar F. Walder (~30 present). A number of questions had accumulated during the course of the session, and there was ample time for discussions. The questions arose on details in Nokleberg's tectonic reconstructions, and on the possible metallogenic importance of the Jurassic/Cretaceous large igneous intrusions in the Arctic. This discussion session made it possible to go deeper into the subject matter presented by the speakers, and to discuss matters not treated by the speakers.

**GENERAL COMMENTS:** It is obvious that it is not possible to cover all metallogeny related topics in this relatively small session at 33IGC. The presence of our Russian colleagues would have broadened our coverage. Russian geologists present in the audience, however, helped filling this gap. The presentations of the session covered a wide geographic area and a wide methodological area. Geographically the presentations of the session covered North-East Asia, Alaska, North-West Canada, Svalbard, and Norway. Other contributions from Russia did not materialize. Methodologically the session covered regional geology, plate tectonics, historic geology, ore microscopy, scanning electron microscopy, mineral paragenesis, radiogenic isotope geochemistry, stable isotope geochemistry, fluid inclusion thermo-barometry, thermochemical (thermodynamic-chemical) modelling, and mining mitigations aimed at tailings and groundwater contamination from previous mining operations.

The different sessions on the geology of the Arctic Region gathered a number of people with thorough knowledge in, and interest for, the geology of this region. It was important and highly relevant to have a separate session on the metallogeny of the Arctic Region. Some of the people attending this session had other major interests within the geology of the Arctic Region, and felt it was important to be present in order to learn about the metallogeny of this region. Thanks to IAGOD for suggesting and sponsoring this session on Metallogeny of the Arctic Region.

## AAN-01 Antarctic geodynamic evolution and paleogeography

**CONVENERS:** Garrik Grikurov, VNIIOkeangeologia, Russia; Rene-Pierre Menot, Universite J. Menot, France;

German Leychenkov, VNIIOkeangeologia, Russia

**NUMBER OF PRESENTATIONS:** 8 oral, 11 poster

**SYMPOSIUM SUMMARY:** The symposium focused on the contribution of Antarctic earth science research to understanding fundamental geological problems, such as: (1) Precambrian geochronology and origin of the Earth's crust; (2) Igneous and metamorphic petrology of crystalline complexes; (3) Evolution of Pacific accretional fold belts; (4) Subglacial crustal structure; (5) History of Gondwana break-up and formation of passive continental margins.

The themes of presentations covered a broad field of Antarctic geoscience (geology, tectonics, geophysics, geochemistry, mineralogy/petrology), the entire geological timescale (from early Precambrian to Recent) and a variety of East and West Antarctica regions key outcropped areas and Antarctic seas. Contributions on metamorphic and magmatic complexes presented extensive up-to-date geochemical and isotopic (geochronological) data. Several lectures and posters summarized results of recently conducted marine and airborne geophysical studies as well as an overview of structure and evolution of the Antarctic continental margin. A preliminary draft of a new Antarctic tectonic map at 1:10 M scale (compiled under CGMW aegis) was demonstrated on a poster together with supplementary small-scale geophysical insets.

**GENERAL COMMENTS:** About 30 - 40 scientists attended the oral session. All speakers displayed high quality presentations and were careful in observing their time slots, so each had 1-3 minutes for questions and short discussions. The poster session was also quite productive and well attended.

**ANNOUNCEMENTS:** Data and results presented during the symposium were partly published in 2007 and 2008 (e.g. Williams et al., 2008, Proceedings of 10th ISAES, Gohl, 2008, Proceedings of 10th ISAES, Leitchenkov et al., 2008 MGR) or are currently in press (e.g. Mikhalsky, Geotectonika) and in preparation for submission to international journals.

## AAN-02 Cenozoic Antarctic glacial history

**CONVENERS:** Fabio Florindo, Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy; Peter J. Barrett, University of Wellington, New Zealand; David M.

Harwood, University of Nebraska-Lincoln, USA

**NUMBER OF PRESENTATIONS:** 15 oral, 7 poster

**SYMPOSIUM SUMMARY:** Antarctica has supported major ice sheets since its separation from Gondwana early in the Cenozoic. Variations in the size and extent of these ice sheets resulted in major variations in global climate and ocean circulation. Yet, a paucity of Cenozoic Antarctic outcrop and its difficult access has limited understanding of the timing and scale of dynamic and stable behaviour of the ice sheets. During the last two decades, studies of sedimentary sequences drilled in and around Antarctica have led to significant advances in the understanding of the evolution of the Cenozoic climate, oceanography, and biota



of the Antarctic continent and the Southern Ocean.

This session was designed to investigate the many orders and scales of variation of Antarctica ice sheets and climate from Antarctic and Subantarctic records, from outcrop studies, deep sea drilling, continental margin drilling and seismic investigations, permafrost and ice core drilling.

These presentations have demonstrated that the Antarctic Ice Sheet has undergone many changes, and has varied in size considerably over the Cenozoic. The nature of these changes has been shown to be associated with global climate conditions, forced externally or through interaction with ice and climate conditions in Antarctica and the Southern Ocean. Over the next decade, through the SCAR program ACE (Antarctic Climate Evolution), we will pursue a broad range of objectives to better comprehend past Antarctic changes, through the organisation of workshops, where interdisciplinary research can be discussed, and through publications allowing dissemination of results to a wide audience. It is only through such integration of geological data and numerical modelling that quantitative assessments of past changes, and possible future scenarios, can be achieved.

*GENERAL COMMENTS:* This all day session was well attended with about 100 attendees. On the average, we found the quality of the presentations high.

*ANNOUNCEMENTS:* Antarctic Climate Evolution by Florindo and Siegert (Eds.). Developments in Earth and Environmental Sciences, The Netherlands, Elsevier, Vol 8, 593 pp, 2008.

#### **AAB-01 Arctic and Antarctic records of deglaciation since the Last Glacial Maximum: Processes, timing and causes**

*CONVENERS:* Robert Larter, British Antarctic Survey, UK; Dag Ottesen, Geological Survey of Norway, Norway

*NUMBER OF PRESENTATIONS:* 9 oral, 6 poster

*SYMPOSIUM SUMMARY:* In recent years there has been a rapid increase in the quantity of age data from both polar regions constraining changes during the last deglaciation. The aim of this session was to bring together marine and terrestrial scientists who are working on deglaciation records from opposite ends of the Earth. Records were presented from marine sediment cores, surface exposure age dating, and studies of landscape evolution and relative sea level changes. Analyses of former basal surfaces revealed by ice retreat, using swath bathymetry and remote sensing data, were also presented, providing insights regarding the dynamics of, and basal processes beneath, the ice sheets immediately prior to deglaciation. Comparing such records, and considering outputs from ice sheet models designed to assimilate new age data, will eventually provide new insights regarding issues such as leads and lags between different ice sheets, the importance of sea level changes in interlocking changes in the ice sheets, rates of change in ice volume, and the feedbacks responsible for rapid changes after the Last Glacial Maximum. Hitherto, difficulty in obtaining reliable and accurate ages has limited the usefulness of some polar records. Approaches to sample selection and new dating methods to improve the precision and resolution of records were considered in

several presentations and discussions.

*GENERAL COMMENTS:* Despite being held on the final morning of the conference, the oral session was well attended and every speaker turned up to give their talk. Lively discussion continued after the session ended. The poster session was held on the previous day, and each presenter gave an introduction to their work during a pre-arranged informal tour of the posters.

#### **AAB-02 Cenozoic bi-polar connections over millennia**

*CONVENERS:* Ross Powell, Northern Illinois University, USA; Julie Brigham-Grette, University of Massachusetts, USA; Tim Naish, Antarctic Research Centre, Victoria University of Wellington, New Zealand; Martin Melles, University of Köln, Germany; Kate Moran, University of Rhode Island, USA; Jan Backman, Stockholm University, Sweden

*NUMBER OF PRESENTATIONS:* 11 oral, 1 poster

*SYMPOSIUM SUMMARY:* Several innovative geological drilling projects (e.g. ACES, Lake El'gygytyn, ANDRILL, SHALDRIL) in the Polar regions are in the process of recovering long sedimentary records of climate and environmental change for the past several hundreds to millions of years. At odds are syntheses of these records and science plans for evaluating conflicting interpretations. The focus of this session was to assess the initial results of these drilling projects and place them in a global context. The session was successfully advertised and solicited as an International Polar Year contribution to the Bipolar Climate Machinery (BIPOMAC) and Antarctic Climate Evolution (ACE) programs.

Lively presentations and discussions during the session emphasize the global nature of Late Cenozoic change, especially the timing and magnitude of past climatic events on orbital and millennial scales and the interplay of events at both poles. First authors and their contributors, and attendees in the session, offered provocative assessments of the polar regions in driving and amplifying global variability and in interpreting the co-evolution of polar paleoenvironments.

Keynote talks in this session introduced and summarized each of the major completed and planned polar drilling projects; there were five presentations each of Antarctica and Arctic science and one relating South Atlantic records to both poles. The first section of the session involved Arctic records from papers lead by Moran, Stickley, Sangiorgi and Krupskaya, focusing on results from the ACES drilling project. These presentations included a general overview of a dynamic Arctic Ocean, biogenic silica productivity in the Middle Eocene, surface water temperature estimates from Tex86 that differ from iceberg rafting inferences made from sedimentology, and arctic weathering regimes inferred from clay mineralogy. Brigham-Grette explained the conflict in data from land records compared with some of those from ACES regarding a cold Arctic in the Paleogene. The last paper on Arctic data was a poster presented by Gleason on isotopic studies of Eocene fish debris used to infer paleoceanography in the Arctic Ocean.

The Antarctic talks focused on recently recovered



ANDRILL core data. Powell and others summarized the Plio-Pleistocene paleoclimatic inferences and framed them with correlative Arctic climatic events. Scherer and others described the youngest warm event recorded in Antarctica as MIS 31 and asked about the Arctic record of this interglacial. Magans et al. and Hinnov et al. presented the distinctive physical properties record of the core and showed Milankovitch-band cyclicity in the Plio-Pleistocene record. Hannah et al. evaluated the use of extant arctic marine palynomorphs as analogs for interpreting inferred Antarctic paleoclimates from the core. Lastly, Ljung evaluated the Holocene bipolar seesaw effect using cores from the South Atlantic.

Papers of the session highlighted the need for more interaction between scientists conducting research in the two polar regions in order to assess how they have reacted and interacted during past warming events, in order to better understand what their future may hold. This topic led to an evening reception and town hall meeting to determine the level of enthusiasm for a Chapman Conference proposal to further develop the science leading to a series of papers in the coming years.

**GENERAL COMMENTS:** The session was well attended and reached a general agreement for the need of such a conference.

## AFRICA AF

Coordinated by S. Félix Toteu, Henrik Stendal

### AFR-01 Pan-African orogeny in Africa and adjacent regions

**CONVENERS:** Henrik Stendal, Bureau of Minerals and Petroleum, Greenland; S. Félix Toteu, University of Botswana, Botswana; Yves Deschamps, BRGM, France  
**NUMBER OF PRESENTATIONS:** 12 oral, 5 poster, 1 no-show

**SYMPOSIUM SUMMARY:** The Pan-African orogeny (ca 600 Ma) has produced throughout the African continent a network of collisional belts that surround major cratonic blocks. The intensive studies of the past few years have considerably contributed to a better understanding of these belts and of crustal processes in the continent as a whole. However, there is still considerable variation in progress to understand the geodynamic processes from one belt to another, as a result of unequal survey inputs. The central African region covers one of these under-surveyed belts. The Pan-African orogeny has also largely controlled processes of some ore deposits that are exploited today in the continent.

The session gave the opportunity to present the most recent research results covering the whole period of the continental evolution between the break-up of Rodinia and the final assembly of west Gondwana. The focus of the presentations covered most of Africa and adjacent areas such as Arabia and Brazil. The sessions covered the following themes: the geo-dynamic evolution of the Pan-African belt; the Meso- to Neoproterozoic transition in

order to constrain the early rifting in relation with the break-up of Rodinia and the assembly of Gondwana supercontinents; the role of the Neoproterozoic crustal processes in the development of ore deposits; the comparison between the Pan-African belts of East and West Africa and correlation with correlative belts on the western side of the Atlantic in Brazil; many new geochronology data both related to deformation, metamorphism and provenance of sedimentary basins; an interesting correlation of Pan-African gold was proposed to stretch from western Tanzania and down to Mozambique.

**GENERAL COMMENTS:** At the session about Pan-African orogeny in Africa and adjacent regions approximately 50 attendants were present. All presentations were of a good quality and the data were new, and many new interesting aspects of the Pan-African development were introduced. Some data were already published, but put into context with the other presentations it gave a good impression of the state of research concerning the Pan-African belt. Many attendants participated in the discussions, which were lively and fruitful.

### AFR-02 Cenozoic volcanism and evolution of the African lithosphere

**CONVENERS:** Luigi Beccaluva, University of Ferrara, Italy; Gianluca Bianchini, University of Kingston, UK; Marjorie Wilson, University of Leeds, UK

**NUMBER OF PRESENTATIONS:** 9 oral, 8 poster

**SYMPOSIUM SUMMARY:** The Cenozoic volcanism in the African plate is the surface expression of complex interactions between the lithosphere and the convecting mantle below. The symposium allowed a systematic discussion of the type of volcanism and the geochemical and petrological characteristics of the magmatic rocks from various African volcanic districts. Studies on mantle xenoliths were also presented providing important constraints on the composition of the relative lithospheric mantle sections. The discussion focused on the presence of one or more mantle plumes beneath the African plate, and on the scale length of the relative convective instability.

**GENERAL COMMENTS:** The overall quality of the presentations was good and the discussion promoted by the speakers and the audience (30-40 persons) was intriguing and stimulating.

**ANNOUNCEMENTS:** As a result, a Special Volume of the Geological Society of America (a GSA Special paper) titled "Volcanism and evolution of the African lithosphere" will be edited by Beccaluva L., Bianchini G., Wilson M., including the most relevant contributions of this symposium.



### AFR-03 Geology of Africa and development strategies for the mining sectors of African countries

*CONVENERS:* David Ovadia, British Geological Survey, UK; Sospeter Muhongo, ICSU, South Africa; Leif Thorning, Geological Survey of Denmark and Greenland, Denmark

*NUMBER OF PRESENTATIONS:* 5 oral, 3 poster

*SYMPOSIUM SUMMARY:* The symposium looked at the economic benefits from geological studies in Africa towards development and poverty reduction. Long term sustainable economic development of most African nations can only depend on what is grown on the ground or what is taken out of the ground. Africa is rich in mineral resources and yet remains poor by almost every other economic indicator. This is especially surprising at a time of high global demand for commodities, especially metals. This session described examples of geological studies that assisted more effectively in the economic growth of Africa and her peoples, and what strategies must be adopted to learn from the mistakes of the past. The session included contributions from those who wished to comment on the need and ways in which geologists and others can apply their skills in a more coordinated way towards economic and social improvements, including in the artisanal mining sector, the better use and sharing of existing data and the collection of new information using techniques that include airborne geophysics, remote sensing and geochronology to understand and identify likely mineral occurrences that have an economic impact.

Two principal conclusions emerged; that it is extremely difficult to demonstrate the links between geological studies and economic development even though most people felt the links are there, and that the time between the former and the latter is considerable.

*GENERAL COMMENTS:* The session was attended by about 40 people, although the numbers dropped to about 20 towards the end of the afternoon. The quality of the presentations, both oral and posters, was excellent and there were very good discussions that had to be curtailed through lack of time.

### AFR-04 Geoscience in Africa

*CONVENERS:* S. Félix Toteu, Center of Geological and Mining Research, Cameroon; Sospeter Muhongo, University of Dar Es Salaam, Tanzania; Henrik Stendal, Geological Survey of Denmark and Greenland, Denmark

*NUMBER OF PRESENTATIONS:* 5 oral, 6 poster, 8 cancelled or no-shows

*SYMPOSIUM SUMMARY:* The Maputo Declaration on the development of geosciences in Africa, adopted on July 5, 2006 during the 21st Colloquium of African Geology, had the vision of promoting wider geoscience education, strengthening the scientific infrastructure and promoting regional centres of excellence, and improving the extent and quality of geological mapping and developing improved geoscience information networks. Despite the huge potential of Africa in natural resources, the contribution of geosciences in the sustainable development of the continent is still limited. On the other hand, Africa is also a continent where there still is a chance, and most

certainly a need, to learn from past mistakes in the management of our earth system in order to improve living conditions for a sizeable proportion of the world's peoples. Based on the Maputo Declaration these important issues made up the core of 'Geosciences in Africa' session. The session highlighted the importance of geosciences in Africa and focused the attention of scientists, funding agencies, surveys and other scientific partners on the need to rediscover geosciences in Africa. The session also focused on the role of the African geosciences community in developing fruitful dialogue with decision-makers and economic partners in order to increase their awareness on the important role of geosciences knowledge and information in everyday life.

*GENERAL COMMENTS:* Discussions during the oral presentation were of a good quality, particularly with regards to the promising future projects in Africa such as African Georesources Observatory System (AEGOS) and the TopoAfrica.

Approximate audience was 25. The 4 missing lecturers did not attend the conference, although some of them were granted Geohost sponsorship. The reason of this is they may not have succeeded in getting the plane ticket to travel. All the missing lecturers were from Africa. The reason for the missing poster presentations is probably the same as above.

## AMERICAS

## AM

Coordinated by Carlos Oiti Berbert, Umberto Cordani

### AMS-02 New research in Andean tectonic evolution

*CONVENERS:* Andrés Folguera, Universidad de Buenos Aires, Argentina; César Vinasco, Universidad de Medellín, Colombia

*NUMBER OF PRESENTATIONS:* 8 oral

*SYMPOSIUM SUMMARY:* Schellart's talk dealt with general aspects regarding the Andean orogen, particularly the controls behind creation of long mountain systems in subduction settings. Gorin analyzed less than 5 Ma evolution of central Colombian valleys in relation to recent tectonic evolution. Vinasco's talk focused on Geology of the Colombian Andes, doing an up-to-date summary and showing new geochemical and structural data. Ruiz showed new fission track data in the Colombian Sub Andean belt and described denudation history in relation to climate in the area. Mescua showed evidence of Late Triassic basin inversion in the Southern Central Andes of Argentina and analyzed its temporal relation to localized thin-skinned deformation. Spagnuolo analyzed in his talk relation between Late Miocene arc-expansion and development of fragil-ductil transitions that facilitated crustal imbrication and mountain building processes in the Southern Central Andes. Folguera on behalf of Rojas Vera showed evidence of Cenozoic extension in the Andes between 36° and 39°S. Finally Folguera analyzed shallow subduction processes through time in the Northern Patagonian Andes since Late Cretaceous.





**GENERAL COMMENTS:** Fruitful discussion aroused from the audience when the very well known structural geologist Peter Cobbold disagreed with evidence of Late Oligocene extension in the Southern Central Andes. He commented on his hypothesis, allowing the audience to have two contrasting viewpoints about the Cenozoic evolution of the Southern Central Andes.

### **AMS-03 South American metallogeny**

**CONVENERS:** Colombo C.G. Tassinari, University of São Paulo, Brazil; Eduardo Zappettini, Geological Survey of Argentina, Argentina

**NUMBER OF PRESENTATIONS:** 5 oral, 2 poster

**SYMPOSIUM SUMMARY:** Most of the South American mining districts have begun only recently to be properly explored for their metallogenic potential. South America includes different kinds of mineral deposits, formed in several time intervals since late Archean. They are related to different tectonic settings, such as Archean and Paleoproterozoic greenstone belts, or Proterozoic and Phanerozoic magmatic arcs. As a consequence, the continent is a good laboratory to study metallogenic processes through geological time. The main geotectonic provinces of South America are the Andean Orogenic Belt and the Brazilian Platform. The latter includes the large Amazonian and São Francisco cratons, the small Rio de La Plata, São Luis and Luis Alves cratonic fragments and a few Neoproterozoic orogenic provinces. From the metallogenic point of view, the Amazonian Craton remains one of the last frontiers for mineral exploration and development in the world. The symposium is devoted to bringing together professionals in different fields of ore geology, to promote interchange of information about metallogeny and modelling of mineral deposits. Topics of interest such as structural geology, isotopic and geochemical data, hydrothermal alteration mineralogy, fluid inclusions and mineralogical studies are strongly encouraged. Those interested are kindly invited to participate, bringing their presence and contribution for the success of the event.

**GENERAL COMMENTS:** During our symposium about 20 persons were present to participate in the activities. For the next IGC I suggest some joint symposiums with metallogeny as the main theme, separated only by continents and not by geological themes such as mineralizations in granitoids or mafic rocks and associated mineralizations etc.

### **AMS-04 South American alkaline igneous complexes**

**CONVENERS:** Celso de Barros Gomes, Institute of Geosciences, University of São Paulo, Brazil; Piero Comin-Chiaromonte, Department of Earth Sciences, University of Trieste, Italy

**NUMBER OF PRESENTATIONS:** 9 poster, 3 no-shows

**SYMPOSIUM SUMMARY:** The symposium had as main goal to provide an opportunity for the discussion of different aspects of the alkaline magmatism in the South American Platform. Considering the numerous occurrences distributed over the Brazilian, Paraguayan, Bolivian and Uruguayan territories, although more

concentrated in the first two countries, the basic idea sounded very attractive and also opportune since much work has been done during the last years, particularly regarding the petrology, geochemistry, geochronology and paleomagnetism of the alkaline rocks.

**GENERAL COMMENTS:** In spite of the great efforts to promote the symposium, its final result brought some frustration due to the small number of contributions submitted (a total of 12) and to the few people attending the poster session. The papers came almost entirely from the Brazilian group of the University of São Paulo working together with Italian researchers (Trieste, Naples). Unfortunately, the symposium did not contribute very much in terms of interacting with people from other countries interested on the subject.

### **AMS-05 Active tectonics in South America**

**CONVENERS:** Claudio Riccomini, Universidade de São Paulo, Brazil; Francisco Hilário Rego Bezerra, Universidade Federal do Rio Grande do Norte, Brazil; Franck Audemard, FUNVISIS, Venezuela

**NUMBER OF PRESENTATIONS:** 7 poster

**SYMPOSIUM SUMMARY:** The geotectonic setting of the South American plate, comprising the Andean chain, the Brazilian and Patagonian platforms and the domain of oceanic crust of its eastern half, offers multiple opportunities to investigate active tectonics in different tectonic contexts. Earthquakes, by far the most hazardous natural event in South America, are concentrated along its western convergent and northern transform margins, where much work has been done to understand the plate-driving forces acting in these regions and to develop reliable stress models. Despite the geographical concentration of many of these studies, including data from high precision global positioning systems, focal mechanisms, fault inversion and in situ stress measurements, the available data need to be integrated to improve the constraints on plate-driving forces and the present-day state-of-stress in South America.

In this context, the symposium on Active tectonics in South was designed: (1) to present and discuss recent data on stress distribution along the different plate boundaries of South America; (2) to evaluate the data on stress distribution in intraplate South America; (3) to evaluate available research methods of investigation of recent and active tectonics in cratonic regions of South America; and (4) to present regional syntheses of active tectonics in South America. The contributions were from Brazil (5), Argentina (1) and France (1), mainly focused on the study of different areas of the Atlantic, the passive continental margin of South America where recent investigations have clearly revealed increasing evidence of active intraplate tectonics, including faulting, seismicity, coseismic deformation and earthquake-induced liquefaction features.

**GENERAL COMMENTS:** More than 80 congress participants attended the session. Discussions among presenters and audience were profitable and some new lines of investigation were proposed. International cooperation of research groups, mainly from South America and Europe, was also envisaged.



**ANNOUNCEMENTS:** There is a proposal of the Geological Society of London to publish a Memoir on the general subject of the symposium.

#### **AMS-06 Neoproterozoic to early Paleozoic orogenic belts of South America**

**CONVENERS:** Antonio Pedrosa-Soares, Federal University of Minas Gerais, Brazil; Carlos Rapela, Centro de Investigaciones Geológicas, Argentina; Marcio Pimentel, University of Brasília, Brazil

**NUMBER OF PRESENTATIONS:** 11 oral, 14 poster, 1 no-show

**SYMPOSIUM SUMMARY:** Four presented lectures focused on the rift-related and oceanic magmatism, orogenic magmatism and arc-related basins, and post-collisional escape tectonics of Neoproterozoic (Brasiliano) orogenic belts located from south to eastern Brazil. These lectures were based on important U-Pb (SHRIMP and LA-ICPMS) geochronological data, both from magmatic and detrital zircon, as well as on geochemical and field data. The main results from these four lectures are: i) the characterization of a late Neoproterozoic (ca. 585 Ma) arc-related volcano-sedimentary succession in southeastern Brazil (Araçuai orogen); and ii) the characterization of the lower Cryogenian rift phase of the precursor basin of the Dom Feliciano orogen (south Brazil and Uruguai). One lecture discussed the evolution of the Rio de La Plata craton. Six lectures focused on different aspects of the evolution of Paleozoic terranes of Argentina and their role on Gondwana assembly. Despite some distinct interpretations, these lectures were also based on very important field, geochemistry and geochronological data. Finally, a very interesting synthesis on Gondwana amalgamation from the Sierras Pampeanas point of view was presented by Carlos Rapela. The poster session mainly focused on different aspects of the Neoproterozoic cratons and mobile belts of Brazil, and the Paleozoic orogenic terranes of Argentina.

**GENERAL COMMENTS:** The overall quality of the oral presentations was excellent, and poster quality was very good. On average 30 people (mainly from Brazil, Argentina, USA, France, Portugal and southwestern Africa) attended the session, and some live but generous discussions took place. The room was full of people in many lectures (despite the fact that this session appeared late in the call for papers and scientific program).

#### **AMS-07 Crustal evolution of the cratonic nuclei of South America**

**CONVENERS:** Wilson Teixeira, University of São Paulo, Brazil; Roberto Dall'Agnol, Federal University of Pará, Brazil; Tapani Rämö, Helsinki University, Finland

**NUMBER OF PRESENTATIONS:** 8 oral, 9 poster, 5 no-shows

**SYMPOSIUM SUMMARY:** The South American continent includes the large Amazonian and São Francisco cratons, among other tectonically stable remnants which extend to the African counterpart. As a whole these cratons contain the oldest (3.4 Ga) Archean record so far reported in the continent, world class mineral deposits (e.

g., Carajás, Iron Quadrangle), as well as Archean and Proterozoic granite-greenstone and high grade terrains, TTG suites, bifs, carbonatic rocks, dike swarms, etc., thereby providing not only clues about Earth's geologic record that survived from recycling, but also holding the trace-relationships of the tectonic settings in the geologic past.

The AMS-07 symposium aims to debate the Archean and Proterozoic geodynamic processes to address issues related with the origin and growth of the continental crust through time and space. Particular emphasis was devoted for geochronology, isotopic signatures, geochemistry and petrology of rock assemblages emphasizing magmatic series, differences in chemical properties and tectonic settings. Contributions emphasizing reconstructions of aggregation of supercontinents in the Paleoproterozoic were also presented in the oral and poster sessions of the symposium, as summarized below:

Two keynote speakers (30' each) reviewed the Paleoproterozoic evolution of Guiana shield, northern Amazonian craton and the tectonic implications with the role of crustal growth versus reworking of the Archean crust. Six additional speakers (15 mins. each) presented the state of geologic and geophysical knowledge of Precambrian cratonic terrains of South America, as well as the tectonic diversity of these terrains and correlations with the African counterpart. This session was followed by the poster session which included 9 presentations dealing with a wide range of subjects, such as: geochemistry of Archean sanukitoid suites, isotopic geochemistry of Paleoproterozoic granitoid rocks and bimodal volcanism (e.g., Carajás province), geochemistry and isotopic characteristics of Mesoproterozoic bimodal (felsic-mafic) magmatic suites, paleomagnetism and magnetic anisotropies of Proterozoic mafic rocks and paleogeographic evolution.

**GENERAL COMMENTS:** The symposium was a very interesting one, with lively, high quality discussions. A significant number of people attended the oral session (about 30; all seats were occupied during the session due to the small size of the room). As a whole we consider that the symposium allowed a worldwide overview of the geological studies that have been done in the Precambrian of South America continent in recent years.

**ANNOUNCEMENTS:** In conjunction with other Brazilian conveners a special publication dedicated to the Precambrian evolution of South America is being planned, based on selected contributions to the symposium.



**ASIA****AS**

Coordinated by Oleg Petrov, Harsh Gupta, Zhang Hongren

**ASI-01 Geodynamic evolution of Asia**

*CONVENERS:* Jin Xiaochi, Chinese Academy of Geological Sciences, China; Manuel Pubellier, Laboratoire de Géologie de l'Ecole Normale Supérieure, France (CGMW); Ren Jishun, Chinese Academy of Geological Sciences, China; Peng Qiming, Ministry of Land and Resources, China

*NUMBER OF PRESENTATIONS:* 30 oral, 29 poster

*SYMPOSIUM SUMMARY:* The session Geodynamic Evolution of Asia was aimed to provide a forum for geologists who have been engaged in or just entered the field of exploring the evolutionary history and the making of Asia. It was also aimed to demonstrate new achievements of the project of coupling the International Geological Map of Asia (IGMA 5000) and related geological studies. The Asian continent is a composite landmass comprising a number of continental blocks and orogenic belts. Its geodynamic evolution has attracted great attention from the geoscientific community. Significant geological units developed in Asia are among others the Ural-Mongolia orogenic belt - the world's largest Paleozoic orogen, the Qinghai-Tibet Plateau with a width of more than 1000 km - the best developed part of the Tethyan tectonic realm, and the West Pacific and North Indian ocean trench-arc-basin systems. Geodynamically, Asia is also closely related to Gondwana. The process of Gondwana dispersion and Asia accretion has been understood, especially in the past 20 years, to be the main theme of Phanerozoic development of Asia. In addition, a large amount of new geological, geophysical and geochemical data including isotopic datings better constrain the geodynamic evolution of Asia. International efforts on map compilation (e.g. IGMA 5000) and related research have allowed correlations over large areas.

*GENERAL COMMENTS:* The theme of this session, Geodynamic evolution of Asia, embodies a variety of disciplines of earth sciences, which may provide clues, constraints, indications, etc. for understanding the geological making of Asia. Therefore, the amount of contributions to this session was relatively large. After reviewing submitted abstracts, 30 for oral presentation and 29 for poster were chosen. This keeps the quality of presentations above average. Oral presentations almost always ended with lively discussions. The shortcomings were the no-shows of a few speakers due to various reasons, which disappointed some attendants, but on the other hand gave more time for further discussion. Another inconvenience was caused by the distance between the session venue and hotels in Oslo, resulting in the reduction of attendant number of the presentations in early morning (started at 8:00).

Original convener Prof. REN Jishun was, due to an unexpected operation, unable to attend the congress. His suggestion that Prof. JIN Xiaochi take over his job was

accepted by the Organising Committee of the 33rd IGC.

**ASI-02 Geology and mineral resources of Northern and Central Eurasia**

*CONVENERS:* Oleg Petrov, All Russian Geological Research Institute (VSEGEI), Russia; Dong Shuwen, Chinese Academy of Geological Sciences (CAGS), China

*NUMBER OF PRESENTATIONS:* 26 oral, 14 poster, 10 no-shows

*SYMPOSIUM SUMMARY:* The idea to organize this symposium was initiated by the Russian and Chinese geological surveys. Partly it resulted from fruitful joint work at the International Project "Atlas of geological maps of Central Asia and adjacent areas at 1:2.5 M scale". The project was carried out by geological surveys from five countries: Russia, China, Mongolia, Kazakhstan, and the Republic of Korea. A GIS Atlas with databases on mineral deposits and geological maps of different content at 1:2.5 M scale for such a large and metallogenically unique area was compiled during this project. The symposium also considered problems of the geological structure, tectonic development and mineral potential of the largest region of the world - Northern and the Central Eurasia; results from the newest isotope-geochronological, isotope-geochemical and metallogenic investigations; data of deep geophysical research and geotraverses. This region occupies the territory of most countries of Northern and Central Asia and is one of the largest in terms of mineral deposits and hydrocarbon potential and production. Nevertheless, the resource potential of this region is far from being exhausted. Major mining companies work in the region and invest significant funds into geological prospecting. Each year the number of new mineral deposit discoveries increases. This is the result of studies done not only by geologists from mining companies, but from geological surveys and science academies as well. Major outcomes from national and international projects by industrial geological enterprises and science academies from many countries in the region - Geological Map of the Central Asia (scale 1:2.5 M), the Tectonic Map the Central Asia (scale 1:2.5 M), Metallogenic Map of the Central Asia (scale 1:2.5 M), the Map of Power Resources of the Central Asia (scale 1:2.5 M) - were presented to participants of the symposium.

*GENERAL COMMENTS:* About 150 people attended the symposium during the first day and about 50 during the second day.

*ANNOUNCEMENTS:* All of the above-mentioned maps displayed by the Russian and Chinese geological surveys at the international exhibition GeoExpo-2008 were published before the opening of the congress. The Russian side was responsible for the compilation of tectonic and metallogenic maps, whereas the Chinese side was responsible for the compilation of the geologic map and map of fuel and energy resources.



#### ASI-04 Evolution of the Arabian-Nubian Shield and its Orogenies

*CONVENERS:* Ali Al-Mishwat, Kuwait University, Kuwait; Mohamed Abdelsalam, University of Missouri, USA; Mengist Teklay, University of Münster, Germany

*NUMBER OF PRESENTATIONS:* 12 oral, 1 poster, 4 no-shows

*SYMPOSIUM SUMMARY:* This symposium was a successful one and, as planned, brought together researchers on its theme and presented papers on structure-tectonics and geochemistry-geochronology. These papers illustrated vast developments in the knowledge of the Arabian-Nubian Shield in Arabia and northeast Africa. Highlighted in the symposium was an accumulation of a large number of precise Precambrian age dates of rocks and events in the shield, as well as extensive field data on structural evolution of certain regions within it. Additionally, some information on mineral deposits, basement geophysics and Precambrian glaciation was presented. The symposium acted as an avenue to present ideas that have developed on the geology of the Arabian-Nubian Shield in the last quarter of a century and pointed to the direction of future research and investigations in this vitally important region of the earth.

*GENERAL COMMENTS:* Approximately 50 people attended the symposium and generated a reasonable amount of discussions on presented ideas.

*ANNOUNCEMENTS:* During the symposium, the convener announced a plan to publish the symposium manuscripts in a future special thematic volume of one of the reputable earth science journals (possibly Precambrian Research) after they have been produced as publication-acceptable manuscripts. Invitation was also extended to other researchers outside the symposium. Presently, this idea is actively pursued.

#### ASI-05 Tectonics and crustal growth in Central Asia

*CONVENERS:* Boris Natal'in, Istanbul Technical University, Turkey; Celal Sengör, Istanbul Technical University, Turkey

*NUMBER OF PRESENTATIONS:* 11 oral, 14 poster, 1 no-show

*SYMPOSIUM SUMMARY:* Studies of continental growth acquired a new component when it was recognized in the early nineties of the last century that the growth of the Altaid Orogenic Complex in Central Asia may have added some 5 million km<sup>2</sup> of new area to Asia, half of which may be juvenile. Continuing studies on granites have largely corroborated this estimate and parts of the Altaid collage have been studied geochemically to reveal a more mafic composition than mature continental crust. At the same time, current work in Central Asia has regrettably followed the precedent of the North American Cordilleran 'terrane studies' and thus erected many terranes without specifying their tectonic nature. Another trend in current studies is strong dependence on geochemical data in the identification of tectonic setting, which is often at odds with physical dimensions of tectonic units if they are compared with modern analogues. It is of the greatest importance not only from the viewpoint of crustal age

studies, but also from the viewpoint of the processes that build the continental crust, to identify the tectonic environments using their present-day equivalents. Tectonic environments and processes are often carelessly labelled, leading to entirely incorrect scenarios of evolution. For instance, appositions of continental units are dubbed as 'collisions', whereas it may have happened by transform suturing.

Thus, the topic of the symposium was intended to bring together those who look at geochemical and geochronological parameters and those who study stratigraphy and structural geology of various areas of Central Asia with a view to finding common ground in the prevailing controversies.

*GENERAL COMMENTS:* 25 presentations were registered for the symposium. Their authors represented 10 countries: China, France, Iran, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Poland, Russia, and Turkey. In addition to the registered participants, the symposium attracted significant attention from other 33IGC participants. The strict Congress schedule left no time to thorough discussion of ideas and results demonstrated in oral presentations. However informal discussions in the poster area clearly demonstrated the significant interest in the subjects of the symposium, as well as more or less common understanding that the comprehensive analysis of all geological aspects is the only appropriate approach for such a complicated issue as continental growth.

*ANNOUNCEMENTS:* The symposium was a part of the planned activity of the IGCP-480 project "Structural and Tectonic Correlation across the Central Asia Orogenic Collage: Implications for Continental Growth and Intracontinental Deformation". Next meeting will be held in Vladivostok, Russia where the participants in the project will have a chance to discuss the junction of Central Asian and Pacific structures, as well as to see subduction-accretion complexes and magmatic arcs constituting the Sikhote Alin Range. Additional information can be found at <http://www.igcp.itu.edu.tr/index.html>

#### ASI-06 Pre-Mesozoic accretionary tectonics in Central Asia

*CONVENERS:* Wenjiao Xiao, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China; Mikhail G. Leonov, Geological Institute, Russian Academy of Sciences, Moscow, Russia; Dmitriy V. Alexeiev, Geological Institute, Russian Academy of Sciences, Moscow, Russia

*NUMBER OF PRESENTATIONS:* 15 oral, 9 poster, 5 cancelled or no-shows

*SYMPOSIUM SUMMARY:* The session was proposed as a joint program between the IGC and the ILP Task Force I, the ERAS: EARTH ACCRETIONARY SYSTEMS (in space and time). The main aim of the session was to provide a more convenient venue for exchange of scientific ideas and research on the accretionary orogens, with an emphasis on the accretionary orogeny in the pre-Mesozoic time in the Central Asia.

The presentations covered a variety of scientific disciplines, including structural geology, regional tectonics,



geochemistry, isotope geochemistry, geochronology, geophysics (paleomagnetism and seismics) and metallogeny. The broad spectrum of presented data allowed to characterise various aspects of the processes of accretionary orogeny and to enable a multidisciplinary approach to the subject.

**GENERAL COMMENTS:** The overall quality of presentations was very good. Up to approx. 80 people attended the session. Active discussions during and after the session indicated substantial interest from the scientific community to the presented data and subject in general. It also allowed an outlining of unsolved questions and principal targets for future research.

**ANNOUNCEMENTS:** The conveners are going to organize a special issue for the session.

### **ASI-07 The Himalayas and neighbouring regions**

**CONVENERS:** Anshu Kumar Sinha, Dept. of Science and Technology, LKO, India; Richard Sinding-Larsen, Norwegian University of Science and Technology, Norway; J.-P. Burg, ETH, Zürich, Switzerland

**NUMBER OF PRESENTATIONS:** 19 oral, 12 poster, 4 no-shows

**SYMPOSIUM SUMMARY:** The theme Himalayas and Neighbouring Regions covered all geological aspects of the Himalayan mountain region as well as neighbouring mountain areas like Tibet, the Karakoram mountains, parts of Hindu Kush, from Iran to Myanmar (Burma). From north it starts from the orogenic belt of Tien Shan, Pamir, Karakoram to the Himalayas, ending with the Indian shield area in the south. The area includes the world's highest mountain, Everest, and the collision zone of Indian and Asian plates about 45 m.y. ago. Tibet is the highest plateau of the world, geodynamically active and controlling the global climate of the Indian Subcontinent, being the highest cold desert on Earth. Study of the area is very important, from plate collision causing earthquakes to the recession of glaciers. Measurements of plate movement, the rise of the Himalayas and the causes of crustal shortening are the focus of the studies. The participation of geoscientists from Bhutan, Nepal, India, Pakistan, China, Afghanistan and Middle Asian countries were welcome in oral and poster sessions.

The key papers covered the basic aspects of evolution of Himalayan region tectonic framework in the broader aspects of neighbouring orogens. There was an extensive presentation and discussion on great Himalayan earthquakes vis-a-vis conceptual tectonic models. The paper presenting the data from the Bamyas Buddhas and Band-e-amir phytoherms lake region of Hindu Kush seismicity influence was of great interest, involving the deep moho isopach line. Active deformation measurements in the eastern syntaxis of Himalayan region and further northeast to Sichuan region with the extensive earthquake on 12 May 2008 in China were highlights of some presentations. Results of new advances concerning the continental dynamics of the Himalayas-Tibet plateau and mapping result in 1:250 000 scale was presented and discussed. The stress field in the western Himalayas with special reference to the 8 October 2005 Muzaffarabad

earthquake was also a highlight of the symposium. The distribution in homogeneity of helium isotope of CO<sub>2</sub> degasification point and its geotectogenesis in southwest China contains good recent research data.

Since the Himalayan region is the most sensitive area from the point of view of recent global climatic change as well as the devastating earthquakes, the data presented in this special symposium requires public attention for protecting the lives of a large population inhabiting this region of our fragile Himalayan ecosystem.

**GENERAL COMMENTS:** The overall quality of presentations were praiseworthy with relevant data generated by participants. There were lively discussion on the topics.

**ANNOUNCEMENTS:** It was announced that the substantial amount of good quality papers would be collected and reviewed for a John Wiley volume.

## **EUROPE**

## **EU**

Coordinated by Kai Sørensen, Dan Evans, Michael Kosinowski

### **EUR-01 Three billion years of geological history of the Baltic Shield and its shelf**

**CONVENERS:** Tamara B. Bayanova, Russian Academy of Sciences, Russia; Victor V. Balagansky, Russian Academy of Sciences, Russia

**NUMBER OF PRESENTATIONS:** 12 oral, 10 poster

**SYMPOSIUM SUMMARY:** The symposium was intended to present current results on tectonics, structural, magmatic, metamorphic, isotope, sedimentary and regional geology. Oral and poster presentations covered the entire Baltic or Fennoscandian Shield, which is the best known and well exposed of the Earth's Precambrian regions. Nevertheless the Baltic Shield is one of the key structures for developing tectonic models of the Early Precambrian as well as models of the global evolution from Archaean time to the present.

One of the main interests was the Baltic Shield and other disciplines that provide new input in our understanding of how the Earth has evolved and impose constraints on tectonic models. The concept of lithospheric plates has proved particularly valuable in evolution of the Early Precambrian. The progress has been provided both by modern equipment including TIMS, ICP-MS, LAM-ICP-MS and SHRIMP-II machines; and instruments for extensive seismic studies (CDP and DSS) in platform regions and the shield through multidisciplinary studies. The symposium presented a number of isotope, geochemistry, geochronology, etc. analyses for the main and most important rocks and structures of the Baltic Shield.

Findings of unique Archaean rocks such as eclogites of different types, ophiolites including an association of sheeted dykes, gabbros and pillow lavas, and boninite series spatially associated with the ophiolites, also have provided significant constraints at least for the Meso- and





Neoarchaean tectonics. It should be noted that these scientific investigations were presented by Russian participants for the first time in the world at the Congress. Palaeomagnetic results for the Baltic shield combined with data on other shield favour the concept of the reconstruction of the oldest supercontinents. Baltic Shield is characterized by a presence of a lot of magmatic rocks and processes and is the well-known LIP province.

*GENERAL COMMENTS:* All oral and poster presentations were supported by high quality demonstration materials including maps, plots, photos etc. Many young scientists from different countries took part in the symposium. About 60 congress participants were present in the first half and 50 in the second part of the symposium, and about 3-4 questions were asked per presentation. There was also a huge discussion about the possibility of the presence of ophiolites in Archaean time.

#### **EUR-04 Tectonic evolution of the lithosphere from European Precambrian Craton to Alpine system on the base of the deep geophysical data**

*CONVENERS:* Aleksander Guterch, Polish Academy of Sciences, Poland; Marek Grad, University of Warsaw, Poland; G. Randy Keller, University of Oklahoma, USA

*NUMBER OF PRESENTATIONS:* 8 oral, 2 poster

*SYMPOSIUM SUMMARY:* Beginning in 1997, Central Europe between the Baltic Sea and Adriatic Sea has been covered by an unprecedented series of seismic experiments to investigate Earth's complex lithospheric structure, up to a depth of about 100 km. These experiments - POLONAISE'97, CELEBRATION 2000, ALP 2002, SUDETES 2003 - have only been possible due to a massive international cooperative effort. The International Consortium consisted of more than 30 institutions from 16 countries in Europe and North America - i.e. from Austria, Belarus, Canada, Croatia, Czech Republic, Denmark, Finland, Germany, Hungary, Lithuania, Poland, Russia, Slovakia, Slovenia, Turkey, and the United States. The majority of the seismic recording instruments was provided by the IRIS/ PASSCAL Instrument Center in Washington and the University of Texas at El Paso (USA). As a result of these experiments, a network of seismic profiles now extends from the East European Craton (east of the Baltic Sea), along and across the Trans-European Suture Zone (TESZ) in Poland and the Bohemian massif, through the Carpathians, Sudetes, and Eastern Alps, to the Pannonian basin, the Dinarides, and Adriatic Sea. Total length of seismic profiles in all experiments is about 20,000 km. In the years 1994 - 97 EURONRIDGE seismic experiment was carried out in the East European Craton, in the area of Lithuania, Belarus and Ukraine along the transect of about 1,000 km length.

The POLONAISE'97, CELEBRATION 2000, ALP 2002, SUDETES 2003, and EUROBRIDGE seismic experiments provide significant new data about the structure and tectonic evolution of Central Europe. As is always the case, it takes an integrated geological and geophysical analysis to interpret the velocity models that result from such experiments.

The TESZ region is a broad zone of deformation that

extends across Europe from the British Isles to the Black Sea region, which formed as Europe was assembled from a complex collage of terranes during the late Palaeozoic. These terranes were accreted along the margin of Baltica (East European Craton), which was formed during the break-up of Rodinia. The tectonic evolution of this region shares many attributes, which is of global importance for studies of terrane tectonics and continental evolution.

Results of these seismic experiments were presented in about 50 papers in international journals and monographs. Further publications will be published in following years.

*GENERAL COMMENTS:* Quality of presentations and discussions was very good. There were 30-40 people attending.

#### **EUR-05 Pre-collisional evolution of the Caledonian-Appalachian orogen**

*CONVENERS:* David Roberts, Geological Survey of Norway, Norway; Øystein Nordgulen, Geological Survey of Norway, Norway; Aaron Yoshinobu, Texas Tech University, USA; Carol Frost, University of Wyoming, USA; Calvin Barnes, Texas Tech University, USA

*NUMBER OF PRESENTATIONS:* 10 oral, 1 poster

*SYMPOSIUM SUMMARY:* The classic Caledonian-Appalachian orogeny was preceded by a complex history of basin and volcanic arc formation, sedimentation, and magmatism in the ancient Iapetus ocean basin. These various tectonic elements were amalgamated, deformed and metamorphosed during pre-Scandian orogenic events (Taconian, Grampian, etc.). Recent geological, geochronological, and geochemical investigations in Scandinavia, the British Isles, Greenland, Newfoundland, and the U.S. have indicated that some pre-Scandian terranes that are now widely dispersed share strikingly similar sediment provenance and metamorphic, magmatic, and tectonic histories. In contrast, other terranes are geologically distinct. Whether these distinctive characteristics are due to isolated sediment provenance etc., or result from a distant origin of the terranes is commonly unclear.

The advent of rapid dating of detrital zircons, the increasing abundance of isotopic data for (meta) igneous and sedimentary rocks, and the large number of high-precision U-Pb ages of plutons and volcanic rocks now permits much more precise reconstructions of pre-Scandian geologic activity throughout the Caledonian-Appalachian orogen. Using these new data and tectonic reconstructions as a basis for comparative studies of pre-Scandian terranes, a better understanding of sediment dispersal patterns, tectonic activity, styles of magmatism, and thermal evolution that accompanied closure of Iapetus may be gained.

With this in mind, contributions were invited to address all aspects of the pre-Scandian evolution of the Caledonian-Appalachian orogen in Scandinavia, the British Isles, North America, and Greenland. The session, containing 10 talks focusing on different parts of the orogen, provided up-to-date summaries of ongoing research exploiting a variety of techniques.

*GENERAL COMMENTS:* Interesting talks were given on



numerous aspects of the early Caledonian (Taconian/Grampian) evolution in Newfoundland, Ireland, Scotland and Scandinavia. One talk dealt with regions in southwest Svalbard, and as an appropriate transition to the following session EUR-06 on Caledonian collision tectonics, a talk was presented on the exhumation of the orogen with examples from western Norway. All the talks were well attended and resulted in lively discussions. Seen in combination with EUR-06, the general conclusion is that renewed collaborative research on the Caledonian mountain belt may yield highly interesting results regarding the formation of orogenic belts in general, and the Early Palaeozoic geological history of the North Atlantic region in particular.

#### **EUR-06 Collisional orogeny in the Caledonian-Appalachian Orogen**

*CONVENERS:* Peter Robinson, Geological Survey of Norway, Norway; David Gee, University of Uppsala, Sweden; Mark Steltenpohl, Auburn University, Alabama, USA

*SYMPOSIUM SUMMARY:* Recent work on the Caledonian-Appalachian orogen is providing new insight into orogenic processes that are inferred to be ongoing in today's major collisional mountain belts. The middle crustal erosion levels of the Caledonides and Appalachians display basement-cover relationships that are deeply buried and the subject of much speculation in the younger orogens (e.g. the Himalaya). This Paleozoic orogen exposes relationships between thrusting and normal faulting, both synchronous and superimposed, that are particularly instructive for understanding collisional contraction, simultaneous with and succeeded by upper crustal collapse. Inverted metamorphic gradients and emplacement of ductile high grade allochthons onto adjacent platforms are important components of the Caledonides and Appalachians, as are the exposures of the deep ductile hinterland, with evidence of partial subduction of continental crust and the crystallization of eclogites with coesite and microdiamonds in Caledonides. These Paleozoic orogens also provide abundant evidence of previous ocean development and subsequent subduction-related magmatism, sedimentation, deformation and metamorphism that occurred prior to collision between the major continents Baltica and Laurentia.

After a morning session concerned with the pre-Scandian evolution of the orogen (EUR-05), an afternoon of 10 lectures and a poster (EUR-06) focused on Laurentia-Baltica collision. Most of the contributions concerned the Scandinavian Caledonides, but lectures on East Greenland, Svalbard and the Appalachians were also included. This Caledonian-Appalachian day attracted an audience of c. 50-80 participants: it stimulated a lively discussion and provided the background for a post-Congress excursion (#34) involving 30 participants.

#### **EUR-07 Comparison of the Uralides and Variscides**

*CONVENERS:* Andres Perez-Estaun, CSIC, Spain; Philippe Matte, CNRS-UMR, France; Victor Puchkov, Russian Academy of Sciences, Russia; Galina N. Savelieva,

Russian Academy of Sciences, Russia

*NUMBER OF PRESENTATIONS:* 13 oral, 7 poster, 2 no-shows

*SYMPOSIUM SUMMARY:* The Uralides and Variscides are the main orogenic edifices built during the Palaeozoic formation of Pangea. Comparison between the Uralides and Variscides allows the role of the dominant processes that were active during the tectonic evolution and the building of the final architecture of the orogenic edifices to be discussed. These orogens are magnificent examples of mountains belts formed by arc-continent collision and continent-continent collision.

This symposium included contributions documenting the geologic evolution of these orogens including changes in tectonic style from Devonian until Triassic times in Europe's various geological provinces in order to unravel the competing roles of governing processes in time. Data on age and spatial correlation of lithospheric structures and tectonic events as well as geophysical dimension of mapping lithosphere evolution patterns in time were also presented. Studies on ophiolites of the Uralides and Variscides demonstrated that they are important indicators of diverse evolutionary paths of paleoceanic basins. Integration of geophysical, geochemical and geochronological data together with other geologic data helped to understand some fundamental questions establishing the relationship between the final orogenic crustal architecture and the pre-orogenic crustal configuration or the orogenic processes.

*GENERAL COMMENTS:* High quality talks covered many themes in geochemistry, high-pressure rocks, ophiolites, metallogeny, seismic reflection profiling and orogenic processes concerning the Uralides and Variscides. Participants in each session were encouraged to discuss the results presented. Attendance was high in the first two sessions and very poor the last session.

#### **EUR-08 The North Atlantic Igneous Province stripped: Origin, magmatic activity, crustal processes and plate kinematics**

*CONVENERS:* Morgan Ganerød, Geological Survey of Norway, Norway; Sonia Rousse, Laboratoire des Mécanismes et Transferts en Géologie, Toulouse, France; Walter Roest, Département Géosciences Marines, Ifremer, France

*NUMBER OF PRESENTATIONS:* 9 oral, 4 poster

*SYMPOSIUM SUMMARY:* The North Atlantic Igneous Province (NAIP) which includes the UK, Ireland, the Faeroes, Greenland and the West Greenland-Baffin corridor is one of several well-known Large Igneous Provinces (LIP) temporally correlated with continental break-up. The NAIP likely owes its origin to the Iceland Plume and broadly corresponds in time to the initiation of seafloor spreading in the NE Atlantic. It is also believed to have triggered global climate changes, with knock-on effects for the biosphere and sedimentary facies. In the last few decades, the Atlantic-Arctic margin has received much attention, partly as a result of hydrocarbon exploration, leading to a rapidly expanding onshore and offshore geological and geophysical data set. This provides a unique



setting to derive new insights into causal links between timing and style of magma emplacement, crustal processes, plume arrival, plate kinematics, uplift, subsidence and the evolution of sedimentary basins. In this session we aimed to paint a more comprehensive picture of the NAIP and its role in shaping the complex North Atlantic geology, and to show the ongoing research interests of different researchers.

**GENERAL COMMENTS:** The session had 4 invited speakers, covering many aspects in the summary of the symposium. Most of the seats were occupied, with a range of 20-35 people in the audience. The presentations were clear and well done which motivated to some questions and discussions.

### **EUR-09 Geology of the Southern Permian Basin area**

**CONVENERS:** J.C. Doornenbal, Geological Survey of the Netherlands, Netherlands; Gerhard H. Bachmann, Martin-Luther-Universität Halle-Wittenberg, Germany; Tim Pharaoh, British Geological Survey, UK; Tadeusz Peryt, Polish Geological Institute, Poland

**NUMBER OF PRESENTATIONS:** 15 oral, 7 poster

**SYMPOSIUM SUMMARY:** The Southern Permian Basin (also referred to as the Central European Basin) is Europe's largest sedimentary basin. It is a typical intracontinental basin that evolved from latest Carboniferous to recent times and extends from Eastern England to Poland and from Denmark to South Germany.

The Southern Permian Basin Atlas project (SPBA) is a joint project of the Geological Surveys of Belgium, Denmark, Germany, Netherlands, Poland and the United Kingdom. The project is supported by a wide range of Petroleum Exploration & Production companies, licensing authorities, research institutes and universities.

The aim of the Atlas, which is due to be published in 2009, is to present a comprehensive and systematic overview of the results of over 150 years of petroleum exploration and research in the Southern Permian Basin. The Atlas aims to stimulate the petroleum E&P industry to continue their activities in this mature basin. The subsurface characterization provided in the Atlas will also be of great value to governments, researchers and other individuals interested in the deep subsurface.

The Atlas has been initiated to celebrate a milestone in the Southern Permian Basin: the discovery of the Groningen gas field in 1959, nearly 50 years ago. This discovery is one of the largest gas fields in Europe and boosted exploration for gas and oil in the Southern Permian Basin. As the Southern Permian Basin gas and oil province continues to mature and with field sizes inevitably decreasing, more and more careful data integration and geoscientific effort will be required to discover new reserves and to augment the recovery of proven hydrocarbon accumulations. The large volume of data that is or will be made available publicly allows the production of an authoritative compilation to support the E&P industry in their efforts to fully develop the basin; efforts which will likely take place in the coming decades. At the same time, easy and inexpensive access to the accumulated knowledge held by educational bodies will lead to a better understanding of the Southern Permian

Basin, and the documentation of this knowledge will assist in the training of the next generation of petroleum geologists.

The Atlas will review the area from eastern England to the Russian-Polish border and is situated between latitudes 50 and 56 degrees North. The Atlas will address the geologic evolution and hydrocarbon potential per stratigraphic interval. The paleogeographic and tectonic evolution will be covered within the framework of the principal stratigraphic intervals, from the Precambrian basement to the Holocene. The various structural and stratigraphic settings will be elucidated by a thorough set of field examples, overview maps and illustrations. In addition, petroleum generation, migration, trapping and production as well as the history of exploration and licensing in the basin will be covered, together with a summary of resource assessments. Other potential options for use of the deep subsurface such as gas storage and geothermal aspects will also be addressed.

This session will include results of the Southern Permian Basin Atlas project and, beyond, other aspects of the basin evolution from Carboniferous to recent times.

**GENERAL COMMENTS:** The overall quality of the presentations was very high. The number of attendants was between 25-35. It was a pity that the symposium was split in two parts - one at the end of the first day and the second part at the beginning of the next day.

**ANNOUNCEMENTS:** The Southern Permian Basin Atlas will be published in June 2009 and the reference is: Doornenbal, J.C. et al., 2009. Petroleum Geological Atlas of the Southern Permian Basin Area. EAGE Publications b.v. The Southern Permian Basin Atlas will be presented at EAGE, June 7-11, 2009, Amsterdam, Netherlands, and Celebration of 50 years Groningen, June 16-18, 2009, Netherlands.

### **EUR-10 The Baltic Sea Basin**

**CONVENERS:** Jan Harff, Leibniz Institute for Baltic Sea Research Warnemünde, Germany; Svante Björck, University of Lund, Sweden; Peer Hoth, Federal Ministry of Economics and Technology, Germany

**NUMBER OF PRESENTATIONS:** 18 oral, 6 poster

**SYMPOSIUM SUMMARY:** The symposium was planned in order to foster the understanding of The Baltic Basin as a unit in terms of genesis, structure, ongoing processes and utilization. During the symposium, geoscientists, climate researchers, biologists, archaeologists, and computer scientists discussed questions such as: formation of the Baltic Basin and geological resources; the stratigraphic record - mirror of climatic changes during the last glacial/interglacial cycle; coastal processes and sediment dynamics; feedback between socioeconomic driving forces and the natural environment since the prehistoric colonization; management of the marine ecosystem; new monitoring strategies and technical device design including satellite observation methods.

Results show that the Baltic Basin serves as a natural laboratory for a variety of geological structures and key processes crucial in the exploration of mineral resources and engineering, the formation of intra-continental



sedimentary basins, interaction of hydrosphere, geosphere, and biosphere in basin and coastal environments. Additionally, Baltic Sea sediments provide high resolution records of climate and environmental change during the late Quaternary. This record allows not only tracing back the change in the natural environment for the last glacial cycle, but also the human impact and therefore socio-economic developments during the last 10,000 years.

The densely populated Baltic drainage basin and the exploitation of Baltic Sea resources cause permanent conflicts between economic interests and the protection of the unique ecological environment of the Baltic Sea.

In a final discussion participants concluded that the scientific information exchange has to be systematically supported by Baltic Sea Geologists (BSG) activities. It is strongly recommended to continue the organization of biannually organized BSG meetings. These meetings should be used by participants from countries around the Baltic for the planning of international research projects, and the harmonization of coastal protection strategies, resource exploitation and the protection of the marine environment. The participants decided to publish the results of the symposium as a book. This publication will not only summarize the state-of-the-art of the investigation of the Baltic Sea Basin but also foster the development of new monitoring strategies and technical device design including satellite observation methods, and the establishment of international research laboratories.

*GENERAL COMMENTS:* The quality of oral and poster presentations was at the international top level. The announced program was fully achieved. The subject of the symposium did touch on general questions debated not only around the Baltic Sea but also of wider general interest.

*ANNOUNCEMENTS:* Deadline for the submission of manuscripts to the editors for publication in a book is December 20, 2008. The book will be published and printed through Springer publishing house in 2009.

### **EUR-12 Cenozoic volcanism in Europe**

*CONVENERS:* Anna Ladenberger, Uppsala University, Sweden; Hilary Downes, Birkbeck College, University of London, UK

*NUMBER OF PRESENTATIONS:* 7 oral, 3 poster

*SYMPOSIUM SUMMARY:* Cenozoic volcanic activity took place throughout Europe. Several stages of mafic, alkaline, calc-alkaline and more silica-saturated volcanism can be traced over a broad area extending from southern Spain (lamproitic) to the Ukraine (calc-alkaline), including the Balkan region and northern Europe. Magmatic activity started in late Cretaceous - Palaeocene and continued to a few thousand years BP with the major phase in the Neogene. Magmatism which occurred in Europe is considered to be associated with different tectono-thermal events: European-African plate collision and subduction, the opening of the North Atlantic, development of an extensive lithospheric rift system (European Cenozoic Rift System), activity of a mantle plume (or plumes) and so on. However, the processes responsible for, and the causal relationship between, tectonic regimes and volcanism are

still under debate.

During the session we discussed the possible scenarios for the evolution of European volcanism by use of all available data from different fields of Earth science; from petrology and geochemistry to geophysics and geodynamics. We summarized the present state-of-the-art on the evolution of volcanism in Europe and linked our discussion to the more global conclusions about the origin of continental volcanism.

*GENERAL COMMENTS:* Our session started with 3 invited lectures given by Marjorie Wilson, Vladislav Babuska and Hilary Downes. These presentations summarized the origin of Cenozoic volcanism in Europe from the petrological, geochemical and geophysical points of view. We obtained a broader picture of magmatic processes which influenced the subcontinental lithosphere after the collision of Africa with Europe. The late afternoon session was focused on more specific areas within Central European Volcanic Province. The session was attended by a satisfying amount of people - during the first part our lecture room was almost full. Flexible timing of our session allowed us to have many questions from the audience and to stimulate interesting discussions.

### **EUR-13 Neogene of NW Europe: Palaeoclimate, tectonics and sedimentation**

*CONVENERS:* Erik S. Rasmussen, GEUS, Denmark; Torsten Utescher, University of Bonn, Germany; Dag Ottesen, NGU, Norway; Jan Laberg, University of Tromsø, Norway

*NUMBER OF PRESENTATIONS:* 11 oral, 7 poster

*SYMPOSIUM SUMMARY:* The Neogene Period in NW Europe is characterised by the strong tectonism associated with the Alpine Orogeny and the opening of the North Atlantic. Land areas were elevated due to compressional and extensional tectonism and due to development of mantle plumes. A variety of sedimentary basins from rift basins, intracratonic basins to passive margins were formed. The climate of the earth has changed to an overall icehouse climate which characterised the Neogene, but in most parts of NW Europe temperate to subtropical climates dominated.

Due to a generally easy accessibility of Neogene deposits (outcrops, pits, high amounts of boreholes), detailed images of the succession on high resolution seismic data, and confident climatic reconstructions based on the study of flora and fauna, the Neogene constitutes an important full scale laboratory for the understanding of geological processes.

The presentations were concentrated on climate and especially tectonism. The sedimentological aspect was included as one presentation which, however, was cancelled and substituted by a presentation of the Neogene of Norden (Erik S. Rasmussen) which focused on sedimentology. The general conclusion about the climate was that temperate to subtropical climate prevailed during the Miocene and Pliocene. However, a climatic deterioration occurred at the end of the Neogene. Tectonism played a major role in the development of the sedimentary basins and examples of Alpine influence and



tectonism associated with the opening of the North Atlantic were presented.

*GENERAL COMMENTS:* The quality of the presentations was high and ca. 40 - 50 people attended Tuesday afternoon and 30 - 40 people attended Wednesday morning. Most oral presentations were followed by one or two questions to clarify aspects of the presentations.

### **EUR-15 Neogene of the Mediterranean: An "ocean laboratory"**

*CONVENERS:* Gert J. De Lange, Utrecht University, Netherlands; Patrizia Ziveri, Universitat Autònoma de Barcelona, Spain; John Woodside, Free University, Netherlands

*NUMBER OF PRESENTATIONS:* 9 oral, 6 poster, 1 cancelled or no-show

*SYMPOSIUM SUMMARY:* The Mediterranean is a small scale ocean that acts as a biogeological "laboratory" where different aspects related to sedimentology, geophysics, geochemistry, paleoecology, paleoceanography, and paleoclimate can be studied with relevance to the global ocean. Such studies may include those from marine deposits on land and in the seafloor, resulting from continental collision, (salt) tectonics, mudflows, tsunamis, brine basins, mud volcanism, methane emission, and gas hydrates to paleoceanography and paleoclimate cycles. Unique deposits have resulted from some of these processes, e.g. evaporites, sapropels and black shales, that themselves may be variably influenced by diagenesis and preservation. We received contributions in all these fields but in particular on two main themes: paleoceanography/paleoclimate, and physical processes such as mud volcanoes.

In the first half of the oral session there were interesting talks on Mediterranean mud volcanoes, such as from the Nile cone (A. Reitz replacing the talk by S. Ceramicola who was unable to come; G.J. De Lange replacing V. Mastalerz), Anaximander area (M. Alexandri; C. Ioakim), and from carbonate mounds in the Alboran area (M. Comas) and Apennines (S. Mecozzi). In the second half, the focus was more on the paleoceanographic aspects such as ecosystems (Ziveri), formation and preservation issues (Mobius; De Lange).

*GENERAL COMMENTS:* Unfortunately, the poster session was on the preceding day, and the oral session on the last day of the Congress which resulted in a relatively limited but highly focussed audience.

### **EUR-17 4-D topography evolution in Europe: Uplift, subsidence and sea level change (TOPO-EUROPE) (ILP)**

*CONVENERS:* Sierd Cloetingh, VU University Amsterdam, Netherlands; Jörg Negendank, GFZ Potsdam, Germany

*NUMBER OF PRESENTATIONS:* 10 oral, 1 poster

*SYMPOSIUM SUMMARY:* The topography of the continents and their margins is controlled by processes taking place at depth in the Earth, at the Earth's surface and in the atmosphere. The lithosphere responds to forces exerted by these processes, generating mountain belts (e.g.

Alps, Apennines, Carpathians, Caucasus and Scandes), elongated rift zones (e.g. Rhine-Rhone rift system), vast areas of recent volcanism (e.g. Massif Central, Rhenish Massif), explosive volcanoes (e.g. Canaries, Azores, Santorini, Vesuvius, Campi Flegrei) and large sedimentary basins (e.g. North Sea, Pannonian Basin, Black and Baltic Seas, Mediterranean, East European Platform basins). Improved knowledge of the deep mantle and its coupling to the lithosphere and the surface is key to understanding the enormous forces that produce these features. The impact of solid-earth processes on surface topography at plate boundaries has been known for several decades, but their significance for intraplate domains, and particularly the vulnerable coastal regions, has only recently been appreciated.

Furthermore, critical feedback mechanisms between solid-earth processes and topography are now recognized. The present state and behaviour of the shallow Earth system is a consequence of processes operating on a wide range of time and spatial scales. Time-varying phenomena include long-term tectonic controls on subsidence, glaciation, uplift and river systems, residual isostatic effects of the ice ages on crustal movements, stress accumulation and release at intraplate boundaries, natural climatic and environmental changes from the distant past to the present, and the powerful short-term anthropogenic impact of the last century. The key spatial dimensions vary from continental-scale mantle convection cells and plumes through regional-scale variations in lithospheric structure and glacial rebound to local-scale coastal erosion and changes to rivers, streams and groundwater. To trace, quantify and forecast topography evolution in response to solid-earth processes and movements of water and air, it is essential that researchers proficient in a wide range of sub-disciplines interact and collaborate. TOPO-EUROPE will link the results of various geomorphological, geological, petrologic, tectonic, geochemical, geochronological, geophysical, hydrological, geodetic, remote sensing and geotechnical investigations both in the field and laboratory. Such an integrated interdisciplinary approach has yet to be achieved on a truly European scale. Researchers in various organisations (e.g. universities, government laboratories, geological surveys) in distinct scientific fields will join forces to implement innovative research strategies that lead to an improved understanding of Europe's dynamic topography and enhanced forecasting capabilities. Activities will be directed to such sensitive areas as onshore and offshore continental margins, densely populated lowlands including flood-prone coastal areas and subsiding deltas, mountain ranges susceptible to landslides and rockfalls, active volcanoes, tectonic features prone to earthquakes and intra-plate basins that may contain hydrocarbon occurrences. TOPO-EUROPE will be linked via its members to a series of programs that focus on diverse aspects of topographic evolution. An important goal will be to simulate the recent past by "inverting" geodata and forecast the future by connecting the past, present and future evolution of the solid-earth system.

*GENERAL COMMENTS:* The oral presentations were top-level scientific quality with a significant impact on the





audience.

### **EUR-18 Palaeogeographic and palaeotectonic development of the Mediterranean and Middle East regions**

*CONVENERS:* William Cavazza, University of Bologna, Italy; Laurent Jolivet, Université Pierre et Marie Curie, Paris, France; Alastair H. F. Robertson, University of Edinburgh, UK

*NUMBER OF PRESENTATIONS:* 21 oral, 13 poster

*SYMPOSIUM SUMMARY:* In recent years the Mediterranean and Middle Eastern regions have become increasingly important to both the academic and industrial communities, and have provided geological interpretations and models that are widely applicable. These regions provide excellent examples of a wide range of palaeogeographic and palaeotectonic settings including rifting, sea-floor spreading, subduction/accretion, collisional and post-collisional (i.e. 'neotectonic') processes. This is also one of the most intensely studied orogenic domains where active tectonics, finite deformation, mantle structure and paleoenvironmental topics can be integrated in consistent models. The present array of interconnected orogens results from a long history of tectonic events spanning Late Precambrian to Quaternary time; these require to be disentangled and restored to their pre-deformation states as far as possible. Until recently the Mediterranean and Middle East regions have tended to be discussed and interpreted separately although they have many features in common (e.g. Cadomian, Variscan and Alpine-age orogenic events) and now need to be considered together.

During the symposium new data and interpretations of Mediterranean/Middle East geological and geophysical settings and processes were presented, with emphasis on multidisciplinary syntheses of broad regions. Talks of particular relevance concerned among others the first presentation of a new set of paleogeographic maps of the Middle-East region produced by the MEBE Project, a consortium of academic institutions and petroleum industries.

*GENERAL COMMENTS:* The overall quality of presentations was good, with a number of outstanding presentations made by top-notch geoscientists. In spite of the high quality of presentations, attendance was rather disappointing, ranging between 20 (early in the morning) and 50 (later in the day). Notwithstanding the relatively minor attendance, the audience contributed actively to the lively discussions, and the chairpersons had to systematically enforce respect of the schedule.

*ANNOUNCEMENTS:* The conveners would like to draw attention to the coming international symposium on the "Geology of the Black Sea region" (Ankara, Turkey, 5-9th October 2009). The aim of the symposium is to present and discuss new data and ideas on the geological evolution of the circum-Black Sea region. The symposium is organized jointly by the Geological Survey of Turkey (General Directorate of Mineral Research & Exploration - MTA) and the Chamber of Geological Engineers (the acting Geological Society of Turkey JMO). It will take place

in the MTA campus and will be preceded and followed by field trips to the Black Sea region.

## **OCEANIA**

## **OC**

### **OCE-01 Oceania and the 34th IGC in Brisbane**

*CONVENERS:* Neil Williams, Geoscience Australia, Australia; Ian Lambert, Geoscience Australia, Australia; Desmond Darby, GNS Science, New Zealand

*NUMBER OF PRESENTATIONS:* 21 oral

*SYMPOSIUM SUMMARY:* The Oceania Symposium provided a sense of what to expect in Brisbane at the 34th IGC in 2012. A diversity of topics was presented in four sessions covering: geological evolution; geohazards; geoenery; and mineral exploration. Within these broad categories the sub themes of infrastructure, major policy decisions, investment, mineral and energy resources, regolith, climate change, marine zones, natural resource management and geoscience information management were discussed. The Oceania Symposium provided an excellent opportunity for leading Australian and New Zealand scientists to exchange ideas and debate geoscience issues.

*GENERAL COMMENTS:* The overall quality of presentations was excellent, with a number of lively questions and sessions following the presentations. There was a significant technical (audiovisual) issue in the early afternoon session. This issue resulted in an unscheduled break at 2.30pm and the scheduled speaker having to delay delivery of the 2.30pm paper to 3.30pm, when the coffee break was scheduled.

The attendance by delegates from the Oceania region was good, but the number of other delegates attending was less than expected, particularly in the early morning session. We feel the newly introduced theme-of-the-day symposia were a more successful innovation and these, along with some major disciplinary symposia, attracted audiences away from the regional symposia.

Based on this experience, the 34th IGC Organising Committee is unlikely to have regional symposia, but we are planning to feature themes of the day (which were also a success at the Australian Earth Sciences Convention in July 2008).

## **WORLD MAPS**

## **WM**

Coordinated by Jean-Paul Cadet, Philippe Rossi

### **WMA-02 OneGeology-Transparent Earth**

*CONVENERS:* Ian Jackson, British Geological Survey, UK; John Broome, Harvey Thorleifson, Jean-Paul Cadet

*SYMPOSIUM SUMMARY:* Following the formal launch of OneGeology and its portal by Simon Winchester prior to the 33rd IGC Opening Ceremony on 6 August and an earlier press conference to announce the initiative to the



media, a full day symposium was held on the project. The oral session was well attended and began with an opening presentation, "OneGeology - from concept to reality". This set the context for the project and the day. It was immediately followed by a series of presentations on the technical and business aspects which provided details of the informatics technology behind OneGeology and also the less tangible cultural, organisational and intellectual property rights issues. A number of talks followed which illustrated how different nations and regions had developed their contribution. These included: Sweden and the Fennoscandian Shield; Italy; USA; Ireland; Iran; Chile; and South East Asia. The Commission for the Geological Map of the World, together with the German-led IGME5000 project looked at the scientific contribution and issues relating to small scale regional and global maps. The final oral presentations explored how OneGeology may catalyse or develop possible future high resolution applications for society. The oral session concluded with a discussion session. The poster session included posters on the

Quaternary aspects and 1:1 million mapping in Columbia and China.

In addition to this specific symposium a number of related OneGeology events were held at the 33rd IGC; these included an Open House where more detailed technical information was available and a stand within the exhibition. Different aspects of the OneGeology project were also covered by presentations in other symposia (CGMW and Geo-information). Finally OneGeology took the opportunity to hold three meetings/workshops at the 33rd IGC - an Operational Management meeting; a Technical Workshop; and a Steering Group meeting.

*GENERAL COMMENTS:* The 33rd IGC in Oslo was a landmark for OneGeology. The 33rd IGC provided a superb venue and platform to present the project to the world. We now look forward to building on a successful launch that could not have been bettered.



## DISCIPLINARY SYMPOSIA (GENERAL)

The Disciplinary Symposia covered all the main Geoscience disciplines (about fifty), which were coordinated by colleagues who were also convening a "General Contributions" symposium for their discipline. The Disciplinary Symposia are organized here in related groups to allow easy navigation within the program.

### BIOGEOSCIENCE

### BGB

#### BGB-01 General contributions to biogeoscience

*CONVENERS:* Bjarte Hannisdal, University of Bergen, Norway; Nicola McLoughlin, University of Bergen, Norway

*NUMBER OF PRESENTATIONS:* 9 oral, 8 poster, 2 no-shows

*SYMPOSIUM SUMMARY:* The interaction of biological and geological processes is at the heart of Earth System Science. Such interactions occur at a range of scales, from microbial cells in pore fluids to global biogeochemical cycles, and from metabolic reaction kinetics to the co-evolution of life and our planet over billions of years. This was an eclectic symposium with a broad spectrum of contributions ranging from planetary thermodynamics to modern microbial mats and arctic biogeochemistry. Participants came from seven different countries, and the average size of the audience was about 25. A highlight of the session was the invited keynotes, which were broad ranging and accessible. Brief discussions took place during the oral session, and more extensive discussions were had during the poster session.

*GENERAL COMMENTS:* There were discrepancies between the web and published programme, which in addition to two no-shows disrupted the continuity of the session. Although individual talks were of high quality, the broad range of topics made it difficult to maintain a thread throughout the session.

#### BGB-02 Geomicrobiology: Low-temperature alteration, mineralization, and microbial interactions

*CONVENERS:* Ingunn H. Thorseth, University of Bergen, Norway; Crispin Little, University of Leeds, UK

*NUMBER OF PRESENTATIONS:* 12 oral, 10 poster, 2 no-shows

*SYMPOSIUM SUMMARY:* The importance of microorganisms in many surface and subsurface geochemical processes (e.g. rock weathering, diagenesis, hydrothermal activity) is widely recognized. However, further extensive interdisciplinary research effort is required to fully explore and evaluate these processes. The objective of this session was to present the latest results and approaches in linking water-rock geochemical reactions and microbial processes. Contributions ranged from field studies of different environments (subaeric, freshwater, marine) to laboratory experiments and

modeling.

#### BGB-03 Life of the early Earth

*CONVENERS:* Harald Furnes, Maarten de Wit, Minik Rosing

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* When and how microbial life first appeared on planet Earth and the consequences for rock-water chemical exchange are the subjects of heated scientific debates. How do we recognize the traces of early life in various rock types, and how far back in time can these be reliably traced? In this session we particularly welcome contributions that focus on these questions. Key topics might include: early Archean biosphere, meta-volcanic rocks, meta-sedimentary rocks, geochemical cycles and astrobiology.

### CLIMATE, GLACIOLOGY

### CG

### CLIMATE CHANGE

### CGC

#### CGC-01 General contributions to climate change

*CONVENERS:* Barbara Wohlfarth, Jörn Thiede, Ted Moore

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* When Vladimir Köppen and Alfred Wegener published on paleoclimates of the geological past in the early years of the last century they understood that global climate is controlled by endogene as well as exogene processes. They believed in long-term and slow climate change. Our modern comprehension of the climate system is that of fast and dramatic changes. The alarming news of the destruction of permafrost landscapes, shrinkage of the Arctic sea ice cover as well as of the Greenland ice sheet, growth of the desert regions, increasing numbers of catastrophic extreme weather events and the increasing temperatures make us wonder what all of this will mean for the world. It may be that the times of extreme warmth during the early Paleogene and Cretaceous can serve as analogs for what our future holds. Times with relatively high atmospheric greenhouse gases appear to be associated with minimal ice on land and high sea levels. There is also evidence that the polar regions were quite warm and supported life forms more typical of temperate and subtropical zones. "Ice ages" have occurred repeatedly on Earth for billions of years. New coring records demonstrate that, in the course of the Early Tertiary, Antarctica and the Arctic had cooled enough to acquire their first ice covers. The Pleistocene ice cores from Greenland have recorded fast and dramatic changes of the atmospheric circulation whose imprints have also been



traced in paleoclimate records from lower latitudes. Only the ongoing warm climatic phase (the Holocene) seems to have been relatively stable allowing the evolution of the highly industrialized modern societies. Modelling the global climate for the future suggests that the impact of man on the climate system will increase with time. Hence questions are asked about what is in store in the future for planet Earth and its inhabitants.

### **CGC-03 Solar drivers of climate change and the stratigraphic record**

*CONVENERS:* R.M. Carter, James Cook University, Townsville, Qld., Australia; W. Soon, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA

*NUMBER OF PRESENTATIONS:* 13 oral, 2 poster

*SYMPOSIUM SUMMARY:* The sun is the primary source of the energy that drives Earth's climate. Direct climate mechanisms involve changes in insolation owing to intrinsic solar variability, and Sun-Earth orbital variations. Indirect mechanisms may amplify the solar influence on climate, such as the inhibition of incoming cosmic ray flux (CRF) during periods of enhanced solar wind - with concomitant reduction in cloud condensation nuclei, fewer clouds and climatic warming. Changes in solar wind and CRF also affect the production of cosmogenic isotopes such as  $^{10}\text{Be}$  and  $^{14}\text{C}$  in the upper atmosphere and  $^{41}\text{Ti}$  in dated meteorites. A pre-observational record of cosmogenic isotopes is available from measurements made across growth rings (e.g. trees, speleothems), or in ice and sediment cores. That solar mechanisms influence Earth's climate is not in doubt. But the precise physical pathways, actual magnitude and periodicity of solar influence, and the nature and fidelity of the solar stratigraphic record, remain the subject of vigorous discussion and current research.

Willie Soon outlined a new Solar-Arctic climate connection mechanism that operates on timescales of several decades to centuries, involving solar irradiance variability, atmospheric heat transport from tropic-to-Arctic, Arctic temperature change itself, and the related linkages among the Arctic sea ice and transports of freshwater to deep water formation sites in the North Atlantic. Henrik Svensmark showed how connections between short-term charged-particle events with water vapor content and aerosol visibility functions add further support to the possibility that high-energy cosmic rays may be associated with the cloud formation processes on Earth. Augusto Mangini and Ian Graham each described new evidence for using  $^{10}\text{Be}$  isotopes as the proxy of cosmic rays, and both expressed caution that we need to more fully understand the nature of these records before rushing to link them to variability of cosmic rays and climate itself. Jan Veizer detailed a 15-year-long record of careful research that points to the strong biological control of water vapor fluxes and carbon dioxide from within a hydrology-controlled framework of climate system. Veizer confirmed that  $\text{CO}_2$  is simply a "very little wheel" in the climate system when compared to the "very big wheel" of water vapor fluxes.

Charles Perry and Robert Baker each explained research that supports a sun-climate connection. Perry re-

emphasized the role of geomagnetic activity and cosmic rays, and Baker presented a theoretical model that connects inter-variability from a solar rotation period of 27 days to the sunspot cycles of 11 years and longer timescales. Both Don Easterbrook and Wibjörn Karlén emphasized the role of large-amplitude variability of the ocean-atmosphere that seems to be rather persistent on timescales of several decades to century. Other speakers also contributed in clarifying the relatively smaller role of  $\text{CO}_2$  forcing on the climate when compared to the large role of oceanic circulation. Liu, Wang and Soon showed how the global monsoon index can be forced to vary in a persistent manner on timescales of 100 and 200 years.

*GENERAL COMMENTS:* This symposium aroused considerable interest, and was well attended by an audience of 80-120 persons throughout, including some senior scientists who participate in the IPCC process. In discussion at the session's end, Charles Hall complained that IPCC representatives had not been invited to present their conclusions that solar forcing cannot explain the climate changes that have been observed over the last 50 years. Conveners Carter and Soon, in reply, explained that the session had been completely open to all scientific contributions.

### **CGC-04 Neoproterozoic ice ages: Quo vadis?**

*CONVENERS:* Graham Shields, University College London, UK; Emmanuelle Arnaud, University of Guelph, Canada; Galen Halverson, University of Adelaide, Australia

*NUMBER OF PRESENTATIONS:* 15 oral, 7 poster

*SYMPOSIUM SUMMARY:* Considerable progress has been made in our understanding of Neoproterozoic climate change over the past decade. However, despite this concerted international and multidisciplinary effort, the scientific community is yet to reach consensus over the number, severity and impact of these ice ages, which form the conceptual basis for the Cryogenian Period of Earth history. The climate change debate has polarized Neoproterozoic researchers into seemingly entrenched camps for and against global glaciation, but detailed regional as well as global synthetic studies are still lacking. IGCP 512 was set up to help remedy this lack, and synthesise new and existing data from around the world. In that spirit, interdisciplinary contributions touching on climate change and Earth System evolution in general during the Neoproterozoic were presented at the IGC. Unresolved questions that were addressed included: What is the sedimentological evidence for glaciation in the Neoproterozoic? How can we distinguish glacioterrestrial from glaciomarine strata? Can we recognise glacio-eustasy and glacio-isostasy in Neoproterozoic sequences? How do major carbon isotope fluctuations relate to sea level changes? How many distinct glacial episodes occurred? How long did glaciation and deglaciation last? What was the global areal extent of ice cover? What was the impact of glaciation on biological evolution? What was the Earth System context in which this Cryogenian cold episode occurred? Were glaciations triggered by tectonic events? These and other similar questions, although difficult to resolve, have acted to dynamise research into this key



interval.

*GENERAL COMMENTS:* Attendance was high during the first half day, but two of the speakers were held up and arrived too late to give their talks which was a great shame. On the second day there were several clashes between similar sessions, making attendance disappointingly low. Discussion ranged from lively to zero depending on available time.

*ANNOUNCEMENTS:* The results presented at this symposium will help towards a global synthesis of Neoproterozoic climate change and will be published in a forthcoming book published by the Geological Society of London (ed. E. Arnaud).

### **CGC-05 Fennoscandian uplift and global sea level changes**

*CONVENERS:* Lawrence Cathles, Cornell University, NY, USA; Willy Fjeldskaar, IRIS/UiS, Stavanger, Norway; Arto Miettinen, Norwegian Polar Institute, Norway; Nils-Axel Mörner, Paleogeophysics & Geodynamics, Sweden

*NUMBER OF PRESENTATIONS:* 15 oral, 6 poster

*SYMPOSIUM SUMMARY:* This symposium was a joint set-up of EGU-16 and CGC-05 under the title "Fennoscandian uplift and global sea level changes". The symposium highlighted partly modern observational data and their implications with respect to the mode of uplift of Fennoscandia and surrounding areas, and partly global sea level changes in view of different driving forces and on-going discussions. The discussions were lively and constructive. It seems we agreed upon two important facts, viz. (1) the Fennoscandian uplift is more complicated than often assumed, and (2) the fear of an ongoing sea level flooding seems exaggerated.

*GENERAL COMMENTS:* Invited talks were given by D. Ottesen (Norway) and S. Uscinowicz (Poland). Main introductions on the Fennoscandian Uplift was given by N.-A. Mörner, and on Global Sea Level by W. Fjeldskaar. The symposium was attended by some 30 persons.

*ANNOUNCEMENTS:* Excursion 11 was held in direct relation to this symposium.

### **CGC-08 Reconstruction of past climates based on combinations of microfossil records**

*CONVENERS:* Sheila Hicks, University of Oulu, Finland; Lena Barnekow, Lund University, Sweden

*NUMBER OF PRESENTATIONS:* 8 oral, 7 poster

*SYMPOSIUM SUMMARY:* A good understanding of the range of variation in past climates is essential for making informed predictions of future climate change. Microfossils (from peat, lake sediment and ice cores) have traditionally provided a means of tracking climate variation, but the accuracy depends on the time resolution and upon whether it is possible to provide quantitative or only qualitative results. Some microfossils present a good proxy for summer temperature while others reflect precipitation or some other factor. Individually each reveals a climate record, whether it be through transfer functions or through changes in the actual quantity of the proxy (accumulation rates), but when two or more proxies are combined the strength of the signal is often greatly increased. This

symposium welcomed papers presenting quantified reconstructions of any aspect of past climate where the basis for the reconstruction is the combination of two or more microfossil proxies.

The oral presentations fell into two distinct groups. Three were high temporal (near-annual) resolution reconstructions based on peat and lake deposits and focused primarily on the very recent past (late Holocene), while the remaining five presented results from marine sediments at a coarse temporal resolution and for longer periods - one reaching back to the Palaeocene-Eocene transition. The microfossil considered ranged from pollen and testate amoebae through non-pollen palynomorphs to foraminifera, calcareous nanoplankton and radiolaria. The use of modern day reference material to avoid misinterpretation of the fossil record was illustrated for all types of sediment. New developments of particular interest include the continuous near annual records from Nordic peat profiles allowing time-series analyses in terms of both temperature and precipitation, evidence of sediment changes in a Turkish lake that are due to earthquakes but could be misinterpreted as climate, the evolution of new taxa during the Holocene in the Arctic, the discovery of extremely well preserved small and fragile taxa off the east African coast and the delimitation of assemblages in high nutrient carbonate sediments, which could be misinterpreted as indicating extra tropical conditions in the fossil record.

*GENERAL COMMENTS:* The presentations were carefully prepared and extremely well illustrated. The audience was smaller than anticipated, largely because the two halves of the session were so very different from each other. The diversity of time-periods, geographical coverage and wide range of microfossils presented illustrated that, although the symposium topic was relevant for many research projects, this mixture was not so conducive to lively and detailed discussions.

### **CGC-09 Glacial-interglacial vegetation dynamics**

*CONVENERS:* Karin Helmens, Stockholm University, Sweden; Heikki Seppä, University of Helsinki, Finland

*NUMBER OF PRESENTATIONS:* 6 oral

*SYMPOSIUM SUMMARY:* Oxygen isotope records in Greenland ice core and foraminifera assemblages in North Atlantic deep-sea sediments show a higher climate variability during the Last Glacial cycle than previously inferred. According to these records, the Last Glacial cycle was characterized by frequent rapid shifts from cold stadial to warm interstadial conditions referred to as Dansgaard-Oeschger (D-O) oscillations. The session CGC-09 "Glacial-interglacial vegetation dynamics", held on Wednesday, August 13 at 08:30 - 11:00, focused on these recent advancements and on the knowledge of vegetation patterns during and response dynamics to the changing environments of the Last Glacial cycle. The session consisted of six oral presentations, with a keynote talk "Interglacial-glacial vegetation dynamics - a natural long-term ecological laboratory" by Prof. John Birks, and another 30 min. talk by Dr. Karin Helmens.

*GENERAL COMMENTS:* It was a nice, small





symposium, attended on average by 20-30 participants. Interesting discussion emerged about the interpretation of the interstadial deposits and on the palaeoclimatic interpretation of the plant macrofossils discovered from these deposits. The only negative side were the cancellations of three oral presentations during the last month.

#### **CGC-11 Lacustrine records as archives of climate change**

**CONVENER:** James T. Teller, University of Manitoba, Winnipeg, Manitoba, Canada

**NUMBER OF PRESENTATIONS:** 11 oral, 10 poster

**SYMPOSIUM SUMMARY:** The symposium was designed to have presentations on lake sediments of any geological age that contained proxy data for climate. The IGC description below accurately describes my intent for this symposium and the actual presentations at IGC. Indeed, as described, we had a wide diversity of presentations that included a wide diversity of proxies, from a number of different time periods, that spanned arctic to equatorial environments. In fact, there may have been too much diversity, and a more focussed symposium might have been better attended (e.g. focus only on Quaternary age deposits, or only on high latitude basins, or only on isotopic or biological proxies).

Modern and ancient lakes of all sizes provide one of the best archives of climate change through the biota, minerals, isotopic composition, and physical characteristics in their sediments, and are generally more responsive to short-term and low-magnitude changes than are oceans. Lake basins span arctic to equatorial environments and hyperarid to wet conditions throughout the modern world and in the geological record, with a particular abundance of records preserved during the Quaternary. Talks and posters related to lake sediments and the record of climate change proxies in them throughout the geological record will be presented, and contributions are welcome.

**GENERAL COMMENTS:** Most oral presentations were excellent, and some generated good (albeit short, given the 15 minute time slot) discussion. Attendance was highly variable, and talks after presentations that were not of widespread interest were poorly attended because people left for alternative talks in other rooms (a common problem in any meeting).

In general, I think there were too many parallel talks scheduled on similar topics at the IGC meeting. The result was that, at least in the areas of climate, geomorphology, and modern & Quaternary processes and deposits (including oceans), many sessions (not only my own) were not well attended. In short, too many sessions at the same time and too few people at the meeting to fill all lecture rooms. I think talks on similar topics should have been spread out over more days.

#### **CGC-12 The challenge of the Younger Dryas**

**CONVENERS:** Øyvind Paasche, Bjerknes Centre for Climate Research, Norway; Jostein Bakke, Department of Geography, Norway

**NUMBER OF PRESENTATIONS:** 6 oral

**SYMPOSIUM SUMMARY:** The Younger Dryas cooling, lasting for some 1200 years, represents a period of rapid shifts in the climate system with large-scale reorganisations of the atmospheric and ocean circulation patterns. The sudden reversal towards a cooler climate, starting around 12 900 cal yrs BP and ending abruptly at 11 700 cal yrs BP, is associated with marked changes in the major components of the North Atlantic climate system such as a major expansion of the winter sea ice margin, a significantly altered hydrological cycle, an enhanced seasonality gradient and a reduction of the Atlantic Meridional Overturning Circulation (AMOC).

The main motivation for holding this session was that although the Younger Dryas has been intensely studied in many parts of the world and explored in model simulations, a consensus on how the event was triggered, stabilized, and ended is yet to be reached - in part because records capturing key locations and processes are either equivocal or not available.

It was our understanding that the timing for this session was ideal given the fact that the numbers of well-dated proxy records capturing the Younger Dryas interval in both hemispheres have increased rapidly in recent years. New datasets from the Alps, Western Norway and Great Britain underscored this improvement by showing glacier records with exceptionally robust chronologies. The climate linkages between the Southern and the Northern hemisphere during the Younger Dryas were discussed as well as potential forcing mechanisms. The question of synchronicity across large geographical areas was raised by several of the presentations.

**GENERAL COMMENTS:** The presentations were of high quality and data was presented from both the Northern and the Southern Hemisphere, covering land as well as the ocean. Several of the contributions were related to glacier systems. 50-70 people participated in the session and there were questions for all talks.

**ANNOUNCEMENTS:** A related future session will be held at the upcoming European Geophysical Union (EGU) meeting in Vienna next year (2009). The title is: "Holocene Global Climate Modes or Not?"

#### **CGC-13 Fjords: climate and environmental change**

**CONVENERS:** Matthias Paetzel, Sogn og Fjordane University College, Norway; Matthias Forwick, University of Tromsø, Norway; Tore Vorren, University of Tromsø, Norway; Ross Powell, Northern Illinois University, USA

**NUMBER OF PRESENTATIONS:** 7 oral, 8 poster (incl. a 5 minute oral presentation for the audience), 1 no-show (poster)

**SYMPOSIUM SUMMARY:** Fjord scientists cover a wide range of environmental, climate and marine research. Due to this variety they usually have to split up their presentations into various science categories. The 33IGC was one of the very few occasions where all fjord science was grouped into one fjord symposium. The symposium showed research from glaciated and non-glaciated fjord settings. Basis for all presentations was the excellent seasonal to millennial resolution at which sedimentary and geomorphologic processes can be studied. The



presentations covered Arctic (Svalbard), European (Norway, Scotland), North American and Antarctic settings. Scientifically they ranged from environmental change and pollution via climate change to sedimentology, geochemistry and fjord formation, spanning over a time scale from Present, Holocene and Quaternary back to the Jurassic. Discussions mostly focused on the interpretation of seismic records and sediment related issues. Due to the wide spectrum of the presented research it is difficult to draw a detailed conclusion. However, it is obvious that high resolution results can be gained from Cenozoic to Recent fjord settings compared to the rather low resolution records from open ocean marine settings.

**GENERAL COMMENTS:** The quality of oral and poster presentations was high and all was presented in an easily understandable manner, keeping the allocated time. Between 50 and 100 persons were attending the symposium, which is regarded as a high number taking into account the relative low number of presentations. Discussions were lively when time allowed; most of them needed to be interrupted and were continued during the break, after the symposium or at the poster session. At the end of the symposium, time was used to discuss the possible publication of the presentations and future meetings. The conveners of the CGC-13 consider the symposium as having been a success.

**ANNOUNCEMENTS:** The presented papers are invited to be published within a London Geological Society Special Publication on "Fjordic Depositional Systems and Archives" by the end of 2009. Main editor is John Howe with William Austin and the CGC-13 conveners Matthias Paetzel, Matthias Forwick and Ross Powell as co-editors. The symposium will be followed up by the 2nd International Workshop on 'Fjord environments: past, present and future', to take place in Bergen, Norway, 6-8 May 2009. The group will also try to organize regular scientific fjord meetings on a biannual basis, most probably alternating between the EUG and the AGU meetings.

## GLACIOLOGY AND GLACIAL GEOLOGY CGG

### CGG-01 General contributions to glaciology and glacial geology

**CONVENERS:** Per Holmlund, Stockholm University, Sweden; Jon Ove Hagen, University of Oslo, Norway; Hans Oerlemans, University of Utrecht, Netherlands; Julian Dowdeswell, Scott Polar Institute, UK; Helgi Björnsson, University of Reykjavik, Iceland

**NUMBER OF PRESENTATIONS:** 10 oral, 13 poster

**SYMPOSIUM SUMMARY:** The announced plan included four different sub-sessions aiming to attract scientists from different research communities. The first one was "Land ice, sea level and global warming". It is inevitable to touch on global warming issues when discussing past and future changes in the extent of glaciers and ice sheets, and we had four oral and one poster presentation on this issue.

The second sub-session concerned "Dynamic variability of outlet glaciers: modern observations and inferences from the geological record". It was originally planned as two sessions differentiating between glaciers and ice sheets, but the glacier part was covered by other meetings run close in time so these sessions were combined. The argument for separating them is that the scientific tasks of concern differs in relation to the scale of the ice, but as the planning developed the interest was focused on outlet glaciers and ice sheets. On the symposium we had two oral and six poster presentations on these issues.

The third sub-session concerned "Evolution and dynamics of glacier lakes: water flow beneath and past ice sheets". The session covered thus both present subglacial lakes and ice dammed lakes, and geological tracers from the past. Our hope was to include some papers on the subglacial lakes of Antarctica; the physical boundaries for their existence, their hydraulic inter connections and age of the water bodies. However, as this was one of the big issues at the SCAR meeting in St Petersburg less than a month before the Geological Congress in Oslo, no such papers came to this meeting. The focus was therefore on ice dammed lakes and geological evidence, and we had three oral papers and four posters.

The fourth sub-session concerned "Geothermal heat flow and ice dynamics". This session aimed to include both volcanic influence on glaciers and ice sheets, and how differences in geothermal heat flux may influence ice sheet dynamics. This session attracted one oral and two poster papers.

The presentations were all chaired by professor Jon Ove Hagen and they were held in one session in room D2 in the Convention Hall between 08.30 and 12.00 AM. Due to the fact that the 33IGC was held between the SCAR meeting in St Petersburg (8-11/7) and the IGS meeting on glacier dynamics (17-22/8) in Limerick, Ireland, the presentations were rather few compared to the area covered.

**GENERAL COMMENTS:** The meeting presented a high standard of oral and poster presentations. The audience numbered constantly around 50 persons and the discussions were fruitful and lively. The comparatively limited number of papers presented should be seen in light of the large number of other international glaciology meetings going on both before and after the 33IGC, and results from most of the IPY-related projects were not yet ready to be presented. In view of these factors the session on glaciology and glacial geology was univocally a successful meeting.

### CGG-02 Subglacial environments: Processes, sediments, landforms, modelling and experiments

**CONVENERS:** Jan A. Piotrowski, University of Aarhus, Denmark and University of Sheffield, UK; Chris D. Clark, University of Sheffield, UK; David J.A. Evans, University of Durham, UK

**NUMBER OF PRESENTATIONS:** 19 oral, 8 poster, 1 no-show

**SYMPOSIUM SUMMARY:** Subglacial environments are fundamentally important for better understanding how past



and modern glaciers and ice sheets interact with the lithosphere, in particular how they move over hard and soft beds, transport and deform sediment, generate landforms and interact with water at the ice/bed interface. Ultimately, the nature of the subglacial environment controls the ice sheet dynamics and influences the course of glaciations, and so its importance for Earth's cold regions cannot be overestimated. Reflecting recent advances in the study of the ice/bed interface, the symposium concerned various aspects of field, laboratory, remote sensing and theoretical work devoted to the subglacial environment. Contributions were given on ice movement mechanisms including ice streaming, sediment erosion and re-distribution, origin of basal tills, formation of active-ice landforms, basal water drainage and its geomorphic impact, subglacial groundwater flow, experimental field- and laboratory studies on sediment deformation, and numerical modelling.

**GENERAL COMMENTS:** The quality of presentations was excellent and the two invited speakers did a great job to ignite lively discussions that were carried out until late during the poster session. The symposium was attended by around 60 participants including many young researchers.

**ANNOUNCEMENTS:** A special issue of *Boreas* is intended as a proceedings volume.

### **CGG-03 Debris transport and deposition by glaciers**

**CONVENERS:** Michael Hambrey, Aberystwyth University, Wales, UK; David Graham, Loughborough University, UK; Neil Glasser, Aberystwyth University, Wales, UK

**NUMBER OF PRESENTATIONS:** 10 oral, 5 poster, 3 no-shows

**SYMPOSIUM SUMMARY:** The aim of this symposium was to draw together researchers in the fields of contemporary glacial processes, glacial sedimentology, ice-sheet modellers, and Quaternary and pre-Quaternary glacial systems. Contributions addressing the following themes were particularly encouraged: contemporary glacial processes; modelling glacial depositional systems, and the sedimentary record of past glacial systems, although no talks were offered on the modelling theme. The symposium was a contribution to the Working Group Debris entrainment and transfer in glaciers of the International Association of Snow and Ice (IACS).

A wide geographical range of topics was presented - from the Polar Regions to temperate areas. Amongst these were four invited keynote presentations that were very well received: Kurt Kjaer (Denmark): Quantification of sediment transport during glacier surges and its impact on landform architecture, focusing on Iceland; Sean Fitzsimons (New Zealand): Sedimentary facies and landform formation at the margins of polar glaciers; focusing especially on the Dry Valleys of Antarctica; Julian Dowdeswell (UK): Glaciers, ice sheets and the transport and delivery of sediments to high-latitude continental margins, emphasising processes on Antarctic and Arctic continental shelves, slopes and basins; Ross Powell (USA): Importance of glacial regime and dynamics to glacial erosion and deposition: questions from the marine realm, which drew on examples from Alaska, Svalbard and

Antarctica.

From the talks presented, as well as those in complementary sessions, it is apparent that there is increasing emphasis on the links between glacier dynamics and structure, and the resulting landforms and sediments. A number of issues came to light where we still have disagreement or inadequate knowledge. These include the exact nature of subglacial processes and the use of non-genetic terms such as diamicton/diamict/diamictite; the terms used to define, and the concepts behind, the temperature characteristics of glaciers, e.g. temperate and subpolar, or warm, cold and polythermal.

**GENERAL COMMENTS:** The quality of presentations was mainly excellent, all speakers using high quality PowerPoint presentations, although the monitor in D2 caused some concern as a few talks faded off the screen temporarily, whilst one talk (my own!) was somewhere lost in the system (possibly sent to another session), which necessitated an 'off-the-cuff' presentation without visual aids. The talks were well attended, peaking at an estimated 150 people in the late morning session. The non-appearance of two speakers allowed a full and lively discussion of the keynote presentations, as well as reference to activities of the IACS Working Group. Unfortunately for some participants, the symposium clashed with another on Antarctica, which contained complementary talks.

**ANNOUNCEMENTS:** Subject to sufficient contributions, speakers were encouraged to submit papers by January for a special issue of *Boreas* in association with the Subglacial Processes symposium. This will be edited by Jan Piotrowski (Aarhus) and David Graham (Loughborough). Future meetings of the Working Group are under discussion: possibilities include the EUG in Vienna in Spring 2009, and a dedicated IAS conference on Glacial Sedimentary Processes and Products in Dunedin, New Zealand in 2010.

## **EARTH INTERIOR, EXPLORATION GEOPHYSICS EI**

### **DEEP EARTH EID**

#### **EID-01 General contributions to deep Earth**

**CONVENERS:** Hans Thybo, University of Copenhagen, Denmark; Shun-Ichiro Karato, Yale University, USA; Brian Kennett, Australia

**NUMBER OF PRESENTATIONS:** 4 poster

**SYMPOSIUM SUMMARY:** This symposium welcomed contributions based on new studies of the deep Earth by all methods. New findings are being made based on integrated studies including seismology, high pressure measurements, petrology and geochemistry as well as numerical modelling of both the propagation of seismic waves and the geochemical composition and physical state of the mantle rocks. Exciting new understanding of the processes around subduction systems are emerging as well as on plume



structures, in addition to the bottom of the mantle and the core. We invite in particular contributions that integrate several methods to the study of Deep Earth.

*GENERAL COMMENTS:* The posters were of high quality and attracted much attention.

## **EID-02 Properties and dynamics of mantle and core**

*CONVENERS:* Eiji Ohtani, Tohoku University, Sendai, Japan; Gerd Steinle-Neumann, University of Bayreuth, Germany; Bernhard Steinberger, NGU, Norway; James Connolly, ETH, Zürich, Switzerland; Shun-ichiro Karato (IMA-CMP), Yale University, New Haven, USA

*NUMBER OF PRESENTATIONS:* 9 oral

*SYMPOSIUM SUMMARY:* Presentations on multidisciplinary subjects related to mantle and core were presented, and exciting and high level discussions formed part of the sessions. The talks covered seismic structure of the mantle and core, laboratory study on high pressure mineral physics of the mantle and core materials, geodynamics and simulations on the mantle and core processes. Main topics were evolution of the core and energy source of the core, seismic structure of the inner core, post-perovskite lens at CMB, electromagnetic transitions in the lower mantle, mantle dynamics estimated from OH diffusion profiles, anelastic properties of the mantle materials, and bulk compositions and heterogeneities in the mantle.

*GENERAL COMMENTS:* About 30-40 people attended our symposium in spite of the session being scheduled for the afternoon of the first day before the opening ceremony. All of the oral presentations were of high quality and provided active and vigorous discussions on the topics of the mineral physics, geochemistry, and structure and dynamics of the mantle, CMB, and core.

*ANNOUNCEMENTS:* Similar sessions related to the deep earth mineralogy and mantle and core dynamics will be organized in the 2010 IMA general meeting in Budapest. Preliminary session titles and lists of tentative conveners are as follows: 1. Deep Earth mineralogy: Jay Bass (US), David Rubie (D), Eiji Ohtani (Jp), Guillaume Fiquet (F), Daniel Farber, Don Weidner (US), David Price (UK); 2. Physical properties and dynamics of the Mantle and core: Eiji Ohtani (Jp), Yinwei Fei (US), Denis Andrault (F); 3. Glasses and melts: from volcanic activity to industrial processes: Daniel Neuville (F), G. Henderson (US), Y. Xue (Jp); 4. Mineral spectroscopy: from laboratory to synchrotron: Georg Amthauer (A), A. Beran (A), Lutz Nasdala (D); 5. Phase transformation, Kinetics and transport properties of minerals, melts and fluids: J. Ingrin (F), D. Frost (D), T. Katsura (Jp); 6. Thermodynamics of minerals: from experiment to simulation: C.A. Geiger (D), Etienne Balan (F), Taku Tsuchiya (Jp), Gerd Steinle-Neumann (D)

## **EID-03 Deep Earth seismic tomography: Observations, models and interpretations**

*CONVENERS:* Frédéric Deschamps, Federal Institute of Technology of Zurich, Switzerland; Lapo Boschi, Federal Institute of Technology of Zurich, Switzerland; Wim Spakman, Utrecht University, Netherlands

*NUMBER OF PRESENTATIONS:* 6 oral, 4 poster

*SYMPOSIUM SUMMARY:* Seismic tomography is our most powerful tool to infer the deep mantle 3D-structure. Agreements have recently been reached on important questions, including the long-wavelength structure of shear-wave velocity anomalies and the existence of deep slabs. Other problems are still debated, in particular the nature and structure of the D" layer. Related challenges concern the mapping of small-scale structures and the estimate of model uncertainties. Beyond the mapping of seismic velocity anomalies, the goal of seismic tomography is to provide appropriate descriptions of deep Earth thermo-chemical structure, and integrate them in a consistent geodynamical model. This can be achieved through multidisciplinary approaches that link recent discoveries and advances in seismology, mineral physics, geochemistry and geodynamics. A long-debated question is the origin of seismic velocity anomalies. Mounting evidence suggests that a purely thermal origin is inappropriate to fully explain the observed anomalies. The present symposium aimed to address these questions and discuss new and recent results in seismic tomography.

Overall, this symposium fully reached its initial goals. In particular, Christine Thomas presented recent observations of reflection of seismic wave on the underside of tomographic slabs. Tarje Nissen-Meyer showed his most recent results on new tomographic method using diffracted waves. Miaki Iishi proposed some global models for the Earth structure based on the Earth free and forced oscillation. Trond Torsvik showed some updated models of Large Igneous Provinces reconstruction, and compared these locations with the distribution of large low shear-wave velocity provinces observed in the deep mantle. New shear-wave velocity models for the upper mantle were presented by C. Weidle and C. Legendre.

*GENERAL COMMENTS:* From 30 to 40 people attended the full symposium. The general level of the presentations was high, in particular from the invited speakers. Results presented during the session were new or recent. Each talk triggered some interesting questions and initiated some discussions that continued during the poster session.

## **EID-05 Mantle petrology**

*CONVENERS:* Massimo Coltorti, University of Ferrara, Italy; Marjorie Wilson, University of Leeds, UK; Michel Gregoire, Toulouse University-CNRS, France; Shoji Arai, Kanazawa University, Japan

*NUMBER OF PRESENTATIONS:* 20 oral, 9 poster, 6 no-shows

*SYMPOSIUM SUMMARY:* Although the mantle occupies more than 75% of the volume of the Earth, its composition, the processes which occur within it and its evolution over time remain matters of considerable debate. The session helped to highlight several aspects of mantle petrology. In situ Re/Os geochronology on mantle sulphide allow to determine the age of depletion events occurring within the mantle and to couple them with episodes of crustal growth. On ophiolites two groups of ages were identified supporting the idea that oceanic



mantle is not uniquely composed by young asthenospheric material. A significant part of it may be composed by subcontinental lithospheric mantle permeated by asthenospheric melts and/or by portion of recycled ultra-refractory sub-arc rocks. The role of metasomatism in re-enriching residual mantle lithologies and the different signature of fluids within intra-plate and suprasubduction settings were also highlighted. In this respect subduction is providing one of the most effective tools to modify mantle composition, recycling oceanic lithosphere down to at least the 670 km discontinuity. The session was also attempting to put together geochemical, geophysical, geochronological and computer simulation modelling in order to achieve a synergic approach to the study of the nature and evolution of the Earth's mantle.

**GENERAL COMMENTS:** Notwithstanding the less than optimal room acoustics and a few not top-quality contributions, the number of people attending the presentations was consistently quite high (from 30 up to 70). Most of the presentations stimulated a nice and fruitful discussion, and our impression was that people enjoyed the symposium and the way it was organized.

#### **EID-07 Geophysical evidence for mantle heterogeneity**

**CONVENERS:** A. Levander, Rice University, Houston, USA; H. Thybo, University of Copenhagen, Denmark; R. van der Hilst, MIT, USA

**NUMBER OF PRESENTATIONS:** 8 oral, 4 poster

**SYMPOSIUM SUMMARY:** The aim of the symposium was to bridge the gap between seismologists, geodynamicists and petrologists in their respective views of mantle heterogeneity. The symposium was very successful in this respect by having an almost equal distribution between the various subjects. The idea of having fine scale heterogeneity in the mantle is relatively new, as it has only been possible recently to detect its presence. This symposium managed to present clear evidence for the existence of such heterogeneity at fine scale and also to provide geodynamic modelling evidence for its causes.

**GENERAL COMMENTS:** The symposium was well attended with more than 100 in the audience at mid morning.

#### **EID-09 The dynamics of plumes**

**CONVENERS:** Bernhard Steinberger, Geological Survey of Norway, Trondheim, Norway; Marjorie Wilson, University of Leeds, UK; Ulrich Achauer (not present)

**NUMBER OF PRESENTATIONS:** 6 oral, 1 poster

**SYMPOSIUM SUMMARY:** This symposium brought together scientists in the field of mantle plumes research to discuss the state-of-the-art of mantle plume dynamics and their geodynamic evolution. Over the last decade seismic tomographic models as well as the geodynamic modelling techniques have greatly improved, with the resolution of the models getting better and better with increasing computer power and available data. While the new models give more realistic pictures of what plumes may look like, the question as to the origin and evolution of mantle plumes is still highly debated. The talks could be loosely

grouped into geodynamics and seismology. The geodynamics talks covered plumes from bottom to top: Judith Vatteville compared the results of numerical and laboratory models regarding the dynamics of plumes; Maxim Ballmer talked about small-scale convection beneath the lithosphere and related secondary volcanism, both caused by mantle plumes; Evgueni Burov discussed the interaction of plume heads with the continental lithosphere. The seismology talks also all emphasized geodynamic interpretation: Lapo Boschi showed that many tomography models tend to contain plume-like features, and that a geodynamic model of plumes tilted by large-scale mantle flow is significantly correlated with tomographic models; Rainer Kind showed how P and S receiver functions allow to study the deflection of the lithosphere-asthenosphere boundary and the discontinuities at 410 and 660 km depth, and what this indicates about the depth of origin and dynamics of plumes; Marjorie Wilson discussed the interpretation of tomographic images of plume-like (low-velocity) features. She suggested that many smaller plumes may be triggered by fluid release in the transition zone, rather than representing hotter temperatures.

**GENERAL COMMENTS:** As all presentations were 30 minute lectures and three of them (Vatteville, Burov, Boschi) were invited, we were given in-depth insights into some of the recent 'hot' topics of mantle plume research.

#### **EID-10 Phase transformations in the Earth's interior**

**CONVENERS:** Craig R. Bina, Northwestern University, USA; Bernard J. Wood, Oxford University, UK

**NUMBER OF PRESENTATIONS:** 11 oral, 5 poster

**SYMPOSIUM SUMMARY:** From hydration-dehydration reactions in subduction zones to subsolidus polymorphism and disproportionation in the transition zone, from electronic-spin transitions in the lower mantle to polymorphism and melting relations near the core-mantle boundary, phase transformations play a major role in the Earth's interior. We solicited contributions on the analysis of phase transformations by experiment, theory, and simulation, as well as studies of their geophysical signatures and geodynamical consequences.

The session began with discussion of apparent variations in the seismological character of mantle phase transitions. A discontinuity may generate different signals when sampled at different frequencies with different probes - including topside and bottomside P-wave interactions, SS precursors, and receiver functions - and may exhibit complexity due to superposed transitions. Furthermore, the apparent sharpness of transition zone discontinuities may depend significantly on variations in both iron and water content, with the magnitude of dependence upon iron content remaining an important topic for future work. Analyses of seismic anisotropy near the core-mantle boundary were also discussed, suggesting a medium that is transversely isotropic about a vertical axis, with SH faster than SV, consistent with lattice-preferred orientation in ppv. This picture may be complicated, however, by hints of more complex styles of anisotropy than pure vertically oriented transverse isotropy.





The next part of the session addressed issues surrounding both mantle melting and reaction kinetics. Thermodynamic calculations suggest a number of interesting effects, including the potential for silicate melt stability at the core-mantle boundary, hydrous melt stability atop the mantle transition zone, and a hotter magma ocean at depth in the primordial Earth in association with large Grüneisen parameters. Furthermore, experiments demonstrate a complex dependence of carbonate stability upon mantle oxygen fugacity, so that there may be two distinct depth regions in which carbonate-rich melts might form in the mantle, potentially separated by a zone of diamond stability.

Oxygen fugacity was also seen to be important in controlling metal segregation in intergranular melts. Kinetic studies demonstrate the importance of iron and water contents in decreasing the plausible extent of olivine metastability, and resistivity measurements indicate a Clapeyron slope of nearly zero for the post-spinel transition in magnetite while appearing to confirm sluggish kinetics in the reverse reaction.

The final portion of the session turned to perovskite-related behavior. New sintered-diamond anvil technology was applied to observe changes in Mg-Fe partitioning in pv-mw assemblages above 40 GPa, possibly associated with electronic spin transitions. The properties of ppv are seen to be significantly dependent upon pv-ppv elemental partitioning relationships. Experiments confirm a drop in bulk sound speed (to accompany a predicted increase in S-wave speed) across the pv-ppv transition, where the bulk-sound speed drop is larger by a factor of four in samples rich in ferric iron compared to ferrous systems while the density increase is larger by a factor of two.

**GENERAL COMMENTS:** Attendance was healthy but did not fill the room. Most of the audience stayed for the entire session and participated in lively discussions which consumed all of the available time and spilled over into coffee breaks.

## EXPLORATION GEOPHYSICS EIE

### EIE-01 General contributions to exploration geophysics

**CONVENERS:** Martin Landrø, Neil Williams

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** In this session we welcome exploration geophysics papers that do not fall within the themes of the other 6 symposia within this field, or papers that cover several of the more specific topics in a comprehensive way. Examples of such papers might be case studies using a variety of exploration techniques, or a paper focusing on a specific problem or challenge that might be of general interest to those attending the exploration geophysics session at the conference. Since this is a geological conference, we welcome papers combining geological methods, concepts, models and so on with

geophysical techniques. Interaction between new drilling techniques, rapid updating of the geological model and geophysical methods are other examples that certainly will be of interest for this session. Preference will be given to papers that focus on exploration for new resources that are deeply buried, or are obscured by overburden.

### EIE-02 Seismic imaging in petroleum exploration and production

**CONVENERS:** Nils Erik Bakke, StatoilHydro, Norway; Anders Sollid, StatoilHydro, Norway; Lars Sønneland, Schlumberger, Norway

**NUMBER OF PRESENTATIONS:** 7 oral, 3 poster

**SYMPOSIUM SUMMARY:** The oil industry is moving into areas with complex structural and stratigraphic traps which are difficult to image seismically. Large and easy traps still exist, but may be difficult to reach for other reasons such as political or environmental. Seismic imaging below heterogeneous overburdens - e.g. salt and basalts - is important both in exploration, development and production phases. More than 60% of the remaining hydrocarbon reserves are expected to be trapped in carbonate reservoirs. Imaging of these reservoirs are still a challenge in particular with respect to their fault - and fracture - systems. Understanding of the reservoirs and traps for optimal positioning of potentially extremely expensive wells will in many cases be crucial for a project. Best images are probably obtained when advanced geophysical and geological knowledge are tightly linked all the way from seismic acquisition and processing to geologic interpretation. The most advanced seismic migration algorithms require a detailed velocity model which is probably best generated through an iterative process between the seismic processors and the geologists. Even if this may sound as a cumbersome way of working, the quality of the end product will be better.

**GENERAL COMMENTS:** The overall quality of the presentations was very high with a wide range from more geological to more geophysical and applied papers. The number of people attending the session was about 50, which I think is good for a geophysical session on a more geological oriented conference. The discussions were good taking into account the limited amount of time between the talks.

### EIE-05 Electromagnetic petroleum exploration

**CONVENERS:** Ståle Johansen, Laust B. Pedersen

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** Full scale trials offshore Angola by Statoil and later by Exxon Mobil showed that CSEM surveys successfully detected resistivity anomalies associated with previously defined drilling targets. CSEM data is now commercially available for the exploration industry and acquisition, processing and interpretation services are offered by several companies. The main advantage of marine CSEM is that it provides new information about the subsurface independent from reflection seismic, but the robustness of the interpretation is enhanced by integration with other geophysical and



geological information. When the results from marine CSEM surveys have been compared with 3D modelling based on well data it has been demonstrated that the structures predicted from the measurements are correct. Additional constraints on Earth structure can be obtained by the simultaneous acquisition of MagnetoTelluric (MT) data on the sea bottom. However, remote sensing of subsurface resistivity variations is not a 'magic bullet' for hydrocarbon identification. This is due to the fact that low permeability lithologies, such as e.g. evaporites, volcanics and tight carbonates, often exhibit enhanced electrical resistivity without containing hydrocarbons. The key to success is effective integration of geophysical and geological data and knowledge. The presentations in this session should cover this integrated workflow where geophysics and geology have been used together to optimize the interpretation of CSEM/MT results. Submitted papers emphasizing only parts of the workflow are also welcome. We encourage the presenters to include field examples in their contributions.

#### **EIE-06 Time lapse seismic: Monitoring fluid, stress and compaction changes**

*CONVENERS:* Martin Landrø, NTNU, Norway; Per Avseth, Odin Petroleum, Norway

*NUMBER OF PRESENTATIONS:* 5 oral

*SYMPOSIUM SUMMARY:* In this symposium we will focus on the present use of time lapse seismic data as a reservoir management tool. Despite a large number of successful 4D case histories, there are few examples demonstrating that we are able to follow fluid fronts in heterogeneous and clay-rich reservoir units. Monitoring of reservoir and overburden stress changes during production is still premature, and rapidly evolving. Using repeated seismic data to map how the reservoir compacts during production, and the associated movement of the overburden rocks is another topical field that is rapidly evolving. This symposium will welcome scientific contributions within the following topics: Case examples showing how time lapse seismic data is used for infill drilling; New methods within seismic monitoring; Combined use of fluid flow simulations, geomodels and 4D seismic; Examples of 4D mapping of reservoir compaction and overburden changes; Innovative ways of combining various monitoring techniques with 4D seismic; Examples of using 4D seismic in carbonate rocks; Rock physics measurements of fluid, stress and compaction changes within various rock samples; How to combine geomechanics and 4D seismic.

*GENERAL COMMENTS:* Most of the themes listed above were indeed covered by the presenters, and the attendance was good, ranging from 25-30 to a maximum of 60-70. Especially the second keynote on geophysical monitoring of CO<sub>2</sub> storage was well attended, and the quality of this presentation was also very good.

#### **EIE-07 High-resolution geophysical imaging of geological structures and processes in environmental studies**

*CONVENERS:* Alan Green, ETH Zurich, Switzerland;

Lars Nielsen, University of Copenhagen, Denmark; Christopher Juhlin, Uppsala University, Sweden

*NUMBER OF PRESENTATIONS:* 16 oral, 8 poster, 1 no-show

*SYMPOSIUM SUMMARY:* A wide variety of innovative high-resolution geophysical techniques for investigating diverse environmental, geological, hydrogeological and engineering problems have been introduced or substantially improved over the past two decades. These techniques include the seismic reflection and ground-penetrating radar (GPR or georadar) imaging methods as well as the tomographic seismic refraction, potential-field, geoelectric, electromagnetic, self-potential and surface nuclear magnetic resonance (SNMR) methods. They are capable of providing high-resolution three-dimensional information on a broad range of critical physical properties. Moreover, the multichannel surface-wave technique supplies estimates of the shear modulus, an important parameter for many engineering and environmental studies. This symposium included invited (8) and submitted papers (16) concerned with (i) the development of new geophysical imaging and tomographic methods and (ii) the novel application of geophysical imaging and tomographic methods.

*GENERAL COMMENTS:* The oral session ran from 8:30 to 17:30, with an initial attendance of about 20 increasing to about 35 by noon. This number stayed almost constant until the end of the session. Although attendance was less than expected, there was great interest in the presentations based on the numerous questions from the audience after most talks. The presented talks and posters showed that high resolution geophysics is a rapidly developing field.

*ANNOUNCEMENTS:* A program is underway to publish some of the presentations in a special issue of the Journal of Applied Geophysics. Submission deadline is 1 December and the goal is to have all reviews completed by April 2009, with the issue in print mid- to late-2009.

### **GEOMAGNETISM**

### **EIG**

#### **EIG-02 Geological sources of global magnetic anomalies as interpreted from World Digital Magnetic Anomaly Map (WDMAM)**

*CONVENERS:* Juha V. Korhonen, GTK, Finland; Colin Reeves, Earthworks, Netherlands; Dhananjay Ravat, University of Kentucky, USA

*NUMBER OF PRESENTATIONS:* 10 oral, 7 poster

*SYMPOSIUM SUMMARY:* World Magnetic Anomaly Map: Yoann Quesnel reported a major activity to correct and compile oceanic magnetic anomaly data. The team made GEODAS data set (1960-2002, c. 2000 cruises, 20 million data records) more reliable in a global sense and detected new anomalies due to achieved lower noise level. Tamara Litvinova reported an extensive variety of sources of Russian magnetic continental anomalies, including spatially exceptionally wide (e.g. Siberian) and by intensity strong (e.g. Kursk) anomalies. Richard Saltus outlined 21 Arctic geological provinces based on CAMP-GM magnetic



and gravity anomalies and WDMAM2007 data set north of 60°N. Jointly with other geo-data sets these data may be used to compile tectonic reconstructions and estimate mineral and energy resource potential of the Arctic. Colin Reeves gave an overview of magnetic anomalies in global geological interpretation. Magnetic anomalies should be transformed to magnetic susceptibility that is not sensitive for variations of the inducing field. Magnetic susceptibilities of Gondwana reconstruction were presented. Juha V. Korhonen reported WDMAM2007 and -2008. The 2008 version will be in 1:25 million scale, include recently corrected oceanic and polar data, new continental data, and a new satellite anomaly model. The problem remains that the near-surface and satellite anomalies correlate incompletely,  $r=0.7$  at best when continued to the same altitude.

**General Geomagnetism and Palaeomagnetism:** Crisan Demetrescu based his analysis on 100-150 years geomagnetic records and suggested that the geomagnetic jerks are a result of the superposition of the 11-year external contribution on the 22- and the 80-year variations. Sergey Filippov reported that the speed of decrease of the central magnetic dipole of the Earth may be as low as 5 nT/yr. This is c. three times smaller to the values indicated by the IGRF models. The used technique accounted for wave and corpuscular radiations of the Sun, and may be applied to improve the IGRF models. Tianshui Yang reported that multiple rapid polarity swings (at least 15 in number) during the Matuyama-Brunhes (M-B) combined with their lengths indicate that the transition may have lasted considerably longer than previously thought. Xiuming Liu showed by examples from Alaska and Siberia that the commonly made assumption of increasing magnetic susceptibility of Chinese loess due to pedogenic evolution may fail because of variation of reducing and oxidizing conditions after deposition.

**GENERAL COMMENTS:** The presentations were of high quality. All papers were discussed and a supplementary discussion (30 minutes) was held. About 60 people attended at most.

**ANNOUNCEMENTS:** Next major session of WDMAM will be held at IAGA2009, in Sopron, Hungary (methods), and the following session is planned at IUGG2011, Melbourne, Australia (new regional data sets). Please see the WDMAM home page <http://projects.gtk.fi/WDMAM/>

## LITHOSPHERE EIL

### EIL-01 General contributions to the lithosphere

**CONVENERS:** Irina M. Artemieva, University of Copenhagen, Denmark; Sierd Cloetingh, Vrije University, Netherlands; Alan Levander, Rice University, USA

**NUMBER OF PRESENTATIONS:** 11 oral, 26 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** This symposium was formed by contributions on the structure of continental and oceanic lithospheres based on studies from geophysics,

tectonics, geochemistry, petrology, geochronology, numerical simulations and laboratory measurements. Special focus was on contributions from interdisciplinary studies that integrated several methods in lithosphere research.

**GENERAL COMMENTS:** Attended by up to 50 people.

### EIL-03 The lithosphere-asthenosphere boundary: Nature, formation and evolution from Hadean to now

**CONVENERS:** Suzanne Y. O'Reilly, Macquarie University, Australia; Juan Carlos Afonso, Institute of Earth Sciences "J. Almera", Spain; Suzan van der Lee, Northwestern University, USA

**NUMBER OF PRESENTATIONS:** 16 oral

**SYMPOSIUM SUMMARY:** The nature of the Lithosphere-Asthenosphere boundary is critical to our understanding of the geodynamic and geochemical evolution of Earth, yet its definition is still controversial. Advances in seismic tomography and potential-field analysis are providing imagery of the present-day subcontinental lithosphere, to depths of several hundred kilometers (and beyond). Seismic discontinuity studies increasingly address the sharpness, velocity jump, depth and nature of the lithosphere-asthenosphere boundary. Geochemical analysis of xenolithic material from the upper mantle and lower crust is providing increasingly sophisticated data on the compositional and thermal structure of this lithosphere, as sampled by volcanic eruptions through time. The geochemistry of primitive magmas tells about the changing composition, temperature and thus rheological behaviour of the convecting mantle. Numerical modelling of dynamic processes in the Earth can investigate how the lithosphere and underlying mantle have behaved through time in response to changing thermal and tectonic regimes. In this symposium we brought together experts in all these disciplines, in an attempt to integrate the different types of data, and to discuss the constraints that help us elucidate the character and location of the Lithosphere-Asthenosphere in the present-day and older Earth.

The session had a very interdisciplinary focus, and brought together frontline research from all the sub-disciplines mentioned above. This allowed in-depth exploration of the concepts of the lithosphere-asthenosphere boundary from different perspectives, highlighted many gaps in our current knowledge, and provided directions for new, integrated research strategies.

**GENERAL COMMENTS:** Most of the presentations were invited. The convener and two co-conveners targeted researchers at the frontline in these subject areas and gave some guidelines about the focus of their presentations. There were two keynote speakers representing experienced researchers renowned for different strands of the subjects to be covered. Other invited speakers ranged from early-career to mid-career to more senior researchers and represented 12 different countries. The most represented country was China with three early-career (women) geophysicists. The gender balance was: 8 women and 8 men as first authors and presenters. The overall quality of presentation was excellent.



The session had 80 to 100 people attending during the whole day and most of the presenters and co-authors stayed with the whole session as it formed an integrated day-long seminar on a directed topic. The conveners set up the program so that presentations from different subject areas (e.g. geochemistry and seismology) were interleaved but with mutual relevance, to encourage the audience and participants to commit to the whole session. This strategy was very successful and resulted in high-quality and thoughtful discussions and questions.

It was suggested that a follow-on session be planned for the 34th IGC in Brisbane, Australia to report on progress on the identified problems to be solved.

**ANNOUNCEMENTS:** We are negotiating with Elsevier to produce a volume based on this session to be published in either *Lithos* or *Tectonophysics*. A significant number of participants have indicated they will contribute.

#### **EIL-04 The continental lithosphere from geophysical and geochemical data**

**CONVENERS:** Irina M. Artemieva, University of Copenhagen, Denmark; W.L. Griffin, Macquarie University, Australia; Jeroen Ritsema, University of Michigan, USA

**NUMBER OF PRESENTATIONS:** 7 oral, 13 poster, 1 no-show

**SYMPOSIUM SUMMARY:** This multi-disciplinary session brought together geophysicists and mantle geochemists to discuss, by combining various geodisciplines, the present-day and the past structure of the lithospheric mantle, its evolution, and processes which form and modify the continents. The session summarized the state-of-the-art knowledge on structure, thickness, and composition, of the continental lithosphere as revealed by geophysical (seismic, thermal, potential fields) methods, and petrological studies of mantle-derived xenoliths. Special focus was on secular trends of lithosphere evolution as reflected in geophysical and geochemical data and on the processes behind them.

**GENERAL COMMENTS:** Attended by ca. 40-60 people.

#### **EIL-06 Seismic anisotropy and deformation of the crust and mantle**

**CONVENERS:** Jaroslava Plomerova, Geophysical Institute, Czech Acad. Sci., Czech Republic; Vadim Levin, Rutgers University, USA; Martha Savage, Victoria University of Wellington, New Zealand; Thorsten W Becker, University of Southern California, USA

**NUMBER OF PRESENTATIONS:** 10 oral, 9 poster, 3 no-shows

**SYMPOSIUM SUMMARY:** Relative motion of rock masses, both past and ongoing, are at the heart of our understanding of the way our planet behaves. One of the few indicators of rock deformation caused by large-scale motions deep within the Earth is the directional dependence (anisotropy) of seismic wave speed. Many modern studies of the Earth's structure address the issues of where seismic anisotropy is seen, what are the parameters of directional dependence, and what that means in terms of Earth's interior dynamics. As our ability to resolve anisotropic structure and to simulate the processes

of rock deformation in computer models are rapidly improving, the study of seismic anisotropy and its implications is evolving, becoming progressively more quantitative. At the same time, an improved understanding of anisotropic texture-formation mechanisms for different conditions makes interpretation of seismic anisotropy indicators more challenging.

Contributions on the state-of-the-art in resolving details of seismic anisotropy at depth; predicting likely effects of anisotropy on seismological observables; and comprehensive interpretations of seismic anisotropy in terms of past and present deformation were presented in the full day symposium. With the use of different techniques (shear-wave splitting, P tomography, receiver functions, surface waves), the authors presented recently achieved results on the crust and mantle structure in different tectonic environments, ranging from the Archean cratons to active subduction and rift zones, and covering large portions of the Earth: from the North (Fennoscandia) to the South (Antarctica) and from the West (Cascadia subduction zone, US) to the East (subductions beneath Indonesia). These also include mantle plume affected regions (Iceland, Indian Ocean) and complicated mosaic of orogenic belts and collision zones in Europe (the Variscan Bohemian Massif, the Apennines, Italy). Both the common and diverse features in the structures were accentuated pointing to the complexities in the Earth three-dimensional anisotropic structure, varying both with depth and geographically. Observations, modelling and interpretation of the large-scale seismic anisotropy were accompanied by analysis of elastic properties of borehole samples and peridotite xenoliths, and by new models considering both the 'competing' fossil and present-day mantle flow related fabrics. Mapping seismic anisotropy reveals domain-like structure (fossil fabric) of the mantle lithosphere, similarly to crust terranes, as well as anisotropy due to contemporary dynamics in the sub-lithospheric mantle.

**GENERAL COMMENTS:** We appreciate the high quality of both the poster and oral presentations delivered in the symposium, as well as brisk discussions of individual contributions and at posters.

#### **EIL-07 The Earth's gravity field - a key to surface tectonics and mantle geodynamics**

**CONVENERS:** Alessandro Forte, Université du Québec à Montréal, Canada; Mikhail Kaban, GeoForschungsZentrum Potsdam, Germany; Tony Watts, University of Oxford, UK

**NUMBER OF PRESENTATIONS:** 6 oral, 8 poster

**SYMPOSIUM SUMMARY:** Geophysical studies of Earth's gravity field have long played a key role in developing our understanding of the internal density distribution and dynamical state of our planet. The increasing availability of continent-wide terrestrial gravity data sets (e.g. through government and commercial surveys) and improvement in coverage of high-resolution surface-ship and swath bathymetry data (e.g. in the southern oceans), together with state-of-the-art satellite derived global gravity variations (e.g. projects CHAMP, GRACE and the future GOCE mission), provide critical constraints on departures from





isostatic equilibrium and hence on the distribution of dynamical stresses in the crust, lithosphere and deep mantle. Recent advances in measuring the time-variable global gravity field (e.g. project GRACE) have also yielded new insights on changing surface mass distributions (e.g. ice sheet variations) and the time-dependent response of the solid Earth to these surface load variations on both long and short geological time scales. Significant progress in constraining dynamical processes in the lithosphere and mantle can be achieved through joint studies of the relationship of surface gravity variations to lateral variations of surface topography, crustal structure, plate tectonic movements and deep heterogeneity in the mantle revealed by seismic tomography. Recent advances in high-resolution seismic tomographic imaging of global 3-D Earth structure promise to provide new insights into the origin of lateral variations in surface gravity and also their long-term temporal variability due to mantle convection. We welcome contributions to this symposium which will help to further advance these different interpretations of the relationship between the surface gravity field and solid Earth dynamics. Multidisciplinary studies which feature a joint interpretation of gravity with a variety of geodynamic surface observables (e.g. surface topography, ocean bathymetry and plate tectonics) are especially welcome.

**GENERAL COMMENTS:** This symposium was moderately attended, as it was held at the same time as two other geophysical symposia related to Earth structure and dynamics. This timing was somewhat unfortunate but, nonetheless, approximately 25 people were in attendance at the beginning. There were significant fluctuations in attendance during the symposium as people entered and left. Each presentation elicited at least one or two questions and this was followed by a general round of questions, and discussion at the end of the symposium to fill the gap left by the late cancellation of one of the oral presentations.

#### **EIL-08 Geoelectromagnetic studies of the Earth's crust and mantle**

**CONVENERS:** Juanjo Ledo, Universitat de Barcelona, Spain; Toivo Korja, University of Oulu, Finland; Igor Rokityansky, Institute of Geophysics, Ukraine

**NUMBER OF PRESENTATIONS:** 8 oral, 4 poster, 4 cancelled or no-shows

**SYMPOSIUM SUMMARY:** In recent years, an increasing number of initiatives have been taken to study the electromagnetic (EM) signature of the Earth's crust and mantle. These initiatives include both the acquisition of new high quality data and development of new tools for the analysis and interpretation of EM data, and its comparison with other geophysical and geological data. EM methods are playing a key role to get a better understanding of the state and evolution of oceanic and continental lithosphere alike. Questions still remain about the nature of deep low resistivity anomalies, its implications on the rheological behaviour of the lithosphere, presence of electrical anisotropy and correlation of electrical resistivity with mechanical, thermal and chemical boundary layers. In oral lectures and posters, important results of deep interior studies in ancient suture and modern

subduction zones, rifts and platforms in volcano geothermal fields and seismogenic zones were presented. The most interesting presentations were "The electrical structure of mantle lithosphere" by A. Jones, "Electrical structure of the mantle beneath Central Europe: Results of the CEMES project" by V. Semenov et al., "Tectonic evolution of accretionary prism in the arc-continent collision of Taiwan as imaged by broadband magnetotelluric transects" by Chow-Son Chen. The common conclusion: The symposium gave clear evidence that geoelectromagnetic methods are very effective valuable tools for the Earth's crust and mantle study.

**GENERAL COMMENTS:** The quality of presentations was good, the number of people attending oral presentations exceeded 20, there was lively discussion in the poster area.

#### **EIL-10 Large-scale seismic transects: Images of the Earth's crust and mantle**

**CONVENERS:** Bruce Goleby, Geosciences Australia, Australia; Randell Stephenson, VU University, Netherlands; Doug Finlayson, Geosciences Australia, Australia; Ramon Carbonell, CSIC Jaume Almera, Spain

**NUMBER OF PRESENTATIONS:** 12 oral, 9 poster, 1 no-show

**SYMPOSIUM SUMMARY:** Most Earth science theory flows from an understanding of the geology at the surface of the Earth. However, seismic images of the Earth's crust and upper mantle give us a detailed insight into the deeper geological structures and tectonic processes that shape the lithosphere and the modern landscapes. They are therefore relevant to natural resource exploration, the distribution and management of groundwater resources and the study and mitigation of natural hazards such as earthquakes. They define the large-scale processes that control the evolution of the landscape and soils. This symposium invites oral and poster contributions in which crustal-scale passive and/or active seismic imaging of the Earth's crust and upper mantle forms the basis of regional, possibly interdisciplinary, studies of the tectonic processes controlling the architecture of orogenic belts, rifts, sedimentary basins, cratons, continental platforms and margins, and major intraoceanic features.

The presentations in the symposium covered a wide range of targets, from the point of view of tectonic age and setting as well as geographically. Images of cratonic lithosphere from Eurasia as well as Australia dominated, but Palaeozoic accreted belts as well as Mesozoic-Cenozoic orogens and basins also received attention. Most presentations dealt with images derived from seismic reflection profiling, but other (especially passive seismic) methods were represented. A number of presentations proposed images of the Earth's crust and mantle based on the integration of diverse geophysical datasets.

**GENERAL COMMENTS:** The quality of presentations was high and the oral part of the symposium was moderately well attended, the poster session less so. All presentations generated some discussion. The symposium was sponsored by IGCP Project 474 - Images of the Earth's Crust - and its successor IGCP Project 559 -





Crustal Architecture and Landscape Evolution.

**ANNOUNCEMENTS:** IGCP Project 559 expects to sponsor a similar symposium at the 2009 European Geosciences Union meeting in Vienna in April.

## ENVIRONMENTAL GEOSCIENCE EG

### ENVIRONMENTAL GEOCHEMISTRY EGC

#### **EGC-01 General contributions to environmental geochemistry**

**CONVENERS:** Jane Plant, Imperial College of London, UK; Vala Ragnarsdottir, University of Bristol, UK; Reijo Salminen, Geological Survey of Finland, Finland

**NUMBER OF PRESENTATIONS:** 25 oral, 18 poster

**SYMPOSIUM SUMMARY:** This symposium covered aspects of the environmental geochemical disciplines that were not included in the other more specific symposia. The effects of natural and man-made chemicals including potentially harmful substances such as trace metals and metalloids, radioactive substances, persistent organic pollutants including industrial pollutants and pesticides, human and veterinary pharmaceuticals, endocrine disrupting chemicals and nanoparticles were considered. Also health problems associated with deficiencies in micronutrients were considered.

In the past 50 years levels of potentially hazardous substances have increased markedly in the environment as a result of industrialisation (e.g. fossil fuel burning), chemically intensive agriculture and urbanisation. Over the same period micronutrients in soils have been depleted as a result of intensive agriculture including the green revolution. The impact of chemicals in the environment on human health, especially cancer and neurological disorders, is now a cause of increasing concern.

**GENERAL COMMENTS:** The quality of presentations was generally good, but because of the great variety of topics the number of people attending the symposium varied from 25 to 70. There were several cancelled and no-show presentations as is usual at the IGC. Four out of 31 oral presentations was cancelled before the conference began. In addition, there were two no-show presentations. This complicated the conveners' work. The situation was worse for posters, with 12 out of 30 presentations no-shows. Time for discussions was very limited except during the no-shows and cancelled presentations.

#### **EGC-03 Urban geochemical mapping**

**CONVENERS:** Rolf Tore Ottesen, Geological Survey of Norway, Norway; Kaj Lax, Geological Survey of Sweden, Sweden; Timo Tarvainen, Geological Survey of Finland, Finland

**NUMBER OF PRESENTATIONS:** 11 oral

**SYMPOSIUM SUMMARY:** The symposium focused on applications of geochemical methods in the urban environment, where contamination has been shown to

cause negative human health effects. The cause of such effects, potential or demonstrated, can be investigated using various geochemical- and medical mapping methods. Natural and anthropogenic contamination may also pose a risk to the environment around the cities. Presentations focused on mapping variability of inorganic and organic pollutants, caused by both natural and anthropogenic processes in urban areas around the world. Three types of urban geochemical mapping were discussed: definition of baselines for a priori defined strata in urban environment; systematic mapping of concentrations in the topsoils using a regular grid or transects; and studies on effects on human health or on ecosystems of certain pollutants in urban environment.

After an excellent keynote lecture giving an overview of this branch of geochemistry by Professor Howard Mielke from Tulane University (New Orleans), ten very good presentations were given presenting results from urban geochemical studies from Europe, North and Central America and Asia. 35-50 persons attended the symposium.

**GENERAL COMMENTS:** On the following day 16 persons participated on an urban geochemical field excursion visiting four localities in Oslo, demonstrating: 1) urban soils in general, 2) the national action plan for mapping and remediation of urban soils in day-care centres and playgrounds, 3) the importance of buildings and outdoor paint as a PCB-source in the urban environment, and 4) natural lead poisoning of soil in a forested area of Oslo.

18 scientists participated in the workshop WSS-19 Urban geochemical mapping methods. The participants were from Europe, North and Central America, Africa and Asia. The workshop resulted in a first draft for a suggested harmonized methodology for urban geochemical mapping. The participants are now all members of the IAGC working group on urban geochemical mapping.

#### **EGC-04 Geochemical mapping from the global to the local scale: The Arthur Darnley Symposium**

**CONVENERS:** David B. Smith, U.S. Geological Survey, USA; Clemens Reimann, Geological Survey of Norway, Norway; Reijo Salminen, Geological Survey of Finland, Finland; Jane Plant, Imperial College, UK

**NUMBER OF PRESENTATIONS:** 17 oral, 8 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** This symposium was dedicated to the memory of Arthur G. Darnley (1930-2006). Arthur was the founder of the Task Group on Global Geochemical Baselines under the auspices of the International Union of Geological Sciences (IUGS) and the International Association of GeoChemistry (IAGC), and served as its Honorary President until his death. His leadership in establishing standardized protocols for conducting national and international geochemical surveys was a major contribution toward the development of a global geochemical database and the understanding of the chemical composition of our planet. Documenting and understanding natural geochemical variability is critical if we are to recognize and understand changes caused by human activities. Presentations at the symposium focused on geochemical mapping projects conducted at widely



varying scales throughout the world to document natural and human-induced geochemical variation in media such as soils, stream sediments, rocks, vegetation, ground water and surface water.

The presentations represented every continent with the exception of Antarctica. Four invited keynote speakers focused on current continental-scale geochemical mapping projects in Europe, North America, Australia, and China. Presentations on regional- and national-scale mapping came from Russia, Colombia, Nigeria, Italy, India, Mexico, Netherlands, Serbia, and Sardinia. It was obvious that defining and understanding the geochemistry of the Earth's near-surface environment is an important subject in many countries as evidenced by on-going projects throughout the world. There is still a need for increased harmonization among these projects so the resulting data sets and maps can be compared across national borders.

The Arthur Darnley Symposium was chosen as the venue for the presentation of the Vernadsky Medal awarded by IAGC in recognition of a distinguished career of scientific accomplishment in geochemistry. It was appropriate that the 2008 Vernadsky Medal was awarded to Prof. Bjørn Bølviken of the Geological Survey of Norway, who is one of the pioneers in developing methods for low-density geochemical mapping at national and international scales.

**GENERAL COMMENTS:** Attendance at the symposium was very good, averaging about 75 over the course of the full-day session. The quality of presentations was generally good, but many presenters had difficulty keeping within the time limit. Two of the original oral presenters were unable to attend IGC and we used these time slots for additional discussion, which was actually a benefit to the symposium.

**ANNOUNCEMENTS:** The IUGS/IAGC Task Group on Global Geochemical Baselines has just published a special volume of the journal *Geochemistry: Exploration, Environment, Analysis* (2008, Volume 8, Part 3/4) dedicated to the memory of Arthur Darnley. This volume, edited by Clemens Reimann (Geological Survey of Norway) and David B. Smith (U.S. Geological Survey), contains 12 papers, some of which were also oral or poster presentations at the Arthur Darnley Symposium at IGC.

Discussions are underway for a possible international conference on geochemical mapping to be held in China during 2009. Also, the Task Group will be convening sessions at the 24th International Applied Geochemistry Symposium, Fredericton, New Brunswick, Canada, June 1-4, 2009.

#### **EGC-06 Geochemical proxies of palaeoenvironmental change in terrestrial environments**

**CONVENERS:** Attila Demeny, Hungarian Academy for Sciences, Budapest, Hungary (main organizer before the Congress, but was prevented from attending through illness); Ian Fairchild, University of Birmingham, UK (convened the session at the Congress itself)

**NUMBER OF PRESENTATIONS:** 5 oral, 9 poster

**SYMPOSIUM SUMMARY:** Geochemical records are extremely valuable for investigations on environmental, and specifically climate change processes in the historical and geological past. Technical developments of dating,

geochemical and isotope geochemical analyses have made high-resolution studies on various terrestrial deposits (e.g. cave deposits, lake sediments, tree rings) possible, which provide complementary proxies for past conditions. Every deposit can reflect climate conditions in its specific way, having certain advantages and disadvantages. Thus, a complex and interdisciplinary approach is needed during the interpretation of geochemical climate records. One important field is monitoring of recent formation processes that can contribute significantly to our knowledge of the behavior of the deposits and the governing factors that determine the chemical and isotopic compositions of different materials. Technical developments can provide new means of analyses throwing new light on environmental change processes, allowing analysis of new chemical variables or at higher time-resolution.

The aim of the session was to compare the different methods and records, evaluate their information content and look ahead to new applications. In the event, there was a strong emphasis in the oral contributions of organic geochemical records of environmental change. The proxies used included peat bogs, speleothems, coals and estuarine sediments. Novel features emphasized include the use of stable isotopes of Sphagnum cellulose, corrections for taxon type and degree of decay on bulk compositions of coal carbon isotopes and the identification of iodine compounds as potential biomass burning indicators extracted from speleothems. The poster presentations included a more dispersed range of topics dealing with lacustrine, loessic and palaeosol environments.

**GENERAL COMMENTS:** Although the audience was quite small (around 20), there was good discussion of the oral presentations which had coherency, although insufficient to enable a publication.

#### **EGC-07 Frontiers of stable isotope analysis for environmental science and biogeochemistry (IAGC)**

**CONVENERS:** Martin Novak, Peter M. Wynn

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** The session will mirror recent advancements in isotope-ratio, thermal-ionisation, and multi-collector ICP mass spectrometry in low-temperature geochemistry. Contributions on not-so-traditional isotope systems, such as e.g. Cr, Cd, Fe, Ca, Li, Mo, Ni and Cl are welcome. Use of mass independent fractionations (MIF) in systems involving atmospheric reactions of asymmetrical molecules in gaseous form will be discussed. Such systems include, for example, sulfur, nitrate-oxygen and sulfate-oxygen. The fast developing field of phosphate-oxygen isotope studies falls well within the scope of this session. A distinct highlight will be studies synthesising data from several isotope systems. Novel interpretations of chemical and isotopic data describing fluxes and pools of environmentally relevant elements in forest and agricultural catchments may be presented. Dispersion pathways of toxic substances and other pollutants in ecosystems will be documented using isotopes. Of interest are microanalytical techniques in stable isotope analysis, including laser ablation MC ICP MS. Isotope studies using H, C, N, O



and S will be also considered whenever isotope data give more insights into processes near the earth surface than chemical data alone. C mineralization pathways in wetlands, and isotope fingerprinting of sources and sinks of greenhouse gases, are two examples of such studies.

## ENVIRONMENTAL GEOLOGY EGG

### EGG-01 General contributions to environmental geology

**CONVENERS:** Reijo Salminen, Geological Survey of Finland, Finland; Benedetto De Vivo, University of Naples, "Federico II", Italy

**NUMBER OF PRESENTATIONS:** 19 oral, 15 poster

**SYMPOSIUM SUMMARY:** This symposium covered aspects of the environmental disciplines that were not included in the other more specific symposia. Environmental geology is a multidisciplinary field of applied science. Thus, the symposium included presentations on a great variety of topics such as land use, geological risk in volcanogenic areas, contaminated land sites and sediments and their remediation technologies, urban geology, environmental impact of mining operations and managing of geologic nature resources, assessment of risk exposure from flooding and erosion. Some presentations also considered geological aspects on managing industrial and domestic waste disposal and minimizing or eliminating effects of pollution.

**GENERAL COMMENTS:** Quality of presentations varied much, but mostly their quality was good enough. Because of great variety of topics the number of people attending the symposium varied much (from 2 to 50), being on average 25.

The number of no-show presentations was too high; six out of 25 oral presentations was cancelled because of the absence of the speaker. This complicated the conveners' work significantly. With posters the situation was even worse: 13 out of 28 presentations were cancelled - only one of these was cancelled before the conference began.

Time for discussions was very limited except during the no-shows.

**ANNOUNCEMENTS:** There are no plans for publishing the presentations. Because this was a 'General contributions' symposium, no discussions nor any decisions about future meetings were done.

### EGG-03 Geological aspects of radon risk mapping, 9th symposium (GARRM 9)

**CONVENERS:** Britt-Marie Ek, Geological Survey of Sweden, Sweden; Marc De Cort, JRC, Italy; Grégoire Dubois, JRC, Italy; Matej Neznal, RADON v.o.s., Czech Republic; Terje Strand, Univ. Oslo, Norway; Gustav Åkerblom, Åkerblom&Åkerblom, Sweden

**NUMBER OF PRESENTATIONS:** 33 oral, 16 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** Exposure to radon is one of the main risks of ionizing radiation, causing tens of

thousands of deaths from lung cancer each year globally. For the last 20 years, millions of radon-related measurements have been made worldwide and, in most cases, processed in the form of "radon risk maps". In 2005 the Radioactivity Environmental Monitoring (REM) group at the Institute for Environment and Sustainability (IES), JRC, Ispra, Italy, started to explore the possibility of generating European Radon maps in the frame of preparing a European Atlas of Natural Radiations. The main objective of this atlas is to familiarize the public with the notion that the environment is naturally radioactive, to promote further studies and to highlight regions with elevated levels of natural radiation. Using lessons learned from the efforts of the European Commission to generate a harmonized European Radon map, the symposium presented and discussed the latest developments in the preparation of radon risk maps derived from indoor and soil-gas measurements. The symposium was structured around three sessions:

Session 1: European, national and regional radon maps (indoor and geogenic) - progress and developments.

Session 2: Methods and instrumentation for radon potential assessment, experiences.

Session 3: Geogenic controls on indoor radon concentrations, radiometry, data modelling.

Subsession: Natural radioactivity in drinking water.

Poster presentations during breaks.

**GENERAL COMMENTS:** The symposium was attended by up to 100 participants coming from all over the world. The attendance during the two days of lectures was very high with many interesting discussions. The discussions continued in the Workshop on Radon risk mapping: From soil-gas to indoor concentrations (WSS-20) that saw 80 registered participants to discuss possible means to prepare a Geogenic Radon Map of Europe (GRME). In contrast to the Indoor Radon Map of Europe (IRME) that covers only areas where indoor measurements are available, the GRME will present the radon potential at any location in Europe using geological and soil data, indoor and soil-gas measurements. The workshop was very successful and with lively discussions. The continued work with GRME will be done in an expert group.

The radon symposium and workshop was followed by a one-day radon excursion to areas along the west of the Oslo Fjord where uranium-rich alumshale and Permian uranium-rich granites are the cause of indoor radon problems. The trip back to Oslo in a sunny afternoon went with boat - a perfect ending of a successful symposium.

**ANNOUNCEMENTS:** A number of presentations will be published in a special issue of the Journal of Environmental Radioactivity. The issue will be entirely dedicated to mapping methods, and 12 full papers are submitted for reviewing.

The 10th International Workshop on Geological Aspects of Radon Risk Mapping has been announced for 2010 in Prague. The Workshop will be merged with an international intercomparison exercise of soil-gas measurements.



**GEO-ENERGY GE****COAL GEOSCIENCE GEC****GEC-01 Contributions to coal geoscience**

*CONVENERS:* Alv Orheim, GeoArktis, Norway; Robert B. Finkelman, USGS, USA; Malte Jochman, Store Norske, Norway

*NUMBER OF PRESENTATIONS:* 5 oral, 6 poster, 1 no-show

*SYMPOSIUM SUMMARY:* As coal will continue to be an important source of energy coal consumption will not diminish in the foreseeable future. New technologies supported by basic and applied coal geology research will be required to minimize the environmental and human health impacts of coal use and to ensure sustainable future developments for coal.

The presentations covered various questions regarding coal geology, and both scientific and applied disciplines were discussed. However, the number of papers was not sufficient to foster larger discussions or to generate fundamental new knowledge transfer among the participants.

No novel conclusions regarding coal formations or related to mining issues or in regard to exploitation of coal could be drawn, although several of the individual papers substantiated important new observations, in particular regarding health issues.

*GENERAL COMMENTS:* Few of the oral lectures met present day requirements. In some cases it would have been advantageous, both to the presenter and to the audience, if the paper had been given as a hard copy presentation. Number of attendees varied from 15 to 35.

**GEOTHERMAL ENERGY GET****GET-01 General contributions to geothermal energy**

*CONVENERS:* Ingvar Birgir Friðleifsson, Anette K. Mortensen, Eduardo R. Iglesias

*NUMBER OF PRESENTATIONS:* 11 oral, 8 poster, 2 no-shows

*SYMPOSIUM SUMMARY:* Two symposia were merged into GET-01, which then formed a forum for presentations and discussions of the status, development and future prospect of geothermal energy from both conventional and unconventional systems.

Geothermal energy can play an important role in reducing the dependence on fossil fuels in some parts of the world. In the direct heating sector, the potential is very large as space heating/cooling and water heating is a significant part of the energy budget in many countries. In the electricity sector, the geographical distribution of suitable geothermal fields is mainly confined to areas on active plate boundaries or with active volcanoes, where some countries

obtain 15-22% of their electricity from geothermal resources.

In order to increase the potential of geothermal power generation, methods to develop unconventional geothermal resources, in particular Enhanced Geothermal Systems (EGS), need to be explored further - for instance through exploration of new types of reservoirs (deep fractured rocks, supercritical fluids); stimulation of permeability of current high-enthalpy reservoirs to enlarge their extent and productivity; enhancement of the viability of current and potential geothermal fields by stimulation technology and improvement of the thermodynamic cycles. Experiences with low-temperature resources (around or even below 100°C) with systems like the Kalina cycle should also be evaluated.

Status and future developments of geothermal energy from conventional systems were presented from a number of countries. Similarly, current and future initiatives to explore enhanced geothermal systems were presented, which left the impression that geothermal energy is going into a phase of considerable development of conventional geothermal systems as well as substantial exploration of unconventional geothermal systems largely stimulated by governmental incentives to reduce their dependence on fossil fuels.

*GENERAL COMMENTS:* Attendance was around 50-70 during the symposium, during the lunch break attendance was high at the poster session and discussions were lively. However, at the afternoon poster session attendance was comparably small.

*ANNOUNCEMENTS:* The World Geothermal Congress in Bali 2010.

**GET-02 Nature of geothermal systems based on geophysical, geochemical, petrological and tectonic studies**

*CONVENERS:* Agnes G Reyes, GNS-Science, New Zealand; Giovanni Gianelli, Istituto di Geoscienze e Georisorse, Italy

*NUMBER OF PRESENTATIONS:* 14 oral, 7 poster

*SYMPOSIUM SUMMARY:* A geothermal resource is a volume of rock or water where heat can be mined economically for conversion to power or for direct utilization at temperatures as low as <100°C to as high as about 380°C. Direct heat utilisation from low-grade sources, such as the constant heat at 12-15m depths, may require as little preparatory work as drilling a well in rock of known heat capacity, for ground source heat pump use. However, the development of an economically redeemable, renewable and sustainable geothermal resource for power generation and large-scale direct heat utilisation requires a multidisciplinary geoscientific evaluation during initial surface exploration, drilling, steam production, and field and pipeline/turbine maintenance. Geological, geochemical and geophysical studies are also needed in the monitoring and remediation of surface and subsurface environmental effects caused by discharge of fluids to the surface, mass withdrawal, reinjection and the attendant hydrological, thermal and pressure adjustments within the system caused by exploitation and development.





**GENERAL COMMENTS:** The overall quality of presentations was average. Because it is a very large conference, and too many sessions going on at the same time, only about 50 to 70% of the lecture room was filled up. Discussions were lively for some of the talks, e.g. the keynote presentation by J. Rowland and a presentation on fluid flow by J. Florian.

### **GET-03 Water-rock interaction**

**CONVENERS:** Halldór Ármannsson, ÍSOR, Iceland GeoSurvey, Iceland; Hélène Pauwels, BRGM-Water Division, France

**NUMBER OF PRESENTATIONS:** 8 oral, 5 poster, 9 cancelled

**SYMPOSIUM SUMMARY:** Water-rock interaction is extremely important in studies of geothermal systems. Alteration mineralogy provides information on the history of geothermal systems, i.e. their age, at what stage of development they are, heating up or cooling down as well as practical information on the present temperature and permeability. Prior to drilling the chemical composition of geothermal fluids which is the result of fluid-rock interaction can yield information on subsurface temperatures as well as origin and direction of flow and probable production characteristics such as deposition and corrosion potential. Topics for this session included thermodynamic and kinetic modelling, tracers of circulation within geothermal systems, gas-rock-water interaction including application to geological CO<sub>2</sub> sequestration, scaling, and environmental impacts such as geomicrobiology of exploited aquifers and processes related to mine drainage. A keen interest was shown in scale formation and possible mineral extraction from geothermal brines, and another popular topic was the use of geochemistry in geothermal exploration.

**GENERAL COMMENTS:** The presentations were of high quality and gave rise to lively discussions, aided by the relaxed atmosphere during breaks due to missing lectures.

**ANNOUNCEMENTS:** The 13th International Symposium on Water-Rock Interaction (WRI-13) will be held in Guanajuato, Mexico, August 23-27, 2010. Secretary-General will be Thomas Kretschmar, Ensenada. Tentative website: <http://wri13.cicese.mx/>

### **GET-05 Geothermal utilization - direct use, electrical production, heat pumps, industry and leisure**

**CONVENERS:** John W. Lund, Oregon Institute of Technology, USA; Leif Bjelm, Lund University, Sweden; Gordon Bloomquist, Washington State University, USA

**NUMBER OF PRESENTATIONS:** 15 orals, 7 no-shows

**SYMPOSIUM SUMMARY:** Geothermal utilization includes electrical generation covering both high temperature (flash steam) and low temperature (binary or organic Rankin cycle) plant operation. Direct-use covers space heating and cooling; greenhouse and aquaculture pond heating; spa and swimming pool heating; lumber, vegetable, fruit and grain drying; mineral extraction from geothermal fluids; along with other process heating. Geothermal heat pumps include both open and closed loop ground-source systems, used for heating and/or

cooling. Other specialized forms of geothermal utilization includes combined heat and power plants concerned with increasing the efficiency and lowering the cost of utilizing geothermal fluids through producing electrical energy and space heating/cooling from the same geothermal resource, and the production of biofuels. The session on geothermal utilization provided a forum to present and discuss various issues to assist researchers, developers and users of geothermal energy.

The topics covered related to geothermal energy included: New Development and District Heating including (3 presentations): Desalination of Sea Water in Mexico; District Heating in Reykjavik, Iceland; and District Heating in Zakopane, Poland; Geothermal Heat Pumps including (4 presentations): A Nordic Perspective; Market Development in Sweden; Using Alluvial Groundwater in Korea; and the Lund, Sweden Geothermal Heat Pump Plant; Electricity Generation (6 presentations): Examples of Combined Heat and Power Plants; Case Study of the Tiwi and Mak-Ban Fields in Philippines; Power in New Zealand; Green Field Geothermal Capacity (Italy); Developments in Australia; and Hot Spring Power Generation in Japan; Balneology and Geothermal Heat Pumps (2 presentations): Numerical Model Development to Predict the Performance of Borehole Heat Exchanger Systems; and Interpretation of Thermal Response Tests.

**GENERAL COMMENTS:** Approximately 50 persons attended the session and there was lively discussion after each presentation.

## **PETROLEUM GEOSCIENCE      GEP**

### **GEP-01 General contributions to petroleum geoscience**

**CONVENERS:** Anthony Spencer, StatoilHydro, Norway; Philip Allen, Imperial College, London, UK; Snorre Olaussen, Eni Norge, Norway

**NUMBER OF PRESENTATIONS:** 4 oral, 17 poster

**SYMPOSIUM SUMMARY:** The IGC programme contained 25 other symposia which covered petroleum geoscience (PG) comprehensively: from exploration to production, from data to methodology and, geographically, from the North Sea to the circum-Arctic. The aim of this symposium was therefore to provide a 'home' for papers submitted to the Congress which did not naturally fit into the other symposia. Also, we aimed to cover some special topics not dealt with in the other symposia: history - the breakthroughs in thinking in PG and their uptake; current work practice - is integration across disciplines achieved?; teaching - do courses fit students for multidisciplinary work?; are current teaching and work practices optimum for e.g. basin analysis?; industry and academia - do we need more active links?; employment - is there a developing manpower gap?

No unsolicited offers of lectures were received and so four talks were invited on some of the special topics - on the exploration play, on work-station collaboration, on a





personal history of exploration, and on the history of exploration principles. 17 posters were accommodated in the symposium and covered many petroleum geoscience topics, from exploration to production, and contained examples from Europe and Asia.

*GENERAL COMMENTS:* About 40 people attended the oral session.

## **GEP-02 Maximising the value of fossil energy and mineral resources**

*CONVENERS:* Per Blystad, Norwegian Petroleum Directorate (NPD), Norway; Charlotte Griffiths, United Nations Economic Commission for Europe (UNECE), Sustainable Energy Division, Switzerland

*NUMBER OF PRESENTATIONS:* 6 oral

*SYMPOSIUM SUMMARY:* The world sees an increasing demand for fossil energy and mineral resources as a large and growing population is coming out of poverty. Markets for capital and energy are globalizing in a way not seen before. To maximize the value of fossil energy and mineral resources means making as much of the geological endowment commercially available as possible through a range of measures, including long sighted energy policies, quality government resource management, quality deployment of geosciences, technology, management and capital in profitable and efficient exploration and production, and adequate pricing and availability of capital through quality communication with the global capital market. To assist this process, the United Nations Economic and Social Council has recommended its Framework Classification for Fossil Energy and Mineral Resources (UNFC) for worldwide use.

The keynote address was delivered by Mr. Farouk Al-Kasim. He pointed to the main challenges ahead to maintain human progress: economic growth, resource supply, cost of energy, environmental impact, technology, institutional, governance and communication. We must find and produce energy cheaper and smarter, use energy more efficient and environmentally friendly, cooperate more efficiently among national authorities and companies, and develop tools for better communication to be able to focus on the challenges themselves. The following presentations focused mostly upon international and national resource management of petroleum resources.

Olga Nemova presented methods for economic evaluation of prospects and fields that provide the basis for management decisions, currently in use in Eastern Siberia, Russian Federation. Software (Strategy V5) is developed by the Siberian Research Institute of geology, geophysics and mineral resources.

Bente Nyland presented the Norwegian petroleum resource management system, focusing upon the NPD resource classification system and its importance for the reporting process of data from companies to the authorities. Use of such a system, based upon the project maturity, provides consistent data sets. Increasingly important environmental data related to the projects are also reported by use of the classification system. Important analyses and forecasts are made based upon the annual data reporting. Charlotte Griffiths and Per Blystad presented

the UN Framework Classification for Fossil Energy and Mineral Resources (UNFC). The process, hosted by the UNECE and assisted by an ad hoc group of experts representing a wide range of stakeholders, was described. The classification is both a framework- and standalone classification. UNFC is defined by three criteria: Economic viability, Technical feasibility/Project maturity, and Knowledge of the geological endowment. Mapping UNFC to SPE PRMS and CRIRSCO classifications demonstrates that UNFC is a framework classification that can be used globally. Sigurd Heiberg presented a case study on the use of project maturity classifications, based upon the NPD classification and the UNFC, demonstrating the strength of such systems.

The petroleum potential of Canada was presented, including both conventional and unconventional petroleum. Canada is the third world gas producer and seventh world crude producer. With increased production from oil sand, Canada is a petroleum giant.

*GENERAL COMMENTS:* Approximately 35 persons attended the symposium and there was some discussion, particularly related to the UNFC process and classification system.

## **GEP-03 Geological basis for estimating world petroleum resources**

*CONVENERS:* Paul H. Nadeau, StatoilHydro, Norway; Donald L. Gautier, USGS, USA

*NUMBER OF PRESENTATIONS:* 7 oral, 1 poster

*SYMPOSIUM SUMMARY:* The volume, distribution, and quality of the world's remaining oil and gas resources are fundamental to the future of human activity. The goal of this programme is to provide a global view of the state of knowledge and uncertainty in estimates of world oil and gas resources.

High quality contributions concerning widely available data bases on fields, reservoirs and reserves (P. Stark IHS Energy, USA), as well as commonly used geologically-based methods of estimating undiscovered (yet-to-find) resources and on the uncertainty surrounding such estimates were presented (J. Lahererre, ASPO, France; D. Gautier & R. Charpentier, USGS, USA). Geological parameters controlling the ultimately recoverable volumes of oil and gas in the world's existing fields were also presented (K. King, ExxonMobil, USA; P. Nadeau, StatoilHydro, Norway).

Case studies as well as methodology papers were encouraged, particularly those that identified:

- major geological challenges
  - sources and impact of uncertainty on these estimates, and
  - the interplay of geology, economics, and technology which determine recovery efficiency and production levels.
- Finally, a philosophical view of the benefits as well as the detriments of energy consumption/production was presented (D. Nummedal, Colorado School of Mines, USA), where global perceptions in light of climate change and supply security concerns are radically changing and must arrive at a new equilibrium if we are to effectively manage our collective future.

*GENERAL COMMENTS:* The session was well attended



(c. 50 to 100) characterized by good adherence to time, as well as informed discussions, some of which was carried by the Norwegian press (Dagens Næringsliv, Aug. 18, 2008) as well as web media (The Oil Drum, <http://www.theoil Drum.com/node/4442#more>).

**ANNOUNCEMENTS:** The participants have been invited to submit their papers for a possible special issue of Petroleum Geoscience.

#### **GEP-04 Hydrocarbon resource assessment methodology in a complex architectural context**

**CONVENERS:** Richard Sinding-Larsen, Norwegian University of Science and Technology, Trondheim, Norway; Karl Johann Skaar, StatoilHydro, Stavanger, Norway

**NUMBER OF PRESENTATIONS:** 7 oral, 9 poster

**SYMPOSIUM SUMMARY:** This symposium covered recent trends in the adaptation of resource assessment methodologies to the complexity of modern prospects and plays. Assessments based on a scenario analysis of alternative geological models that represent an integrated interpretation of the geology were emphasized.

The symposium addressed quantitative uncertainty analysis relative to basin-play-prospect interactions, both in mature basins as well as in frontier basins with normally sparse well coverage. The objectives of the symposium was to present methodologies and workflows that integrate (i) the evaluation of play and prospect risk with (ii) the understanding of the distribution and variability of depositional attributes. Also, methodologies that take account of (iii) reservoir architecture relative to the uncertainties of the depositional model and (iv) the quality of the available database were presented. The symposium further emphasized how recent advances, both in map-based technology and the capture of uncertainty associated with petroleum system dynamics, can be used to reality-check play and prospect probabilities, as well as recoverable resources. Examples from the construction and use of an analogue database containing number and sizes of oil and gas accumulations were particularly enlightening. The possibility to use Bayesian discovery process modelling both in frontier and mature basins provided encouraging possibilities for evaluating the uncertainty of numbers and sizes of undiscovered accumulations. A review of the prognoses before drilling and results after drilling of wildcat wells drilled between 1998 and 2007 on the Norwegian Continental Shelf provided insight into the evolution of exploration efficiency. A case study from the Møre Basin Norwegian Sea exemplified the resource assessment workflow used by StatoilHydro. Play level assessment and the importance of proper choice of parent distribution was emphasised. An integrated play and prospect assessment applied to the frontier North Falkland basin showed the need for regional and prospect specific calibration. The future trend in Petroleum resource assessment with model-based stochastic simulation showed the possibilities to portray future clusters of potential discoveries.

**GENERAL COMMENTS:** The overall quality of the presentations both oral and poster were good and several

resource assessment issues created lively discussions. 18 people attended the session.

**ANNOUNCEMENTS:** A special issue of Natural Resources Research is in preparation.

#### **GEP-06 Petroleum geoscience of the North Sea**

**CONVENERS:** Gunnar V. Soiland, NPD, Norway; Sigrud Borthen Toven, StatoilHydro, Norway; Ragnar Knarud, StatoilHydro, Norway

**NUMBER OF PRESENTATIONS:** 9 oral, 1 poster, 1 no-show

**SYMPOSIUM SUMMARY:** The exploration and production of oil and gas in the North Sea have been very successful through the discovery and development of many large fields. Some of first fields to be developed are producing from chalk reservoirs. The low permeability of the chalk rock caused pessimistic estimates of recovery and production rates. Developments in technology and geological understanding have constantly improved both, with important jumps at certain years where horizontal well technology and later on the use of water injection became available at large scale.

Fields with clastic reservoirs also have proved to expel more oil and gas than originally estimated through advanced drilling and other IOR initiatives. The high recovery rates we see in the North Sea is a direct result of advanced geologic mapping and modelling of the reservoirs. The field development in the North Sea has been helped by a wide array of disciplines and technologies ranging from regional mapping, analysis of burial history, pressure development, filling history and detailed reservoir architecture. In this symposium we heard about the geological contributions in the widest sense to the success in both finding and exploiting the reservoirs.

**GENERAL COMMENTS:** The overall quality of the presentations was high and given mainly by senior professionals from the oil companies active in Norway. The audience counted only around 30 people this late Friday afternoon. The limited number of attendees may reflect that North Sea Petroleum geoscience is regularly presented at various venues around Norway at conferences, meetings and seminars. Petroleum geoscientists attending the 33IGC may therefore have used the opportunity to visit more 'exotic' symposia - rather than listening to fairly well known subjects.

#### **GEP-07 Petroleum geoscience on the frontier to mature basins of the Atlantic margins from Norway to Ireland - a tribute to Peter Ziegler**

**CONVENERS:** Kari Lokna, Dave Ellis, Mark Seger

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** The North East Atlantic province, located between East Greenland and North West Europe, stretches 3000 km from the Barents Sea to the Bay of Biscay and Labrador Sea. It contains numerous Late Palaeozoic to Cenozoic basins which are genetically related in terms of their evolution as conjugate passive margins. However, their structural and sedimentary character as well as their thermal history varies significantly. As a



consequence there are considerable variations in the prospectivity and play types as well as in their exploration- and production history. Over the last decades this province has been a laboratory for studies of the formation and petroleum potential of rift basins and passive volcanic margins. This symposium aims to bring together geoscientists from academia and the petroleum industry in order to present recent advances in understanding, particularly on the following themes: Regional synthesis; Basin evolution, tectonostratigraphy and thermal history; Petroleum systems and play types; Exploration- and production experiences.

#### **GEP-09 Linking petroleum systems and plays to sedimentary basin evolution**

*CONVENERS:* Maarten Corver, VU University Amsterdam, Netherlands; Harry Doust, VU University Amsterdam, Netherlands; Morten Rye-Larsen, Statoil ASA, Norway

*NUMBER OF PRESENTATIONS:* 17 oral, 24 poster

*SYMPOSIUM SUMMARY:* The objectives of this session were to investigate whether standard phases/cycles in basin evolution can be linked to development of petroleum systems. If so, which types of petroleum systems? And can we use such relationships as a practical aid in resource assessments and exploration risk analysis? In other words, we were seeking integration between large-scale geodynamic, ongoing tectonic/sedimentary response models and petroleum occurrence.

The oral and poster session was divided in two parts: a conceptual part, where new modelling techniques were explained and discussed, and an applied part, where new insights on frontier areas were presented.

The conceptual session was dominated by a diversity of approaches to the modelling, the dynamics of stress evolution and sedimentary processes in basin and petroleum development. Techniques, including frontier maturity models and stratigraphic approaches, were presented. Evolutionary paths of extensional and sag basins and rifted continental margins were described and discussed. In the poster session topics such as geodynamic framework of petroleum systems, problems and issues associated with maturation modelling and source rock depositional environment models were presented.

In the applied session frontier areas were coupled to evolutionary trends in basin development. Petroleum system models demonstrated their value to exploration of basement and volcanic reservoirs, complex basins and old basins with long histories.

The poster session further focused on insight on metallogenesis and fossil fuels, traps and regional structural models as well as reservoirs related to their sequence framework and provenance.

*GENERAL COMMENTS:* The symposium gave an update in the current research. These new models and applications on frontier areas are generating new insights on petroleum systems and plays in relation to basin evolution.

*ANNOUNCEMENTS:* Papers from this symposium will possibly be published in a special volume in Marine and

Petroleum Geology journal dedicated to this subject.

#### **GEP-10 Global controls on sequence stratigraphy**

*CONVENERS:* Peter Sharland, Neflex, UK; Ken Miller, Rutgers University, USA

*NUMBER OF PRESENTATIONS:* 7 oral

*SYMPOSIUM SUMMARY:* The purpose of this symposium was to explore the latest developments in the field of global sequence stratigraphy with an emphasis on causation. What is driving the '3rd order' (i.e., 1-3 myr scale) global stratigraphic cycles observed in the rock record?

The conveners chose speakers who have approached this problem from differing perspectives - geodynamics, tectonics, palaeo-climate and glacio-eustasy. Bilal Haq presented his latest work on Palaeozoic sequences stating glacio-eustasy as the cause for many of them with the cause of others as yet unknown. Gérard Stampfli presented the first GIS Phanerozoic geodynamic model demonstrating the relatively slow nature of plate-scale tectonic influences and the uncertainty around ocean volume changes. Philip Heckel demonstrated the effect in the U.S. of the speed and amplitude of sea level change and sediment response resulting from the late Palaeozoic glaciations. Annie Arnaud presented Aptian data from SE France demonstrating biotic ocean stress resulting from climate change. Mike Simmons presented the latest glacio-eustatic thinking from Neflex as to the causation behind their global model. This view was challenged by Ashton Embry who argued from a Canadian perspective for tectonics and basin structural changes as the key control for global sequences. Ken Miller wrapped up with a review of the Late Cretaceous to Neogene glacio-eustatic work on the US east coast by his group.

*GENERAL COMMENTS:* Although much new data, work and thinking has taken place over recent years, there is still no overall consensus in the community as to the main driver of 3rd order global sequences. However it is clear from recent data and work that ice seems to have been more prevalent in the past than previously recognised. It still remains to provide full integration (given all the feedback loops) between glacio-eustasy and tectonics. Given the speed of work this cannot now be many years away and will no doubt be the subject of future sessions.

#### **GEP-11 Palaeogeography, palaeo-Earth systems modelling and petroleum exploration**

*CONVENERS:* Jim Harris, Fugro Robertson Limited, UK; Les Leith, Statoil Hydro, Norway; Arne Rasmussen, Statoil Hydro, Norway

*NUMBER OF PRESENTATIONS:* 7 oral

*SYMPOSIUM SUMMARY:* The symposium was instigated as a result of palaeo-Earth systems based projects supported by StatoilHydro and other oil companies. These projects have all involved the development of new methodologies originally constructed by both commercial and academic research groups.

The role of palaeo-Earth systems including palaeoclimate and palaeoclimatic variation as one of the main controls on sedimentary facies and stratal architecture has received a



significant resurgence of interest over the last five or so years. This has coincided with a now universal interest in climate change that has stimulated the development of a new generation of sophisticated general circulation models (GCMs). The application of these models to understand ancient climate systems is referred to as palaeo-Earth systems modelling, and to make this possible new palaeogeographic mapping methodologies have been devised. With the increasing need for new ventures exploration, the oil industry is taking advantage of this synergy between climatic and geological modelling to reduce exploration risk.

In parallel with these developments three-dimensional sedimentation and stratigraphic simulation models have also been developed. In an exploration context these models can now be applied to the prediction of reservoir, source, and seal characteristics.

This symposium considered the following topics related to these subjects: Development of palaeotectonic and palaeogeographic constraints on GCMs; New approaches to palaeo-Earth systems modelling and testing of model results; Application of palaeo-Earth systems models for facies and stratigraphic prediction, with particular emphasis on hydrocarbon exploration.

**GENERAL COMMENTS:** All the presentations were of good or very good quality and in excess of 50 delegates attended the session. The timing of this session with the sequence stratigraphic session that followed provided a good basis for some lively related discussions.

### **GEP-13 Abiotic deep origin of hydrocarbons: Myth or reality?**

**CONVENERS:** Vladimir Kutcherov, Royal Institute of Technology, Stockholm, Sweden; Yuri Galant, Israel

**NUMBER OF PRESENTATIONS:** 10 oral, 6 poster

**SYMPOSIUM SUMMARY:** Ten speakers and more than 100 participants debated arguments and contra-arguments dealing with the theory of the abiotic deep genesis of hydrocarbons. The latest theoretical and experimental results, geological and geochemical evidence confirming abyssal deep hydrocarbon origin were presented on the symposium. It was concluded that the theory of the abiotic deep genesis of hydrocarbons which recognizes that petroleum is a primordial material of deep origin erupted into the crust of the Earth is converting from geological hypothesis to the physical theory.

**GENERAL COMMENTS:** The problem of petroleum origin that is becoming one of the key questions for petroleum industry needs to be discussed in a separate conference.

### **GEP-15 Geology for efficient hydrocarbon recovery**

**CONVENERS:** Ragnar Knarud, Marie Kjølberg

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** This symposium will illustrate that predictive and detailed geological reservoir characterization is essential to support decisions on reservoir management and to achieve high hydrocarbon recovery rates. Geological reservoir characterization

develops during field life from less certain models at early stages to highly detailed models that are used to guide infill drilling and improved recovery methods at the tail of field life. The quality of this work often dictates profitability and the extent of field life. Geological interpretation and description based on both data and concepts make up the fundament for both static and dynamic models used in reservoir management. The symposium will address data acquisition and interpretation, model construction and use and methodological contributions; also, case examples will be included.

### **GEP-16 Improved understanding of the clastic reservoirs through the use of new technologies**

**CONVENERS:** Bjørn Anders Lundschiene, Norwegian Petroleum Directorate, Norway; Trond Lien, StatoilHydro, Norway; Ragnar Knarud, StatoilHydro, Norway

**NUMBER OF PRESENTATIONS:** 12 oral, 4 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** In exploring frontier areas, with low well control and often sparse seismic, precise prediction of reservoir distribution and quality is challenging. In such areas, prediction relies on geological models and concepts. New tools and technologies are needed to improve basin understanding and thereby improve reservoir prediction. These new technologies need to range from global scale (e.g. climate), through basin scale (e.g. source-to-sink concepts) and down to depositional system scale (e.g. depositional processes). Successful production and high recovery from oil and gas fields will strongly rely on a thorough understanding of the reservoir. New concepts and technologies are also needed here, to improve the understanding of complex reservoir architectures and heterogeneities. The symposium aimed to cover new concepts and technologies for improving understanding of clastic reservoirs, both in terms of exploration and production issues and basin and system scale developments. The focus of the symposium was on new technologies to improve understanding of: 1. Global scale, clastic systems development 2. Basin scale (source-to-sink) clastic systems development 3. System scale understanding of variation in reservoir geometries and architecture. New technologies, concepts and tools can emerge from the novel use of remote sensing, seismic interpretation, well interpretation, outcrop analogues, experimental studies and depositional modelling.

**GENERAL COMMENTS:** The presentations were of high variability regarding their scientific content and focus, ranging from seismic modelling of clastic outcrop analogues to variations of petrophysical properties along deformation bands and various methods of statistic based forward modelling of reservoirs. Detailed items like lithological analysis from well data and detection of productive intervals in various types of reservoirs were also focused.

The presentations were all of high quality. The number attendees were approximately 30 at the most, and there were adequate questions to all speakers.



### **GEP-17 Unconventional hydrocarbons - coalbed methane, shale gas, tight-gas sands, heavy oil, and oil shale**

*CONVENERS:* Romeo M. Flores, U.S. Geological Survey, USA; Richard M. Pollastro, U.S. Geological Survey, USA

*NUMBER OF PRESENTATIONS:* 14 oral, 3 no-shows

*SYMPOSIUM SUMMARY:* On a global scale, thousands of trillions of cubic feet are estimated to reside within unconventional natural gas resources. Exploration, development, and production of unconventional gas will continue to grow in importance adding to world energy supply as demand continues to increase. Production of these unconventional resources demands growing research and development in petroleum geology and technology. The coalbed, shale, tight gas sands gases symposium will focus on the geology, origin, exploration, assessment, and development of unconventional natural gas. This symposium was seeking a multidisciplinary overview of these unconventional gas resources worldwide and solicited presentations on new areas of investigation, discoveries, and research advances from both invited and volunteered papers. The increasing global activity in research and development made this venue relevant for researchers, practitioners, explorationists, and economists to present state-of-the-art scientific knowledge, methodology, and technology in investigating these unconventional gas resources. Worldwide, 70 per cent of the coalbed gas is commercially produced from the United States and 30 per cent mainly from Australia, Canada, China, Columbia, India, United Kingdom, Russia, and Ukraine. Continued success in exploration, development, and production of shale gas and tight gas sands in the United States stimulated global interest in these unconventional gas resources in the Middle East, North Africa, China, Australia, and Canada. Thus, the symposium provides an ideal setting to deliberate the emergence and resurgence of these unconventional gas resources as a significant part of the energy mix

*GENERAL COMMENTS:* There were a total of 17 oral papers scheduled for whole-day presentation. Two papers from China and one paper from India were no-shows. The cancellation of these papers put the symposium in a predicament of prolonging preceding papers, discussions and coffee break. I suggest strongly that the authors of these no-show papers (Jinchuan Zhang, Xiangning Zhang, and Ravi Misra) should not only be severely admonished but also banned from submitting papers for the two forthcoming IGC meetings. It is my impression that authors from these countries are prone to submit papers only to count toward their bibliography and purposely not attend. Banning of authors that do not show to present their papers at the meetings and without valid reasons such as family emergency, sickness, etc. are presently enforced by the American Association of Petroleum Geologists, Geological Society of America, American Geophysical Union and other reputable organizations. I recommend for the IGC to adopt and enforced this no-show/ban rule. It is only fair to rule-abiding authors who come prepared and present their papers at the Congress and to the 'health' of the symposia.

Another glitch at the symposium was the delayed start of

the symposium because of the change in train schedule on Saturday. The delay cut down on discussions and coffee break.

Despite all these shortcomings, the symposium was successful and promoted very good lively discussions and exchange of ideas by participants. Overall, the venue was very good and the Congress was well organized.

### **GEP-18 Compaction processes - porosity, permeability and rock properties evolution in sedimentary basins - a tribute to Knut Bjørlykke**

*CONVENERS:* Per Aagaard, Jens Jahren, Paul H. Nadeau, Per Arne Bjørkum

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* This symposium invites lectures and posters addressing some of the key processes controlling compaction, and therefore rock properties: porosity, permeability and fluid flow in sedimentary basins. All natural processes modifying sediments after deposition are referred to as diagenesis in geological literature. This term includes compaction processes responsible for modifying porosity and permeability in porous sedimentary rocks. Compaction can be both mechanical and chemical. Mechanical compaction is a function of effective stress. Chemical compaction involves dissolution and precipitation of mineral grains leading to cement formation. In siliciclastic systems mechanical compaction will take place in uncemented sediments at shallow burial. Chemical compaction will control the overall compaction and strength of the rock during deeper burial when mineral kinetics is fast enough to produce cement. The compaction driven fluid flux in sedimentary basins is a function of the rate of compaction, which may be calculated based on sedimentation rates and porosity/depth curves. Sediment compaction is critical for basin modelling since it determines the rate of density increase as a function of depth for different lithologies. Rock physical properties, including velocities, also vary greatly as a function of primary composition and burial history.

### **GEP-19 Carbonate reservoirs and plays**

*CONVENERS:* Tore Amund Svånå, StatoilHydro, Norway; Joanna Garland, Cambridge Carbonates Ltd., UK

*NUMBER OF PRESENTATIONS:* 8 oral, 7 poster, 9 no-shows

*SYMPOSIUM SUMMARY:* The symposium aimed to cover a broad range of topics dealing with carbonate reservoirs and plays. Contributors were invited for oral or poster presentations within themes that included: Carbonate reservoir characterization; Building and implementing sequence stratigraphic frameworks in carbonate settings; Predicting carbonate reservoir quality and productivity; Climatic influence on carbonate reservoirs; Impact of diagenesis on carbonate reservoirs; Mixed carbonate and siliciclastic reservoirs; Geometry and distribution of carbonate reservoirs; Use of analogues for evaluating carbonate plays; Modelling of carbonate reservoirs; Seismic mapping and carbonate play evaluation. This list of themes illustrates that special challenges are





related to evaluation and characterization of carbonate reservoirs, compared to siliciclastic reservoirs. As carbonate reservoirs are contributing to a significant proportion of the world's hydrocarbon production, they have been subject to a large amount of studies that aim to increase our understanding of these reservoirs. The 'Carbonate Reservoirs and Plays' symposium should be a contribution to widen and deepen this knowledge.

Several contributions that originally were planned for the Carbonates Reservoirs and Plays session were moved to other sessions. In particular this was the case for presentations dealing with outcrop studies.

**GENERAL COMMENTS:** Number of people attending: At the beginning it was approximately 8, at the end of the session there were about 25 there. The overall quality of the presentations was good. Important new insights into the subject of burial/hydrothermal dolomitization were presented by the invited keynote speaker Rudy Swennen and in the talk by Stian Soltvedt et al.

**ANNOUNCEMENTS:** As part of a Geological Society of London initiative, 6 papers from the Carbonate Reservoirs and Plays session will be offered for publication. This thematic set of papers will cover 3 papers from Iran (in Cenozoic and Cretaceous hydrocarbon plays), one paper from southern Iraq (Cretaceous reservoir), a paper from Canada (hydrothermal dolomites), and a paper discussing the Zechstein carbonates in Poland. We look forward to these papers being published and available to the scientific community.

#### **GEP-20 Outcrop studies: Fundamental to petroleum reservoir characterization and modelling (AAPG)**

**CONVENERS:** Peter McCabe, Ernest A. Mancini, Jim Blankenship

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** This symposium will bring together stratigraphers, sedimentologists, petroleum geoscientists, petrophysicists, geophysicists and petroleum engineers to discuss the importance of outcrop and field mapping in understanding stratal architecture and geometry, the fabric of lithofacies and the heterogeneities of petroleum reservoirs. The study of sedimentary facies in surface exposures provides an opportunity to view the variations between and within stratal units at various scales, to study the surfaces bounding the units and the subtle transitions in units. Knowledge of these elements is vital to petroleum geoscientists and engineers in characterizing and modelling flow units within heterogeneous reservoirs and in formulating enhanced recovery strategies. It is crucial to stress to petroleum geoscientists and engineers, for economic reasons, the importance of using outcrop analogues - to delineate subtle variations in the architecture of heterogeneous reservoirs for improving the prediction of flow patterns in stratal units.

## **GEOMORPHOLOGY, SOIL SCIENCE GS**

### **GEOMORPHOLOGY GSM**

#### **GSM-01 General contributions to geomorphology**

**CONVENERS:** Ole Humlum, University of Oslo, Norway; Monique Fort, Centre de Géographie Physique, Université Paris 7 - Denis Diderot, France

**NUMBER OF PRESENTATIONS:** 13 oral, 15 posters, 13 no-shows

**SYMPOSIUM SUMMARY:** Geomorphology is the science concerned with the form of the land surface and the processes which create it. This symposium welcomed contributions within this broad theme, e.g. uplift and subsidence, river action, wind action, chemical reactions in rock weathering, effects of soil properties on slope stability, the role of the vegetation cover, techniques for analysis of slope stability, landscape change over long periods of time, reconstruction of past environments from sedimentary or landform analysis, and the effect of climatic and meteorological conditions on geomorphic processes.

The oral presentations were organized into three sessions, on methods, small scale - short term processes and landforms, and large scale - long term processes and landforms.

**GENERAL COMMENTS:** The three sessions were attended by between 7 and 15 participants. Most presentations were well-illustrated and were completed on time. At least one question or comment followed each presentation. Audience participation was international, covering several subdisciplines of geomorphology, thus providing opportunities to develop new contacts.

#### **GSM-02 Geomorphology and landscape response to global change - a tribute to Olav Slaymaker**

**CONVENERS:** Xiaoping Yang, Institute of Geology and Geophysics, Chinese Academy of Sciences, China; Andrew Goudie, Oxford University, UK, Monique Fort, Université Paris 7, France

**NUMBER OF PRESENTATIONS:** 9 oral, 5 poster, 1 no-show

**SYMPOSIUM SUMMARY:** In all climate zones the landscapes and landforms have been proven to be sensitive to climate changes. This session did address two interconnected issues: 1) How have the landforms and landscapes responded to the Late Quaternary climate changes in various parts of the world? 2) How will the world's landscapes respond to the future climate change (both temperature and moisture as well as changes of magnitude and frequency of extreme events)? The session started with a keynote lecture titled "Why geomorphology matters in global environmental change" by Professor Olav Slaymaker. Topics of other presentations included: a) the processes and trends of retreat and degradation of glaciers and permafrost in the future based on the understanding of past changes; b) the potential changes of the local and regional fluvial, aeolian and lacustrine as well as coastal



systems in relation to climate fluctuations, and c) frequency and intensity changes of geomorphic disasters such as desertification, sandstorms, landslides and debris flows in the past and their potential trends in the future. Through intensive discussions the participants have basically agreed Slaymaker's warning that the issues - effects of deliberate landscape change via land use or land cover change (this may include extractions from, additions to or transformations of elements of the landscape), effects of sea level change on coastal landscapes, and effects of climate, transmitted through hydrology, aridity, vegetation and sediment and solute transport - should be given greater attention in the global change studies in the years to come.

**GENERAL COMMENTS:** The overall quality of presentations was very good, reflecting the recent progress in this field. About 40 people (at peak time) attended the session and there were lively discussions, particular to the keynote talk. As the session took place before the official opening of the Congress, the number of attendees was not as large as we expected.

**ANNOUNCEMENTS:** The possibilities of a special issue of an international journal (CATENA or Quaternary International) are being explored to publish the best papers from this session. At the congress we asked the authors to indicate their preferences.

The next meeting, closely related to the theme of this session, will be the 7th International Conference on Geomorphology, to be held 6-11 July 2009 in Melbourne, Australia. We sincerely hope that many experts will attend this congress (for further details please visit the congress website at [www.geomorphology2009.com](http://www.geomorphology2009.com) or [www.geomorph.org](http://www.geomorph.org)).

### **GSM-03 Karst as a global phenomenon - a tribute to Derek Ford and Paul Williams**

**CONVENERS:** Stein-Erik Lauritzen, University of Bergen, Norway; Timothy C. Atkinson, University College London, UK; Pavel Bosák, Institute of Geology AS CR, Czech Republic

**NUMBER OF PRESENTATIONS:** 14 oral, 2 poster

**SYMPOSIUM SUMMARY:** Professors emeriti Derek Ford (McMaster University, Canada) and Paul Williams (University of Auckland, New Zealand) were both students of Dr. Majorie Sweeting, the 'grand old lady of karst', and undertook their doctoral research based at the universities of Oxford and Cambridge, respectively, although they spent most of their academic careers in Canada and New Zealand. The ideas of these two individuals have spread worldwide through their many students and post docs. By their academic careers, the two of them have indeed revolutionised karst science through new methodology and models. They were authors of the first comprehensive monograph and textbook on karstology in 1989: 'Karst Geomorphology and Hydrology', since revised in their new and expanded second edition (2007) 'Karst Hydrogeology and Geomorphology'. The symposium invited their former students and worldwide colleagues to submit presentations in speleogenesis, karst geomorphology, palaeokarst and karst hydrogeology.

**GENERAL COMMENTS:** Meeting with 20- 30

attendants, good discussions and interesting presentations.

**ANNOUNCEMENTS:** Papers will be collected for a special issue in The International Journal of Speleology.

## **SOIL SCIENCE GSS**

### **GSS-01 Contributions to soil science**

**CONVENERS:** Marie-Agnès Courty, Sonia M.B. Oliveira

**NOTE:** A pre-Congress or post-Congress summary was not received.

## **GEOTECHNOLOGY, REMOTE SENSING GT**

## **ENGINEERING GEOLOGY AND GEOTECHNICS GTE**

### **GTE-01 Contributions to engineering geology and geotechnics**

**CONVENERS:** Roger Olsson, Norwegian Geotechnical Institute, Oslo, Norway; Claudio Margottini, APAT Geological Survey of Italy, Roma, Italy

**NUMBER OF PRESENTATIONS:** 16 oral, 30 poster, 4 cancelled

**SYMPOSIUM SUMMARY:** The aim of the symposium was to present the latest developments regarding investigation methods for characterisation of soil and rock, geological structures and groundwater, as well as the changes in geotechnical properties due to geological processes. The abstracts received covered a wide range of subjects, however most of them fitted well with the main aims of the symposium. The symposium was divided into four subjects; laboratory experiments, field experiments, landslides, and engineering geology, though most of the abstracts were in landslides and engineering geology.

Dr. Margottini's very interesting keynote lecture "Engineering geology and cultural heritage" was presented first. The next presentation was about laboratory testing of colloid silica grout in sand. This was followed by a coffee/tea break. After the morning break there were three presentations concerning field tests; the first regarding SPT tests, the second about reflection seismic and the third about the use of the GeoGauge.

After a two-hour lunch break, four papers regarding different aspects of landslides were presented. One was about the huge landslide on the Machu Picchu citadel, and another was about paleoseismic evidence of surface rupture caused by the 2005 Kashmir earthquake in Pakistan Himalaya and coseismic generated slope conditions. After the afternoon coffee/tea break there were four more presentations. The first two were about the interaction between geology and engineering geology and the other two were in the intersection between engineering geology



and rock mechanics.

In summary, the symposia had a balanced mix covering the entire engineering geology field. There was a lack of discussion but some questions.

*GENERAL COMMENTS:* The oral presentations were in general excellent and the number of people attending the symposia varied from 10 to 30. There were fewer people at the start, and less discussion than hoped for. The poster session was sometimes less visited than expected.

## GEOMECHANICS

## GTM

### GTM-01 Contributions to geomechanics

*CONVENERS:* Fabrice Cuisiat, Norwegian Geotechnical Institute, Norway; Anne Skjærstein, RWE-DEA, Norway; Erling Fjær, Sintef Petroleum, Norway

*NUMBER OF PRESENTATIONS:* 10 oral, 7 poster, 1 no-show

*SYMPOSIUM SUMMARY:* The symposium was dedicated to any contribution related to geomechanics including theoretical aspects, computational and analytical methods, constitutive modelling, validations and field examples. Focus was put on the integration between geomechanics and geology, in particular case histories where geomechanics and geology were strongly interrelated. A parallel goal of the session was to promote exchange of information across the geo-disciplines and between research organizations, industry and academia.

A keynote lecture discussed the mechanisms and multiphysical processes in environmental geomechanics, as well as provided some practical applications. The rest of the symposium was divided into four groups of presentations dealing with geomechanics, landslides, formation stress and fracturing. Finally a Poster session closed the symposium.

The contributions to the symposium covered a wide range of topics, such as: Laboratory testing and geomechanical properties of geological media; In situ rock stresses; Wave propagation in yielding materials; Fracturing, micro-mechanics; Multi-physics processes in environmental geomechanics; Landslides monitoring.

*GENERAL COMMENTS:* The quality of the oral presentations was generally good, although some contributors had difficulty to limit their presentation to the allocated time. The contributors and audience covered a broad range from academia, research centres to oil companies. However, the total number of contributors and participants was small (maximum 25) so that discussions were limited to few questions after each presentation.

*ANNOUNCEMENTS:* See the GALAHAD project (Advanced Remote Monitoring Techniques for Glaciers, Avalanches and Landslides Hazard Mitigation) at <http://www.galahad.eu/>.

## NEW METHODS, NEW TECHNOLOGIES AND NANOGEOSCIENCE GTN

### GTN-01 General contributions to new methods and technologies

*CONVENERS:* Jean-Jacques Royer, Andrea G. Fabbri

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* During the last decade, new methods and technologies have appeared on the market and are now available to geoscientists for investigating the Earth. Among them are: GPS, real time accessible remotely sensed databases, mobile devices such as cellular phones connected to image databases or to the Internet, global earth visualization tools, on-site diagnostics geochemical or geophysical devices, portable seismic sub-surface equipments, laser scanner capturing 3-D structures of the Earth surface, including powerful computer resources that are now usable in the field to facilitate and improve resource appraisal works. This situation was not imaginable ten years ago and has at times drastically changed the way geologists work in the field and in the lab. Can we predict now what will be next in the forthcoming ten or twenty years and the type of technological and methodological revolution geologists must be prepared for? This is one of the topics this session wants to address and opens its discussion to practitioners in the geosciences. Contributions related to the field of quantitative geology are solicited including: spatial prediction models, hazards prediction and risk analysis assessment, new technologies for landslide hazard assessment and management, quantitative methods (indicators, indices...) for environmental quality, best practice and governance in environmental management studies, image processing and remote sensing applied to resource evaluations, GIS technologies. Theoretical and methodological presentations together with contributions oriented on case studies are welcome.

### GTN-04 Visualization and innovative techniques in geosciences

*CONVENERS:* Jean-Jacques Royer, Qiuming Cheng

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* This session aims at investigating suitable new advanced visualization techniques to be used in Geosciences and Geographic Information System. It will cover all aspects of visualization from multi-valuated time-dependent quantitative data to qualitative ones, including 3-D or 4-D modeling. Presentations of new acquisition tools or devices, such as virtual reality visualization technologies, methodological and conceptual papers together with contributions oriented on case studies are welcome. Technologically advanced approaches based on parallel computing using computer grids and/or parallel graphic processor units are also considered. Methodological presentations are requested in various fields of visualization





such as GIS, remotely sensed data, massive grid models, processing based on graphic parallel units and computer network (grid computing) applications in geosciences. Exchanges and visualization of huge geological datasets or numerical models, especially through the web, are considered. The geophysicist (and astronomers) community are developing approaches based on the Grid to process the deluge of data provided by the 3-D and 4-D acquisition seismic campaigns. Similar approaches can be envisaged for processing huge reservoir models (Giga grid) as well as inversion or fluid flow modelling problems. This session would like to offer the practitioners to debate and discuss the future needs in these fields. Case study presentations are requested in various fields of geology such as (but not exclusively) multi-spectral, time and spatial remotely sensed data, GIS, 3-4 D seismic, reservoir modelling, hydrogeology, remote sensing, mining models, mineral appraisal studies, geochemical prospecting, natural resource evaluation, risk analysis.

#### **GTN-05 Future trends in 3D and 4D modelling in geosciences**

*CONVENERS:* Guillaume Caumon, Nancy Université, France; Charles H. Sword, Chevron Exploration Technology Company, San Ramon, CA, USA

*NUMBER OF PRESENTATIONS:* 14 oral, 2 no-shows

*SYMPOSIUM SUMMARY:* The wealth of 3D geological modelling packages and the spreading of 'pretty pictures' of 3D geo-models on the web and in publications may give the wrong impression that geological modelling is mature, and is only a business for software engineers. We believe that there is still a lot of fundamental and applied multidisciplinary research to be conducted before geological modelling reaches its full potential, leading to better quantifications of geological processes, better assessments about natural hazards and better management of underground resources.

In this session, we had presentations about forward modelling techniques (plate tectonics, fault-propagation folding, sedimentary processes) and geometric modelling honoring subsurface data (channel modelling, structural modelling). Some case studies about model building also showed the interest of new technologies for subsurface data integration.

The scale range was very large, from the global earth scale down to the fossil scale, including reservoir and ore deposit scales. One future challenge for geological modelling will be to consider several scales at a time, e.g. the plate tectonics and the reservoir.

It is interesting to mention that two of the presentations aiming at reconstructing subsurface geometry or heterogeneities conditioned to data also had a focus on honoring some physical principles, namely depositional processes and deformation mechanics. This suggests that the gap between pure data-fitting and physics-based modelling methods is reducing, which is simply excellent for the geosciences community as a whole.

*GENERAL COMMENTS:* The overall presentation quality was good to excellent, except for two no-shows. The audience was made up of about 20 to 50 people,

although more attendance could probably have been achieved if related sessions had not been held simultaneously (MAG sessions). Each talk was followed by questions from the audience, which continued during coffee breaks.

*ANNOUNCEMENTS:* A special issue of Computers and Geosciences for the GTN sessions as a whole is currently being discussed with the editors.

## **REMOTE SENSING      GTR**

### **GTR-01 General contributions to geological remote sensing**

*CONVENERS:* Gerhard Bax, University of Uppsala and RockSpace, Sweden; Stuart Marsh, British Geological Survey, UK; Frank J.A. van Ruitenbeek, International Institute for Geo-Information Science and Earth Observation (ITC), Netherlands

*NUMBER OF PRESENTATIONS:* 8 oral, 7 poster, 5 no-shows

*SYMPOSIUM SUMMARY:* Remote sensing technology is used in Earth Sciences for a great number of purposes. Early attempts were stereo pairs of aerial photographs, thus providing information on spectral reflectance, textural information and elevation of the land surface. In the past decades, space born imagery with better spectral, but far less spatial resolution was used. Now the Earth science community has access to multispectral imagery with meter resolution and elevation derived from the same (ASTER) or other sensors (SRTM). This general session invited contributions spanning over a wider field than the more specialized sessions GTR-02 - 05. The previously announced session GTR-03, with its 7 oral presentations on remote sensing in Arctic and Alpine environments was amalgamated into this general session for practical reasons.

*GENERAL COMMENTS:* The audience was estimated at between 20 and 50 people. As most of the speakers finished their presentations in time, we had time for valuable and interesting discussions.

### **GTR-02 Geological mapping using satellite techniques**

*CONVENER:* Jean-Paul Deroin, University of Paris-Est, now with the University of Reims, France

*NUMBER OF PRESENTATIONS:* 10 oral, 6 poster, 3 cancelled

*SYMPOSIUM SUMMARY:* The objective of this session was to emphasise the methodological and applied recent progress in geological remote sensing, particularly using optical data. During the last years new satellites and spacecrafts have been launched, illustrating the vitality of Earth observation in a great number of countries, for example Spot-4 and Spin-2 (1998), IKONOS, Landsat-7, EOS-Terra, and Oceansat (1999), EO-1 and EROS (2000), QuickBird and PROBA (2001), ENVISAT, Spot-5, Orbview-3, and EOS-Aqua (2002), Formosat-2 (2004), Cartosat-1 (2005), ALOS and Komsat-2 (2006)... This



great diversity of new sensors resulted in advances in multispectral and superspectral imageries complementary to hyperspectral field and airborne studies and very high resolution sensors with less than 1-m resolution. One of the goals of this session was to illustrate the interest of remote-sensing data in operational geological mapping programmes, but this point was not really developed during the symposium. The session also dealt with other aspects of applied Earth sciences such as mining geology and hydrogeology, where geology plays a key role. These themes were successfully dealt with.

The interest of the ASTER sensor has been particularly emphasised by many authors (lithology, mineral exploration). The following sensors have been also extensively used: Landsat TM and/or ETM+, Spot 5, QuickBird, Meteosat. The combination of satellite data and airborne data (geophysical or optical) has frequently been mentioned. From a thematic point of view the main geological topics were tectonics (5 presentations), geological mapping (4), metallogeny (3), and hydrogeology (2).

**GENERAL COMMENTS:** Most of the oral presentations were followed by vivid discussions. More than 50 persons participated at the symposium. Unfortunately, the late-in-the-day scheduling of the poster session (17:00-19:00 PM) did not allow discussions with all authors (only 3 of 6 were met).

**ANNOUNCEMENTS:** An initiative has been launched for publishing some of the papers presented during the symposium, also including remote-sensing presentations in the sessions GTR-01, GTR-03 and GTR-04 (J.P. Derooin, G. Bax, S. Marsh, A. Crosta, J. Taranik, W. Paradella and J. Dehls). The international scientific journal *Photo Interpretation* (Editor ESKA, Paris, France) has accepted to consider a special issue.

#### **GTR-04 Hyperspectral remote sensing and image spectroscopy**

**CONVENERS:** Alvaro P. Crósta, University of Campinas, Brazil; James V. Taranik, University of Nevada/Reno, USA  
**NUMBER OF PRESENTATIONS:** 9 oral, 3 poster, 4 no-shows

**SYMPOSIUM SUMMARY:** Significant advancements in remote sensing instrumentation in the past decade have moved the leading edge of geological remote sensing from multispectral satellite imagery into high spectral resolution hyperspectral sensors operating onboard airplanes and satellites. This technological leap has been supported by mineral spectroscopy, an analytical technique which has become operational for mineral analysis due to the development of ground based field portable high resolution spectrometers. The combination of mineral spectroscopy and hyperspectral remote sensing benefited a large number of applications of geological remote sensing, in particular mineral exploration and lithologic mapping. As a result, geologists are now able to produce much more detailed geological and mineral exploration information using these new tools, even in remote and inaccessible terrains. At the same time, novel image processing techniques are being developed to cope with these types of

remote sensing data, providing the means for extracting the desired geological information. Oral and poster presentations in this symposium covered all the main issues regarding data acquisition and processing, different types of applications of hyperspectral remote sensing, and discussed current and future technological and application trends. The two keynote speakers presented an excellent overview of key issues on these topics.

**GENERAL COMMENTS:** Almost all oral presentations were of top quality, without a single no-show. Unfortunately there wasn't much time left for discussion (two minutes at the most) after the presentations. The number of no-shows in the poster session was significant. The number of attendants during the oral session was about 40 on average.

**ANNOUNCEMENTS:** There was an offer by Prof. Jean-Paul Derooin, Chief-editor of *Photo Interpretation*, an international scientific journal published by a private editor, ESKA, Paris, France, to publish a special issue of the journal devoted to the remote sensing sessions (GTR-01 through GTR-05) held during the 33IGC.

#### **GTR-05 Microwave remote sensing**

**CONVENERS:** Waldir Renato Paradella, National Institute for Space Research (INPE), Brazil; John Dehls, Norwegian Geological Survey, Norway

**NUMBER OF PRESENTATIONS:** 17 oral, 1 poster, 3 no-shows

**SYMPOSIUM SUMMARY:** The papers presented during the two-day sessions of the Microwave Remote Sensing symposium confirmed the very promising era of Synthetic Aperture Radar (SAR) technology that geoscientists are facing with the advent of new orbital systems such as ENVISAT/ASAR, ALOS/PALSAR, TerraSAR-X and RADARSAT-2. SAR technology has proved to be a strategic data source for several fields of applications in the Geosciences ranging from conventional monoscopic (2D) and stereoscopic (3D) visualization for topographic and geological mapping (rock discrimination/structural analysis), data fusion techniques for mapping and mineral exploration, environmental monitoring and management of man-induced disaster or natural geohazards. The presentations were dominated by a definitive change in the scheme of deriving information towards the use of more quantitative approaches mainly based on Differential Interferometric SAR (DInSAR). Two sophisticated DInSAR techniques were discussed in depth: Permanent Scatter SAR Interferometry (PSInSAR) and Small Baseline Subset (SBAS). Examples of detection of subtle terrain deformation through DInSAR were presented covering distinct application fields: detection of fault movements related to earthquakes, oil and gas exploitations, volcanic activities, mining induced surface deformation, landslide monitoring, subsidence analysis in aquifer and infrastructure monitoring. In addition, two examples of applications based on ground-based interferometric real-aperture radar were also presented for geohazard areas (glacier slide measurements and active rockslides). Finally, details of two important radar commercial missions, TerraSAR-X (Germany) and RADARSAT (Canada), were





also addressed.

**GENERAL COMMENTS:** The Microwave Remote Sensing symposium during this part of the 33IGC provided an overview of the main trends in current SAR applied to Geosciences with presentations of experts from ten countries (Norway, Brazil, Canada, China, Germany, Italy, Japan, Slovenia, Spain, and USA), which highlighted the importance of this fundamental remote sensing technology in the Geosciences.

## HISTORICAL GEOLOGY, PALEONTOLOGY HP

### PALEONTOLOGY HPF

#### HPF-01 General contributions to paleontology and historical geology

**CONVENERS:** Else Marie Friis, Swedish Museum of Natural History, Sweden; David L. Bruton, University of Oslo, Norway

**NUMBER OF PRESENTATIONS:** 32 oral

**SYMPOSIUM SUMMARY:** Palaeontology and historical geology is a multifaceted discipline spanning from evolutionary biology to isotope geology and from microscopic algae to feathered dinosaurs. Exciting developments over the past years include the finding of new, exquisitely preserved fossils from many different time periods and different palaeogeographic areas and the introduction of new methods for high-resolution and non-destructive studies of ancient organisms at cellular and ultrastructural level. The field has also witnessed an increased interdisciplinary effort in such areas as dating of phylogenetic trees and evolutionary events in plant and animals, and the study of diversity and ecosystem changes over time. This symposium welcomed contributions to palaeontology and historical geology that could not be accommodated in any of the more specialised symposia described in the programme.

Compared with previous geological congresses over the past decade, the Oslo meeting attracted far more interest in palaeontology. This general session was held over one whole day (Friday August 8th) and half the morning on the following day. In total 32 lectures were presented and the topics covered aspects of Precambrian (Ediacaran) micro and macro palaeontology, radiolarian biostratigraphy, Lower and Upper Palaeozoic palaeoenvironments and faunas, Jurassic marine reptiles, and the use of recent microfaunas to interpret fossil microfaunas.

**GENERAL COMMENTS:** There were no posters associated with this session. Audiences varied from 10-25. There were no no-shows. The congress organisers are to be congratulated on arranging a most impressive PowerPoint facility for all sessions.

#### HPF-07 Rise and fall of the Ediacaran (Vendian) biota

**CONVENERS:** Patricia Vickers-Rich, Monash University,

Melbourne, Australia; Mikhail Fedonkin, Paleontological Institute, Russian Academy of Sciences, Moscow, Russia; Jim Gehling, South Australian Museum, Adelaide, Australia

**NUMBER OF PRESENTATIONS:** 12 orals, 5 poster

**SYMPOSIUM SUMMARY:** The symposium was organized by the coordinators of UNESCO IGCP493 (M. Fedonkin, P. Vickers-Rich and J. Gehling). Participation in this program was across the board from graduate students to seasoned professionals as well as a number of cross-disciplinary attendees. Topics also ranged widely across systematics of the unique Ediacaran metazoans and carbonaceous algal remains to tectonics, geochemistry to palaeoecology and functional morphology and even reconstruction art. The symposium encouraged cross-discipline discussion and insights for future international projects. Exemplary titles include Rick Squire et al.'s "Supermountains and Earth's O<sub>2</sub>-rich Elixir of Life", Ekaterina Serezhnikova's "Bacterial Symbiosis: The Driver for Morphological Peculiarities of the Vendian Organisms?", Maxim Leonov's "The Terminal Neoproterozoic 'Gap' in the Evolutionary Progress of the Algal Flora: Artifact or Reality?", G. Narbonne et al.'s "Growth and Development of Early Ediacarans", Jim Gehling's and Mary Droser's "Mat Communities of the Ediacara Biota in South Australia", Shu-hai Xiao et al.'s "Wide Distribution of Horodyskia- and Palaeopascichnus-like Fossils in Upper Ediacaran Cherts of South China", Fedonkin et al.'s "A Neoproterozoic Chordate with Possible Affinity to the Ascidians" and P. Trusler and P. Vickers-Rich's "Portraits of the Past. Scientific Reconstruction Art". This symposium was also a forum for the planning of future IGCP projects.

**GENERAL COMMENTS:** This was a lively symposium attended by approximately 50 participants and resulted in excellent discussion, and followed on by further discussion of the Cryogenian.

This meeting marks the final of IGCP493 and discussions were underway for submission of a new IGCP project to follow up discoveries made during this project. New directions proposed were to search for the predecessors of the Ediacarans as well as the progeny - pushing the known envelope of this enigmatic assemblage of the late Neoproterozoic.

**ANNOUNCEMENTS:** Two books published in late 2007 are the direct results of IGCP493 (2003-2008): Fedonkin, M. A., Gehling, J., Grey, K., Narbonne, G. & Vickers-Rich, P., 2007. "The Rise of Animals. Evolution and Diversification of the Kingdom Animalia". Johns Hopkins University Press, Baltimore; and Vickers-Rich, P. & Komarower, P., eds., 2007. "The Rise and Fall of the Ediacaran Biota". Geological Society of London, Special Contribution 286, London.

#### HPF-09 Marine and non-marine Jurassic; Global correlation and major geological events

**CONVENERS:** Vivi Vajda, Lund University, Sweden; Jingeng Sha, Nanjing Institute of Paleontology, China

**NUMBER OF PRESENTATIONS:** 13 oral, 2 poster

**SYMPOSIUM SUMMARY:** The Jurassic period is an important interval in the evolution of life on Earth, and the



study of Jurassic sediments is just as thrilling and exciting for geoscientists as it is economically significant for the companies exploiting hydrocarbons. The Jurassic, which stretches from around 200 to around 145 million years ago, and thus covers a time span of about 55 million years, encompasses some of the most significant global events in the planet's geological history, including mass extinctions, global greenhouse conditions, sea level changes, anoxia events, major volcanic activity, the early stages of Pangean breakup, and changes in marine and non-marine ecosystems.

The principal goal for this symposium was to gather scientists linked to the IGCP Project 506 and other scientists with interest in the topic "JURASSIC - BIODIVERSITY AND CLIMATE" to contribute to the main goals, presenting their data on stratigraphy, paleogeography, paleoenvironmental studies, geochemistry and biodiversity trends for the Jurassic.

**GENERAL COMMENTS:** The lectures were given during the 8th of August, all of them interesting, high quality with a broad scientific coverage. Talks included marine invertebrate groups, terrestrial fauna and flora, geochemistry and sedimentology. Geographical coverage was outstanding including results from Scandinavia, Russia, Argentina, central Europe and Mexico. Additionally, the two invited keynote speakers gave important and high profile talks on the Australian and the Chinese Jurassic, respectively. Their participation was supported by the 33rd IGC Geohost program, which made these important contributions possible and for which we are very grateful.

The session was well attended by a relatively large group of international scientists, and discussions were intense when debating the interpretations of the Triassic-Jurassic mass extinction event.

The symposium was followed by a post-Congress excursion to Southern Sweden and the island of Bornholm, Denmark.

**ANNOUNCEMENTS:** Publications related to the symposium: Special issue of GFF: "Jurassic - biodiversity and climate" to be published in March 2009. Next meeting in Bucharest, Romania in September 2009.

#### **HPF-10 Dawn of the Danian**

**CONVENERS:** Jeffrey Stilwell, Monash University, Australia; Eckart Håkansson, Institute of Geography and Geology, Denmark

**NUMBER OF PRESENTATIONS:** 4 oral, 1 cancelled or no-show

**SYMPOSIUM SUMMARY:** The symposium was based on research of the IGCP 522 working group. The keynote address was by Dr Håkansson et al., who provided firm, convincing evidence of the survivorship of ammonites at the K-Pg (a.k.a. K-T) boundary into the Danian in the Danish basin. This 'survivorship without recovery' scenario of specific ammonite groups such as *Baculites* and *Hoploscaphites* has also been established in the Maastricht area, and similar patterns are present in other macroinvertebrate and vertebrate groups such as the enigmatic record of non-avian dinosaur remains (seemingly not reworked) in the early Danian of the Chatham Islands,

as discussed by Dr Jeffrey Stilwell of Monash University. Dr Håkansson went on in his second talk to describe the inferred 'poisonous' seas of the Danian after the mass extinction, reflecting the depauperate nature of faunas with low-Mg skeletons, and resultant low diversity for a protracted interval. Dr Stilwell et al. discussed the evidence of a higher survivorship magnitude in the southern high latitudes of ca. 40% after the extinction and the origins of both macroinvertebrate and vertebrate taxa in the Austral Danian. One of the more significant findings in recent years is the discovery of the world's oldest stem penguins at ca. 66-64 Ma (most likely just older than 65 Ma) by Stilwell and his team, and astoundingly, a diversity of modern birds (up to four species in one horizon) at this time in this remote region of the SW Pacific. Finally, Dr Gallala et al. presented her group's findings on foraminiferal extinction and survivorship in complete and continuous sections in Bidart (SW France), as exemplified by their very detailed, high resolution biostratigraphic analyses. Particularly significant are new data on the composition of planktonic opportunistic forms in the early Danian and the phases of their recovery during the Danian interval.

**GENERAL COMMENTS:** The presentations were moderately well attended, despite the late-in-the-day scheduling of the session. One paper by F Cabellaro et al. on Foraminifera was not presented. Several researchers approached us after the session to relay how impressed they were with the talks and the wealth of new data from the Danian across a diversity of taxonomic groups.

#### **HPF-12 Environmental micropaleontology: Past, Present, Future**

**CONVENERS:** Valentina Yanko, Odessa I.I. Mechnikov National University, Ukraine; Ronald Main, University of Delaware, USA

**NUMBER OF PRESENTATIONS:** 16 oral, 12 poster, 8 no-shows

**SYMPOSIUM SUMMARY:** Micro- and meioorganisms (e.g., foraminifera, ostracoda, radiolaria, diatoms, nannoplankton, dinoflagellates, pollen, spores) are among the main taxa studied in micropaleontology. The value of these groups in biostratigraphy and paleoenvironmental reconstructions is well known. These taxa are also very sensitive to environmental disturbances, both natural (e.g., global warming, anoxia, oil-gas seepages, hypersaline and low salinity environments, earthquakes) and anthropogenic (pollution by heavy metals, hydrocarbons, domestic sewage, fertilizers). These taxa can therefore be used as indicators of stressed environments. This is especially important for the coastal zone, which is strongly affected by human intervention and where these organisms are widely distributed. The symposium will discuss the value of micro- and meioorganisms for a variety of applications, many of which are not generally associated with traditional micropaleontology, but which may represent the future of the field.

**GENERAL COMMENTS:** There was a lively discussion regarding the future of Environmental Micropaleontology with main emphasis on experimental ecotoxicological



methods and molecular approaches to study hard-shelled micro- and meioorganisms. Contributions to the symposium were of a medium and high quality. Number of attendees was about 30 people.

**ANNOUNCEMENTS:** The 6th International Conference "Environmental Micropaleontology, Microbiology and Meiobenthology" EMMM'2010, Paleontological Institute, Russian Academy of Sciences, Moscow, Russia.

**Publications:** Special volume of per-reviewed journal *Environmental Micropaleontology, Microbiology and Meiobenthology*.

### **HPF-13 Major events in the evolution of marine biota**

**CONVENERS:** David Harper, University of Copenhagen, Denmark; Rong Jiayu, Chinese Academy of Sciences, China

**NUMBER OF PRESENTATIONS:** 15 oral, 4 posters, 2 no-shows

**SYMPOSIUM SUMMARY:** Marine ecosystems have evolved through at least 3.8 Ga of Earth history. Metazoan life has participated in at least five unique evolutionary faunas, commencing with the Neoproterozoic Ediacara fauna and ending with the Modern fauna that dominated Mesozoic and Cenozoic marine environments. These faunas are generally partitioned by extinction and subsequent radiation events; for example the Paleozoic evolutionary fauna was established during the Great Ordovician Biodiversification and largely disappeared during the end-Permian extinction. Within each evolutionary fauna characteristic ecological systems were developed, involving new community and guild structures, innovative bioturbation and tiering strategies, trophic chains and predator-prey interactions together with distinctive organism-substrate relationships.

This symposium targeted both the ecological and taxonomic changes that occurred during major events in the history of the marine biosphere and offered a strong focus on multidisciplinary solutions to our understanding of these changes in the biodiversity and biocomplexity of the marine ecosystem through deep time.

**GENERAL COMMENTS:** Attendance number remained constant at about 25-30 participants throughout the day. Since there were a number of competing palaeontology and stratigraphy sessions there was considerable traffic in and out of the session, and a number of delegates expressed their disappointment at missing presentations since they were elsewhere. A few of the papers, such as those on the Ordovician biodiversification and extinction, the P/T boundary, the K/T boundary and that on chemosynthetic biotas generated good discussions.

### **HPF-14 Major events in the evolution of terrestrial biota**

**CONVENERS:** Stephen McLoughlin, Swedish Museum of Natural History, Stockholm, Sweden; Zhou Zhonghe, Chinese Academy of Sciences, Beijing, China

**NUMBER OF PRESENTATIONS:** 8 oral, 1 poster

**SYMPOSIUM SUMMARY:** Recent discoveries of exceptional fossils have significantly advanced knowledge of the evolution of Earth's terrestrial biota. Colonization of

the land allowed organisms to exploit a wide range of new resources. Plants and animals adapted to the pressures of the terrestrial environment by adopting novel body plans. The development of diverse terrestrial ecosystems profoundly altered Earth's weathering regime, hydrological cycle, atmosphere and nutrient pathways. This symposium aimed to highlight major events in the evolution of the terrestrial biota, in terms of both paleobiological innovations and adaptations to paleoenvironmental crises, in order to better resolve the evolution of Earth's terrestrial ecosystems over the past 400 million years. The symposium was designed to address aspects of: early terrestrial ecosystems; high-resolution biostratigraphy and dating of major terrestrial events; architectural innovations and reproductive strategies in land animals and plants; animal-plant coevolution; biotic interaction in the fossil record; paleoclimatic and paleogeographic changes and their impact on biotic evolution; Mesozoic and Cenozoic non-marine trace fossils and lagerstätte (e.g. sinter deposits and the Jehol biota); terrestrial adaptations to polar environments; mechanisms for macroevolution of major animal and plant groups in view of advances in both molecular and developmental biology; and the sedimentology and geochronology of fossil-bearing terrestrial deposits.

**GENERAL COMMENTS:** This symposium covered terrestrial biotas ranging in age from Devonian to Cretaceous. Presentations dealt with fossil faunas, floras and microbial ecosystems. Results especially focussed on improved age and palaeoenvironmental interpretation of fossil biotas, and illustrated examples of exceptional biotic preservation including silicified hot-spring communities, stromatolite-encrusted lacustrine vegetation, pristine pteridosperm cuticle assemblages, opalized austral high-latitude biotas, and the remarkable Cretaceous Jehol biota. The symposium was well-attended with keen debate on a broad range of topics.

**ANNOUNCEMENTS:** No proceedings volume is planned specifically for this symposium. However, contributions associated with this symposium topic have been invited to link with those of 33IGC symposium HPF-09 (Marine and non-marine Jurassic; Global correlation and major geological events) for inclusion in a special volume of GFF to be guest edited by Dr Vivi Vajda, Lund University.

### **HPF-15 Mining the fossil record through geoinformatics**

**CONVENERS:** Anthony D. Barnosky, University of California, Berkeley, CA, USA; Marc A. Carrasco, University of California, Berkeley, CA, USA

**NUMBER OF PRESENTATIONS:** 6 oral

**SYMPOSIUM SUMMARY:** A growing area in geoinformatics is the assembly of paleontological and geological data in electronic databases, designed for a myriad of purposes that range from addressing specific research questions to keeping track of specimen collections. These newly assembled, massive datasets provide new ways to attack important paleontological, ecological and geological questions, including (1)



evolutionary mechanisms at macro- through micro-scales, (2) response of species and biotas to environmental changes, (3) ecological dynamics through geological and ecological time, (4) interpretation of past and future climate dynamics, and (5) establishing long-term ecological baselines against which to compare ongoing global changes. This symposium showcased how researchers are using geoinformatics to study these and related topics, as well as to present methodological advances in the field of geoinformatics. Among the topics covered were new developments in Quaternary paleoecology in Mexico, South America, and the United States; using fossils to define biodiversity baselines for assessing biodiversity decline into the future; and using fossil mammals as paleoclimate proxies for precipitation.

**GENERAL COMMENTS:** Of particular value were follow-up discussions by an international group of paleontologists to develop methods for integration of information from various independent database efforts to attack questions about evolution and ecology on the global scale.

**ANNOUNCEMENTS:** Participants were enthusiastic about future meetings to initiate international collaborations on geo-bioinformatics projects.

#### **HPF-16 Correlation between the marine and terrestrial realms: Problems, solutions, applications**

**CONVENERS:** Karen Dybkjær, Geological Survey of Denmark and Greenland, Denmark; Sofie Lindström, Geological Survey of Denmark and Greenland, Denmark

**NUMBER OF PRESENTATIONS:** 4 oral, 1 poster

**SYMPOSIUM SUMMARY:** The aim of this symposium was to demonstrate various aspects of sea-land correlation and to present potential solutions to these problems by bringing together researchers from many different subdisciplines, e.g. stratigraphy, sedimentology, palynology, biostratigraphy, geochemistry, etc. Six oral presentations were planned, but two presentations were cancelled; Marie-Agnes Courty's flight got delayed and Ali Al-Juboury never turned up. One poster was included in the symposium.

**GENERAL COMMENTS:** The quality of the presentations were in general very high, but unfortunately only 10-15 people attended. Only a few, shortlived discussions arose, mainly concerning the Triassic-Jurassic boundary.

#### **HPF-17 Trace fossils - ichnological concepts and methods**

**CONVENERS:** Dirk Knaust, StatoilHydro, Norway; Richard G. Bromley, University of Copenhagen, Denmark

**NUMBER OF PRESENTATIONS:** 15 oral, 7 poster

**SYMPOSIUM SUMMARY:** The intention of this symposium was to present new results and ideas in the field of ichnology with special focus on ichnological concepts and methods. Although not all submissions strictly lived up to this scope, a broader frame of presentations was allowed and no paper had to be rejected. The study of trace fossils, ichnology, enjoys great popularity amongst palaeontologists and sedimentologists mainly because of its value in the reconstruction of palaeo-

environments. The early concept of ichnofacies zonation has been continuously refined and the constituent ichnocoenoses are widely used in distinguishing sub-environments. Neo-ichnological studies play an important role in understanding both simple and complex trace fossils. The behaviour of vertebrates can be better understood by studying their tracks, trails, burrows, nests, bite traces and coprolites. Ichnofabric analysis serves in solving problems when trace fossils and their tiering patterns are available in either cored well or outcrop sections. Bioturbation modifies sediments considerably and the destructive effect of bioerosion is a major agent in reef and hardground substrates. Key stratigraphic surfaces become obvious when employing ichnology and can be used in sequence stratigraphic analysis. Certain ichnotaxa are even useable for biostratigraphy, backed by the progress achieved in ichnotaxonomy. Recent advances in ichnology show the immense impact of infaunal organisms in generating biogenically enhanced porosity and permeability, with implications for hydrocarbon and aquifer reservoirs. The symposium has shown the progress made in the application of ichnological concepts and methods in continental to deep-marine environments from the Vendian to the Recent and certainly left its impact on the academic and industrial arena of geoscience.

**GENERAL COMMENTS:** Despite logistic problems (train cancellation, Oslo tunnel closure and delay) in the beginning, the symposium developed into a successful meeting of ichnologists and interested geoscientists with an average number of participants between 20 and 30. The quality of the presentations varied but was good overall. Most of the oral and poster presentations got time for questions and discussions. Three keynote talks were given by invited speakers and each of them opened one block of lectures and attracted many participants. Especially the link to Dolf Seilacher's "Fossil Art" exhibition organised and sponsored by StatoilHydro was an eye-catching promotion for the Trace fossils symposium.

**ANNOUNCEMENTS:** The symposium on trace fossils in Oslo is only one of the numerous activities of the busy community of ichnologists and is reflecting the strong interest and applicability of this science to solve a number of problems. Related meetings include the "Second Congress on Ichnology" held in Krakow in August, a GSA symposium in honour of Al Curran and a special session on ichnology during the AAPG Conference in Cape Town in October. Likewise, a wealth of publications is currently dealing with special aspects of ichnology and several books summarise the new trends.

### **PRECAMBRIAN GEOLOGY**

### **HPP**

#### **HPP-01 General contributions to Precambrian geology**

**CONVENERS:** Raimo Lahtinen, Geological Survey of Finland, Finland; Simon Wilde, Southern Cross University, Australia



**NUMBER OF PRESENTATIONS:** 15 oral, 7 poster, 9 no-shows

**SYMPOSIUM SUMMARY:** The Precambrian covers most of the Earth's history and spans key events, including the formation of Earth, onset of plate tectonics, irreversible oxidation of atmosphere and hydrosphere to the evolution of complex multicellular organisms, including the first animals. There is still a controversy when modern-type plate tectonics started. Subduction-type processes probably operated already during the Neoproterozoic or earlier but eclogites and UHP rocks are rare before the Neoproterozoic era. The exponential decline of Earth's radiogenic heat production has affected the formation and evolution of continental crust, lithospheric mantle and the style of plate interaction. Crustal growth is dominantly a Precambrian phenomenon and the net crustal mass input from (Meso-) Neoproterozoic to present seems to be only 10-20% or less. The Archean-Proterozoic transition is one of several critical intervals in Earth history when the terrestrial systems were experiencing rapid, global-scale changes seen as worldwide occurrences of glaciation, red beds and carbon isotope excursion. The role of Precambrian supercontinents Kenorland, Columbia and Rodinia is very important in understanding the mantle dynamics, crustal growth and hydro-atmospheric evolution of the Earth system. For this general symposium, we invite presentations on the field aspects, petrology, geochemistry, structural geology and isotope geology of Precambrian geology and presentation of models bearing on the evolution of Precambrian lithosphere.

The first part of the symposium concentrated on the Archean. Simon Wilde, a keynote lecturer, emphasized the complex nature of events in the Eoarchean of the North China Craton seen in the emplacement of several generations of trondhjemitic prior to 3.63 Ga. Goodenough gave an overview of the Archaean Antongil Block, northern Madagascar and how it may be correlated with the Dharwar craton of India. She presented data, in another presentation, of c. 2500 Ma age for a terrane boundary in the Lewisian Gneiss favoring initial terrane assembly within Laurentia. Slabunov described the geology of the Belomorian province in the Fennoscandian Shield and how the occurrence of Archean ophiolitic bodies, eclogites and island arc-type volcanism in an Archean collision zone can be correlated with Phanerozoic ones. Mints described the deep crustal structures of Neoproterozoic Volgo-Uralian and their possible plume-related origin.

The second part included several presentations on the evolution of the Paleoproterozoic in central Sweden based on studies in relation with disposal of highly radioactive nuclear waste. Michael Stephens discussed the tectonic styles of the region and proposed a conceptual model for the tectonic evolution. Poster by Hermansson et al. further elaborated the model. Carl-Henric Wahlgren described in more detail the geological evolution of the Laxemar-Simpevarp site. Hans Mattson and Håkan Isaksson described how geophysical data can be used in delineating the nature and extent of deformation zones, and Oystein Nordgulen presented a study on the kinematic history of the Forsmark area. Chris Juhlin presented detailed seismic

studies on three sites indicating sub-horizontal reflectors at 2-5 km depth, either from fracture zones or mafic sheets.

In the afternoon the main focus was on the Meso- and Neoproterozoic. Giulio Viola presented a kinematic evolution model for the Precambrian "Mylonite Zone" of the Sveconorwegian orogen. Dmitry Gladkochub presented new geochronological data that reveal a c. 1 billion year gap in igneous activity and the absence of sedimentary sequences with ages between c. 1.7 and 0.7 Ga in southern Siberia. Svetlana Anisimova discussed biostratigraphical and historical-geological data in southern Siberia and implications to its Meso-Neoproterozoic evolution. Elmira Nalivkina and Evgeni Sharkov presented ideas related to the evolution of Earth's crust.

Posters included Døssing's poster on the continuation of inferred Paleoproterozoic structures from the west to the east coasts of central Greenland. Costa and Oliveira presented data on Paleoproterozoic arc-continent collision from the Sao Francisco craton, Brazil. Mansfeld presented a tectonic model for the evolution of the Paleoproterozoic transscandinavian igneous belt and Slagstad for the Mesoproterozoic Rogaland area in Fennoscandia. There were also posters on late-Proterozoic mineralized pegmatites in Nigeria (Ekwueme) and possible impact origin of diamondiferous eclogites (Blyuman).

**GENERAL COMMENTS:** Overall, the symposium was well-attended and proved to be successful in achieving its aims.

#### **HPP-04 From Rodinia to Nuna and beyond: Precambrian supercontinent reconstructions delving deeper in time**

**CONVENERS:** Svetlana Bogdanova, University of Lund, Sweden; David Evans, Yale University, USA; Mauro Cesar Galdes, State University of Rio de Janeiro, Brazil

**NUMBER OF PRESENTATIONS:** 14 oral, 9 poster

**SYMPOSIUM SUMMARY:** This session, sponsored by IGCP Projects 440 ("Assembly and break-up of Rodinia") and 509 ("Paleoproterozoic supercontinents and global evolution"), brought together researchers working on all of the present continents, united by the quest for accurate paleogeographic reconstructions through the last three billion years. These are the vital preconditions for understanding the role of supercontinents in mantle dynamics, as well as providing the boundary conditions for studies in global climate and hydroatmospheric chemistry of the evolving Earth system.

Scientific highlights included the keynote presentation by Zheng-Xiang Li, summarizing the Geodynamic Map of Rodinia - the principal output of IGCP Project 440. The following presentations covered such diverse topics as late Mesoproterozoic orogenic activity around the world (Grenville, Sveconorwegian, Maud, Pinjarra, Central Indian) with implications for Rodinia paleogeography, and post-Rodinia breakup tectonostratigraphy (western India) and paleolatitudes of Neoproterozoic glacial deposits (South China). Delving deeper in time, many presentations reported new geochronologic and/or paleomagnetic data from Archaean and Paleoproterozoic rocks (Australia, India, Siberia, Laurentia, Baltica, S. Africa).





One common theme of these presentations is the apparent convergence of several ideas on the configuration of the pre-Rodinian supercontinent Nuna, which amalgamated at about 1900-1800 Ma. Not surprisingly for a meeting in Norway, many of the discussions centered on the paleogeographic relationships between northern Europe and North America, the cratonic portions of which appear to have assembled and dispersed in varying configurations throughout the last 2.5 billion years. These connections, as well as others presented in the session, will form the cornerstones to global paleogeographic models of pre-Pangean supercontinents in the coming years.

*GENERAL COMMENTS:* The session was well attended, with more than 100 audience participants typically present at each talk, and lengthy discussions at the posters.

*ANNOUNCEMENTS:* The on-going plan of the IGCP 509 activity includes several meetings and corresponding publications. These issues were discussed during the business meeting of that project during the Congress.

### **HPP-05 Evolution of Archean crust**

*CONVENERS:* Yildirim Dilek, Harald Furnes, Maarten de Wit

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* The role of plate tectonics in the evolution of Phanerozoic and Proterozoic crust is well established, but is a subject of debate regarding the Archean history. Crustal growth and differentiation through punctuated events (i.e. emplacement of mantle 'super-plumes') versus continuous subduction processes and whether Archean crust was too weak and mobile to behave as in rigid plates are fundamental questions in geodynamics. The occurrence of boninites, adakites, Mg-andesites, and ophiolites in some of the Archean greenstone belts suggests that Phanerozoic-like subduction zone tectonics may have been operating as early as 3.8 Ga. Specific questions to explore include the nature of magmatic and tectonic accretion of Archean continental crust and cratonization processes; sources of mantle magmatism; geodynamic evolution of greenstone belts, oceanic crust, and Archean ocean basins; and the operation of plume activities and subduction processes in the Archean. This session is designed to evaluate the diverse datasets from the Archean rock record in order to address these questions and to better understand the nature and tempo of those processes involved in development of the Archean crust and their implications for the planetary evolution.

### **HPP-06 The evolving Earth system through Archean-Palaeoproterozoic transition**

*CONVENERS:* Victor A. Melezhik, Geological Survey of Norway, Trondheim, Norway; David A.D. Evans, Yale University, USA

*NUMBER OF PRESENTATIONS:* 7 oral

*SYMPOSIUM SUMMARY:* The symposium was a joint session of IGCP Project 509 (Palaeoproterozoic Supercontinents and Global Evolution), ICDP FAR-DEEP (Fennoscandia Arctic Russia - Drilling Early Earth

Project), the Agouren Institute Kaapvaal Drilling Project, and ABDP (NASA Astrobiology Drilling Project).

The Archean-Proterozoic transition is one of several critical intervals in Earth history when the terrestrial systems were experiencing rapid, global-scale changes. The sequence of events includes the first global icehouse event, oxidation of the atmosphere and emergence of an aerobic world, and global perturbations in the carbon cycle, all representing the greatest challenge to life on Earth since its beginning. Overall, there is incomplete understanding of the timing, cause(s) and specifically the biological consequences with respect to the most profound change in surface environments during the early history of planet Earth.

Two 30-minute- and five 15-minute presentations during morning session on 14th of August were devoted to various aspects of Earth system evolution through Archean-Palaeoproterozoic transition. This covered microbial alteration in pillow lavas, sulphur and carbon biogeochemistry and isotope geochemistry, response of anaerobic biosphere to the oxidation of the atmosphere, global perturbation in the carbon cycle, palaeogeographic reconstructions, and palaeomagnetic studies.

*GENERAL COMMENTS:* All presentations received excellent attention and great attendance, and were followed by extensive discussions showing interest from the international scientific community to Earth evolution in Deep Time.

### **HPP-07 Late Neoproterozoic orogenic belts and assembly of Gondwana**

*CONVENERS:* Bernard Bingen, Geological Survey of Norway, Norway; Joachim Jacobs, University of Bergen, Norway; Alan S. Collins, The University of Adelaide, Australia; Giulio Viola, Geological Survey of Norway, Norway; Mark A. Smethurst, Geological Survey of Norway, Norway; Daud Jamal, Eduardo Mondlane University, Mozambique

*NUMBER OF PRESENTATIONS:* 15 oral, 6 poster, 1 no-show

*SYMPOSIUM SUMMARY:* Symposium HPP-07 was designed as a forum for geoscientists specialized in different disciplines, including geological mapping, stratigraphy, tectonics, geochronology, geochemistry, isotope geochemistry, petrology, geophysics, paleomagnetism and not least economic geology, for presentation and discussion of recent advances in understanding of the assembly of Gondwana Supercontinent at the end of the Neoproterozoic. Gondwana formed by assembly of Austral cratons, along Pan-African - Brasiliano orogenic belts. The Pan-African - Brasiliano system has multiple branches through Australia, India, Antarctica, Africa and South America, and qualifies as one of the largest orogenies that has affected planet Earth. Improved reconstruction of this orogenic cycle, and evaluation of its impact on Phanerozoic Earth history requires global and regional studies.

The symposium attracted 21 abstracts. It started with a keynote presentation on paleomagnetic constraints on the assembly of Gondwana by Sergei Pisarevsky, The



University of Edinburgh, United Kingdom, and closed by another keynote presentation on the link between supercontinent assembly and super-mineral and oil resources by Alan Collins, the University of Adelaide, Australia. The main flavour of the symposium was the tectonic evolution of the East-African orogen, extending from the Arabian-Nubian Shield to East Antarctica, where a lot of large scale recent research took place in the last couple of years.

*GENERAL COMMENTS:* The symposium benefited from good attendance, peaking above 50 persons in the late morning part of the session.

## QUATERNARY GEOLOGY

## HPQ

### HPQ-01 General contributions to Quaternary geology

*CONVENERS:* Kurt H. Kjær, University of Copenhagen, Denmark; Svend Funder, University of Copenhagen, Denmark

*NUMBER OF PRESENTATIONS:* 11 oral, 19 poster

*SYMPOSIUM SUMMARY:* This general session addresses recent advances in Quaternary fields which are not covered by other specific symposia. Examples are recent results of DNA analysis in Quaternary geology and the 'battle' over Quaternary stratigraphical terminology. Talks on these topics have been solicited. In addition the Quaternary general symposium includes both process related themes on larger systems as well as human adaptation and sea level changes from important regional areas. We encourage presentations within these topics, but would also like to receive presentations outside these proposals.

*GENERAL COMMENTS:* Up to 70 people attended each oral presentation.

### HPQ-02 Black Sea-Mediterranean Corridor during last 30 ky: Sea level change and human adaptation

*CONVENERS:* Valentina Yanko, Odessa I.I. Mechnikov National University, Ukraine; Yucel Yilmaz, Kadir Has University, Turkey; Pavel Dolukhanov, University of New Castle, UK

*NUMBER OF PRESENTATIONS:* 19 oral, 8 poster, 6 no-shows

*SYMPOSIUM SUMMARY:* This symposium is an important part of the IGCP 521 project "Black Sea-Mediterranean Corridor during last 30 ky: Sea level change and human adaptation". The Black Sea-Mediterranean Corridor ("Corridor") is an integrated oceanographic system defined here as the large geographical area covering the Manych-Kerch Gateway (Manych Valley, the Sea of Azov and the Kerch Strait) that lies to the east of the Black Sea, the Black Sea, the Marmara Gateway (the Bosphorus Strait, the Sea of Marmara and the Dardanelles), the Aegean Sea, the Eastern Mediterranean and their coasts. At Late Pleistocene the "Corridor" was connected to the Caspian Sea via the Manych Gateway. Today, the "Corridor" is of strategic importance not only for all coastal countries that fall in a category of developing countries and countries in transit, but also for at least 17

other countries sharing a drainage basin that is one-third the size of the European continent.

The IGCP 521-IGC Symposium has the multiple focus of (1) encouraging participants from the developing countries and countries in transit to take up intensive and forward-looking discussions about advanced scientific topics, potential areas of collaboration, and future scientific priorities within the framework of IGCP-521, (2) establishing long-term collaboration between individual scientists from the developing countries, countries in transit and scientific centers in order to strengthen existing ties, forge new ones, and enhance partnership potential, (3) building an awareness of sustainable development in the developing countries and countries in transit, and (4) increasing further capacity for growth in the developing countries and countries in transit bordering the "Corridor" by contributing to the sharing and transferring of knowledge on sustainable development.

The main objectives of the symposium were:

1. To discuss the actual status and to identify the main gaps in our knowledge on sustainable development of the coastal countries bordering the "Corridor" under global climate change, sea level fluctuations and coastline migration.
2. To build an interactive and interdisciplinary cooperation to define and to quantify all the processes involved, from climate change/active tectonics to the evolution of biodiversity and human civilization for the entire "Corridor" in the context of its sustainable development and risk assessment under various climate/sea level scenarios.
3. To discuss the advantages of the new analytical techniques and state-of-the-art interpretation of data.
4. To discuss possible interactions between environmental factors and human migration and subsistence using GIS-based modelling (in the form of VR 3-D interactive maps) of vegetation (i.e. climate), biota and human dispersal.
5. To encourage participants to contribute more actively to the preservation of cultural and religious heritage through the study of ancient cultures, civilizations, and their legends.

*GENERAL COMMENTS:* There was a lively discussion regarding the development of the Black Sea in Late Pleistocene and Holocene with special attention given to a possible flooding of the Black Sea in early Holocene.

Number of attendees was about 50 people. Most of the contributions to the symposium were of a high quality.

*ANNOUNCEMENTS:* The conveners were approached by Marine Geology journal to publish symposium proceedings in a special IGC volume. IGCP 521 fifth plenary meeting and field trip in Turkey, October 2009.

### HPQ-04 Quaternary palaeo-ice streams of the northern and southern hemisphere

*CONVENERS:* Dag Ottesen, Geological Survey of Norway, Norway; Chris Clark, University of Sheffield, UK; Atle Nygård, University of Bergen, Norway

*NUMBER OF PRESENTATIONS:* 4 oral, 5 poster

*SYMPOSIUM SUMMARY:* The aim of this session was to bring together scientists working with palaeo-ice streams



both in marine and terrestrial environments in both hemispheres. Many excellent data from both swath bathymetry of glaciated shelves and satellite images from large land areas were presented. Deeply buried surfaces with evidence of palaeo-ice streams from 3D-seismic cubes were also shown. The importance of ice streams in regulating the ice sheet mass balance was discussed. The understanding of the whole 'life cycle' of an ice stream is crucial if predictions of the response of the West Antarctic Ice Sheet to changes in climate, sea level and ocean circulation are to be made.

**GENERAL COMMENTS:** Despite being the last session of the conference and held in a very remote room, the session was well attended with excellent talks and discussions.

## STRATIGRAPHY

## HPS

### HPS-01 General contributions to stratigraphy

**CONVENERS:** Alexey Tesakov, Geological Institute of the Russian Academy of Sciences, Russia; Geir Birger Larssen, StatoilHydro, Norway

**NUMBER OF PRESENTATIONS:** 7 oral, 11 poster, 20 no-shows

**SYMPOSIUM SUMMARY:** The symposium General contributions to stratigraphy was aimed at covering a broad scope of relevant topics. First of all, these were reviews of advances in stratigraphy of Phanerozoic time intervals not covered by (or not fitting in) more specific symposia, namely, Cenozoic, Permo-Triassic, Carboniferous, Ordovician, Silurian, Cambrian, etc. Oral presentations of S. Peng (China) and L. Babcock (USA), as well as T. Pegel et al. (Russia) were devoted to issues of global chronostratigraphy of the Cambrian. S. Peng (invited speaker) focused on achieved standard units and GSSPs and on approaches to definition of still undefined series and stages of the Cambrian. T. Pegel and colleagues proposed three well studied continuous sections in Eastern Siberia (Russia) as candidates for standard global stages and GSSP of the Cambrian (fifth, ninth, and tenth still undefined stages). J. Marshall (UK) and his colleagues reported on litho-biostratigraphic markers suitable for correlations between Middle Devonian (Givetian) sedimentary basins of Scotland, Baltic region, and eastern coast of North America. Climatic oscillations evident in lithological features and palynological signatures are shown as reliable correlation tools. Poster presentation of V. Tsyganko (Russia) gave a review of approaches to Famennian subdivision based on different biotic groups with the special reference to data from the west Uralian region. V. Zazkharov and M. Rogov (Russia) displayed a poster presentation on high-latitude Arctic sections pertinent to the definition of the Jurassic-Cretaceous boundary in the Boreal Realm. M. Duncic (Serbia) reported on the Late Cretaceous planktonic foraminifera and nannofossils from boreholes in the Pannonian Basin. N. Galala (Tunisia) presented a high-resolution study of

transitional interval at the Cretaceous/Paleogene boundary in two marine sections in Tunisia and Spain. The study shows a detailed picture of mass extinction of planktonic foraminifera at the boundary and the subsequent restoration of diversity in this group through an adaptive radiation of few surviving opportunistic forms and by external immigrations.

The symposium also encouraged presentations in theoretical issues of stratigraphy. The presentation of T. Koren (Russia) was devoted to the proposed concept of RSSP, regional stratotype section and point. A ramified system of carefully selected and thoroughly investigated auxiliary stratotypes will provide more stable global correlations and enforce stability by tight integration of regional stratigraphies into the international interconnected framework based on GSSPs. This presentation was illustrated with numerous examples from the practice of lower Paleozoic stratigraphy in Russia. The presentation of A. Tesakov and E. Vangengeim (Russia) was devoted to terrestrial biochronology (exemplified by Plio-Pleistocene mammal-based scale of Russia), highly operational but still lacking formal status in stratigraphic codes. It is suggested that continental biochronological systems deserve more efforts in definition of their theoretical basis and incorporation into standard chronostratigraphy. J. Wang (China) modelled sedimentological characters in transgressive-regressive cycles of continental lake basins. **GENERAL COMMENTS:** Mostly high quality professional presentations. Most attended and discussed was the early Paleozoic block of lectures (Peng, Pegel, Koren).

### HPS-05 Recent developments in the Geologic Timescale (ICS)

**CONVENERS:** Felix M. Gradstein, James G. Ogg, Mike Villeneuve

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** Stratigraphic standardization through the work of the International Commission on Stratigraphy (ICS) is actively refining the international chronostratigraphic scale. Several traditional European-based stages have been replaced with new subdivisions that allow global correlation. New stratigraphically meaningful linear age dates and improved insights in processing methods for extracting such high-precision age assignments improve age assignments of key geologic stage boundaries and other global correlation horizons. Statistical techniques of compiling integrated linear scales within zones and stages are maturing. Orbital tuning is greatly refining Neogene, Paleogene and part of Mesozoic geochronology. Anticipated advances in the Geologic Time Scale during the next few years include:

- A Planetary scale and a geologically realistic Precambrian scale.
- Formal definition of all Phanerozoic stage boundaries.
- Orbital tuning of polarity chrons, fossil and physical events for entire Cenozoic and Cretaceous.
- A detailed database of high-resolution radiometric ages with 'best practice' procedures.



- Full error analysis, monitor ages and conversions.
- Resolving age dating controversies (e.g. zircon reworking and statistics).
- Improved dating of several 'neglected' intervals (e.g. Upper Jurassic - Lower Cretaceous).
- Detailed integrated stratigraphy for Upper Paleozoic through Lower Mesozoic.

The TS-Creator(r) visualization package lets the user create onscreen and downloadable charts of any portion of the geologic time scale with a choice of bio-magneto-chemo-sequence and other events and trends of Earth History (see [www.stratigraphy.org](http://www.stratigraphy.org)).

### **HPS-06 Milestones in quantitative biostratigraphy (ICS)**

*CONVENERS:* Felix M. Gradstein, Frits Agterberg

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* This symposium highlights major advances in quantitative stratigraphy. This small but dedicated branch of stratigraphic science over the last decade has seen a consolidation of methods, and a good understanding of their advantages and limitations.

During the early life of quantitative (bio)stratigraphy, with IGCP Project 148 and its successor in ICS up front, new methods stood in line to be programmed and evaluated. Given the almost universally deterministic approach to stratigraphic correlation, emphasis these days is almost exclusively on creation of the most detailed (fossil event) biozonation using methods, and then correlating such zonation subjectively through (well) sections. Correlation of physical well logs or of orbitally tuned sections is also not left to automatic processing programs, but quickly steered by hand, elegantly avoiding pitfalls like missing data, repetitive signals, or plain noise.

The modern biostratigraphic programs of choice are Ranking and Scaling (RASC), Constrained Optimization (CONOP) and Unitary Association (UA). Each one exploits different properties of the (often complex) fossil record to arrive at zonal answers. RASC is optimal for larger datasets with main fossil events, and handles noise well, like outliers and missing data. CONOP has taken over the niche of former 'graphic correlation' users, and does so in a far superior manner. The results of RASC and CONOP often converge well on the same zonal answer, although methods and assumptions are completely different. UA builds a robust zonation along the path of the concurrent range zone. RASC has best graphics.

### **HPS-07 Pliocene-Pleistocene correlations and global change**

*CONVENERS:* Maria Bianca Cita, University of Milano, Italy; Brad Pillans, The Australian National University, Canberra, Australia

*NUMBER OF PRESENTATIONS:* 21 oral, 4 poster

*SYMPOSIUM SUMMARY:* The symposium was organized by a representative of ICS (Cita, chair of the Subcommission on Stratigraphic Classification) and a representative of INQUA (Pillans, chair of the Stratigraphy and Chronology Commission) following a 2006 suggestion

of Felix Gradstein, chair of the ICS, aimed at clarifying the stratigraphic significance of the last five million years of the history of our planet. Purpose of the symposium was to present a wide spectrum of the important, novel, and in part unexpected scientific results that have to be considered prior to make a long desired, possibly non-controversial decision on the significance and duration of the Quaternary. Most presentations were invited, but several were contributed. A wide global multifaced scenario resulted from showing the major scientific advances obtained in the last thirty years by drilling in all the oceans (1901 DSDP-ODP drill sites), by drilling through the existing ice caps and in an endoreic lake from the largest continent. From Siberia to Mongolia to the summit of Antarctica, back northwards to Europe, to the Atlantic to the central Arctic Ocean, the first 11 presentations were of outstanding interest. John Clague was invited to talk about Louis Agassiz and the theory of the ice ages. After that, 8 lectures presented personal or institutional positions towards the problem of the definition, duration and internal subdivision of the Quaternary.

*GENERAL COMMENTS:* The overall quality of the presentations was good to very good. The attendance was good, with people standing at times. All the presenters were there. No time allocated for discussion (the discussion should have happened in the following public session).

Strong points of the symposium were the broad perspective, the presentation of a variety of new evidence for climate change during the ice ages, and prior to the ice ages - the response of mammals and of vegetation to climate change; the response of sediments to climate change; the extraterrestrial forcing (Milankovitch cyclicity) versus terrestrial forcing (geodynamics, paleoceanography). Weak points of the symposium were lack of time for discussion (all presentations lasted 15 minutes, including question time). Disappointing public session to follow.

*ANNOUNCEMENTS:* The conveners plan to collect papers given at the symposium for publication to the INQUA journal Quaternary International. A call for papers has been launched in September.

### **HPS-08 Oligocene Series: A time of change in earth and life history**

*CONVENERS:* Noël Vandenberghe, University Leuven, Belgium; Yuri Gladenkov, Russian Academy of Sciences, Moscow, Russia

*NUMBER OF PRESENTATIONS:* 12 oral, 8 poster, 2 cancelled

*SYMPOSIUM SUMMARY:* The Oligocene time is seeing the change towards a significant cooling of the planet. An increased number of studies are documenting several aspects of this changing Oligocene earth and life history in different parts of the world. The symposium was intended to give a forum to those scientists working in the field of the Oligocene to present their work and to establish contacts in the Oligocene community.

The contributions have been arranged according to the paleogeographical area of the studied sections. The oral and poster contributions have been dealing with areas as diverse as the North Pacific, Arctic and Antarctic areas,



USA, Tethys and Paratethys, the North Sea Basin, Siberia and the Atlantic. This is from a paleoclimate point of view a most interesting mix. The papers have contributed to the general stratigraphic knowledge and correlations and in many papers the link to the climatic evolution was explicitly shown.

As general conclusions from the symposium, the conveners appreciated the contributions from very widespread geographic areas, including the confirmation of a drastic cooling of the climate during the Oligocene, using many different techniques varying from classical lithostratigraphy over paleontology to isotope-chemistry and proving the added value of multidisciplinary approaches in stratigraphy.

**GENERAL COMMENTS:** The symposium was followed by a varying amount of attendants, generally between 20 and 40. The reason for the variable number of attendants was that many other symposia also attracting stratigraphers were taking place at the same time. Posters attracted the normal amount of interested participants, including participants that did not attend the Oligocene symposium itself.

#### **HPS-09 Stratigraphic correlation of Neoproterozoic strata**

**CONVENERS:** Jim Gehling, South Australian Museum, Australia; Shuhai Xiao, Virginia Tech., USA; Graham Shields, University College London, UK

**NUMBER OF PRESENTATIONS:** 8 oral, 2 poster

**SYMPOSIUM SUMMARY:** The Neoproterozoic era (c. 1000-542 million years ago) represents a defining transitional interval in Earth history that witnessed the most dramatic climatic swings ever experienced, accompanied by significant changes to our planet's atmospheric and oceanic composition, as well as the dawn of animal life on Earth. Despite its importance, the Neoproterozoic still receives scant attention from stratigraphers because of the difficulties in global correlation because of the absence of useful fossil markers. In 2004, the Terminal Proterozoic Subcommittee recognised recent advances made in late Neoproterozoic geology by formalising a new period, the Ediacaran Period (and System). The Ediacaran Period (c. 632-542 Ma) represents the time from the end of global glaciation to the first appearance worldwide of somewhat complicated trace fossils (*Trichophycus pedum*) that appear in places together with the last remnants of the soft-bodied Ediacara fauna. A basal Ediacaran GSSP has been established at Enorama Creek, South Australia, defined at the base of "cap dolostones" and has now been dated elsewhere in the world at 635 Ma. Further subdivision of the Ediacaran Period and definition of the base of the earlier Cryogenian Period are stated aims of the Neoproterozoic (Ediacaran and Cryogenian) subcommission. During this short symposium, contributions from a range of disciplines touching on the state-of-the-art in Neoproterozoic stratigraphic correlation were made in preparation for discussions by the Neoproterozoic Subcommittee of the ICS. Major questions that remain unresolved to date are: whether Precambrian strata can be successfully correlated

using biostratigraphy, how globally significant are C-isotope excursions, can Sr-isotope stratigraphy function as a global correlation tool, when did the earlier Cryogenian glaciations begin/occur, are regional deglaciations of global significance in the Neoproterozoic, how can we use a range of correlation tools to define the base of the Cryogenian Period and further subdivide the Ediacaran Period? These and more deliberations will help us to extend the rock-based subdivision of the geological time scale deeper into the Precambrian.

**GENERAL COMMENTS:** Attendance was good and discussions were lively both during and after the session. However, the symposium was marred by the absence of some key Chinese speakers who were unable to obtain visas in time for the IGC.

**ANNOUNCEMENTS:** This symposium was followed by a workshop in Uppsala, Sweden where more detailed discussions on biostratigraphic correlation was carried out.

#### **HPS-10 Stratigraphic subdivisions of the Cretaceous System: State of the art**

**CONVENERS:** Isabella Premoli Silva, University of Milano, Italy; Fynn Surlyk, University of Copenhagen, Denmark; Ireneusz Walaszczyk, University of Warsaw, Poland

**NUMBER OF PRESENTATIONS:** 8 oral, 2 poster

**SYMPOSIUM SUMMARY:** The symposium was organized by the Subcommittee on Cretaceous Stratigraphy with the aim of convening all Cretaceous specialists attending the 33IGC. Purpose of the symposium was to present the progress made by the numerous Working Groups on Cretaceous stage boundaries since the session on Cretaceous stratigraphy held at the 32nd IGC 2004 in Florence and the discussion during the SCS meeting in Neuchatel (Sept. 2005).

The state-of-the-art on Cretaceous subdivision was overviewed and the problems concerning some GSSPs were discussed, i.e. base of the Coniacian, base of the Santonian, and subordinately base of the Campanian. Some presentations focused on stage boundaries and substage subdivisions approached by integrated multidisciplinary stratigraphies. In particular, cyclostratigraphic studies allowed to quantify stage to zone duration (Aptian, K/Pg) and to precise the age of the K/Pg boundary, respectively. Moreover, new evolutionary index taxa (Inoceramids) have been presented (Albian, Maastrichtian) as well as the utility of the Re-Os geochronometer to organic-bearing sediments (Aptian/Albian and Cenomanian/Turonian boundaries). Finally, one presentation showed the arising difficulties in applying the 'standard' planktonic foraminiferal zonal scheme outside the tropical paleoenvironmental regime.

**GENERAL COMMENTS:** The overall quality of the presentations was good and the attendance was far better than expected with more than 40 people attending. All the protagonists were present except one (poster). Positive points of the symposium were the integrated multidisciplinary perspective finally applied in most of the presentations, and new techniques/proxies in cyclostratigraphy and radiometric dating. Weak points of





the symposium were the limited number of presentations and the short time for discussion as most presentations lasted 15 minutes.

**ANNOUNCEMENTS:** Cretaceous subdivision will be further discussed in an ad-hoc meeting of ICS at the 8th International Symposium on the Cretaceous System, University of Plymouth, UK, 6 -12 September 2009. Convenors: Malcolm Hart and Gregory Price. Moreover, in preparation of the Plymouth meeting, a two days Workshop on the Berriasian GSSP and Jurassic/Cretaceous boundary is planned for January 2009 in Milan (Italy). Convenor: William Wimbledon, chair of the WG; Contact person: Elisabetta Erba.

### **HPS-11 The EARTHTIME project**

**CONVENERS:** Sam Bowring, MIT, USA; Trond Torsvik, Geological Survey/University of Oslo, Norway; Klaudia Kuiper, Vrije Universiteit Amsterdam, Netherlands

**NUMBER OF PRESENTATIONS:** 5 oral, 2 poster, 1 no-show

**SYMPOSIUM SUMMARY:** EARTHTIME is an international initiative aimed at sequencing Earth history through the integration of geochronology, stratigraphy and paleontology. By integrating new methods of biostratigraphic correlation, cyclostratigraphy, chemostratigraphy, magnetostratigraphy, and statistical treatments of paleontological datasets with high-precision geochronology it is possible to resolve the rates of geological and evolutionary processes. The EARTHTIME initiative requires unprecedented levels of cooperation and communication between geochronologists, paleontologists, proxy-stratigraphers, ecologists, biologists, climate scientists, and modellers. The oral contribution "The EARTHTIME initiative: A review of accomplishments and promise" by Noah McLean, Samuel Bowring, James Bowring, Daniel Condon, Matthew Heizler, Randy Parrish, Jahandar Ramezani, Blair Schoene and Klaudia Kuiper (presenting) gave an overview of the programme and results obtained till August 2008.

High-precision geochronological techniques have advanced to the point where uncertainties of 0.1%-0.05 % are routinely attainable for rocks that range in age from 700 Ma to less than 10 Ma. When biostratigraphy is calibrated with radiometric dates and/or orbital tuning, temporal resolution can be achieved to the sub-100 kyr level into the Paleozoic. There are many fundamental problems in Earth's history that can be addressed with a highly resolved, calibrated time scale. These problems include evolutionary radiations, mass extinctions and biotic recoveries, responses to changes in sea level, climate, and ocean chemistry, enhanced integration of terrestrial and marine records, as well as tempo of fluctuations in the earth's magnetic field and history of the geodynamo.

The four oral contributions "Solving Earth history problems with the Astronomical Time Scale" by Linda Hinnov (presenting) and James Ogg, "Synchronizing rock clocks of Earth history" by Klaudia Kuiper (presenting), Alan Deino, Frits Hilgen, Wout Krijgsman, Paul Renne and Jan Wijbrans, "Testing the Milankovitch hypothesis: U-Pb geochronology and spectral analysis of Eocene

lacustrine sequences, Green River Formation, Wyoming, USA" by Malka Machlus (presenting), Jahandar Ramezani, Samuel Bowring, Sidney Hemming, and "Magnetostratigraphy, radiometric dating, and carbon isotope analysis of continental strata in western Canada: implications for the age of the Paleocene-Eocene boundary" by Ted Evans (presenting), Jack Lerbekmo, Larry Heaman and Karlis Muehlenbacks as well as the poster presentation "Refining the mid-Triassic timescale" by Quentin Crowley and Dan Condon involved the integration of (radio-)isotope geochronology, chronostratigraphy, cyclostratigraphy and magnetostratigraphy, which can then be applied to understanding problems in earth history.

**GENERAL COMMENTS:** Around 40 people attended the session. A number of Eastern European scientists expressed their interest in the initiative and were referred to the websites ([www.earth-time.org](http://www.earth-time.org) and [www.earthtime-eu.eu](http://www.earthtime-eu.eu)) for contact details.

### **HPS-12 New developments in stratigraphic classification**

**CONVENERS:** Maria Bianca Cita, University of Milano, Italy; Christopher G. St. C. Kendall, University of South Carolina, USA; Andreas Strasser, University of Fribourg, Switzerland; Stanley C. Finney, University of California, Long Beach, USA

**NUMBER OF PRESENTATIONS:** 20 oral at the symposium (August 8) and 5 presentations at the workshop (August 10)

**SYMPOSIUM SUMMARY:** Stratigraphy has always been a core business in Earth sciences, and stratigraphic classification is crucial in setting up the rules for defining the various units. The International Subcommission on Stratigraphic Classification (ISSC) organized the symposium and the following workshop to present and discuss the results obtained so far by a project initiated in 2005. The project has a 'bottom-up' approach and is aimed at updating, upgrading and implementing the International Stratigraphic Guide, first published in 1976. Several new subdisciplines of Stratigraphy developed in the last decades. The first two review papers sponsored by ISSC have been published in 2006 (Cyclostratigraphy) and in 2008 (Chemostratigraphy) in the journal Newsletters on Stratigraphy. Magnetostratigraphy is very advanced. Lithostratigraphy, Biostratigraphy and Chronostratigraphy are in progress. Sequence Stratigraphy, the most exciting and popular branch, very important for oil exploration, has no fixed rules and suffers from conflicting terminologies (and concepts). Eight presentations documenting one or more case studies were presented at the symposium, five long presentations on principles and terminology at the workshop. A general and intense discussion aiming at reaching a consensus followed.

**GENERAL COMMENTS:** The overall quality of the presentations was good and the attendance was satisfactory (50 to 100 participants to the symposium, 20 to 30 to the workshop). Most presentations were invited, and included ISSC and ICS officers, and numerous protagonists of the Sequence Stratigraphy (mostly American) community.



**ANNOUNCEMENTS:** The discussion on Sequence Stratigraphic concepts and terminologies will continue in Denver, Colorado, USA, on June 7, 2009, at the opening of the AAPG congress, at a SEPM workshop. Contact person: Christopher G. St. C. Kendall.

## HYDROGEOLOGY

## HY

## HYDROGEOLOGY

## HYH

### HYH-01 General contributions to hydrogeology

**CONVENERS:** Karsten H. Jensen, University of Copenhagen, Denmark; Leonard Konikow, U.S. Geological Survey, USA

**NUMBER OF PRESENTATIONS:** 27 oral, 25 poster, 3 no-shows

**SYMPOSIUM SUMMARY:** The oral part of the symposium included general contributions to hydrogeology and was organized in the following themes: (1) Geophysics, (2) Groundwater chemistry and quality, (3) Hydrogeological modelling, (4) Hydrogeological mapping, (5) Urbanization, sustainability and risk, and (6) Recharge. Each theme had 5-6 contributions. The presentations included theoretical studies as well as case stories within the various subject areas and perhaps with a slight bias towards applied studies. Given that the symposium was of a general nature it was broad in scope and included papers that could not fit into the other more specific hydrogeological sessions. In view of these circumstances no general conclusions can be drawn.

**GENERAL COMMENTS:** The symposium had a broad geographical representation with presenters from many different countries. In this regard it was different from symposia organized by organizations such as GSA, AGU, and EGU. However, the symposium did not attract many top international scientists within the field and the presentations were of variable quality. The number of people attending the symposium was rather low in the morning (10 or less) but later it was higher (about 30). Some of the presentations generated a lively discussion. Most hydrogeologists will probably look for other meetings to present their research and it will require a lot of effort to brand the International Geological Congresses as the meeting place for hydrogeologists.

### HYH-02 Groundwater resources and management

**CONVENERS:** Jarl Ovsedal, Oslo, Norway; Afia Akhtar, Geological Survey of Bangladesh, Bangladesh; Bhawani Shanker Paliwal, Jai Narain Vyas University, Jodhpur, India; Stephen Ragone, National Ground Water Association, USA

**NUMBER OF PRESENTATIONS:** 25 oral, 17 poster, 30 cancelled or no-shows

**SYMPOSIUM SUMMARY:** A wide range of issues were addressed including groundwater resources, aquifer conditions, depleting levels of groundwater, artificial recharge, hydrological and chemical characteristics of

groundwater, geothermal areas, monitoring of groundwater basins, pollution and contamination of groundwater - especially the presence of arsenic, fluoride and nitrates in groundwater and the effects on human health, hydrogeological hazards in urban areas. Problems of waterlogging in canal/agricultural areas was addressed with due emphasis on possible remedies.

Application of Remote Sensing and GIS Technology in exploration development and management of groundwater resources is another aspect which received maximum focus in the symposium. Issues such as the need of public participation in planning and management of groundwater and spreading awareness in the society were discussed with strong contributions on these issues. Effects of constructing dams, tunnels and canals on groundwater also generated interest from the audience. Other areas were use of groundwater for industrial development and urbanization, excessive use of groundwater in agriculture and impact of surface and groundwater interaction. Some papers were concerned with fringe areas like groundwater and vegetation ecology. Use of groundwater in oil and gas recovery was also discussed in the symposium.

**GENERAL COMMENTS:** The standard of presentations was high throughout and time keeping was good. Audiences were relatively large despite the fact that the first session began on 6th August in the afternoon, with important Plenary Sessions running parallel to the Early Morning sessions of 7th and 8th August 2008.

From discussion, Groundwater Resources and Management emerged as an issue of widespread and growing concern internationally and might deserve a special session at 34th IGC in 2012. There was a clear evidence of efforts by researchers to ensure that results are used by planning, management and civil protection authorities for a better future of the human society, although with varying success.

The process adopted for review and acceptance/rejection of abstracts was good. The loss of a few presentations/posters seemed to relate to authors not securing Geohost support. The sub-committee kindly awarded Geohost support to conveners from India and Bangladesh, but they did not get support for their air fares.

**ANNOUNCEMENTS:** All contributors have been asked to submit full papers for publication. The Scientific Publishers (India) have already made a commitment to publish the Proceedings in the form of a book. The contributors have been requested to send their full paper no later than 31<sup>st</sup> December 2008. *At the time of publishing this General Proceedings, the book has been published: B.S. Palival (Editor), 2010: Global Groundwater Resources and Management, Scientific Publishers, Jodhpur, India ([www.scientificpub.com](http://www.scientificpub.com)).*

### HYH-05 Hydrogeological aspects of Quaternary geology and climate change

**CONVENERS:** Sylvi Haldorsen, Norwegian University of Life Sciences, Norway; Ola M. Sæther, Geological Survey of Norway, Norway

**NUMBER OF PRESENTATIONS:** 8 oral, 5 poster

**SYMPOSIUM SUMMARY:** Groundwater and climate history are closely linked. Longer and shorter climate cycles



during the Quaternary have resulted in great changes of groundwater flow systems over longer and shorter time spans. Groundwater has during the past years become an increasingly important factor within reconstructions of palaeoclimate. For lakes or wetlands fed entirely by groundwater the hydrological patterns reflect the precipitation. High rainfall gives high lake levels and large wetland distribution, while dry periods give low lake levels, often with increasing salinity, and shrinking wetlands. The isotopic, geochemical and biological variations through sediment records are used to reveal periods of wet and dry climate periods during the Quaternary, especially in areas outside the large Quaternary ice sheets. Groundwater may also play an important role in the formation of Quaternary sediment assemblages in glaciated areas. This is for instance shown by studies of groundwater flow in connection with ice sheets, where the presence of groundwater is critical for the sedimentary and glaciectonic processes. In polar areas the fluctuation in sea level and the extension of glaciers through glacial-interglacial cycles highly controls the distribution of permafrost and thereby groundwater recharge- and discharge conditions. Large groundwater aquifers may have a composite long-term recharge history, with long phases without any recharge in between wetter phases with a favourable recharge situation. Groundwater in earlier recharge-aquifers may become totally fossil during dry-climate events. The palaeoclimate history in combination with isotopes and other geochemical parameters is used to reconstruct the history of such aquifers. Sea-level fluctuations may have a major influence upon many groundwater aquifers. Rising sea level may cause a problem in areas where the groundwater level is close to the present sea level, with saltwater intrusion becoming a problem. The examples from the past have shown us that climate changes can have dramatic effects on groundwater systems. This will become even more critical during a future global climate change and sea level rise, when the demand for drinking water is so much larger than it was in the past, and there is an increasing exploitation of groundwater aquifers. We invite lectures linked to the relation between groundwater and global climate change. This includes long-term changes over millennia to shorter-term decadal changes. We acknowledge lectures dealing with past global changes in climate and sea level, as well as future predictions. We would also welcome lectures that discuss the impact on groundwater related to local human changes compared to global changes in climate and sea level.

Quaternary sediments are in most cases the least unconsolidated aquifer material and therefore have a high porosity. The aquifers in Quaternary sediments form the uppermost aquifers, and are commonly unconfined. Therefore they are in many cases different from confined aquifers in pre-Quaternary rocks. Such aquifers are, therefore, often sensitive to anthropogenic pollution. During the session pollution problems were addressed by several of the presenters.

**GENERAL COMMENTS:** All the posters were shown in a Powerpoint slide presentation during the oral part of the session. Thereby also the posters became a part of the

general discussion. With a few exceptions there were questions to all the presentations. The 'Speaker Service' and the technical presentation system worked very well in our session. We believe that something could have been done to make the poster area more attractive. There should have been more space between the poster boards, and maybe an open space with a bar in the middle, where one could get something to drink (not necessarily alcoholic). We believe that many participants only reached the stand area and did not make it to posters during the breaks.

**ANNOUNCEMENTS:** The Bulletin of the Geological Society of London expressed a wish to publish a special volume within the theme Groundwater and Global Change. All presenters have been invited to express their interest to contribute to this volume.

### **HYH-06 Groundwater development - experiences from low-income countries, foreign aid projects and disaster relief - a symposium including the UNESCO-IUGS-IGCP project GROWNET**

**CONVENERS:** Kim Rudolph-Lund, Norwegian Geotechnical Institute, Norway; Costantino Faillace, Friends of Adivasis Trust, India; Shrikant D. Limaye, Ground Water Institute, India

**NUMBER OF PRESENTATIONS:** 19 oral, 1 poster

**SYMPOSIUM SUMMARY:** The symposium was designed to encompass a wide spectrum of practical topics related to groundwater development in low-income countries as defined by the World Bank. Of the current 185 member countries, there are 53 countries from East Asia and Pacific, Central Asia, Caribbean, Middle East, South Asia and Sub-Saharan Africa in this category. The focus was upon the safe and adequate supply of groundwater to the indigenous populations in these countries. A secure and predictable water supply has a direct bearing on the development of a safe and secure local food supply. As the water supply is exploited it also needs to be managed to avoid overuse, which could lead to deterioration of the local watershed. Foreign aid and disaster relief often overlaps with development aid used to create long-term sustainable economic growth. The symposium also focused on project design including the technical aspects and how the projects afterwards have been evaluated based upon suggested criteria.

After the registration of the 20 abstracts, the symposium was divided into three main topics within the area of Groundwater Development: Topic 1: Groundwater management and training, Topic 2: Groundwater assessment, Topic 3: Groundwater characterization using geochemical and geophysical methods.

The session began with a presentation about Ethiopian Groundwater Resources Management by guest speaker His Excellency Minister Asfaw Dingamo from the Ethiopian Ministry of Water Resources. His talk was attended by the largest number of people present during the session (approximately 40 persons) and generated a lively discussion about the sustainable development of groundwater resources. The interest by the audience was obvious during the question and answer session immediately following the presentation, as they engaged



the Minister in a lively discussion about comparative practises in other countries.

Ten countries were represented during the first topic of the session, presenting papers about water harvesting techniques (Jordan), sustainable groundwater development and conservation (India), decision support systems for catchment management (Portugal, Bolivia, Chile, Peru, United Kingdom, Spain), groundwater management (USA) and training efforts for water resource development (China).

Six countries were represented during the second topic of the session, presenting papers about techniques for groundwater recharge (India), over-exploitation and contamination of groundwater (Pakistan), a holistic approach to WATSAN in developing countries (Norway), the international groundwater resources centre - IGRAC (Netherlands), groundwater recharge (USA) and aquifer vulnerability (Mexico).

Six countries were also represented during the third topic of the session, presenting papers about hydrochemical characterization (Ethiopia), geochemical modelling (Egypt), using geophysical methods to identify successful groundwater wells (India), and using remote sensing and geo-electrical methods to locate and delineate aquifers (India).

#### **HYH-07 Groundwater flow and water-rock interaction in compact fractured rocks: Storage of nuclear waste, field evidence and mathematical models**

*CONVENERS:* Tomas Paces, Czech Geological Survey, Czech Republic; Gert Knutsson, Royal Technical University, Sweden; Peter Wikberg, SKB- Swedish Nuclear Fuel and Waste Management Co., Sweden

*NUMBER OF PRESENTATIONS:* 18 oral, 4 poster, 1 no-show

*SYMPOSIUM SUMMARY:* The symposium focused on groundwater flow, water-rock interaction, methods of field and laboratory research of hard fractured rocks and modelling of the processes in the fractured hard rocks. The research was focused mostly on rocks suitable for a final repository of spent nuclear fuel. Six presentations dealt with the results of research conducted at the proposed geology repository of spent nuclear fuel at Forsmark, Sweden. Five lectures described results of hydrochemical and geochemical research and modelling. Three lectures dealt with conceptual simplifications and model uncertainties, fracture network simulations and the effect of roughness of fractures on fluid flow and transport. Other papers addressed problems of groundwater recharge in crystalline rocks, the hydraulic anisotropy in hard rocks of the underground laboratory in Äspö, Sweden, a new borehole visual method of precise detection of the transport of fluorescein tracer in fractures, fracture analysis from borehole TV images, permeability of granite, validation of modelling of matrix porosity, and role of aggressive groundwater in underground constructions.

*GENERAL COMMENTS:* Lectures and posters were well prepared and their presentations were clear and understandable. The quality of the contributions was well above good standards.

One absentee enabled the participants to discuss relevant problems. Discussion in regular time was not possible due to a tight schedule. Many presented results and methods were new and conceptual, clearly showing the present state of the research into hydraulics and water-rock interaction in crystalline rocks with discrete fracture permeability. Number of participants varied around 50 during the two sessions.

*ANNOUNCEMENTS:* The group agreed to put together all the Powerpoint presentations and distribute the set among themselves and other interested scientists. Tom Paces will distribute the set of presentations upon request (tomas.paces@geology.cz).

#### **HYH-08 Management of coastal aquifers**

*CONVENERS:* Shrikant Daji Limaye, AGID, Ground Water Institute (NGO), Pune, India; Giovanni Barrocu, University of Cagliari, Italy

*NUMBER OF PRESENTATIONS:* 7 oral, 1 poster

*SYMPOSIUM SUMMARY:* Approximately 70% of the world's population lives in coastal areas, and the majority of these people depend partly or fully on coastal aquifers for freshwater. The symposium dealt with the important issue of supplying adequate water for domestic, irrigational and industrial use to coastal communities, towns and major cities. Although major urban centers obtain their water supply from distant surface reservoirs, groundwater plays the role of an auxiliary supply under control of the user. Most other coastal communities and farms depend totally upon groundwater locally available in the alluvial or consolidated aquifer. The fragility of these aquifers and their sensitivity to human activity and over-exploitation was discussed by the authors on the background of the problems in their countries. Papers dealt with case studies in exploration, assessment, exploitation, monitoring, remote sensing, modelling, pollution control, recharge augmentation, controlling salt water intrusion, and promoting people's participation, with emphasis on methods and tools for the study and protection strategies for sustainability of quality and quantity.

*GENERAL COMMENTS:* The presentations were interesting and lively discussions followed. The attendance of about 25 delegates was encouraging.

*ANNOUNCEMENTS:* Management of coastal aquifers would be discussed again during the International Groundwater Symposium (Thailand, Feb 2009) and the 5th World Water Forum (Istanbul March 2009).

#### **HYH-09 International perspectives on karst aquifers and water resources (UNESCO-IUGS-IGCP 513)**

*CONVENERS:* Chris Groves, Hoffman Environmental Research Institute, Western Kentucky University, USA; Yuan Daoxian, International Research Center for Karst, China; Bartolome Andreo-Navarro, Universidad de Malaga, Spain; Heather Viles, Oxford University, UK

*NUMBER OF PRESENTATIONS:* 10 oral, 5 poster

*SYMPOSIUM SUMMARY:* This symposium was sponsored by the UNESCO/IUGS International Geoscience Programme (IGCP) 513: Global Study of Karst Aquifers and Water Resources. While it has been



estimated that over one billion people rely on karst aquifers for water supply, these systems often present serious challenges with regard to both water quantity and quality, even in places of relatively abundant rainfall. In many countries with serious karst-related water supply issues, there are also limited resources with which to solve these problems. The purpose of this symposium was to share perspectives on karst-related water supply issues and their solutions, from a variety of international perspectives. The symposium had authors or co-authors from 10 countries (Uzbekistan, Iraq, Serbia and Montenegro, China, Spain, Italy, Brazil, France, United States and Turkey).

**GENERAL COMMENTS:** The session provided an opportunity for sharing of information and experiences, and most importantly, development of international relationships between scientists who do not often have an opportunity to interact in person. Past conferences within the framework of IGCP 513, as well as the preceeding karst-related Projects (IGCP 299, IGCP 379, and IGCP 448) have led to an enormous amount of synergy and leveraging, and the interactions at this conference should produce the same result.

**ANNOUNCEMENTS:** Communication among interested scientists will continue in 2009 with sessions associated with karst water resources at the International Congress of Speleology (Texas, USA), the Conference on Hypogene Speleogenesis and Karst Hydrogeology of Artesian Basins (Chernivtsy, Ukraine), and the Conference on Sustainability of the Karst Environment - Dinaric Karst and other Karst Regions (Plitvice Lakes, Croatia).

## INFORMATION, EDUCATION, ETHICS, HISTORY IE

## GEOARCHAEOLOGY IEA

### IEA-01 General contributions to geoarchaeology

**CONVENERS:** Magnus Hellqvist, Högskolan Dalarna, Sweden; Filippos Tsikalas, University of Oslo, Norway

**NUMBER OF PRESENTATIONS:** 5 oral, 6 poster, 4 no-shows

**SYMPOSIUM SUMMARY:** Background for the symposium is the growing interest and activity within the field of geoarchaeology and environmental archaeology - more from the international perspective than Scandinavian. Methods and background of the researchers are very often within Earth Science and to some extent Archaeology. This general symposium was opened for presentations in a wide perspective to show the broad field of research and methods. There were also some more specific symposia within the theme geoarchaeology following up more specialised method parts (e.g. geophysics and geochemistry within geoarchaeology).

Geoarchaeology provides the interface between the Earth Sciences and Archaeology. Being a multidisciplinary field of research, applying geological knowledge, concepts and

methods for solving archaeological problems, Geoarchaeology involves many aspects of Earth Science, such as bedrock and Quaternary geology, soil science, sedimentology, physical geography and geophysics. Studies include earth surface dynamics (physical and biological), sedimentation processes, techniques for non-destructive prospecting, and the determination of the age and provenance of various phenomena. Common to all the work is the characterization of the natural environment during the evolution of mankind, and the impact of human activity on this environment, including implications for both short and long term climate change. Contributions, oral and posters, are welcome that will stimulate creative discussion of all aspects of this subject.

**GENERAL COMMENTS:** The quality was varying, but in general very good. The audience filled the lecture room more or less completely during the symposium. Quite lively discussions.

**ANNOUNCEMENTS:** There was a general wish among all IEA-symposia people to get together in a common publication. The driving force of that is Lucy Wilson, convener of IEA-04. One possible publication is with the Geological Society Special Publication.

### IEA-03 Geophysical and geochemical archaeology

**CONVENERS:** Oleg B. Khavroshkin, Schmidt Institute of Physics of the Earth RAS, Russia

**NUMBER OF PRESENTATIONS:** 6 oral, 9 poster

**SYMPOSIUM SUMMARY:** The development of modern archaeology involves new directions of research such as geophysics and geochemistry, and new methods and instruments. Objects for research are geophysical and geochemical fields and geological structures (archaeological sites and objects and also surrounding areas). Main directions of exploration include: seismic, microseismic waves and signals inside ancient structures; geodesic sizes location and classification of natural and artificial heterogeneity inside massive building blocks and ancient buildings; geochemistry probes from objects. These tasks are carried out by monitoring areas and objects from space and by aviation systems, and by using geophysical methods and instruments, petrologic, geochemical, and other methods for analyzing matter, details of destroyed buildings and other places which are connected with archaeological areas.

**GENERAL COMMENTS:** The symposium dealt with modern technical methods for analysis of ancient techniques for treatment of different rocks and metals and different geophysical methods for search of new archaeological sites, such as Egyptian pyramids and surrounding areas and geochemical indicators of settlements. The lecture room was filled, and there were many interesting questions about methods and results.

### IEA-04 The geoarchaeological perspective: Human interactions with the geosphere

**CONVENERS:** Lucy Wilson, University of New Brunswick in Saint John, Canada; Pam Dickinson, University of New Brunswick, Canada; Eric Fouache, Université Paris 12, France





**NUMBER OF PRESENTATIONS:** 11 oral, 1 poster

**SYMPOSIUM SUMMARY:** Specialists and the general public alike are currently very aware of human impacts on our environment. Climate change, desertification, soil erosion, natural hazards and other topics are much in the news, and were the subject of many sessions at the 33rd IGC. Human influence on the environment is not a new phenomenon, however: geoarchaeologists study the traces of human interactions with the geosphere dating back to ancient times, as well as up to and in the present. Geoarchaeological investigations provide the key to recognizing landscape change, and allow us to interpret the ways that humans have both affected, and been affected by, the geosphere. In this session, we were first of all enthralled by the keynote speaker's topic of "How geoarchaeology can save the planet": many thanks to the IGC organisers for the funding that made it possible to bring in Dr. Erika Guttman from Cardiff, UK. Subsequent papers dealt with more detailed case studies, demonstrating the results of particular methods and approaches to reconstructing past behaviours. The session demonstrated some of the lessons that we can learn from ancient humans, both hopeful (it is possible to live sustainably in marginal and difficult areas, using appropriate water- and land-management techniques) and salutary (how our actions have affected forest cover, groundwater composition and discharge, slope stability, and a host of other environmental factors). The geoarchaeological perspective can thus provide a longer-term view of human/nature interactions, and should be a valuable contributor to discussions of sustainable policies for the future.

**GENERAL COMMENTS:** The session was well attended, both by presenters and by an interested general audience. The presentations elicited a good number of serious questions from the audience, which resulted in interesting discussions of methodology and in particular of the lessons that can be learned. One take-away message was that past land-use practices can not only be successfully re-adopted today, but can be improved upon through modern understanding of geomorphology, soil science and hydrology, and that these approaches are valid not only in developing countries, but also in the developed world.

**ANNOUNCEMENTS:** Work is underway to try to group some of the presentations (and some supplementary papers from other sessions) into a publication. It is hoped that the discussions will be continued in the future, especially at the upcoming Developing International Geoarchaeology meeting (DIG 2009) in Canada, and at the next meeting of the International Association of Geomorphologists' Working Group on Geoarchaeology.

#### **IEA-05 Geology and cultural heritage**

**CONVENER:** Tom Heldal, Geological Survey of Norway, Norway

**NUMBER OF PRESENTATIONS:** 11 oral, 14 poster, 9 no-shows

**SYMPOSIUM SUMMARY:** Preservation of our cultural heritage for future generations requires multidisciplinary research where geology is increasingly important. Most

ancient monuments and historical buildings are made of stone; hence rocks are essential for the visual character of many historical cityscapes. Furthermore, the extraction of stone and mineral resources since the Stone Age has left 'industrial' landscapes that are significant historical monuments in their own right. The symposium focused on various aspects of application of geological knowledge to cultural heritage research, divided in three thematic approaches. The first was about geology and cultural landscapes, with special emphasis on ancient stone quarries. 'Stone in cultural heritage' focused on studies of stone provenance in historical buildings. The last theme, environmental aspects, gave insight in some projects where geological knowledge is crucial for the preservation of world heritage monuments.

**GENERAL COMMENTS:** The presentations were generally of good quality and were well acknowledged by the audience. Due to a few no-show presentations, there was some extra time for discussion. The symposium had between 20 and 50 attendants.

#### **IEA-06 Geoarchaeology and archaeometry**

**CONVENER:** Patrick Degryse, Katholieke Universiteit Leuven, Belgium

**NUMBER OF PRESENTATIONS:** 8 oral, 5 poster

**SYMPOSIUM SUMMARY:** In the light of the increasing importance of interdisciplinary research in archaeology, of which archaeometrical research is a major part, a session dealing with the application of geosciences to archaeological questions was held. Specifically, the session focused on mineralogical and geochemical research on the use of ores and minerals/stones in ancient craft activity. This included several lectures and posters dealing with the exploitation and use of mineral resources in ancient times, spread over several material categories (stone, marble, glass, metal...) and through history. Also, presentations on the reconstruction of the past climate and of the human diet were held. Techniques ranged from stable and radiogenic isotopes over elemental analysis to petrography and cathodoluminescence.

**GENERAL COMMENTS:** The overall quality of the presentations was high, and discussion time was put to good use, especially dealing with the interaction of archaeology and geology. Interesting suggestions were made on how the geologist and archaeologist should interact more closely, and how scientists from both disciplines can communicate in a better way, speaking each other's language. Often, the geosciences can provide the necessary evidence for answers to archaeological questions, but care needs to be taken by the geosciences so that the broader archaeological picture is not lost in a bombardment of analytical techniques. The attendance to the session was surprisingly high, with 30 to 40 people for each lecture, a mixture of both geoscientists and archaeologists.



## GEOSCIENCE EDUCATION AND ETHICS IEE

### IEE-01 General contributions to geoscience education and ethics

CONVENER: Kåre Kullerud

NOTE: A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** Geoscientists are very well aware of the importance of their knowledge for modern society. However, among the rest of the world's population the knowledge about geoscience in general and its importance for society is highly variable. The main reason for this is that geoscience education at school and elsewhere in the society in many countries has been given very low priority. However, the number of exceptions from this rule is steadily growing, and today there are many interesting geoscience education projects going on in many countries. This symposium invites speakers to present all types of new and innovative projects in geoscience education. The symposium seeks presentations with focus within the formal education systems, such as schools and universities, or with focus on geoscience education of the general public.

### IEE-02 Geoscience for schools in developing countries

CONVENERS: Afia Akhtar, Bangladesh Geological Survey, Bangladesh (President AGID); Antony J. Reedman, Secretary AGID

NUMBER OF PRESENTATIONS: 9 oral, 4 no-shows

**SYMPOSIUM SUMMARY:** In an introduction to the seminar it was noted that children are normally curious about the world in which they live, and those in poorer communities of the developing world, living closer to the natural world, quickly understand that adequate supplies of food water, shelter and protection from natural disasters are crucial to their daily survival. They need to be taught how, to a large extent, all these vital necessities are dependent on geological factors. Individual geoscientists may, or may not, be good at communicating their science to non-geologists, but a partnership between professional teachers and geoscientists, between local teachers and geologists, is most likely to develop a successful approach to spreading a geological message in local schools. Several contributions indicated that in various countries 'geology', if introduced in schools at all, only appeared as part of the geography curriculum and even that rarely before secondary or senior levels. The situation in India, for example, was analysed in detail and the need for closer integration of geology and geography into a geoscience discipline discussed. Other contributions outlined the situation in Sri Lanka, Pakistan and the policy in Russia. A unit set up in the Bangladesh Geological Survey to encourage geological awareness amongst schoolteachers and the general public illustrated the part that government geological institutions could play.

The need for geoscience education in schools to provide a

foundation for natural hazard preparedness in India was a theme introduced in a paper from India and examples given of how this was being done. From Brazil came interesting experimental examples of geology being introduced to school children through simple local environmental projects conducted by graduating students in the Tutorial Education of the Brazilian Ministry of Education program. The experiment showed that a geological view of the environment can improve children's thinking abilities on the prevention and solution of local environmental problems. The current state of 'geoscience literacy' amongst secondary school students in India was examined in a case study amongst eighteen schools, which revealed a worrying lack of knowledge about earth processes (82% had no idea about the causes and relationships of earthquakes and tsunamis). The introduction of geology to children at primary school was a topic for discussion after a final presentation showing how this was successfully achieved by an enterprising geoscientist working in Namibia.

**GENERAL COMMENTS:** The symposium, with attendance varying between 20 and 40 participants during the three quarter-day sessions, showed how much serious thought was being given to ways of introducing geoscience into the school curricula in various developing countries and how much remained to be done. As one of the senior speakers from India stressed, geoscientists needed to be more confident and more proactive if the situation is to improve in the future.

### IEE-03 Earth system geoscience education

CONVENERS: Gerald H. Krockover, Purdue University, USA; Daniel P. Shepardson, Purdue University, USA

NUMBER OF PRESENTATIONS: 8 oral, 4 poster

**SYMPOSIUM SUMMARY:** The Earth System Geoscience Education symposium addressed the implementation of earth system topics into the science curriculum for both science and nonscience majors. Sessions addressed the research underlying the need for reform of earth system course offerings, sample methods and techniques for successful implementation, field-based activities, direct experiences, and laboratory experiences that result in positive learning outcomes. Oral presentation topics included: How broad should Earth system geosciences education be utilized? Using Action based research teams for Earth system education reform; the impact of Earth's life support system; geologic problem solving in the field; the design, implementation, and assessment of field-based Earth system science; improving visual understanding in Earth system science; and using cycles such as the water and rock cycles for stimulating Earth system science learning. Poster presentations included: Student mental models and Earth systems learning; new methods of laboratory applications for Earth systems science education; EaRTH school competence development; and Earth system science in everyday life.

Symposium discussion on the topic of Earth systems education, which teaches a holistic Earth governed by complex geosphere, atmosphere, hydrosphere, and biosphere processes, served as the major theme. Earth



systems science is moving into a worldwide context; new technologies - such as the cyberinfrastructure - are more clearly revealing planet components and complex interactions; new paradigms are showing the Earth as interrelated systems; and new understandings of Earth systems are informing decisions of societal consequence. Earth systems education is a valuable conduit for helping learners at all levels build skills in inquiry, increase visual literacy, understand systems and models, learn to solve real-world problems, and apply these skills in other areas. Such proficiencies are becoming increasingly important in our highly populated and urbanized world that requires informed decisions for a healthy and productive environment and economy.

**GENERAL COMMENTS:** The symposium ran very smoothly and it worked well to have all the presentations pre-loaded on the server. The room for the symposium was excellent. Sixty-eight persons attended the symposium and discussion ensued at the completion of the presentations. Lively discussions centered around the topics: the definition of Earth system science education, the role of direct experiences, the role of games in Earth system science, and how to reform and improve undergraduate Earth system science courses at colleges and universities.

**ANNOUNCEMENTS:** The symposium is considering the development of a monograph resulting from this session and plans to conduct another symposium on the topic of Earth system geosciences education at the 34th IGC meeting in Australia.

#### **IEE-04 Impact and value of geological knowledge**

**CONVENERS:** Peadar McArdle, Geological Survey of Ireland, Ireland; Hans Peter Schoenlaub, Geologische Bundesanstalt, Austria

**NUMBER OF PRESENTATIONS:** 5 oral, 4 poster

**SYMPOSIUM SUMMARY:** The geoscience sector comprises the customers and stakeholders of the geoscience industry, services, research and education, as well as their providers. It has considerable impact on a wide range of other sectors such as energy, environment, health, infrastructure, planning, construction, marine, heritage and tourism. This symposium explored the impact and value of the sector's knowledge.

A study of the impact of geological knowledge at the level of EU institutions noted that Eurogeosurveys and its members contribute to a wide range of different EU policies and programmes. Geoscience information has proven to be a cost-effective investment in areas such as mineral resources; for example the potential remediation costs in mining projects are an order of magnitude greater than the cost of government-funded minerals programmes. Cost-benefit and socio-economic studies of specific geoscience programmes have been undertaken in many countries. An evidence-based appraisal of the benefits arising from Geo Sure, the ground stability information service of the British Geological Survey, showed that insurers would save an estimated £70-270 million in reduced insurance claims by 2030, and that society would receive many invisible benefits (informed property

decisions, avoidance of injuries, and growth in the knowledge economy).

An economic study of the geoscience sector in Ireland indicated that its activities accounted for 3% of GNP and 1.2% of employment. In discussion some emphasis was placed on the increased Irish Government investment in geoscience as a response to the coherent priorities set by the sector in the National Geoscience Programme (2007-2013). There were indications that the value of the geoscience sector might approach 10% of GNP in certain countries that are rich in natural resources.

The TELLUS project in Northern Ireland used outreach activities to successfully communicate the value of geoscience. Media campaigns, public advertisements, a dedicated phone hotline and mailshots were all used to good effect. In parallel, educational initiatives in schools and communities reached many pupils who provided excellent feedback. In another example, renewed uranium exploration in Finland recently met with resistance, based on fear and uncertainty, from NGOs and local communities. Open communication and high quality information were regarded as essential to mitigate this situation. In the Republic of Korea, due to increased awareness, both geoscientists and the public recognised that geoscience contributes to the country's economy and quality of life.

It is important that the socio-economic impact of geoscience is widely understood by decision-makers and the general public in order to ensure that its activities are adequately funded and it attracts increasing numbers of high-quality students.

**GENERAL COMMENTS:** The attendance of about 25 found the presentations very interesting and took part in a discussion that provided new insights.

#### **IEE-05 Geoscience education for the 21st century (IUGS Commission on Geoscience Education, Training & Technological Transfer)**

**CONVENERS:** Ian Clark, Chan-Jong Kim, Chris King

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** Geoscience education is highly relevant to all levels of society but is often neglected. There is a growing trend to adopt an Earth System Science approach to the way we design curricula and present information. The symposium will be broken into three themes: Undergraduate Geoscience Education; School Geoscience Education; and Informal Geoscience Education (museums, parks, etc.). Each theme will be linked by the questions of "what is relevant for the 21st century?" and "is Earth System Science the most appropriate approach?" The aim of the symposium will be to canvass a wide audience on these topics and to promote geoscience education worldwide.

#### **IEE-07 Geoethics I**

**CONVENERS:** Vaclav Nemec, The Mining Příbram Symposium, Czech Republic; Lidmila Nemcova, The Mining Příbram Symposium, Czech Republic

**NUMBER OF PRESENTATIONS:** 9 oral, 5 poster, 2 no-



shows

**SYMPOSIUM SUMMARY:** Geoethics - born in 1991 at the junction of ethics and geology - has been accepted by both earth and social sciences due to the necessity of an appropriate ethical attitude to the whole geosphere, and of a critical analysis of geoethical dilemmas and finding ways to solve them. The symposium Geoethics I - also in liaison with the symposium IEE-08 Geoethics II - has given a possibility to redefine actual tasks of this discipline and to present a large spectrum of both theoretically oriented ideas and practical case studies, covering problems of a complex and reasonable use of resources, deep research and monitoring of processes with the aim to prevent critical ecological situations. One necessity would seem to be looking after sources of geoethics which could be found also in various religious cultures (e. g. Christian denominations, Buddhism or Islam). Responsible decisions at any level (from the personal to the global) should be based on priorities of spiritual and moral values and principles common to all mankind including future generations.

All specificities of Earth sciences as well as the social responsibility of their representatives are to be taken into consideration and an interdisciplinary approach should be applied, both in actual cases and in strategic trajectories. Geoethical solutions also presume an economic and social analysis before recommending and influencing final political decisions. No general recipes can be elaborated; any case should be examined individually taking into consideration the basic principles of the common good and sustainable development. Geoethics as a means of influence over people's consciousness presumes to be supported by and cultivated in the educational system starting at primary school level.

The closing discussion was carried out at the Business Meeting 87 of the Working Group for Geoethics under the umbrella of the Association of Geoscientists for International Development. This WG will be responsible for the further development and promoting of geoethics.

**GENERAL COMMENTS:** All oral presentations and posters had the expected qualitative level. The broad international spectrum of presenters (from all parts of Europe, Asia and America) and of attending people should also be emphasized. The number of people present in the room during the whole day was among 15 - 45 persons, the total number reached around 75 people. About 20 additional people, unable to attend because of other obligations at the Congress, expressed their interest in geoethics. The whole schedule was completely filled by presentations (incl. 2 orally presented posters) and lively discussions.

**ANNOUNCEMENTS:** Regular international sessions on geoethics will continue at Příbram (Czech Republic, October 12-16, 2009) but also in Moscow (perhaps April 2009) and Italy (Rimini, September 2009). Plans for publishing results are under discussion.

## **IEE-08 Geoethics II: Earth sciences and the ethics of sustainable world cultures**

**CONVENERS:** Paul H. Reitan, University at Buffalo,

USA; Allison Palmer, Cambrian Institute, USA; Kirsten Halsnaes, Risoe-DTU, UNEP Risoe Centre, Denmark

**NUMBER OF PRESENTATIONS:** 4 oral

**SYMPOSIUM SUMMARY:** The Earth Sciences inform us of emerging and worsening problems that threaten a successfully sustainable future for human societies and the Earth systems upon which our societies depend. Problems arise from population growth, per capita demand for increased affluence (thus exponential growth in resource consumption), and abuse of land and sea. A sustainable future, including equity, justice and peace, will be found only if our societies transform their present dominant and expanding culture to ones whose practices, policies and ethics, along with its accepted rules of behavior and reward systems, are consistent with sustainability.

The challenges are enormous: 1) the science to discover and define limits and threats; 2) the technologies and societal changes needed to respond, including the opportunity for sustainable development and economic growth in the world's poor regions; 3) the ethical framework(s) of a culture or cultures that will pursue sustainable lifeways.

The first two oral presentations (Reitan, Gjelsvik) examined the findings of the Earth Sciences that define the growing threats to long-term success of human societies and philosophical considerations of how we should and should not value the future. This was followed by a stimulating discussion about the values that should guide societies as they regard the future. As the final talk was introduced, but the speaker was not present, it became apparent that some in the audience wanted to talk about Lomborg and his ideas on how resources should be allocated. Thus a free-ranging discussion ensued on priorities (regarding e.g. climate change, health threats, economic growth) as societies move toward and plan for the future.

It was clear when the discussions ended with the two hour allocated time slot that there are significant differences about how we should evaluate the present, and what values should be prioritized in thinking about the consequences of how we act now and for the future. A number of participants in the discussions emphasized the importance of explicit concern among Earth scientists about ethics as we practice our profession and contribute to present wellbeing as well as to future equity, justice, and peace.

**GENERAL COMMENTS:** It was a great disappointment that Dr. Halsnaes was, on very short notice, unable to attend the Congress to present her paper and contribute to the discussion. It was also unfortunate that Dr. Hansen did not appear to present his paper on the "Lomborg Case", as there was a group of intense supporters of Lomborg's ideas who attended the symposium. The maximum number present was probably about 30/40. The two presentations, each one-half hour, were excellent and thought-provoking.

**ANNOUNCEMENTS:** A symposium (three hour duration, six speakers) on a related set of issues will be part of the 2009 American Association for the Advancement of Science (AAAS) annual meeting which will be in Chicago, Illinois, USA, 12-16 February 2009. The title of the symposium: "Toward the Science and Ethics of a Culture



of Sustainability".

### IEE-09 Geoscience and art

**CONVENER:** José Sellés-Martínez, University of Buenos Aires, Argentina

**NUMBER OF PRESENTATIONS:** 5 oral, 1 no-show

**SYMPOSIUM SUMMARY:** The links between geosciences and the arts are close, longstanding and manifold. From Palaeolithic times to the present, geologic materials have been transformed into works of art. Minerals used as pigments; clay and stones shaped for pottery, monuments and building; metals used for jewellery, forging and statuary... the list seems endless. The landscape itself has served not only as a source of inspiration to painters, writers or composers, but has also become part of the work of art itself, as in Land Art. Geoscientific knowledge, on the other hand, has become a powerful tool to help experts determine age, origin or authenticity of master works, precious stones, etc. It also helps in the conservation and restoration of buildings, monuments and objects made of geologic materials. Geoscientific imagery (maps, sections, microphotographs, computer-generated images, etc.) is also being regarded not only as information, but also valued for its aesthetic appeal. These multiple relationships offer a superb tool to introduce geological concepts in formal and non-formal geological education. Science educators can make use of art works, literature, music, urban environments, etc. to motivate students and to introduce geological concepts to the general public.

The symposium on Geoscience and Art aimed to gather contributions addressing the relationships between geosciences and art from different approaches, and to establish a network of researchers and educators working in this interdisciplinary area in order to help them exchange information, methods and materials. The contributions covered the field of artists working with local geologic materials, design students trying to make deep time and geological scale visible, the aesthetic appeal of geologic structures and textures, the artistic and scientific value of old geological maps, and the origin and application of geologic material throughout the history of art in an informal educational environment.

**GENERAL COMMENTS:** Presenters and attending people were very enthusiastic with the presentations and there was general consensus about meeting again in forthcoming events.

**ANNOUNCEMENTS:** An invitation to submit a project for a publication in the Special Papers Series of the Geological Society of London has been received, and the draft of the project is being prepared also considering contributors that, for different reasons, could not attend the symposium in Oslo.

## HISTORY OF GEOSCIENCES IEH

### IEH-01 General contributions to history of geosciences (INHIGEO)

**CONVENERS:** Jens Morten Hansen, Geological Survey of Denmark, Denmark; David Oldroyd, University of New South Wales, Australia

**NUMBER OF PRESENTATIONS:** 22 oral, 8 poster, 5 no-shows

**SYMPOSIUM SUMMARY:** The session was organised by, and on behalf of, the International Commission on the History of Geological Sciences. Originally two symposia were envisaged by the above **CONVENERS**: one on the history of ideas about sustainability in relation to the earth sciences; and a miscellaneous section, consisting of papers on any topics relating to the history of geology. In the event only three papers were offered to the proposed sustainability session, so the two sessions were combined. This proved to be most effective, yielding a full-day programme and some very interesting papers, with a considerable number of non-INHIGEO people participating. It is clear from the experience of this meeting that the procedure adopted was well suited to the situation in Oslo. Attendance was good, with the meeting room being almost full for the whole day.

INHIGEO holds a conference annually in different parts of the world. For such events, one or two major themes are selected and a coherent set of papers is presented, which in most cases in the last 20 years or so has resulted in publications in the form of edited volumes or special issues of appropriate journals. However, it is difficult to apply this model for the years when IGCs are held. If a theme is established, it has usually been necessary to invite (or cajole!) people to come, and when it comes to publication the invited speakers do not always provide good papers, or they produce ones that are too long for a volume or tangential to the proposed theme. Despite such problems, a GSL Special Publication on major contributions to geology in the 20th C was produced as a result of the Rio Congress in 2000, and a volume on the history of geology in Italy was produced as an outcome of the Florence Congress in 2004.

It is clear that no such volume could be produced as a product of the miscellaneous papers presented in Oslo. However, the editor of Earth Sciences History (David Oldroyd) has invited all the contributors to the 33rd IGC symposium IEH-01 to offer their papers to that journal, not as a special issue, but as and when the papers may be ready to submit. Thus far six authors have stated their wish to do this. This is somewhat disappointing, but the eventual published output cannot be gauged at this stage. We think, nevertheless, that the model used in Oslo may sometimes be appropriate, given that only a few INHIGEO members were able to attend, presumably being deterred by costs and the fact that only a tiny portion of the whole Congress could be devoted to history of geology. Also, the Commission's field excursion (conducted by boat in the Oslo Fjord) was unrelated to the





miscellaneous set of historical papers. It may also be mentioned here that INHIGEO has only a tiny number of Scandinavian members and this probably had some bearing on the situation. However, we would like to acknowledge the considerable assistance afforded to us by Björn Sundquist in arranging the meeting at a time convenient to INHIGEO.

**GENERAL COMMENTS:** There was limited time for the discussion of each paper, but none of them failed to attract interest. The keynote paper by A. M. C. Sengör was characteristically provocative, being devoted to the question of why the history of geoscience is important and interesting to geologists. This paper is to be offered to Earth Sciences History.

**ANNOUNCEMENTS:** Future meetings of INHIGEO are scheduled for Canada (2009), Spain (2010), Japan (2011) and Australia (2012).

### IEH-03 Myth and geology

**CONVENER:** Luigi Piccardi, C.N.R. - Istituto di Geoscienze e Georisorse, Firenze, Italy (could not attend); W. Bruce Masse, Los Alamos National Laboratory, USA

**NUMBER OF PRESENTATIONS:** 4 oral, 1 poster, 1 no-show

**SYMPOSIUM SUMMARY:** Myth storylines have the potential to provide valuable information to the geological sciences. The discipline of geomythology is still in its infancy. Many geological events in the past have been explained by myths or legends and these tales have been passed on to warn successive generations about geological hazards. Scientists and scholars from a variety of disciplines have interest in these studies, and the topics covered include geological hazards, such as earthquakes, tsunamis, volcanic eruptions, and cosmic impacts. Other scholars consider historical and literary perspectives, education, and the sacred and cultural values of rocks, fossils, geological formations, and landscape.

The symposium purposefully did not adhere to a specific theme, therefore the four oral presentations covered a wide range of topics within the overall discipline of geomythology. These included Barbara and Michael Rappenglück on the possibility that the Chiemgau crater field in Bavaria, Germany, was the inspiration for the Phaethon myth. This lecture was followed by James Wandersee and Renee Clary's presentation on the Native American use of pipestone as a potential educational tool for the general public. Next, Tiziana Lanza presented her ideas that Shakespeare's *Tempest* was inspired by actual volcanic events and knowledge of published myths and oral histories from the Mediterranean region. The last speaker, Bruce Masse, indicated that a record of Hawaii's Kilauea Volcano eruptive history may be preserved in myths that can be dated in time to as early as the 6th century A.D.

The single poster presenter, Toshio Kutsukake, added to the wide range of topics in that his poster was biographically oriented, focusing on the geological and alchemical references of Kuhkai (774-835 A.D.), founder of the Shingon sect of esoteric Buddhism.

**GENERAL COMMENTS:** The four oral presentations

were of excellent polished quality, and all stayed within their 15 minutes of allotted time, usually with one or two minutes for discussion immediately following their presentations. The symposium venue had seating for about 50 people, and was full for all four presentations and for the discussions. There were about 15 minutes available for general discussion at the end of the symposium, with questions being directed to all four presenters. The questions came from a variety of audience members and the general discussions can be characterized as lively and animated. The attendance and wide-ranging questions indicated that there is still considerable interest in the general topic of myth and geology.

**ANNOUNCEMENTS:** An announcement was made by convener Bruce Masse regarding the recent death of Dorothy Vitaliano, on June 26, 2008. Vitaliano was the founder of the discipline of Geomythology, and had coined the term with her 1973 publication *Legends of the Earth*. She was also the keynote speaker for the Myth and Geology symposium in 2004 at the IGC meetings in Florence, Italy.

### IEH-05 History of exploration of the polar regions (INHIGEO)

**CONVENERS:** Cornelia Lüdecke, University of Hamburg, Germany; Naja Mikkelsen, Geological Survey of Denmark and Greenland, Denmark; Geir Hestmark, University of Oslo, Norway

**NUMBER OF PRESENTATIONS:** 6 oral, 1 poster

**SYMPOSIUM SUMMARY:** This INHIGEO symposium wanted to focus on the scientific investigation of the polar regions since the 19th century. The first co-ordinated attempt to investigate the polar regions was made during the International Polar Year (1882-1883), which focussed on standardized meteorological and magnetic measurements around the Arctic Ocean. In addition other disciplines such as astronomy, biology, ethnology, or geology used the temporary stations for investigations apart from the official programme. This happened during the time of internationalisation and institutionalisation of meteorology contrasting the imperialism and colonialism at the end of the 19th century. A similar co-ordinated programme was adopted by five expeditions to Antarctica (1901-1905) which resulted in the concept of Antarctica being an ice-covered continent. When the poles had been discovered around 1910 and the development of new instruments after World War I allowed the investigation of upper air regions, a second International Polar Year was organized (1932-1933). Finally the International Geophysical Year (1957-1958) highlighted the increase of knowledge production especially in Antarctica when the Cold War determined politics between the United States and the Soviet Union. The INHIGEO symposium covered all scientific aspects as well as the cultural and political background of polar exploration.

Due to the small number of speakers only a few aspects could be discussed.

Elena Minina (Vernadsky State geological museum RAS, Moscow, Russian Federation) presented Michael K. Sidorov (1823-1887) and his interest in the exploration of



the Russian north. Tatiana Ivanova (Lomonosov Moscow State University, Russian Federation) added an introduction of the Russian geologist V.A. Rusanov (1875-1913) and his famous investigation of the Arctic. Geir Hestmark (University of Oslo, Norway) talked about Fridtjof Nansen (1861-1930) and Arctic geomorphology, while Gregory Good (West Virginia University, United States) concentrated on Roald Amundsen's (1872-1928) role among the magneticians in the first two decades of the 20th century. Marianne Klemun (Department for History, Vienna, Austria) described the national euphoria and the associated appreciation of science in advance of the Austrian-Hungarian North Pole expedition (1872-1874), which discovered Franz Josef Land. Finally David Branagan (University of Sydney, Australia) focussed on the early Australian story concerning geology and geophysics of Antarctica. In addition, Renee Clary (Mississippi State University, USA) and James Wandersee (Louisiana State University, USA) presented a poster on heroes and hardships to answer the question: Does the early history of polar exploration have value for the science classroom?

It is interesting to note that four papers had a biographical focus and two were nationally oriented. The poster used the heroic age of polar research to discuss the importance of polar history in education.

**GENERAL COMMENTS:** Unfortunately the conveners could not attend the session due to other obligations. Their thanks go to Geir Hestmark who accepted to replace them during the conference. The original list of tentative planned papers had been much longer, but most of the authors had not been members of INHIGEO or belonged to any other group represented in the IGC, so without any obligation to participate in the congress in Oslo overall costs seemed to have been too high to register.

## GEOSCIENCE INFORMATION IEI

### IEI-01 General contributions to geoscience information (CGI, IAMG, GIC)

**CONVENERS:** Ian Jackson, John Broome, Udo Strauss, Robert Tomas

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** This will be the opening plenary session of the Geoscience Information symposium and as such will set the scene for the five main sessions and their many sub-sessions within the symposium. The total Geoscience Information symposium is intended to provide a coherent and comprehensive framework for the optimum presentation and discussion of what is arguably the fastest growing area in the geosciences - geoscience information and geoinformatics. Presentations in this opening general session will be expected to be of premier content and quality and have considerable international scope, relevance and gravity. Five of the six individual presentations selected will each cover one of the key issues that form the subject of the individual parallel sessions. These topics are: Data

capture and acquisition; Information management; Information dissemination and delivery; Information technology and systems; and 3- and 4-dimensional modelling. This opening session will be matched by a plenary closing and wrap up session which is planned largely as a discussion forum with a selected panel to facilitate it - enabling participants to debate and agree actions and collaborative work which they feel should be taken forward.

Data capture and acquisition Coordinator: Guy Buller

### IEI-02-04 Data capture and acquisition

**CONVENERS:** Colm Jordan, British Geological Survey, UK; Mary Carter, Geological Survey of Ireland, Ireland

**NUMBER OF PRESENTATIONS:** 11 oral, 7 poster

**SYMPOSIUM SUMMARY:** The 'Data Capture and Acquisition' symposium was an amalgamation of three sessions covering the following topics: 1) IEI-02 Advances in digital data capture in geological mapping, 2) IEI-03 The increasing contributions and opportunities presented by remotely sensed data, and 3) IEI-04 Putting new life into old data - digital conversion and exploitation of paper records.

The demand for up-to-date geoscientific data, information and knowledge in these times of climate change awareness, regional natural disasters and high natural resource prices is increasing. Valuable historical data are becoming more accessible with advances in semi-automated scanning systems, and traditional occupations such as field mapping are being enhanced by rapidly changing technology. New airborne and satellite sensors are being deployed and are providing geoscientists with datasets that are changing the way we see the world. The challenge that the geological community has set itself in this period of rapidly developing technology is to utilise efficiently the existing analogue records, whilst developing and deploying new effective digital techniques to collect, manage, manipulate and disseminate results to each other and our customers.

The symposium began with presentations demonstrating that Tablet PC and PDA digital field mapping systems have built upon recent IT developments, and Surveys are now using such systems in mapping projects across the globe. Rather than simply replicating the traditional pen and paper techniques, these new systems provide greater functionality to field geologists whilst also ensuring that obligatory data are collected and international standards are met.

The move to digital techniques was also described by organisations that are continuing to develop and implement efficient ways of digitising existing paper records and maps and converting them to database and digital map format. A combination of semi-automated scanning and digitising has enabled new geological maps of large territories to be produced quickly, and at low cost. These new maps are being made available to geoscientists and the public via a variety of web portal interfaces.

We were also shown how remote sensing data such as Digital Terrain Models (DTMs), geophysics and a variety of airborne and satellite imagery are being integrated efficiently into surveys, both in the desk study and the field



mapping stages. These are providing our geoscientists with a new suite of tools with which to interpret and map our environment.

In summary, the theme of the session evolved to show how Surveys are successfully embracing and developing digital techniques to make better use of existing paper records, to collect new (field) information, and to produce a new generation of outputs including new 2D and 3D map formats. The digital era has enabled Surveys to utilise new opportunities for collection, manipulation and dissemination of data, information and knowledge.

**GENERAL COMMENTS:** The symposium was very well attended with over 120 participants in the early afternoon, and approximately 70 returning after the coffee break. Despite possible language barriers the presentations were of a consistently high standard with lively discussions following many of the oral presentations. The posters were also very well-attended, and this encouraged discussion to continue after the formal symposium had ended. Furthermore, the presenters from the British Geological Survey and the Geological Survey of Finland who described their respective digital field data capture systems during the symposium each provided live demonstrations of their systems at their respective stands at the conference centre the following day. The feedback from this format was very positive as it allowed conference attendees to inspect the systems closely and assess their true qualities.

Information management Coordinator: John Broome

#### **IEI-05 If you can't find the data, why bother collecting and keeping it? - the importance of good metadata**

**CONVENERS:** Per Ryghaug, NGU, Norway; Jerry Giles, British Geological Survey, UK

**NUMBER OF PRESENTATIONS:** 6 oral

**SYMPOSIUM SUMMARY:** The presentations focussed on the importance of metadata as a fundamental requirement to ensure geoscience data are properly managed and discoverable. Geoscience organizations manage a wealth of irreplaceable information and their datasets are potentially valuable to a wide range of users. The session brought together experts in creation, management, dissemination and exploitation of metadata that describes geoscience datasets. Presentations focussed on best practices and issues related to: creation of metadata, management of metadata, metadata standard including INSPIRE, and the importance of standard language and thesauri.

#### **IEI-06 Data models and architectures**

**CONVENERS:** Boyan Broderic, Natural Resources Canada, Canada; John Laxton, British Geological Survey, UK

**NUMBER OF PRESENTATIONS:** 6 oral, 5 poster

**SYMPOSIUM SUMMARY:** The subject of geoscience data models and architectures is currently a 'hot topic'. Innovative contributions were presented concerning the design and implementation of data structures for storing or transferring geoscience information, such as conceptual and logical schema for databases or mark-up languages.

Talks addressed modelling of geoscience information systems, standardization, layered earth models, data structures, and the application of ontologies in data modelling.

#### **IEI-07 Interoperability and exchange formats - developments in XML, GML, GeoSciML, OGC, ISO and other standards**

**CONVENERS:** Simon Cox, University of Southampton, UK; Lars-Kristian Stölen, SGU, Sweden

**NUMBER OF PRESENTATIONS:** 6 oral, 3 poster

**SYMPOSIUM SUMMARY:** The presentations focussed on current development in the use of XML and GML mark-up language as the preferred format for exchange of geoscience information. The focus was primarily on international collaboration efforts such as the GeoSciML initiative. Technological opportunities arising from the evolution of geospatial information standards are making such interoperability a viable proposition. Discussion focussed on the requirement for a common conceptual data model to which data held in existing databases can be mapped. Interoperability initiatives in the groundwater and borehole data domains built using related GML approaches were also presented.

#### **IEI-09 Spatial data infrastructures and strategies for geoscience information**

**CONVENERS:** François Robidas, Jan Kooijman, Dutch Portal for Geoscientific data and information at TNO, Netherlands

**NUMBER OF PRESENTATIONS:** 6 oral, 2 poster

**SYMPOSIUM SUMMARY:** The development and use of spatial data infrastructures (SDIs) was addressed in the presentations from around the world. Major initiatives addressing the inclusion of different types of geoscience data into SDIs were presented from Europe (eWater, eEarth, INSPIRE, SEIS), Brazil (ArcExibe), and Switzerland (geodata policy). Optimum policy and methodology for incorporation of geoscience data in spatial data infrastructures were discussed as well as issues that have been encountered.

#### **IEI-11 Managing the transition from map making to database building**

**CONVENERS:** Dave Soller, USGS, USA; Clinton Smyth, Georeference Online Ltd, Vancouver, Canada

**NUMBER OF PRESENTATIONS:** 6 oral, 2 poster

**SYMPOSIUM SUMMARY:** For centuries the geological map has been the principal output of geological data collection and interpretation, but many geoscience organizations are now in the process of, or are planning to, transition from traditional geological paper map production to the construction of digital geoscience databases. In the internet age, geological maps are of limited utility and no longer meet the requirements of all users, particularly non-geologists. This session focussed on approaches, tools, and challenges associated with transitioning from paper map making to database building; including data files, web services, and different scales of maps designed for specific users.



Information dissemination and delivery Coordinator: Ian Jackson

### **IEI-12 Geological maps in the digital era: Quo Vadis?**

*CONVENERS:* Kristine Asch, Koji Wakita

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* During the last centuries geological maps have gone through a considerable development, starting with black and white rudimentary displays of natural resource bearing strata through graphically intricate and beautifully coloured paper maps to 3- and 4-D modelling and internet availability. Modern computing systems (for example Geographic Information Systems, and web mapping on the internet) allow us to store, retrieve and present far more information and knowledge about a specific area than ever could be displayed on a 2-dimensional paper map. The revolutionary point is that the storage and recording of data and information cannot be separated from the means of distributing it. There is no longer the need to try and serve all purposes with the same general-purpose paper document. This session aims to show possible and probable future developments of geological maps and spatial geological data. Presentations are sought which may address issues such as web mapping applications for user-tailored maps, web (and automated) services for emergency response, geological data feeding in environmental monitoring, off-shore geological mapping, new applications and approaches to geological map data for unusual use cases, and new and innovative ways in which geological maps are being presented digitally.

### **IEI-13/17 Developments in geoscience information i) the developing world, ii) uncertainty**

*CONVENERS:* Anna-Karren Nguno, Max Fernandez, Gina Ross

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* This session will focus on methods and techniques available for quantification and visualization of errors (or likelihood of errors) of geologic properties interpreted from digital datasets using geographic information systems (GIS) and 3D modelling tools. Uncertainty research is an important focus for scientists using these tools. Quantification and visualization of potential errors in the estimation of the values of regionally variable properties of identified geologic units are essential in fields such as engineering geology or resource exploration, where the design of an engineering structure or the conduct of an exploration program are typically dependent on hazard or risk assessments based in part on error analysis. GIS and 3D modelling tools typically develop maps of interpolated data generated from observations at discrete points. Evaluation of the reliability of the resulting maps is related to the quantification of the uncertainty of the estimates made from those observations. The possibility of evaluation of uncertainty depends on the method of interpolation considered. Uncertainty needs to be taken into account in decision-making and risk

assessment. Papers in this session evaluate methods based on models of variables intended to provide measures of uncertainty of the estimates. Sources of spatial variation of the phenomenon of interest will be considered along with associated error characteristics. Problems of small sample size of the original data set used to develop regional estimates may also be addressed.

The efficient delivery of geoscience information is as important to the developing world as it is to the developed world. The need for information on energy and mineral resources to benefit these nations and the timely availability of information about natural hazards and environmental issues is of critical importance to the health and wellbeing of citizens. However, the contexts of these two worlds can be very different and the development of information systems and solutions must take this into account if they are to be successful and, just as important, sustainable. This session seeks presentations that will provide information on the needs and aspirations of developing countries for geoscience information and examples of the systems and services which have been developed to effectively and appropriately meet these needs.

### **IEI-14 Decision support systems: best practice in using GIS and geoscience data to help society's problems**

*CONVENERS:* Robert Tomas, Bobo Nordahl

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* There have been many practical examples of the utilization of geoscience data to support or help to solve society's problems in different fields such as: Protection of the environment; Geohazards; Sustainable management of natural resources; Land use planning. Nevertheless the general awareness about the importance of geological data is still low. The majority of geoscience data are spatially oriented, therefore the application of geographic information systems can greatly improve on this. This session plans to provide examples of practical usage of geoscience data organized and provided through GIS, especially for supporting the process of decision-making for land planners in state, regional or local authorities. It has been proved that a practical use of geoscience data often is problematic for non-specialists. To address this issue some automation reporting systems that combine several different geoscience datasets plus the specialist's interpretation have been developed in order to provide geoscience information that is easy to understand and use. In this session we would like to demonstrate some of these comprehensive applications that are either in an operational state or planned. The main goal of the applications should be to serve the society with geoscience information which requires a low level of geological knowledge to use.



**IEI-15/16 Accessing and sharing geoscience information: the problems and issues of disseminating geoscience data in a digital era (including digital rights management, licensing, IPR, copyright, public sector data for free or a fee, and liability)**

*CONVENERS:* Ian Jackson, Bernhard Wagner

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* The amount of geoscience data available and especially digital data is increasing exponentially. However, in addition to the technical and scientific issues in making this data accessible in a digital era there are other challenges. These challenges are common to the wider spatial information domain of which geology is a part, and the new European Directive on spatial data (INSPIRE) will have to address and resolve many of them. The challenges include: The issue of ownership, copyright and digital rights management - should we be asserting our rights or making data available with no conditions; how does an organisation or individual provide access to data while retaining their rights over their data? Charging for geoscience data gathered and delivered by public sector bodies; should that data be free?; what are the pros and cons? The issue of liability for the data and information - if the organisation releases a dataset or report that proves to be inaccurate and results in loss or damage, should it be sued and how can it best protect itself? How to motivate the private sector to support national/international geoscience information infrastructures. Last but not least we would like to see papers relating to sharing geoscience information - nationally or globally. This sub-session wishes to encourage presentations on these topics particularly and the conveners aspire to construct a session programme that will see some of the arguments presented in a challenging and adversarial way, in order to bring out the issues to the full and see a stimulating debate.

In the last few years there has been tremendous progress concerning the capabilities and speed of visualisation of spatial data on the internet. This development was strongly fostered by new developments on Web 2.0 like Google Earth, and the consequences it will have in the near future on delivery of spatial information can just vaguely be anticipated. It is certain to also have a huge impact on the dissemination of geological spatial information. In order to fully use the potential features of the internet, several developments are still necessary: development of internationally acknowledged standards on a technical and semantic basis as well as common reference systems (coordinates); development of optimized tool boxes for visualisation of spatial data from different sources through web map services, web feature services, web gazetteer services etc; build-up of national and international geodata infrastructures; harmonization and interoperability of spatial geoscience information; improvement of cartographic features of visualisation. The strong understanding of the need to build geodata infrastructures is reflected through national and international initiatives like GMES, INSPIRE and GEOSS to name just a few. The session will provide a platform to present latest developments in the field of geoscience information

delivery through the internet and present prospects for the near future.

Information technology and systems Coordinator: Udo Strauss

**IEI-19 Digital standards, security and authentication of web-based database**

*CONVENERS:* Ryoichi Kouda, Udo Strauss

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* The Web provides a convenient and instantaneous way of publishing geoscience data. As the use of the World Wide Web grows on both intranets and the public internet, information security is becoming crucial to organisations. Now that it is extremely easy to disseminate information, it is equally important to ensure that the information is only accessible to those who have the rights to use it. However, never before has information security had so many vulnerable points. The session will focus on this challenge. Implementation standards and best practices for identification and authentication techniques, content protection, secure access and communication to web-based databases and applications will be topics. Information to be shared in this sub-session will include experience with commercial and private sector IT security standards, regulations and policies.

**IEI-20 Free and open-source geospatial software: applications in Earth Sciences and recent development**

*CONVENERS:* Henning Lorenz, Uppsala University, Sweden; Markus Neteler, Centro di Ecologia Alpina, Italy

*NUMBER OF PRESENTATIONS:* 5 oral, 4 poster, 2 no-shows

*SYMPOSIUM SUMMARY:* An immense amount of spatial data are collected by earth scientists every year, e.g. geophysical investigations, remotely sensed data and information acquired during field work. This information has to be stored, interpreted and, ideally, published and shared within the Earth Sciences community. To tackle this challenge without the help of dedicated geospatial software and networks is unthinkable. Unfortunately, proprietary software solutions tend to be expensive or downright unaffordable for scientific institutions, particularly in less developed countries, and data sharing is impeded by proprietary formats. However, during the last two decades several alternative software packages have been developed in the open-source community and are now available for free. The functionality of these highly flexible software solutions includes, amongst others, classical GIS and remote sensing task, virtual reality and geospatial data storage and sharing. Furthermore, the open source nature of the software allows for peer review of the programme code and therewith a good understanding of the processes operating on the users' data. This symposium attempted to provide a forum to present and discuss all aspects of scientific work in Earth Sciences which utilises and/or is related to free and open-source geospatial software. Its





main intention was to make the geoscientific community aware of the diversity, power and advantages of free and open-source geospatial software and to attract new users.

**GENERAL COMMENTS:** Although the session comprised only 9 contributions (5 oral and 4 poster presentations; 2 were cancelled), the authors represented the whole width of the open-source community with affiliations at universities and colleges, public service, research institutes and industry. Equally broad were the topics of the presentations, covering latest free and open-source software development, its use in research, outreach, teaching and spatial data infrastructure - e.g. spatial data storage and its publication and sharing via internet. Interest in the session was surprisingly large and the audience was about 90-100 people during Paul Wessel's talk about the Generic Mapping Tools. The audience did not disperse despite the break caused by the cancelled talks, and a lively discussion developed about free and open-source geospatial software in general and its utilization for geology in particular. The relatively good attendance and an audience poll indicating that only about 20% of the attendees were actively using free and open-source software shows that the session was successful and our intention had been achieved.

3 and 4D modelling and visualisation Coordinator: Andy Howard

### **IEI-22-25 From 2D to 3D: Moving geological surveys from a mapping to a modelling culture**

**CONVENERS:** Andy Howard, British Geological Survey, UK; Harvey Thorleifson, University of Minnesota and Minnesota Geological Survey, USA; Catherine Truffert, BRGM, France, Jacques Vairon, BRGM, France

**NUMBER OF PRESENTATIONS:** 12 oral, 8 poster

**SYMPOSIUM SUMMARY:** National, provincial and state geological survey organisations are moving increasingly towards development and implementation of 3D digital models as primary repositories for management and delivery of geoscientific knowledge. The associated transition from a 2D mapping to a 3D modelling culture is creating a wide range of scientific, technical and organisational challenges. Presentations were invited to demonstrate integrated and/or novel solutions, covering development of both systems and methodologies, and delivery of downstream services and product to clients. Specific topics included: maximising accessibility of prior information and knowledge in the survey process, capture of geologists' implicit 3D knowledge in models; integration of multi-resolution approaches and datasets; model validation and quality assurance; methods of presentation and publication of 3D models to a diverse user community, including clients without access to sophisticated modelling or GIS systems; development and use of model-based, 3D GIS or decision-support systems to broaden the traditional client base of geological surveys; modelling in sparse data environments, and modelling applications for urban geology, mineral reconnaissance and resource evaluation.

**CONCLUSIONS:** 1) 3D modelling is an inescapable practice of Geological Surveys; 2) Geologists have always

modelled the subsurface in 3D, but traditionally have only been able to capture their 3D model as a 2D map, constrained by the technology of the printing press; 3) Geological surveys have diverse 'user requirements' for 3D modelling software. Some common requirements emerged: a) Mathematical ('implicit') interpolation enables rapid model building, but usually requires constraint by the geologist's spatial and conceptual insight and understanding to generate a sensible model; b) No single software package ('holy grail') is available to meet Surveys' needs. Most surveys need a combination of simple, inexpensive and user-friendly software for rapid model building and knowledge capture, supplemented by more specialist software to develop and communicate the model for specific applications; c) Simple visualisation and '3D GIS' capability is needed to deliver 3D models to users and decision-makers who have no access to the modelling software itself; 4) Models must be populated volumetrically with properties - models built from a framework of discontinuities (faults, stratigraphic boundaries and unconformities) have lesser value and are harder to communicate to non-specialist users; 5) Reducing uncertainty and errors in source data is a time-consuming component of the modelling process. Data such as boreholes and seismic sections are often interpreted beforehand with a conceptual model in mind, which subsequently proves inconsistent with the digital model once constructed. Iterative correction of source data and model is often required to ensure consistency, but is typically a time-consuming, manual process carried out 'outside' the modelling software environment; 6) Communication of uncertainty is essential; most models are used for predictive purposes, requiring risk to be quantified and managed. A volumetric indication of the probability that a specific cell has the properties actually predicted by the model presented a very promising approach.

**Actions:** Individual Surveys continue to experiment with software and methods. All participants agreed that Surveys need to share ideas, experience and best practice for mutual benefit. It was suggested that future collaboration could build on existing networks or commissions in IUGS, and recommended that an international 3D modelling workshop, aimed at identifying specific challenges, be organised as a first step. The conveners agreed to follow-up this recommendation.

**GENERAL COMMENTS:** The oral session was well attended with a peak audience of about 80 delegates, with an average of between 30 and 40. Speakers included representatives from the United Kingdom, Russia, New Zealand, Netherlands, USA, Australia, France and Japan. Presentations were of a uniformly high standard and encouraged lively discussion.

### **IEI-26 Geoscience Information impromptu short talks and discussion**

**CONVENER:** Harvey Thorleifson, University of Minnesota, USA

**NUMBER OF PRESENTATIONS:** The session consisted of reports from each geoscience information session, and



general discussion

**SYMPOSIUM SUMMARY:** Reports were received regarding the following sessions, presented by one or more of the conveners or their representative: General contributions to geoscience information (IEI-01), Data capture and acquisition (IEI-02 - 04), If you can't find the data, why bother collecting and keeping it? - the importance of good metadata (IEI-05), Data models and architectures (IEI-06), Interoperability and exchange formats - developments in XML, GML, GeoSciML, OGC, ISO and other standards (IEI-07), Spatial data infrastructures and strategies for geoscience information (IEI-09), Managing the transition from map making to database building (IEI-11), Geological maps in the digital era: Quo Vadis? (IEI-12), Developments in geoscience information i) the developing world ii) uncertainty (IEI-13 + 17), Decision support systems: best practice in using GIS and geoscience data to help society's problems (IEI-14), Accessing and sharing geoscience information: the problems and issues of disseminating geoscience data in a digital era (including digital rights management, licensing, IPR, copyright, public sector data for free or a fee, and liability) (IEI-15 + 16), Digital standards, security and authentication of web-based database (IEI-19), Free and open-source geospatial software: applications in Earth Sciences and recent development (IEI-20), and, finally, Adding an extra dimension: moving geological surveys to a 3D culture (IEI-22 - 25).

**GENERAL COMMENTS:** The consensus of the group was that the geoscience information sessions had been a great success, with much emphasis on the prominent and highly successful global launch of OneGeology.

## GEOHERITAGE AND SOCIETY

IES

### IES-01 General contributions to geoheritage and society

**CONVENER:** Tony Reedman, Secretary, Association of Geoscientists for International Development

**NUMBER OF PRESENTATIONS:** 7 oral, 8 poster, 3 no-shows

**SYMPOSIUM SUMMARY:** 'Geoheritage', literally meaning that which is, or may be, inherited from the earth, is a particularly wide-ranging subject. The ways in which a nation's populace interacts with its geoheritage determines much of its national character. Various symposia (IES-2, IES-03 and IES-04) dealt with such practical topics as geotourism, conservation, the establishment of geoparks and their management, and the relationship between geoheritage and education; but discussion of the many other topics related either nationally or internationally to the broad concept of 'geoheritage and society' were addressed in symposium IES-01.

Murray Gray's presentation, "Geodiversity: Developing the paradigm", provided an excellent starting point for the symposium by discussing the development, definition, usage and increasing international acceptance of the term

'geodiversity'. Each country should protect its own geodiversity so 'national geosites' were important, as was the need to make better connections between the increasing number of terms such as 'geosite', 'geoheritage site' and 'geopark'. A second presentation, suggesting that earth scientists should be more proactive at both national and international levels concerning geodiversity issues and the conservation of geosites, explained how soil functions and a landscape hierarchical model, using the river valley as an example, were attracting attention in the Netherlands as tools for integrating geodiversity in spatial planning.

The ensuing presentations covered a wide range of examples of protection, promotion and popular education in aspects of geoheritage in a variety of countries. These included the successful activities of a number of enthusiastic volunteers in Belgium in introducing the public to aspects of their national geoheritage; a strategy for the preservation of a country's 'moveable geological heritage' through the work of museums in Serbia; and threats from natural hazards and anthropogenic activity to natural reserves near the Black Sea and the River Danube in Romania. The potential for interaction between geoheritage and tourism (geotourism) was very well illustrated by proposed routes through landscapes formed at ice margins during the Last Glaciation in Lithuania. Geomorphologic features due to past glaciation and recent glacioisostatic land uplift are also a feature of the Kvarken Archipelago, the first World Natural Heritage Site in Finland. A Quaternary geoheritage site in the Extramadura of Portugal shaped by fluviokarstic and periglacial processes was also introduced and its scientific and geotourist attractions explained.

**GENERAL COMMENTS:** All presentations were beautifully illustrated, making for a rewarding session for the 20 to 40 participants at the symposium taking place on the first afternoon of IGC. An equally interesting selection of posters was presented on the second day. The evidence suggests that the topic of 'geoheritage' is commanding increasing attention in many countries and the question of its conservation and use in public education is a growing concern of more and more practising geoscientists.

### IES-02 Earth heritage: Science, education and capacity building (IUGS, UNESCO, GGN)

**CONVENERS:** Peter Bobrowsky, Robert Missotten, Zhao Xun

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** The appreciation we share with other geoscientists and the public at large for beautiful landscapes, unique geological features and active geological processes provides a basic tenet for the concept of GeoHeritage. Underlying the need for preservation, conservation, public outreach and geotourism rests a disciplinary obligation to better communicate the science of geology to the wider global community. The purpose of this session centres on identifying what elements of existing geological heritage or outreach initiatives are amenable to detailed scientific analysis, what social benefits arise from the study of such initiatives and how do such



public outreach initiatives transform geological observations into information readily assimilated by the general public. Do these initiatives provide an inroad for education in developing countries, why raise awareness in new initiatives such as geoparks instead of traditional means of teaching and education, and so on. This session provides an excellent opportunity for scientists interested in geological heritage research, outreach and education to share in case study successes and failures, help focus the future direction of such initiatives and network with others who share common interests in these related topics.

### **IES-03 Geosites and landscape - conservation and management strategies**

**CONVENERS:** José Brilha, ProGEO, University of Minho, Portugal; Emmanuel Reynard, IAG, University of Lausanne, Switzerland

**NUMBER OF PRESENTATIONS:** 10 oral, 5 poster

**SYMPOSIUM SUMMARY:** Geoconservation has a history of more than 100 years. Strategies and practices vary. To improve its position it is important to develop the field in a wide perspective, linking local interests with national and international efforts, geology with landscape and protection with use. This symposium dealt with pragmatic issues regarding the establishment of conservation and management strategies concerning geoheritage. These strategies vary between each country as a consequence of the availability of geological knowledge, legal framework and institutional commitment of national authorities. During this symposium some experiences were described from different countries worldwide which allowed the discussion between participants.

**ANNOUNCEMENTS:** The increasing importance of geoconservation within Earth Sciences is responsible for the creation of the first peer-reviewed international journal dedicated to this theme. Geoheritage, published by Springer, will start in 2009. It is expected that this journal will promote the exchange of information, concepts, methodologies, data and experiences between geoconservation experts all around the world.

### **IES-04 Geoparks and geotourism (EGN)**

**CONVENERS:** Nickolaos Zouros, University of the Aegean, Greece; Patrick McKeever, Universiti Kebangsaan, Malaysia

**NUMBER OF PRESENTATIONS:** 22 oral, 13 poster

**SYMPOSIUM SUMMARY:** Recent years have seen the development of a new concept in conservation, heritage promotion and geoscience education. Inextricably linked to sustainable development, the concept of a 'geopark' was first developed in Europe where a network of geoparks was launched in 2000. Following the success and growth of this network (the European Geoparks Network), UNESCO adopted the geopark concept and, in 2004, launched the Global Network of National Geoparks. Today, with 56 members across the world, geoparks are a leading initiative in promoting Earth Sciences to local communities and to a wider, non-specialist audience primarily through the development of 'geotourism' - sustainable tourism based on Earth's geological heritage.

Since 2004, geoparks have featured at the International Geological Congress. In 2008 in Oslo, a full day-long session was dedicated to this new topic and no less than 22 oral presentations were accepted for presentation alongside 13 poster presentations. The papers came from all continents except North America and Antarctica, with a range spanning from areas with a strong potential of developing geotourism through to areas aiming to develop geoparks and presentations giving the results of projects within developed geoparks. The keynote presentation from N. Zouros and PJ Mc Keever provided an overview of the geopark concept and the activities of the European Geoparks Network. There was active audience participation throughout the day with busy question and answer sessions including a longer Q&A session during one of the breaks. The session was consistently well-attended throughout the day with auditorium typically 50 - 75% full at most times.

## **MINERALOGY, PETROLOGY, ISOTOPE GEOLOGY, VOLCANOLOGY MP**

## **GEOCHRONOLOGY AND ISOTOPE GEOLOGY MPC**

### **MPC-01 General contributions to geochronology and isotope geology**

**CONVENER:** Åke Johansson, Swedish Museum of Natural History, Sweden

**NUMBER OF PRESENTATIONS:** 4 oral, 17 poster, 19 cancelled and no-shows

**SYMPOSIUM SUMMARY:** Isotope geology has developed from the classical field of geochronology to a broad range of applications within the geosciences, including petrogenetic and ore genetic studies, studies of mantle composition and crustal growth, and geochemical investigations of exogenic processes with bearing on environmental problems. This symposium invited contributions from all fields of isotope geology, including classical geochronology, and in particular contributions highlighting new methods and analytical techniques or new and innovative applications.

In practice, the symposium became a 'smorgasbord' of different contributions, including a few highlighting new methods and applications. This makes it difficult to summarize or draw any conclusions from the symposium.

**GENERAL COMMENTS:** The symposium was dominated by poster contributions, largely from Russia, with only four (out of six scheduled) oral contributions (from Japan, Russia, and Turkey). The large number of no-shows (half of the scheduled posters) may be due to people from Russia, China and other countries not being able to make it to the congress. The quality of the contributions was somewhat variable, with many of the abstracts suffering from linguistic problems, but the methods and



data presented were generally of good quality. The number of people attending the oral presentations increased from about 10 at the start to c. 25 at the end. Fairly long and lively discussions made it possible to fill most of the gaps created by the two cancelled talks.

### **MPC-02 Geochronology of metamorphic reactions and deformation in high-grade orogenic settings**

*CONVENERS:* Jenny Andersson, Geological Survey of Sweden, Sweden; Bernard Bingen, Geological Survey of Norway, Norway; Ulf Söderlund, University of Lund, Sweden; Fernando Corfu, University of Oslo, Norway; David Cornell, University of Gothenburg, Sweden

*NUMBER OF PRESENTATIONS:* 13 oral, 5 poster

*SYMPOSIUM SUMMARY:* The symposium MPC-02 was designed as a forum for presentation and discussion of recent advances in geochronology of metamorphic reactions, deformation phases and metasomatic processes under high-grade metamorphic conditions. It was also a follow up of the pre-meeting excursion No 51, "The Sveconorwegian orogen of southern Scandinavia: P-T-t evolution of polymetamorphic high-grade domains", during which case studies in southern Scandinavia were illustrated and discussed in the field. The symposium attracted 18 abstracts addressing different aspects of the proposed theme. This included a selection of different high-grade orogenic settings represented in the geological record, exposed in different parts of the planet, and covering a wide time span, from the Archean to the Tertiary.

The symposium was aimed at the combination of field geology, metamorphic petrology and application of microsampling geochronological-geochemical methods which is a growing field of interest, to pin down the metamorphic conditions and timing of tectonothermal events in orogenic terranes. Contributions highlighted the application of isotope geochronology and geochemistry to construct, characterise, and directly date the P-T-t evolution and tectonic build-up of high-grade metamorphic complexes. Particular focus was put on the connection between metamorphic reactions and the behaviour of different isotopic systems and geochronometers in high-grade rocks. The session brought together structural geologists, metamorphic petrologists, isotope geochemists and other geoscientists combining their expertise towards an increased understanding of geochronology and modelling geotectonic cycles and, thereby, the crustal evolution of our continents.

*GENERAL COMMENTS:* The session was a real success as attendance reached more than 100 persons during the morning and 40-60 persons during the afternoon. Keynote speaker, D. Rubatto, Australian National University, Canberra, gave an excellent review of a number of case studies illustrating geochronological work on high-grade metamorphism using a combined approach of textural observations, petrology of major phases, trace element partitioning and ion microprobe dating. Keynote speaker S. Kamo, University of Toronto, Canada, presented a summary of the outstanding career of T. Krogh, a leading geochronologist deceased in the spring of 2008, who has

played a key role for the development of the field of geochronology. Keynote speaker J. Glodny, GeoForschungsZentrum, Potsdam, Germany, illustrated the potential of petrology-guided Rb-Sr multi-mineral geochronology to constrain the history of HP terranes. We feel that all talks were of high scientific standard and very well performed. A number of questions were raised after each talk and discussions continued during coffee breaks.

### **MPC-03 Precambrian isotope chemostratigraphy**

*CONVENERS:* Alcides Nobrega Sial, NEG-LABISE, UFPE, Recife, Brazil; Claudio Gaucher, Universidad de la Republica, Montevideo, Uruguay; Valderez Pinto Ferreira, NEG-LABISE, UFPE, Recife, Brazil

*NUMBER OF PRESENTATIONS:* 8 oral, 8 poster, 5 no-shows

*SYMPOSIUM SUMMARY:* This symposium highlighted the use of chemical and isotope stratigraphy in Precambrian successions and their correlations worldwide as a tool to understanding environmental and global climatic changes. We gathered specialists from different continents (North and South Americas, Asia and Europe), and the symposium has helped to shed some light on the understanding on some well-known C isotope anomalies (eg Lomagundi) and on some extreme isotope excursions of the Neoproterozoic corresponding to freeze-and-fry abrupt climatic changes. Although the main goal of the symposium was the Precambrian chemostratigraphy, contributions dealing with the Cambrian SPICE and SNICE anomalies were also allowed. The symposium had two keynote speakers: A. Jay Kaufman (USA) and Juha Karhu (Finland).

The symposium covered a large variety of subjects and case histories (Paleoproterozoic to Neoproterozoic), bringing together people from different countries with different experience and generating fruitful discussions. As a whole this was a rewarding experience for conveners and, we hope, for the audience.

*GENERAL COMMENTS:* Presentations were fairly good to excellent, starting with two keynote talks. The first one was given by Prof. Alan Jay Kaufman (University of Maryland) who gave a fairly complete picture of the atmospheric, climatic and biological evolution at both ends of the Proterozoic Eon. Prof. Juha Karhu as the second keynote speaker examined the current knowledge of the end of the Paleoproterozoic carbon isotope excursion, providing some new very important time constraints. Another highlight of the symposium was given by J. C. Silva Tamayo (Univ. of Bern) who focused on more evidence of a short-lived global perturbation in the marine Ca isotopic composition in the aftermath of the 0.64 Ga global glaciations. The possibility of Post-Gaskiers glacial events from sedimentary successions of southwestern Gondwana was examined by Claudio Gaucher (Uruguay). A very important contribution for the application of chemical/isotopic chemostratigraphy was given by Hartwig Frimmel (Germany) who examined the REE geochemistry of Neoproterozoic carbonates and deviation from normal marine signatures.

Important contributions have arisen from some of the





posters that focussed mainly on the Neoproterozoic of South America and Paleoproterozoic of South America and India. Most presentations were followed by stimulating discussions, always conducted in a friendly atmosphere.

#### **ANNOUNCEMENTS:**

We have presented to the editor of the Precambrian Research (Elsevier) a preliminary proposal for a special issue containing papers that have been presented in this symposium. We are at present preparing a reworked proposal to account for some of the observations made by the editor (Tim Horscroft) to be resubmitted soon. This publication should have the following organization: Title: Insights of Precambrian Isotope Chemostratigraphy. The publication will contain, we hope, about 15 papers (mostly presented in this symposium) and will have as Guest Editors: Alcides N. Sial, NEG-LABISE, Juha Karhu and Valderez P. Ferreira.

#### **MPC-04 Constraining timing and rates of surface processes by low temperature thermochronology**

**CONVENERS:** Bart W.H. Hendriks, Geological Survey of Norway, Norway; Tim F. Redfield, Geological Survey of Norway, Norway

**NUMBER OF PRESENTATIONS:** 5 oral, 1 poster, 1 cancellation, 1 no-show

**SYMPOSIUM SUMMARY:** Low temperature thermochronology is routinely used to quantify denudation rates and to constrain the timing of processes in the uppermost few kilometres of the earth's crust. Rapid progress in the development of thermochronological methods and also the application of these methods to a rapidly extending range of mineral phases has enabled the study of the coupling of tectonic, geodynamic and surface processes. However, the apparent incompatibility of certain results from different thermochronometers, the irreproducibility of other results, and the creation of modelling artefacts stemming from our incomplete understanding of the physics underlying the methods themselves frequently create difficulties - and even controversies - in the interpretation of low temperature thermal histories. In this session specialists in the various low temperature thermochronological techniques discussed the fundamental reasons for these problems as well as the changes in analytical techniques and modelling approaches that help to solve them.

**GENERAL COMMENTS:** Because of a cancellation and a no-show there was plenty of time for discussion, which developed very well. The audience of about 20 people took part in the discussion together with the speakers.

#### **MPC-05 Evolution of the crust and oceans through Re-Os geochemistry: A decade of discovery**

**CONVENERS:** Holly Stein, Colorado State University, USA, and Geological Survey of Norway, Norway; Judith Hannah, Colorado State University, USA, and Geological Survey of Norway, Norway

**NUMBER OF PRESENTATIONS:** 10 oral, 2 poster

**SYMPOSIUM SUMMARY:** Pioneering analytical work on Re-Os geochronology and geochemistry made extensive use of samples from Nordic localities. In the 1960s, early

workers realized that molybdenite provided a single mineral geologic clock, and the Baltic shield was rich with molybdenite. Analytical difficulties, however, prevented application of the Re-Os method. In the last decade, advances in analytical methods led to high-precision Re-Os isotopic data, and applications of Re-Os geochemistry exploded to include a range of minerals and geologic environments in crustal regimes. This symposium focused on Re-Os applications that document the chronology of crustal processes and the evolution of Os isotopic compositions in the earth's crust and oceans through geologic time. Topics included (i) Re-Os chronology of igneous rocks and ore deposits using sulphide minerals; (ii) Re-Os isotopic applications to tectonic processes; (iii) Re-Os systematics in groundwaters and use of the Re-Os system to model contributions of weathering to ocean chemistry; (iv) applications of Re-Os isotope geochemistry to hydrocarbon generation and migration; and (v) use of Re-Os chronology of black shales to correlate sedimentary units and refine the global time scale.

Presentations and discussions demonstrated that although a globally limited number of labs are applying this isotopic system to evolution of upper continental crust and surface environments, Re-Os geochronology is a maturing science. Some audience members questioned the accuracy of data leading to new or revised understanding, but the overwhelming majority, both presenters and audience, agreed that the methods are sound and provide new insights. The focus of current work includes further understanding of Re-Os systematics in various environments, improving sampling strategies, and developing new applications for related sciences (e.g. tectonics and global chemical cycles).

**GENERAL COMMENTS:** Attendance varied throughout the session from about 30 to 50 persons. Discussion was lively. In most cases, questions had to be terminated to stay on schedule. Further discussion continued at the posters after the oral session concluded.

### **EXPERIMENTAL PETROLOGY AND MINERALOGY MPE**

#### **MPE-01 Contributions to experimental petrology and mineralogy - a tribute to Surendra Saxena**

**CONVENER:** Peter Lazor, Uppsala University, Sweden

**NUMBER OF PRESENTATIONS:** 5 oral, 5 poster

**SYMPOSIUM SUMMARY:** This symposium is dedicated to Professor Surendra K. Saxena whose 50 years long (and still counting) scientific career made a huge impact in the fields of mineralogy, petrology, geochemistry, and thermodynamics of fluids, rocks and minerals. All contributions presenting experimental aspects in these fields are welcome. We are particularly interested in high-pressure and high-temperature studies on the Earth and planetary interiors, which include phenomena such as melting, chemical reactions and phase transformations, as well as equation-of-state studies, and which use





experimental techniques of laser and resistively heated diamond anvil cell, multi-anvil apparatus, synchrotron x-ray diffraction and Raman spectroscopy, applied to mantle and core materials.

Speakers presented research which was thematically well connected to the research activities of Prof. Saxena throughout his scientific career. Prof. Saxena attended the symposium and presented some of his latest results on high-pressure properties of iron, as well as a brief overview of his past research. The symposium was successful in reaching its main goal - to pay a tribute to Surendra Saxena. *GENERAL COMMENTS:* A moderate number of people (20-25) attended the symposium. Scheduled for the early morning, the session suffered from limited transport possibilities from Oslo to the conference site.

## IGNEOUS PETROLOGY

## MPI

### MPI-01 General contributions to igneous petrology

*CONVENERS:* Brian Robins, University of Bergen, Norway; Marjorie Wilson, University of Leeds, UK

*NUMBER OF PRESENTATIONS:* 6 oral, 35 poster

*SYMPOSIUM SUMMARY:* The symposium attracted a wide range of contributions exploring diverse aspects of magmatic systems on the Earth. The contributions focussed on the fundamental causes of igneous activity, the interplay between tectonic environment and magmatic activity, and the nature of the physical and chemical processes that take place during the generation, extraction, mixing, contamination and crystallisation of magma.

*GENERAL COMMENTS:* Poster presentations were the predominant medium and were scrutinised and discussed by a large number of congress delegates.

### MPI-02 Integrated perspectives on the accretion of oceanic crust

*CONVENERS:* Yildirim Dilek, Jeffrey A. Karson

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* Investigations of the processes associated with the accretion of oceanic crust come from several different perspectives, all of which contribute significantly to the current perception of seafloor spreading. This session is designed to bring together presentations that will represent these various perspectives in order to provide an up-to-date assessment of progress towards a comprehensive understanding of the genesis of the oceanic crust. Major topics will include investigations of oceanic crust at spreading centers and subduction zone environments, from deep crustal drilling, and in "tectonic windows", the seismic structure of oceanic crust and spreading centers at mid-ocean ridges and in backarc basins, and field and geochemical investigations of ophiolite complexes. Presentations will focus on the interplay of tectonic, magmatic, and hydrothermal processes in the formation and evolution of modern and ancient oceanic crust across a broad spectrum of spreading

rates, magma budgets, mantle dynamics, and tectonic settings.

### MPI-03 Granite classification - a never-ending problem

*CONVENERS:* Bernard Bonin, Université de Paris-Sud, Orsay, France, chairman of the IUGS-SSIR; Tom Andersen, University of Oslo, Norway; Tapani Rämö, University of Helsinki, Finland, co-leader of IGCP510

*NUMBER OF PRESENTATIONS:* 6 oral, 8 poster, 4 no-shows

*SYMPOSIUM SUMMARY:* Granites are simple quartz feldspar rocks but there is no consensus about how and where granitic magmas originate and how and where they evolve. In this session devoted to granite classification, two major issues were addressed: 1) Use and significance of chemical diagrams. In the SSIR nomenclatural scheme, plutonic rocks are classified using the QAP diagram, while the TAS diagram is the simplest way to discriminate volcanic rocks. Is the TAS diagram a chemical equivalent of the modal QAP diagram? Can it be used for plutonic rocks? 2) Fate of alphabet classification. This genetic classification never gained a worldwide consensus. We wish to examine parameters describing granite and to discuss whether it is possible to obtain answers to the genetic conundrum.

The oral presentations concentrated on the significance of alkali contents and behaviours of felsic rocks. The alphabetical classification in general was not discussed, though A-type granites constitute a part of it. Every aspect of alkali-lime-alumina relationships were considered: significance of saturation indices, suggested new boundaries in the felsic end-member of the TAS diagram, use and misuse of classical words such as calc-alkaline and alkaline, redox conditions and tectonic settings of contrasting ferroan igneous suites. Co-sponsors: IUGS 'Subcommission on Systematics of Igneous Rocks' and UNESCO-IUGS IGCP510 'A-type granites and their evolution in space and time'. As the session was co-sponsored by IGCP510, some oral and most poster presentations concerned A-type granites in space and time, and their relevance to calc-alkaline igneous suites.

*GENERAL COMMENTS:* Despite the non-favourable fact that the symposium took place in the second half of the afternoon, the room allocated for oral presentations was unexpectedly full during the whole session, i.e. more than 50 people attended. The oral session was run in time and, after the oral talks were formally delivered, a lively general discussion lasted about half an hour, before people moving to the poster session hall.

*ANNOUNCEMENTS:* No special issue was planned at this stage. Publications are expected for the last meeting of the IGCP510 in 2009-2010.

### MPI-04 Mafic dyke swarms: A global perspective

*CONVENERS:* Rajesh K. Srivastava, Banaras Hindu University, India; Wouter Bleeker, Geological Survey of Canada, Canada; Richard Ernst, Carleton University & Ernst Geosciences, Canada

*NUMBER OF PRESENTATIONS:* 14 oral, 4 poster



**SYMPOSIUM SUMMARY:** In recent years, short-lived mantle generated magmatic events, particularly large igneous provinces (LIPs) and their dyke swarms, have emerged as the key tool in paleogeographic reconstructions. Major magmatic events store an incredibly diverse range of high-quality information, punctuating Earth history at an average frequency of  $\sim 10$  events per 100 myr, waxing and waning in tune with the supercontinent cycle - the 'pulse of the Earth'. Because of great depth and lateral extent, mafic dyke swarms provide the most complete record of short-lived, mantle-generated magmatic events through time and space. W. Bleeker and M. Hamilton introduced and emphasized these points. Then numerous regional dyke swarm summaries were presented: (i) D. Gladkochub et al. (with new U-Pb geochronology) on southern Siberia, (ii) J. Vuollo on the Fennoscandian shield, (iii) A. Stepanova and V. Stepanov on the Belomorian province, (iv) R. Ernst et al. on Russia and selected adjacent regions, (v) C. Rao and R. Srivastava on Indian dykes emplaced in different cratons of the Indian shield, (vi) T. Radhakrishna and M. Jayananda on mafic dykes of the southern Indian craton, (vii) J. R. Olsson et al. (with new U-Pb geochronology) on dolerite dyke swarms of Kaapvaal craton, (viii) P. Peng et al. on dyke swarms of the North China craton. In addition, D. Evans and H. Halls reviewed evidence from dyke swarms for the relative rotation between east and west halves of the Superior craton, H. Halls et al. presented new information on the 2.1 Ga Marathon swarm of Canada, and H. Xue and F. Ma. presented on ultramafic-mafic sills of the central China craton.

**GENERAL COMMENTS:** This symposium was held over two days; an afternoon session of the 8th August and a morning session of 9th August 2008. Both sessions were well attended, with an average attendance of 50 and a peak attendance of more than 100. In general the talks were of very high quality and discussion was lively.

**ANNOUNCEMENTS:** A special issue of Precambrian Research based on the papers presented in the symposium is in process. Sixth International Dyke Conference (IDC-6) will be held at Banaras Hindu University, Varanasi, India during 4th to 7th February 2010.

#### **MPI-05 Large Igneous Provinces: Initiation, evolution and origin**

**CONVENERS:** Lothar Vierendeck-Goette, Friedrich-Schiller-University Jena, Germany; Sverre Planke, Volcanic Basin Petroleum Research, Oslo, Norway

**NUMBER OF PRESENTATIONS:** 8 oral, 2 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** The events during initiation and evolution of mafic Large Igneous Provinces were documented for LIPs on all continents (except S-America) covering ages from Mid-Proterozoic to Early Tertiary. In most provinces magma emplacement as lava and pillowed flows was preceded by sill intrusions into a continental basin with abundant magma-wet sediment interaction. Venting resulting in synsedimentary volcanoclastic interlayers provided the age control for sill emplacement as the initial igneous phase for a number of LIPs: Late

Permian Siberian Traps (Alexander Polozov, Sverre Planke), Jurassic Ferrar Province, Antarctica (Lothar Vierendeck-Goette), Jurassic Karroo, S Africa (Sverre Planke); Paleogene North Atlantic Igneous Province, Norwegian Sea, Europe (Sverre Planke & Michael Abratis). No unequivocal proof was given that underlying sills predate lava flows for the Ediacarian Volhynian Traps in E-Poland to W-Ukraine (Nonna Bakun-Czubarow) and the Devonian Minusinsk and Kuznetsk troughs, S Siberia (Geliy Fedoseev). In all instances a crystalline basement was overlain by poorly to unconsolidated siliciclastic sediments indicating downwarping of continental crust prior to magmatism for some 10 Ma.

The LIP magmas usually belong to the tholeiitic differentiation series with the exception of the alkalic Eastern Deccan Traps (Dalim Paul). In the Ediacarian Volhynian Traps in Eastern Europe (Nonna Bakun-Czubarow) a minor interval of alkali- and trachybasaltic lavas separates massive tholeiitic sills from flows. While crustal contamination occurred to various degrees, involvement of molten continental crust was only reported for the Early Cambrian Kalkarindji Province in NW Australia (Lena Evins) and the North Atlantic Igneous Province (Michael Abratis).

Models were presented for (1) viscosity dependent mixing between sediments and magma (Geliy Fedoseev), (2) sediment permeability dependency of venting processes (Sverre Planke), (3) the fractal spectrum of volcanic particles with the water-magma ratio during eruption (Lena Evins), as well as (4) transport of magmas over several 100 to 1000 km (Dalim Paul).

**GENERAL COMMENTS:** The audience comprised 50 people before the coffee break and 30 afterwards. The quality of presentations was good. The discussions often were very informative, as two Canadian colleagues (Richard Ernst, IAVCEI LIP Commission, & Wouter Bleeker, Geol Surv Canada) added information on their almost identical lithological observations from Archean greenstone belts. Remark: two more abstracts had been assigned as lectures to the conveners but did not feature in the public abstract volume or on the schedule outside the lecture hall, nor had poster boards been assigned. Unfortunately, the data were never presented.

#### **MPI-06 Layered intrusions and the evolution of magma chambers - a tribute to J. Richard Wilson**

**CONVENERS:** Christian Tegner, University of Aarhus, Denmark; Bernard Charlier, University of Liege, Belgium; Brian Robins, University of Bergen, Norway

**NUMBER OF PRESENTATIONS:** 12 oral, 9 poster, 1 cancelled

**SYMPOSIUM SUMMARY:** Magma slowly cools, crystallizes and interacts with crustal country rocks in magma chambers. These processes generate the diversity of volcanic and plutonic rocks, some containing important mineral deposits. We invited contributions from all fields of research that addressed magma chamber processes including field relations, petrography, petrology, geophysics and geochemistry. The symposium complemented excursion no. 26 (Magma Geopark: The Rogaland



Anorthosite Province).

The symposium was a tribute to J. Richard Wilson for his contributions to the understanding of processes in mafic magma chambers, particularly on compositional zoning in magma chambers which was the subject of his own presentation. Richard Wilson is an archetypal layered intrusionist. His numerous studies of layered mafic intrusions in Norway, Greenland, Scotland, South Africa and other localities are based on meticulous and extensive fieldwork complemented by detailed chemical analyses. His studies have resulted in rigorous and innovative interpretations, and led to 3 papers in the prestigious journal *Nature* on the Fongen-Hyllingen complex, which is far from common for studies on layered intrusions. In addition to research, Richard has taught thousands of hours of mineralogy and petrology and has supervised more than 50 master and Ph.D. students. He has also been extensively used as an expert referee by scientific publications.

**GENERAL COMMENTS:** The overall quality of the majority of the presentations was good to excellent. Around 40 people attended the symposium. Lively discussions followed most of the presentations.

#### **MPI-07 Alkaline and carbonatite magmatism and related ore deposits**

**CONVENERS:** Lia Kogarko, Vernadsky Institute, Russia; Tom Andersen, University of Oslo, Norway; Kathryn Moore, National University of Ireland Galway, Ireland

**NUMBER OF PRESENTATIONS:** 21 oral and 19 poster

**SYMPOSIUM SUMMARY:** The symposium covered broad aspects of the geochemistry, petrology, mineralogy and economic geology of alkaline and carbonatitic rocks. The presentations took place on 9 August. New data and theories were presented on the sources of alkaline magmas, and on the differentiated series from parental magmas to residual peralkaline and carbonatitic melts. New data were presented on models and economic potential of rare metal mineral deposits of Eastern part of the Baltic Shield.

The formation of graphite and diamond in carbonate magmas was discussed in a number of contributions. It was shown that redox conditions of graphite-bearing carbonatites fall between quartz-magnetite-fayalite buffer and approximately one log unit below this buffer (I.D. Ryabchikov). Similar redox characteristics are typical for many mantle-derived magmas, e.g. for MORBs. Graphite is formed during cooling at the expense of the reduction of carbonates (in the melt or crystalline phases) or CO<sub>2</sub> in fluid phase. It has been demonstrated that hydrocarbon-rich fluids in alkaline rocks are formed not by Fischer-Tropsch synthesis, but due to the interaction of water with the earlier formed graphite at temperatures below 400°C. In a number of contributions (Y.A. Litvin et al.) the possibility of the synthesis of diamond in carbonate melts has been demonstrated experimentally.

T. Andersen presented a description of mineral parageneses of Na-Ca-Nb-Ti-Zr-bearing minerals of nepheline syenite pegmatites in the Langesundfjord area in the Oslo Rift. He demonstrated that the relative stability of assemblages depends on the peralkalinity of the magma

(expressed as aNa<sub>2</sub>Si<sub>2</sub>O<sub>5</sub>) and the activities of the volatile components H<sub>2</sub>O, HF and Cl. The peralkalinity and volatile activities of the crystallizing pegmatite magma are most likely a result of fractionation processes prior to emplacement, and the Na-Zr silicate assemblages reflect the physico-chemical conditions during final crystallization. The results of investigation of melt inclusions and the analysis of a series of rocks of Belaya Zima magmatic complex, reported by I. Andreeva and V. Kovalenko, show that crystal fractionation and silicate-carbonate liquid immiscibility were the main processes in the formation of ijolites and carbonatites. The data on the trace-element compositions of glasses from homogenized melt inclusions and alkaline rocks and carbonatites constrain the composition of the mantle source of this magmatic complex. The source of alkaline rocks and carbonatites was represented by the depleted mantle that experienced metasomatic alteration. The major agents of mantle metasomatism were sodic and calcic carbonate melts.

A. Costanzo et al. presented results of microthermometric and laser Raman studies which permitted to constrain the nature of the primary magmatic fluids trapped in nepheline crystals in tinguaita from the Poços de Caldas Massif, Brazil. Their data imply that there are at least two generations of carbonatite magma production and ascent in this massif.

**ANNOUNCEMENTS:** During the discussion after the session it was proposed to launch a new IGCP project: "Alkaline and carbonatitic magmatism and related ore deposits".

## **METAMORPHIC PETROLOGY**

## **MPN**

#### **MPN-01 General contributions to metamorphic petrology**

**CONVENERS:** William Carlson, University of Texas at Austin, USA; Simon Harley, University of Edinburgh, UK

**NUMBER OF PRESENTATIONS:** 9 poster, 1 no-show

**SYMPOSIUM SUMMARY:** This symposium was designed to facilitate contributions on any aspect of metamorphic petrology and its applications. It included new areas of investigation and themes arising from but not specific to the more specialized symposia, such as those devoted to UHT metamorphism, migmatites and granites, geochronology of metamorphism, and metamorphism through time and space.

Three of the posters described petrological analysis of specific metamorphic regions or terranes, spread widely across the globe. Three posters dealt with specific issues of metamorphic mineral chemistry or assemblages, and two focused on fluid-rock interactions during metamorphism. One poster addressed thermochemical modelling of high-pressure mafic rocks.

**GENERAL COMMENTS:** These posters seemed to be well-received, with viewers in numbers that seemed to match those for other sessions.



**MPN-02 Metamorphism and metamorphic processes**

CONVENER: Håkon Austrheim, University of Oslo, Norway

NUMBER OF PRESENTATIONS: 16 oral, 28 poster

*SYMPOSIUM SUMMARY:* This symposium was designed to facilitate contributions that focus on developments in our understanding of metamorphic processes on all scales, from recrystallisation, reaction and diffusion, to fluid-mineral-melt interactions, metamorphism-deformation relations, and metamorphism in orogeny. As in MPN-01, this symposium will present contributions that include new areas of investigation and themes arising from but not specific to the more specialized symposia, such as those devoted to UHT metamorphism, migmatites and granites, geochronology of metamorphism, and metamorphism within the context of Gondwana.

The symposium was put together by Simon Harley and gave a good overview of the activity and state-of-art in metamorphic petrology. Metamorphic petrology provides input data for geodynamic modelling and interpretation of geophysical data, and for a future symposium a stronger cross-disciplinary approach would be favourable.

*GENERAL COMMENTS:* There is typically not much time for discussion in events of this type, but a question or two followed most of the presentations.

**MPN-03 Mineral replacement and mass transfer in hydrothermal systems: From the nanoscale to the megascale**

CONVENERS: Andrew Putnis, University of Münster, Germany; Ane K. Engvik, NGU, Trondheim, Norway

NUMBER OF PRESENTATIONS: 16 oral, 8 poster

*SYMPOSIUM SUMMARY:* The role of fluids in the reequilibration of minerals and rocks is fundamental to understanding the mechanisms and kinetics of metamorphic and metasomatic processes. An important aspect of the problem is to determine the scale over which mass transfer takes place, the nature of the fluids which catalyse reactions, and the processes which promote fluid infiltration. Porosity generation due to coupled dissolution-precipitation and hydraulic fracture, as well as reaction interfaces between parent and product phases can be studied on the nanoscale as well as on the field scale. This session focused on mechanisms of hydrothermal reactions and textural development from both experiments and studies of natural rocks. There were two 30 minute keynote lectures which successfully described the context of the talks which followed. The extent of replacement mechanisms in the earth and the mechanism of fluid transport and element mobility was emphasised throughout.

*GENERAL COMMENTS:* Discussion was somewhat limited, perhaps because of the number of attendees without English as a native language. The sessions were however very well attended. Most of the talks were excellent, with a couple of talks in the last session which may have been better placed as posters. Overall, the feedback about the symposium has been very positive. We were approached by both *Lithos* and the *European Journal of Mineralogy* about a special issue based on the

symposium, but as the main speakers were already at various stages of publishing their work, no further action will be taken.

**MPN-05 Earthquakes, fluids and metamorphism**

CONVENERS: Torgeir B. Andersen, University of Oslo, Norway; Timm John, University of Oslo, Norway

NUMBER OF PRESENTATIONS: 8 oral

*SYMPOSIUM SUMMARY:* All presenters gave high-quality and innovative contributions to the interesting link (s) between metamorphism and seismicity. It is interesting to note that results presented by keynote speakers Miller and Rietbrock are published in high quality publications like *Nature* and *Science* respectively, and that another two of the contributions (Andersen et al. and Medvedev et al.) now are either in press or in revision after review for similar high standing journals (*Geology* and *Nature-Geoscience*, respectively). The limited participation from both European and American colleagues to our symposium was mainly due to collision with a Gordon Conference first week in August on "Real-time Rheology" arranged in New Hampshire, US.

*GENERAL COMMENTS:* The presentations were attended by approximately 50 persons and there were many questions and discussions to all the contributions.

*ANNOUNCEMENTS:* In press: Andersen T.B. et al. (December 2008) "Stress release in exhumed intermediate-deep earthquakes determined from ultramafic pseudotachylite", *Geology*. In revision: John, T., Medvedev, S. et al. (in revision) "Self-localized thermal runaway as a mechanism for intermediate and deep earthquakes", *Nature-geoscience*.

**MPN-06 Extreme metamorphism during the amalgamation of Gondwana: Tectonics, rates and models**

CONVENERS: Chris Clark, Alan Collins, Renato Moraes, M. Santosh

NOTE: A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* The Neoproterozoic break-up of Rodinia and subsequent Ediacaran/Cambrian amalgamation of Gondwana represented a dramatic rearrangement of continental landmasses during a period of extreme climatic fluctuation and biological diversification. The geological events during this period preserve a unique record of extreme metamorphism in both the western and eastern regions of Gondwana (e.g. the Anápolis-Itaçu complex, Brazil; the Southern Granulite Terrane, India; southern Madagascar; The Prydz Bay region of Antarctica; The East African Orogen of Uganda, etc.). The aim of this symposium is to explore the tectonics, timing and models for the generation of these extreme metamorphic conditions and the styles of orogenic processes during this period of Earth history. As such this session will be multidisciplinary, open, and not restricted to petrologists, geochronologists and geodynamicists. This symposium is associated with The International Association of Gondwana Research and forms a contribution to the International Lithosphere Program





Task Force 1 (Accretionary Orogens).

## **MPN-12 Sederholm symposium on high-grade metamorphism, crustal melting, migmatites and granites**

*CONVENERS:* Michael Brown, University of Maryland, USA; Olav Eklund, Turku University, Finland; Peter Sorjonen-Ward, Geological Survey of Finland, Finland

*NUMBER OF PRESENTATIONS:* 22 oral, 11 poster, 10 no-shows

*SYMPOSIUM SUMMARY:* The 33rd IGC occurred 101 years after J.J. Sederholm published his paper "Om granit och gnejs, deras uppkomst, uppträdande och utbredning inom urberget i Fennoskandia" (On granite and gneiss, their origin, relations and occurrence in the Precambrian complex of Fenno-Scandia). This paper stimulated research in crustal melting processes. Sederholm's contribution was remarkable because of its wide scope from analysis of processes in outcrop to the regional scale. To celebrate Sederholm's work and progress in understanding crustal processes and secular evolution we arranged five symposia and an associated field excursion (No. 16).

The original five symposia were: MPN-07 "Secular change in metamorphism and crustal melting" (*CONVENERS:* Mike Brown, Tony Kemp), MPN-08 "Microstructural analysis of high-grade metamorphic rocks and implications for fluid and melt flow in the crust" (*CONVENERS:* Ed Sawyer, Marian Holness), MPN-09 "Petrology, geochemistry, isotope geochemistry and geochronology of high-grade metamorphic processes and partial melting" (*CONVENERS:* Olav Eklund, Peter Sorjonen-Ward), MPN-10 "Migmatite terranes - the role of partially molten crust in orogenic processes" (*CONVENERS:* Carlo Dietl, Roberto Weinberg, Marco Elter), and MPN-11 "From migmatites to plutons: The fate of granitic magmas" (convener: Roberto Weinberg). However, in the end we decided that our "Sederholm Symposia on Migmatites and Granites" would have more impact as a single event with a broad title rather than five smaller events. This proved to be correct judging from informal feedback, which was very positive. Our final title "High-Grade Metamorphism, Crustal Melting, Migmatites and Granites" was designed to incorporate the range of themes from the original five symposia.

After an introduction about the career of Sederholm ("Introduction: Jakob Johannes Sederholm" by Eklund), there followed a run of three linked keynotes, as follows: "The metamorphic record of changes in tectonothermal regime on Earth and the geodynamic implications" by Brown, "Secular change in metamorphism and magma production at active margins: Numerical modelling" by Gerya et al., and "Granulites, granites and crustal growth" by Hawkesworth and Kemp. Our other keynotes on "Ductile fractures: The origin of dykes" by Weinberg and Regenauer-Lieb, "The link between migmatites and granites: polyphase melting and granite magmatism during the tectonic evolution of the Fosdick migmatite dome, West Antarctica" by Korhonen et al., and "Microstructures in migmatites derived from leucocratic felsic plutonic rocks: Evidence for aqueous fluids causing anatexis" by

Sawyer, were also well received.

*GENERAL COMMENTS:* We were gratified that the room (D 10) was very full during the first day of our symposium (Wed. August 13th) and still quite full on the Thursday morning (August 14th).

*ANNOUNCEMENTS:* A thematic volume in the journal *Lithos*, which originated as a Nordic journal, is planned; the editors will be: Michael Brown, University of Maryland, USA; Olav Eklund, Turku University, Finland; Fawna Korhonen, University of Maryland, USA; and Peter Sorjonen-Ward, Geological Survey of Finland, Finland.

## **MINERALOGY**

## **MPM**

### **MPM-01 General contributions to mineralogy**

*CONVENERS:* Kari K. Kojonen, Geological Survey of Finland, Finland; C.J. Stanley, NHM, UK (not present)

*NUMBER OF PRESENTATIONS:* 20 oral, 23 poster, 3 no-shows

*SYMPOSIUM SUMMARY:* The symposium was started by a keynote lecture given by Prof. K. Tsukamoto on "Mineral growth in space" followed by a presentation from Brazil by A. Romano on a rock type of possible meteoric origin. The following two presentations were on diamond properties; two presentations were cancelled (N. Perchiazzi, O. Kovalchuck). After the morning break Prof. D. Vaughan started the subsymposium on environmental mineralogy with a keynote lecture followed by four other presentations on environmental mineralogy. The lecture room was almost filled with delegates during these presentations. Before lunch there was an additional presentation by Prof. N. Yushkin on "curved mineralogy". After the lunch break the symposium continued with various more classical mineralogical presentations on djerfisherite, aenigmatite, tourmaline, pyrochlore, and type minerals in Brazil. One presentation by Y. Kalinin was cancelled. After the afternoon coffee break there were two final presentations, on calcium silicates and on diffusion on minerals.

*GENERAL COMMENTS:* The unfavourable location of the lecture room clearly decreased the number of delegates attending the symposium; the room was difficult to find. The early morning sessions were attended only by a few delegates. The other convener, Dr. C.J. Stanley, did not come to Oslo. Both of the keynote lectures were very good and interesting. Two of the three no-shows were from Eastern Europe or Russia. The subjects of the other oral presentations were mostly already published previously on other occasions. The most interesting part for the delegates seemed to be the environmental mineralogy, which was merged with general mineralogy due to low number of papers obtained.

The poster presentations spanned very diverse subjects including copper investment in Jordan, heavy metals in soil in copper ore fields, mercury pollution in gold mining, mineralogical study of wild carp otoliths, environmental impact of mining areas, REE studies of basalt, fluorapatites





in lavas, analcime-bentonite-bauxite presentations, crystal chemical and structural studies on several minerals, experimental mineralogy, Ni-Co-Fe arsenides in Norilsk ore field, cryptic structures in rocks, and phytofulgurites. Some of these are clearly not mineralogical subjects.

**MPM-02 Frontiers in quartz research: The genesis, crystal chemistry and economic importance of igneous, metamorphic and hydrothermal SiO<sub>2</sub>-polymorphs**

*CONVENERS:* Rune B. Larsen, Norwegian University of Science and Technology (NTNU), Trondheim, Norway; Peter M. Ihlen, Geological Survey of Norway, Trondheim, Norway; Axel Müller, Geological Survey of Norway, Trondheim, Norway

*NUMBER OF PRESENTATIONS:* 16 oral, 4 poster

*SYMPOSIUM SUMMARY:* Although quartz is a major constituent of the Earth's crust, relatively few attempts were previously made to use quartz for petrogenetic interpretations because the textures, the trace element concentration and lattice position were poorly resolved by common analytical techniques. The emergence of better and more affordable in situ microprobe techniques, together with the improvement of conventional methods (SIMS, LA-ICP-MS, EMP, SEM-CL) over the past decade, has provided an avalanche of new data on textures and trace elements comprising quartz. These analytical advances allow for high precision estimates of the abundance of trace elements in quartz, the micro texture, e. g. growth zoning, recrystallisation, preferred crystal orientation and the structural characterisation of defect centres in the crystal lattice.

Tentatively we suggested contributions from the following five main research areas: Crystal chemistry of SiO<sub>2</sub> polymorphs; New analytical approaches; Quartz textures; Petrogenetic applications; and Economic applications. We were very pleased to receive several contributions to each of these sub-topics. We invited five keynote speakers and received immediate acceptance from four of them (L. Götze, A. van den Kerkhof, B. Rusk, M. Stevens-Kalceff).

This is the first symposium at an international conference concerned with the entire spectrum of quartz research, and we were of the opinion that the time was overdue for a symposium of this kind. The relatively high numbers of contributions to this small research field and a well-attended symposium confirmed this notion.

*GENERAL COMMENTS:* The early morning session of the symposium was attended by only 20-25 people (poor Saturday transport service). From the late morning session and throughout the day it became hard to find a seat in this relatively small presentation room (50 seats?) and at times we had several people standing or sitting in the aisle. When allowed by time constraints most of the talks were followed by questions and the coffee breaks were well used for discussions. A good crowd followed the session throughout, and discussions carried on afterwards.

Several contributors expressed their joy over finally having a dedicated symposium in quartz research and encouraged annual or at least bi-annual symposia. Many participants were frustrated that they could not make it to the early

morning session, as transport options were scarce Saturday morning. The room was not large enough for this symposium and was very difficult to find. There should have been a coffee service closer to the room to encourage a natural facility for discussions in the breaks (the nearest was in the poster hall).

*ANNOUNCEMENTS:* Mineralogical Magazine has agreed to publish a special edition of their journal with the conveners as guest editors.

**MPM-04 Platinum-group mineralogy**

*CONVENERS:* Andy M. McDonald, Laurentian University, Sudbury, Canada; Kari Kojonen, Geological Survey of Finland, Espoo, Finland

*NUMBER OF PRESENTATIONS:* 14 oral, 3 poster

*SYMPOSIUM SUMMARY:* Due to major advances in the technological applications of platinum-group elements, associated exploration programs have recently attracted incredible attention. Ironically, relatively little is known regarding the true chemical formulae, atomic arrangements and chemical diversity that exist amongst platinum-group minerals. This session presented a unique opportunity to bring together international researchers involved in PGM research from a variety of vantage points, including crystallography, synthesis, geological setting, genesis, mineral beneficiation and isotopic analyses. In doing so, a unique forum in which to discuss this fascinating group of minerals from a variety of perspectives was created. Workers analyzing PGM from a myriad of possible geological environments were invited to provide submissions. The principle goal of the session was to provide a means by which individuals researching PGM, and those involved in their exploration and beneficiation, can be exposed to the current state-of-knowledge of this geologically, economically and technologically relevant mineral group.

*GENERAL COMMENTS:* The session was financially supported by the Applied Mineralogy section of MinSoc and logistically by IMA-COM, via the Chair, Dr. Nigel Cook. On average, there were between 30 and 35 audience members per talk for both those presented in the morning and afternoon sessions.

Two keynote speakers were invited. Dr. Louis Cabri who spoke on challenges relating to the study of PGM distribution in ores, along with analyses of PGE in these ores, highlighted some of the outstanding issues (e.g. crystallography). Dr. Malitch Kreshimir spoke on the application of Re-Os systematics to dating the origin of PGM. Dr. Kreshimir demonstrated how this approach can provide fundamental data relating to the paragenesis of these minerals and at the same time formulate new tools useful in the exploration of such ore deposits. A large number of presentations focused on PGM from ophiolites in the Dominican Republic (Zaccarini et al.), Brazil (Garuti et al.), Turkey (Uysal et al.), Bulgaria (Gervilla et al.) and New Caledonia (González-Jiménez et al.), reinforcing the concept that despite their varied geological and temporal settings, there are significant similarities in the PGM contained within these lithologies. Presentations were also made on PGM from mafic intrusions including those



found in the Monchegorsk complex (Grokhovskaya) and the Fedorovo-Pansky intrusion (Subbotin et al.), Russia, along with those found in placer deposits from northern Lapland (Konjonen et al., Tornroos et al.). Finally, presentations were made on crystal chemistry of PGM from 'hydrothermally' remobilized components of ores in Sudbury (McDonald et al.) and the synthesis of PGM using the silica-tube methods under moderate temperatures (Vymazalová et al.). It is also notable that the conclusion of the formal presentations was followed by stimulating discussions involving the audience and presenters. These clearly highlighted the breadth of experience and knowledge available and the keen interest that so many researchers have in PGM. In conclusion, the key objectives of the special session on Platinum-Group mineralogy, to bring together those researchers with a keen interest in these minerals and to facilitate stimulating discussions, were met.

**ANNOUNCEMENTS:** Planned sessions that will build upon the focus and success of this meeting include Platinum-Group Mineralogy and Automated Mineral Processing (Andy McDonald, International Platinum Symposium, June, 2010) and the analysis of PGM (IMA-COM-sponsored short course in Loeben, Austria, organized by Federica Zaccarini and Aberra Mogessie in September 2010).

#### **MPM-06 Melts and glasses in mineralogy and petrology (IMA-CMP)**

**CONVENERS:** Daniel Neuville et al.

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** Glasses and melts play an important role in the formation and evolution of the earth, as well as in glass processing and for the storage of nuclear wastes. The structure and properties of glasses and silicate melts are becoming more well known but some aspects remain poorly understood; for example, the glass transition, and the relationship between short and medium range order. Contributions to this symposium are invited on diverse aspects of glasses and melts, in relation to properties, structure and dynamics.

#### **MPM-07 Mineral spectroscopy**

**CONVENER:** Georg Amthauer, University of Salzburg, Austria

**NUMBER OF PRESENTATIONS:** 5 oral, 5 poster

**SYMPOSIUM SUMMARY:** The symposium has demonstrated the usefulness of spectroscopic methods in earth sciences. On the one hand, important crystal chemical and structural properties of some minerals (clays, carbonates, monazite, apatite, quartz, diamond, etc.) were studied by the application of different kinds of spectroscopic methods, such as Mössbauer-, XAS-, UV-VIS-NIR-, IR-, Raman-, NMR-, EPR-, CL- spectroscopy. On the other hand, important geological and petrological information is produced by such investigations. In many studies, spectroscopic methods complete results from X-ray diffraction. One presentation was given on a Raman spectroscopy study of Fe<sup>3+</sup> in glasses.

**GENERAL COMMENTS:** About 25 persons attended the symposium. All the oral as well as the poster presentations were of good quality and initiated lively and interesting discussions.

**ANNOUNCEMENTS:** A very similar symposium will be organized during the next conference of the International Mineralogical Association in 2010 in Budapest.

#### **MPM-10 Fluids and melts in the Earth's mantle: From natural observation to HT-HP experiment**

**CONVENERS:** Leonid L. Perchuk, Moscow State University, Moscow, Russia; Oleg G. Safonov, Institute of Experimental Mineralogy, Chernogolovka, Russia

**NUMBER OF PRESENTATIONS:** 3 oral, 6 poster

**SYMPOSIUM SUMMARY:** The session collected contributions from researchers who provide petrological, geochemical, and experimental evidences for activity of alkaline deep-seated fluids and melts in the Earth's mantle. Presentations describe evidences for alkalic silicate, carbonate-silicate, chloride-carbonate liquids from mantle xenoliths from basalts and kimberlites, as well as from diamond inclusions. Special attention was paid to experimental studies of alkali-rich melts and fluids at the HP-HT conditions, including equilibria of mantle minerals with alkalic liquids, synthesis and stability of specific alkaline HP phases, partitioning of major, trace and volatile components between minerals, melts, and fluids, diamond growth in the melts, physical and mechanical properties of the alkalic liquids at the mantle conditions, etc. Most of these topics were highlighted by the oral and poster presentations in the session MPM-10. Oral presentations by Safonov et al. and Litvin, as well as poster presentations by Kostyuk et al. and Butvina and Safonov, were dedicated to the experimental studies of mineral equilibria at high-pressure conditions with participation of alkalic melts and fluids. For example, the talk by Litvin gave a comprehensive review of diamond synthesis in the alkalic melts under upper mantle conditions, while Safonov et al. presented a new model for evolution of alkalic chloride-bearing liquids in the upper mantle. Posters by Kostyuk et al. and Butvina and Safonov showed results of experiments on melting of eclogites with participation of carbonate and chloride-bearing fluids/melts. Observations from natural assemblages were presented in the talk by Robles et al. and poster presentations by Sukharev et al., Guzmics et al., and Schmaedicke et al. For example, Guzmics et al. presented very interesting data on the mantle-derived phosphorus-rich melts, while Robles et al. and Schmaedicke et al. showed results of multi-methodical studies of trace element and volatile components in minerals from kimberlites and their xenoliths. Application of fluid-mineral equilibria for deciphering of P-T and fluid conditions in the upper mantle was considered in the presentation by Simakov.

**GENERAL COMMENTS:** All presentations provided high-quality data on their topics, which resulted in lively discussions during both oral and poster sessions. About 20 people were attending the oral session.



**MPM-11 Phase transformations and geodynamics**

*CONVENERS:* Taras Gerya, Swiss Federal Institute of Technology (ETH-Zurich), Switzerland; Leonid Perchuk, Moscow State University, Russia

*NUMBER OF PRESENTATIONS:* 6 oral, 5 poster

*SYMPOSIUM SUMMARY:* This cross-disciplinary symposium involved observers, experimentalists and modellers for discussing three principal issues: 1. How phase transformations affect geodynamic processes at various depths and scales? 2. How natural observations and experimental data on phase transitions can be used for deciphering geodynamic evolution? 3. How can we include effects of phase transformations in numerical models of geodynamic processes and what can we gain from this? Contributions presented at this symposium covered all three aspects and addressed several hot topics of modern geodynamics (such as subduction initiation, geodynamic effects of slab hydration and formation of sedimentary basin) where phase transformations have first order effects on geodynamic development. (The presentation by R. Bousquet was withdrawn by the author, the time slot was used by Y. Mishin for giving a lecture on his poster.)

*GENERAL COMMENTS:* The session was well attended and overall quality of contributions was high (e.g. at least one contribution is currently in press in *Nature*). Both oral contributions and posters produced viable discussions on such issues as causes for subduction-related seismic anisotropy, mechanisms of subduction initiation, magmatic arcs growth etc.

**MPM-12 New developments in microbeam techniques**

*CONVENERS:* Jan Kosler, University of Bergen, Norway; John Hanchar, Memorial University of Newfoundland, Canada; Martin Whitehouse, Natural History Museum, Stockholm, Sweden

*NUMBER OF PRESENTATIONS:* 4 oral, 2 poster, 3 cancellations

*SYMPOSIUM SUMMARY:* The symposium summarized some of the recent advancements in microanalytical techniques, including laser ablation ICP-MS, accelerator, electron and x-ray microbeam analysis that have opened new possibilities to study elemental and isotopic variations with previously unmatched spatial resolution, detection capabilities and analytical precision. Contributions in this session included analytical technique development and new applications of microbeam analysis, including elemental concentration measurements, elemental and isotopic mapping and use of microbeam techniques for studying spatial variations in chemical and isotopic composition of geological and environmental materials.

*GENERAL COMMENTS:* Given its size and narrow focus, the symposium was well attended and several contributions triggered lively discussion both during and after the session.

**MPM-13 Inclusions in minerals (WGIM IMA)**

*CONVENERS:* Sergey Smirnov, Institute of Geology and Mineralogy SB RAS, Russia; Pei Ni, Nanjing University, China

*NUMBER OF PRESENTATIONS:* 5 oral, 13 poster

*SYMPOSIUM SUMMARY:* Minerals contain a variety of different phases that were entrapped in the course of their formation and then isolated as inclusions. All of them can be divided into three groups: mineral inclusions, fluid, and melt inclusions. Recently they are believed to be an important source of geochemical and petrological information. They give geologists an opportunity to trace past geological processes from the nano- and microscale up to the rock formation scale. As isolated phases the inclusions frequently bring geological information that was erased from rocks by subsequent overprinting processes. In spite of the fact that inclusions have been studied for more than 150 years, they still trigger intense discussions on their origin, properties and importance. On the other hand they have proved their importance in revealing P-T-X conditions of mineral and rock formation from the Earth mantle depths to the surface of the Earth and even in the Solar system.

The session was addressed to those who deal with inclusions in minerals for reconstruction of geological processes - magma evolution, metamorphism, ore formation, sedimentary basin evolution, etc.

The abstract papers were devoted to problems of inclusion microanalysis, age and isotopic study of microinclusions. The majority of the presented papers were dedicated to inclusion evidences of magma evolution and its relation to ore formation. One of the important topics presented at the IGC was development of melt inclusions study methods.

*GENERAL COMMENTS:* The session was not as large as at the previous Congress. This is explained by huge conference activity in 2008 related to inclusions in minerals (three international conferences). However the presented papers initiated lively discussions in the course of the session and afterwards.

*ANNOUNCEMENTS:* Publication of the session proceedings is discussed with Russian Geology and Geophysics journal authorities.

**VOLCANOLOGY****MPV****MPV-01 General contributions to volcanology**

*CONVENERS:* Valentin Troll, Uppsala University, Sweden; Freysteinn Sigmundsson, University of Iceland, Iceland

*NUMBER OF PRESENTATIONS:* 13 oral, 14 poster

*SYMPOSIUM SUMMARY:* This session provided a general forum for new developments in volcanology and was open to any type of research related to volcanoes and volcanic activity not covered by the more specific sessions. The session conveners hoped to also attract research contributions by non-volcanologists working on problems that touch on volcanology and seeking feedback from the volcanological community. This goal was generally met with numerous contributions relevant for volcanoes in a wider context. Noteworthy was a contribution on engineering approaches to Italian volcanoes that also



sparked considerable debate.

*GENERAL COMMENTS:* We had on average up to 20 people attending, providing a 'small meeting' atmosphere that allowed for friendly and interactive discussions. Unfortunately, several of the early talks were cancelled, leaving inconvenient gaps in the schedule.

#### **MPV-05 Volcanic eruptions: Chamber-, conduit-, and depositional processes and their implication for monitoring and hazard assessment**

*CONVENERS:* Valentin Troll, Uppsala University, Sweden; Jane Chadwick, Free University, Netherlands

*NUMBER OF PRESENTATIONS:* 12 oral, 10 poster

*SYMPOSIUM SUMMARY:* The volcano-magma system comprises the source region where magma is generated, the storage reservoirs where it ponds and evolves, the feeder conduits and the edifice from which a fraction of the original magma eventually erupts. The assessment of the eruptive behaviour of volcanoes is largely dependent on the interplay of processes and physical parameters that influence magmas from source to surface. This session brought together researchers from across the fields of petrology, volcanology and volcano monitoring to summarise the current state of knowledge and discuss future avenues for multi-disciplinary research approaches. We hosted several outstanding talks, two of which were presenting groundbreaking new results that will alter the way we think about volcanoes. The symposium was therefore a complete success.

*GENERAL COMMENTS:* We had on average about 25 people attending, providing a 'family meeting' atmosphere that allowed for friendly and interactive discussions. Altogether a rewarding experience for the speakers as well as the audience.

#### **MPV-06 The construction/destruction of magmatic and volcanic systems: New insights into magma-tectonic and volcano-tectonic processes in the Earth's crust**

*CONVENERS:* Olivier Galland, University of Oslo, Norway; Eoghan Holohan, Trinity College Dublin, Ireland

*NUMBER OF PRESENTATIONS:* 10 orals, 8 posters, 4 cancelled and no-shows

*SYMPOSIUM SUMMARY:* Magmatic and volcanic activity is intimately linked to the deformation of the Earth's crust on local and regional scales. Mechanisms of magma transport, storage, and eruption, and of the associated construction and destruction of volcanic systems have been studied for decades, but many interlinked aspects are still debated. These include: 1) the geometric evolution of sub-volcanic plutons and plumbing systems; 2) the interactions between stress, fracturing, intrusion, and eruption; 3) the control of regional-tectonic regimes on the ascent, emplacement and eruption of magma; 4) the structural evolution of volcanic edifices, including shields, calderas, and strato-volcanoes.

This session invited contributions providing new insights into the processes of magma ascent, emplacement and eruption, and into the mechanical relationships between volcanoes, sub-volcanic intrusions, and crustal

deformation. The session aimed at bringing together and help further integrate approaches such as field study, petrology and geochemistry, experimental and numerical modelling, remote sensing, geodesy and geophysics, to improve our understanding of the physical development of magmatic and volcanic systems.

In conclusion, the session was a success because it showed a broad variety of scientific approaches addressing similar geological systems. The session was very consistent, and the presentations explored the magma-tectonic processes at very different scales.

*GENERAL COMMENTS:* Presentations were excellent, and the following discussions very stimulating. There were only a few tens of people attending the session. The small number might be related to the fact that the session took place the last day of the conference. In addition, we also regret that the schedule was modified after the contributors received confirmation emails. For example, our oral session initially scheduled on August 13th was moved with a very late notice to the 14th, and one speaker booked his flight on the evening of the 13th. This is unacceptable for a conference such as IGC. Finally, some of the posters were located far from the others, so discussions were extremely difficult.

## **MINERAL RESOURCES**

## **MR**

## **INDUSTRIAL MINERAL DEPOSITS**

## **MRB**

#### **MRB-01 Contributions to industrial mineral deposits**

*CONVENER:* Nikolaos Arvanitiidis, Institute of Geology and Mineral Exploration (IGME), Greece

*NUMBER OF PRESENTATIONS:* 8 oral, 9 poster, 3 no-shows

*SYMPOSIUM SUMMARY:* A total number of 17 papers were submitted for presentation under the Industrial Mineral Deposits session. All of them were evaluated to reach either oral or poster level. Evaluation criteria were based on scientific relevance and excellence, but the aspects for resource development perspectives were also considered. The talc/soapstone project in Norway makes a characteristic example of such an industrial mineral prospect, which through successful exploration achieved economic feasibility. During the discussions questions were raised and addressed on the global and European industrial minerals market with respect to China's and India's supplies and demands, as well as to the request for sustainable development. Major conclusions coming up could be summarized as follows: 1) Industrial minerals are important commodities for a variety of every-day life uses, 2) Industrial minerals could lead to new high-tech industrial applications and high added value products, 3) Best practice guides in terms of defining and implementing the proper sustainable development indicators and corresponding LCA studies should be determined, 4) Environmental issues with respect to relevant policies as





well as to corresponding land use conflicts should be taken into account, elaborated and implemented, 5) Recycling/reuse of by-products and 'low-grade' resources and/or mine wastes in terms of turning them to potential resources and commercial products contributes to environmental and commodities sustainability.

**GENERAL COMMENTS:** Most of the papers were concerning industrial mineral resources in Asian countries, like China, Iran, Vietnam, Turkey and Kazakhstan; some from Europe, like Portugal, Latvia, Norway, Russia and Ukraine; as well as one Greek-Australian and one German-South African. They focused on industrial mineral issues related to (i) isotope geochemistry studies (ii) mineral genetic and economic geology on nitrates, potash, ruby and sapphire, colemanite, bentonite, rock salt, amber, fluor spar, ceramic clays and potential talk deposits in Norway, and (iii) quartz metallurgy, while one paper focused on the copper industry in China.

The quality of the presentations varied but was generally of reasonably acceptable level. The audience number of about 15 people attending the oral presentations was considered poor taking into account that this was the only industrial minerals session of the congress, and the fact that the topic concerned a market of global importance. The main reasons were (i) the very early start of the session (the afternoon of the registration day), and (ii) venue of the session (room 31) - outside of the main congress building, not so easy to find and access.

The discussions were lively and considered mainly environmental issues in terms of sustainable development, but also new industrial mineral based products.

**ANNOUNCEMENTS:** Lithium Supply & Markets 2009, 26 January 2009 - 28 January 2009, Sheraton Santiago Hotel & Convention Centre, Santiago, Chile, Organiser: Industrial Minerals Event; 15th Int'l Bauxite & Alumina Seminar, 11 February 2009 - 13 February 2009, Ritz Carlton Golf & Spa Resort, Montego Bay, Jamaica, Organiser: Industrial Minerals Event; MagMin 2009, 10 May 2009 - 12 May 2009, Hotel Okura, Amsterdam, Netherlands, Organiser: Industrial Minerals Event.

## CONSTRUCTION MATERIALS MRC

### MRC-08 Geological construction materials

**CONVENERS:** Björn Schouenborg, CBI, Swedish Cement and Concrete research Institute, Sweden; Peer-Richard Neeb, NGU, Geological Survey of Norway, Norway

**NUMBER OF PRESENTATIONS:** 32 oral, 26 poster

**SYMPOSIUM SUMMARY:** The symposium on geological construction materials was organised by a combined effort of IAEG (International Association of Engineering Geologists) C10: Building stones and Ornamental Rocks and C17: Aggregates.

The essential discussions can be summarised as follows:

Production of aggregates and natural stone represent some of the world's major industries. The worldwide

consumption of construction materials is rapidly increasing, at the same time as available resources are getting more limited. The world has not unlimited resources of sand, gravel and bedrock for aggregate and dimension stone production. The sustainable utilisation of mineral resources is therefore a key issue of the modern raw material industry. Sustainable usage includes the smallest possible impacts on land use and scenery, the minimum emissions and, additionally, the most feasible use of exploited raw materials. The latter includes the exploitation and wide range of use of the given material and also the application of the best available processing technology to minimize the production loss and waste.

One of the main contributions of engineering geologists to the study of aggregates and natural stone is to define its origin, mineralogical composition, petrographic characteristics and geological processes that have affected it. Understanding and quantifying the geological parameters are the keys to understanding the potential of the bedrock. A relationship between mineralogy, fabric, etc. and the performance of different rock materials in the final product have frequently been documented. This enables the engineering geologists to better evaluate the best usage of raw materials for aggregate and natural stone production.

The quality of existing dimension stone products and selection criteria for new products included presentations of quality frameworks for the proper application and use of dimension stones in the construction industry. Research and case studies in connection with standard methods demonstrated a better understanding of the behaviour of stone products under different loading and climatic conditions.

Finally, several presentations also highlighted new approaches for promoting the sustainable use of rock materials and initiated practical concepts for their re-use. Recycling of any excess secondary geological material diminishes the need to open new quarries and thereby contributes to a more sustainable utilization.

The seminar also included a much appreciated excursion to Feiring Bruk's high quality aggregate quarry in Bjönndalen. The quarry is dominated by a beautiful Permian rhomb porphyry with plenty of different mineralisations.

**GENERAL COMMENTS:** Many excellent presentations were made and gave much food for thought. The collaboration between natural stone and aggregate experts promoted a good use of ideas from one field into the other. It was also clearly demonstrated that these former very traditional industries are now working with advanced technology and many innovations.

**ANNOUNCEMENTS:** It has been decided to publish 20 to 25 of the contributions in the Bulletin of Engineering Geology and the Environment.





**MINERAL DEPOSITS MRD****MRD-01 General contributions to mineral deposits**

*CONVENERS:* Krister Sundblad, University of Turku, Finland; Eiji Izawa, Kyushu University, Japan; Milka K de Brodtkorb, University of Buenos Aires-Conicet, Argentina

*NUMBER OF PRESENTATIONS:* 12 oral (16 no-shows), 11 poster (15 no-shows)

*SYMPOSIUM SUMMARY:* The purpose of this symposium as outlined in the second circular was to attract "scientific contributions related to all kinds of mineral deposits (including metalliferous and non-metalliferous mineral resources). The contributions may be descriptive (and/or interpretative) and may concern geological, mineralogical, geochemical and economic aspects of individual deposits and/or new discoveries, deposit types and/or districts. They can also be metallogenetical overviews of smaller or larger areas."

The idea was to create a forum for presentations in Ore Deposit Geology that did not fit into any of the other 20 ore deposit sessions at 33IGC. The ambition to create an interesting session with this theme failed, however, due to two reasons. The first reason was very expected due to the given circumstances; the topics of the contributors were very diverse and it was very difficult from the beginning to construct a meaningful program for these presentations. Even more important was the fact that almost 60% of the contributors never arrived to Oslo. Since these no-shows, without exception, were not communicated in advance to the conveners, it resulted in a program that was without any red thread and full of empty spaces, for 20, 40 or 60 minutes. It was completely meaningless to attend this session because it was never known if a missing speaker would turn up in the last minute, which contributed to repel any interest for the session. The audience for most speakers was as rule composed of the closest friends/colleagues, and usually also the next speaker who came early enough to see how the conditions in the lecture hall were like. The rest of the audience was normally restricted to less than half a dozen (often one or two) 'real' attendees. Many speakers expressed their frustration when they realized that they would be speaking in front of a non-existing audience. Several even proposed to cancel their presentation, something I consequently refused, claiming that at least I had an interest in their presentation.

*GENERAL COMMENTS:* As it turned out, lots of work had gone into this session by speakers and conveners but most speakers had no real audience, and the entire session can be characterized as a complete failure. It would probably have been better to force these kinds of contributions into other sessions where they at least would have received an audience, even if it would have been unrelated to the main session. To avoid the massive no-show is more difficult, even if it already from the beginning was expected that not everyone could be expected to turn up from the very large proportion of speakers from countries such as China, Iran and Iraq.

**MRD-02 Deep sources and signatures of ore forming systems - a tool for new discoveries of mineral deposits**

*CONVENERS:* Lawrence M. Cathles, Cornell University, USA; Sergei Cherkasov, Vernadsky SGM RAS/ Russian-French Metallogenic Laboratory, Russia

*NUMBER OF PRESENTATIONS:* 14 oral, 3 poster, 2 no-shows

*SYMPOSIUM SUMMARY:* The session was opened with a keynote presentation (S. Cherkasov) outlining the general idea on importance of tracing signatures and studying geometry of energy paleo-sources representing an engine for endogenic ore-forming processes, along with some examples of such studies in Russia and CIS countries. Two more keynote talks were given by Lawrence Cathles proposing to study large mid-crustal sills by receiver function analysis and by Richard Blewett (Geoscience Australia) describing deep signatures of a world-class Archaean gold system in Australia.

Subsequent talks focused on different issues related to the topic, including examples of recent research in Australia (two different studies presented by L. Feltrin from the James Cook University; K. Gessner, The University of Western Australia), China (J. Deng, China University of Geosciences), Egypt (H. Helmy, Minia University), Uzbekistan (I. Sidorova, Institute of Geology & Geophysics), Russian Aldan shield (N. Vishnevskaya, poster, Vernadsky SGM RAS).

Another group of presentations described methods of studying the deep structure of Earth crust with emphasis on the traces of ore-forming systems. Larry Brown (Cornell University) suggested use of seismic methods for detection of crustal fluids, R. Zhang (Institute of Mineral Resources, Chinese Academy of Geological Sciences) talked about physical-chemical modelling of hydrothermal transport, M. Esfahaninejad (Geological survey of Iran) demonstrated GIS usage for modelling porphyry copper deposits. Also, a model for the same type of deposits was presented by E. Puchkov (SBS Group, Kazakhstan). One extra (late submission) presentation on arc metallogenesis was presented by K. Rebrina (Monash University, Australia).

A 30-minute discussion was held after the presentation with 14 participants. The results of the session have indicated a genuinely new approach to understanding metallogeny of ore deposits from the point of energy supply needed to facilitate the ore-forming process. It is also clear that in many cases traces (remnants) of the heat-and-mass transport paleosystems today can be fixed (at crustal scale) with geophysical methods; and for mineral deposits of many types, some spatial correlation is being revealed between the elements of such systems and location of the deposits.

*GENERAL COMMENTS:* The symposium was sponsored by the International Association on the Genesis of Ore Deposits (IAGOD) and the Russian-French Metallogenic Laboratory. Three participants had obtained support from the Geohost program. Total number of participants including listeners was c. 35.

*ANNOUNCEMENTS:* The participants agreed to apply to International Association on the Genesis of Ore



Deposits for establishment of an international working group on the subject.

### **MRD-03 Recent and future developments on marine minerals**

*CONVENERS:* David S. Cronan, Imperial College, UK; Peter A. Rona, Rutgers University, USA; Akira Usui, Kochi University, Japan

*NUMBER OF PRESENTATIONS:* 15 oral, 7 poster

*SYMPOSIUM SUMMARY:* This is an exciting and pivotal time for deep-sea minerals. Industry is gearing up for initial mining of seafloor volcanogenic massive sulphide (VMS) deposits in volcanic island arcs of the western Pacific. Pioneer Investors are positioned with the International Seabed Authority for exploration and eventual mining of manganese nodules in the Clarion-Clipperton Zone in the eastern equatorial Pacific and in the Indian Ocean. Exploration and assessment continues on cobalt-rich ferromanganese crusts on oceanic seamounts.

The session attempted to encapsulate the current state-of-the-art in research on all of these marine minerals, and served as a snapshot of the present situation in regard to them. It was supported by two 'pillars'; hydrothermal minerals and cobalt-rich ferromanganese crusts, the two most active areas of deep-sea minerals research and development at the present time. The relative importance of these respective topics can be estimated from the fact that marine mining of marine hydrothermal deposits is projected for the end of the present decade, and there is considerable commercial interest in ferromanganese crusts. *GENERAL COMMENTS:* The overall quality of the oral presentations and posters was excellent. After a slow start, the numbers of audience built up to a maximum of about 50. The formal session was followed by an excellent discussion session lasting for almost 2 hours in which the Secretary General of the UN International Seabed Authority participated.

*ANNOUNCEMENTS:* It is intended to produce a publication of most of the presented papers.

### **MRD-04 Giant ore deposits**

*CONVENERS:* Peter Laznicka, Adelaide, Australia; Pei Rongfu, Chinese Academy of Geological Sciences, Beijing, China; Mikhail Rafailovich, Kazakhstan

*NUMBER OF PRESENTATIONS:* 10 oral, 6 poster, 5 no-shows

*SYMPOSIUM SUMMARY:* The original symposium theme was introduced as follows: "In the age of increasing globalization, most metals supply comes from giant/world class deposits or complexes, wherever they are in the world. It is believed this will persist at least until the end of this century, provided new discoveries are made to replenish the exhausted ones. Some individual metal accumulations dwarf the rest of the world's deposits, yet the scientific understanding of them varies and some are virtually unknown outside their home countries. This session invites international resource geologists and researchers to contribute to our understanding of exceptional metal accumulations. There is an urgent need of factual, up-to-date descriptions especially of the poorly

known deposits outside the reach of the English language literature, in order to establish a balanced global database for comparative studies. Also welcome will be contributions that address the special conditions that might have influenced local super-accumulations of ore metals, and how the 'giants' differ from the 'commoner' ore deposits, if at all."

The above objective was basically followed by the 16 contributions actually delivered, but as the only limiting factor for inclusion was the superior ore tonnage, no common conclusion was reached given the small population of example deposits actually presented. A wealth of factual information has, however, been delivered on little known yet significant mineral deposits such as probably the geologically oldest ore 'giant' (Spinifex Ridge Mo-Cu; Barley et al.), the Erzgebirge uranium long hidden behind the Iron Curtain (Seifert), or the Burmese jade which, although not a typical ore, supports a billion dollar industry (Kirwin).

*GENERAL COMMENTS:* As is usually the case, the content and presentation quality varied but the Powerpoint format assured a generally good quality of the visuals. Although the symposium started first thing in the morning on the first day of symposia, it attracted an initial audience of about 50 growing to some 100-120. There was not much time for discussions, at most only for two or three questions. Unfortunately, the two co-conveners did not show up so the session was run by Peter Laznicka alone, with ad-hoc help from Doug Kirwin.

*ANNOUNCEMENTS:* The Geological Society (London) has extended an invitation to publish the proceedings in one of their special publications. Unfortunately, it appears that there would be no critical mass of acceptable contributions to make this happen.

### **MRD-05 Results of First Global Mineral Resource Assessment and other large-region assessment studies**

*CONVENERS:* Michael Zientek, Andor Lips, Daniel Cassard, Hee-Young Chun, Sergej Cherkasov, Leon Ehlers, Eduardo Zappettini

*NOTE:* A post-Congress summary was not received. The summary below is pre-Congress.

*SYMPOSIUM SUMMARY:* Global demand for mineral resources will continue to increase for the foreseeable future. Informed planning for sustainable mineral resource development requires the availability of unbiased information on the global distribution of identified and undiscovered mineral resources. The symposium will report on progress, results, methods, applications, and research in global-, regional- and continental-scale assessments on non-fuel mineral resources. The symposium will present initial results from a cooperative international research project to delineate the principal land areas in the world that have potential for undiscovered mineral resources of copper, platinum-group elements, and potash. The symposium also invites papers on large-region mineral resource assessment studies from around the world. Focus areas include: (1) regional characteristics of mineral belts (ore deposit modelling, geodynamics, economic reviews, etc.); (2) development of large-region



resource information systems (inventories, modelling, exploration surveys, continent-scale mineral potential, economic assessments, mineral resource-related environmental studies); and (3) data-or expert-driven assessment methods.

#### **MRD-06 Granitic magmatism and associated mineralizations**

*CONVENERS:* Alcides Nobrega Sial, NEG-LABISE, UFPE, Recife, Brazil; Jorge Silva Bettencourt, USP, São Paulo, Brazil; Cristina Pinheiro De Campos, LMU, Munich, Germany

*NUMBER OF PRESENTATIONS:* 14 oral, 12 poster, 17 no-shows

*SYMPOSIUM SUMMARY:* This symposium was aimed at discussing physical and chemical mechanisms responsible for the genesis and evolution of granitic magmatism and on how these mechanisms were reflected in the chemical and isotopic composition of granites and their metallogeny. The main goal of the symposium was to gather specialists in petrology, geochemistry and metallogeny with experience in different geodynamic settings, from Archean to Recent.

Following our previous experience with symposia of this nature which we have had the opportunity to organize in the two previous IGCs (2000 in Rio de Janeiro and 2004 in Florence), we expected to have a solid contribution on granite study, including genesis, emplacement and tectonics. In turn, however, we have received a massive contribution to the study of granite-related ore deposits. This was to a certain extent a pleasant and enriching new experience (among the 44 contributions to this symposium, only 4 dealt with granite studies *sensu stricto*).

The symposium covered a large variety of case histories on granite-related ore systems, bringing together people from different countries with different experience generating fruitful discussions. As a whole this was a rewarding experience for conveners and, we hope, for the audience.

*GENERAL COMMENTS:* Regarding that this symposium was held on August 13th, that is, very close to the closure of the 33IGC, it attracted an expressive audience over the whole day. Presentations were fairly good to excellent, starting with the keynote talk by Prof. Krister Sundblad who gave a fairly complete picture of the state-of-art on Indium worldwide. Most presentations were followed by stimulating discussions, always in a friendly atmosphere.

*ANNOUNCEMENTS:* We have presented to the Geological Society of London-Geological Society Publishing House-JGS a proposal for a book containing papers that have been presented in this symposium. We received today (August 22nd, 2008) a formal acceptance letter from Ms Angharad Hills. This publication will be structured as follows:

Title: "Granite-related ore systems". The publication will focus on recent progress on granite geology and related mineralizations. It will have as Guest Editors: Alcides N. Sial, NEG-LABISE, Jorge S. Bettencourt, Cristina P. De Campos and Valderez P. Ferreira. It will be composed of the following sections: 1- Introductory Chapter, 2- Granite-

Pegmatite systems, 3- Skarn and greisen-veins systems, 4- Porphyry systems, 5- Orogenic and Epithermal gold systems, 6- Polymetallic intrusion-related systems, 7 -Vein-type Sn-W systems, and 8 -Special Case Studies.

#### **MRD-07 Geology and mineral potential of CIS countries**

*CONVENERS:* Oleg Petrov, All Russian Geological Research Institute (VSEGEI), Russia; Reimar Seltnann, Natural History Museum, CERCAMS (Centre for Russian and Central EurAsian Mineral Studies), UK

*NUMBER OF PRESENTATIONS:* 8 oral, 12 poster, 4 no-shows

*SYMPOSIUM SUMMARY:* This session invited oral and poster contributions on state-of-the-art research in geology and metallogeny focused on the mineral potential of CIS countries. Topics ranged from geological framework for prognosis via prospecting and exploration to assessment of mineral potential. General reviews and new metallogenic concepts were also considered with focus on single commodities, selected regions and individual metallogenic epochs. Interdisciplinary approaches featuring application of modern methods in economic geology of key mineral deposits were encouraged. The session was dedicated to the memory of Prof. Gunnar Kautsky, late IAGOD President, who during the Cold War acted jointly with his CIS colleagues as a bridge between researchers in the eastern and western hemispheres, encouraging cooperation and transfer of know-how across borders. Alongside contributions from state geological surveys, university and academic research, the conveners particularly encouraged novel approaches resulting from international collaborative research. A number of invited keynotes from high-level experts showcased the synthesis of vast knowledge compiled during the past few decades resulting in novel approaches and leading to new mineral districts.

*GENERAL COMMENTS:* About 50 people attended the high-quality half-day symposium that was jointly co-sponsored by IAGOD and CERCAMS, and contributed to lively discussions. Some oral presenters had in addition supplementary poster presentations. The Geohost program of the IGC largely contributed to the success of the symposium by subsidizing participants from the new independent states of the former Soviet Union.

*ANNOUNCEMENTS:* Three outstanding presentations from the session became invited papers for publication in the IAGOD periodical *Ore Geology Reviews* (Elsevier) and are currently under review.

A follow-up meeting is scheduled to take place in London (25-28 November 2008) as IGCP-480 and USGS-GMRAP co-sponsored CERCAMS-12 workshop on "Metallogeny of Central Asia from Kazakhstan to Xinjiang - Research in Progress".

#### **MRD-08 Volcanic-hosted massive sulphide deposits: Controls on distribution and timing**

*CONVENERS:* Rodney Allen, Boliden Mineral and Luleå University of Technology, Sweden; Jan Peter, Geological Survey of Canada, Canada

*NUMBER OF PRESENTATIONS:* 17 oral, 11 poster



**SYMPOSIUM SUMMARY:** Volcanic-hosted Massive Sulphide (VMS) deposits are one of the world's most important sources of zinc, copper, lead, silver and gold. They sustain many mining companies and communities in both developed and less developed nations. Major VMS deposits formed at specific times (on specific stratigraphic horizons) in marine, extensional basins associated with volcanic arcs. The IGCP 502 project "Global comparison of VMS districts" has been active since 2004 and includes 200 scientists from 30 nations. This project aims to define the key geological events that control the distribution, timing and genesis of VMS deposits.

The oral symposium opened with a group of presentations on the regional tectonic, volcanic and structural settings of VMS deposits worldwide and in Iran, India, Spain and Finland. This was followed by a group of presentations on specific VMS deposits and exploration strategies in the Bergslagen and Skellefte mining districts in Sweden, and Bathurst, Canada. The symposium then focused on specific features of modern and ancient VMS hydrothermal systems, and finally on the application of new concepts and analytical techniques. Each section started with a longer introductory presentation, which was followed by shorter specific studies. Valery Maslennikov (Russia) delivered the keynote paper: 'Trace elements in ancient and modern 'black smokers''. The poster session comprised a diverse and interesting range of studies on VMS deposits and mining districts in Yemen, Iran, China, Mexico, Sweden, Canada, Argentina (Deception Island) and Japan.

**GENERAL COMMENTS:** The symposium was attended by about 200 scientists and generated lively discussion. A common theme through the symposium was the location of VMS ores on one or two specific stratigraphic horizons in each mining district, the close relationship between extensional tectonics, volcanism and VMS, and the importance of comparisons between modern and ancient VMS systems.

Following the symposium, 30 participants enjoyed field excursion No. 12 to the unusual and diverse Proterozoic polymetallic volcanic- and limestone-hosted ore deposits of the Bergslagen mining district in Sweden. During 6 days we looked at 5 interesting ore deposits and their geologic setting. Feedback from many participants indicate that the field excursion was a big success and a highlight of the meeting.

**ANNOUNCEMENTS:** The next IGCP-502 meeting on VMS deposits is planned for March 2009 in Morocco and will focus on the Palaeozoic VMS deposits of the Marrakech region.

#### **MRD-09 Au-Ag telluride-selenide deposits**

**CONVENERS:** Nigel Cook, University of Oslo, Norway; Kari Kojonen, Geological Survey of Finland, Finland

**NUMBER OF PRESENTATIONS:** 8 oral, 4 poster

**SYMPOSIUM SUMMARY:** The session was the final event of a successful IGCP programme (IGCP-486, 2003-2008). The session was sponsored by IGCP-486, the International Association on the Genesis of Ore Deposits (IAGOD) and the International Mineralogical Association Commission on Ore Mineralogy (IMA-COM).

The session opened with a keynote presentation (Ciobanu et al.) outlining research showing that bismuth tellurides and sulphosalts may carry significant amounts of invisible gold, and how this gold may be incorporated into the structures of the minerals. Subsequent talks focused on the latest, fascinating results on telluride-bearing ores in various locations which have been investigated during IGCP-486: the Russian Urals (Maslennikov et al.), Sardinia (Fadda et al.), Finland (Kojonen) and Greece (Voudouris and Spry). After a short break, oral presentations continued with the results of new research from Uzbekistan (Koneev et al.), and Japan (Shimizu et al.), the latter also showing new data on the behaviour of indium in epithermal systems. A final oral presentation (Echmaeva and Osadchii) outlined application of the EMF method to phase relationships and thermodynamic properties in the system Ag-Au-Te.

The poster presentations followed similar 'regional' themes. Two posters from Uzbek students (Khalmatov, Mun) showed the impressive gains in understanding Au-Te deposits of Uzbekistan that have been achieved during IGCP-486. Other posters described deposits in China (Xiao et al.) and an epithermal gold occurrence in Ethiopia (Fiori et al.).

**GENERAL COMMENTS:** Lively discussion followed each of the talks and was continued by some of the participants in an informal setting the same evening.

#### **MRD-10 Large ore provinces of Central Asia**

**CONVENERS:** Ginayat R. Beczhanov, Academy of Mineral Resources of the Republic of Kazakhstan, Kazakhstan; Bernd Lehmann, Institute of Mineralogy and Mineral Resources Technical University of Clausthal, Germany; Dmitry Pushcharovsky, Moscow State University, Russia

**NUMBER OF PRESENTATIONS:** 10 oral, 23 poster, 9 no-shows

**SYMPOSIUM SUMMARY:** Central Asia or the so-called 'Large Central Asia' (Mongolia, western part of China, Kazakhstan, Russian territory bordering with Mongolia and Kazakhstan, Uzbekistan, Kyrgyzia, Tajikistan, Turkmenia, Afghanistan) both due to its geographical location and its giant ore provinces takes on more economical, ecological and geopolitical value in the modern world.

The formation of large ore provinces is closely connected with global geodynamic processes - moving of lithospheric plates, development of Siberia, Emeishan and Tarim superplumes, etc. Joint study of the large ore provinces from the point of view of modern global geological conceptions in the frame of unified transboundary structures will potentially reveal new mechanisms of ore genesis, and will enlarge the potential mineral resources in each country and region as a whole. On the other hand, it should be considered that the influence on the environment connected with mineral raw materials processing often turns out to be so substantial that it affects the interests of neighbouring countries and influences the continent as a whole.

The geological situation of Central Asia is dominated by a huge collage of Phanerozoic subduction-accretion



complexes (Altaid orogenic system) in between the Urals to the west, Siberian platform to the north, Circum-Pacific orogenic belt and North China Craton to the east, and the Cenozoic Alpidic mountain ranges to the south. This region hosts a number of major ore provinces, and the wide spectrum of the symposium contributed to better awareness of the major problems on large ore provinces control, as well as attracting attention to the necessity of their detailed mineralogical and geochemical study; it also promoted productive contacts between experts working in the various countries.

**GENERAL COMMENTS:** The number of participants was 109. The majority of the oral presentations were devoted to the study of regional metallogenic principles and characteristics of the largest ore provinces. Poster presentations were equally informative and interesting; new data on deposits of various genetic types were presented. Posters allowed a more detailed discussion of the most fundamental issues of ore bearing in Central Asia. Most of the reports submitted to the session were published in the monographic collection "Large ore provinces of Central Asia", which was issued by the National Committee of Geologists of Kazakhstan in Russian prior to the congress. The National Committee of Geologists of Kazakhstan noted a high level of organization at the Congress, especially efficient work from the Science Committee and its Chairman Dr. David Gee, and the Scientific Programme Coordinator Dr. Björn Sundquist.

#### **MRD-11 Metallogeny of Fennoscandia**

**CONVENERS:** Felix Mitrofanov, KSC RAS, Russia; Krister Sundblad, University of Turku, Finland; Pär Weihed, Technical University of Luleå, Sweden

**NUMBER OF PRESENTATIONS:** 8 oral, 4 poster

**SYMPOSIUM SUMMARY:** The symposium was intended to present currently available data on mined and unexploited metalliferous deposits to the researchers of the region's geology and specialists working in the mining industry. Oral and poster presentations (8 and 4 respectively) covered the entire Fennoscandia (Fennoscandian Shield and the Caledonides). Large metallogenic provinces (regions) and the leading metals - Au, Pt, Pd, Cu, Fe, Ti, Cr and U - were the subject of discussions.

The Geological Surveys of Finland, Russia, Norway and Sweden compiled the Fennoscandian Ore Deposit database (FODD) and the Fennoscandian Deposit Map (authors: P. Eilu, N. Philipov et al.). Presently the FODD contains information on 293 mines and deposits in Finland, 154 in Norway, 237 in Russia and 260 in Sweden. It includes data on location, mining history, tonnage, commodity grades, geological setting, age, ore mineralogy, style of mineralization, genetic models and sources of data about such metals as Ag, Au, Be, Co, Cr, Cu, Fe, Li, Mn, Nb, Ni, Pb, Pd, Pt, Rh, REE, Sc, Sn, Ta, Ti, U, V, W, Y, Zn, and Zr.

The presentations of symposium MRD-11, "Russian Fennoscandia metallogeny" (authors: F. Mitrofanov and A. Golubev) and "Proterozoic metallogeny of the Ladoga region in Karelia" (authors K. Sundblad, V. Ivashchenko

and T. Lehtila), were dedicated to mineral resources of large regions in Russia and Finland and the relation between regional metallogeny and geodynamics and magmatism. The authors reported significant data for potential users such as mining companies.

New data for Europe and Russian Asia on PGE mineralization in layered mafic -ultramafic intrusions were presented in the papers "Russian Fennoscandia metallogeny", "Large igneous provinces of Northern Eurasia and PGE-Cu-Ni ore deposits" (authors: E. Sharkov and O. Dyuzhikov) and "Two stages of the Fedorov deposit and associated PGE mineralization formation: isotope U-Pb data on zircon (Kola Peninsula)" (authors: E. Nitkina, T. Bayanova, F. Mitrofanov). These data substantiate distinguishing a new superlarge PGE-bearing province of Palaeoproterozoic (NE Scandinavian) in Europe, provide information on some most promising PGE deposits for development (including those in the Fedorovo-Pana massif on the Kola Peninsula), and associate PGE mineralization with a long-term (ca. 100 Ma) plume activity. Such a long-term plume activity, determined by the U-Pb and Sm-Nd isotopic methods for PGE-bearing layered intrusions on the Kola Peninsula, provoked a lively discussion among the audience.

Finally, one more paper is worth noting - K. Saalman et al. "Timing of orogenic gold mineralization in southern Finland and its relationship to the Palaeoproterozoic Svecofennian tectonic evolution", in which the structural relation between Au-mineralization and shear-zones is proved and the age and time-interval (ca. 20-30 Ma) of its formation is determined.

**GENERAL COMMENTS:** 30-40 congress participants took part, 3-4 questions per presentation were raised.

#### **MRD-12 Fluvial palaeo-systems: Evolution and mineral deposits**

**CONVENERS:** Natalia Patyk-Kara, IGEM RAS, Moscow, Russia; Baohong Hou, CRC LEME, PIRSA, Adelaide, Australia

**NUMBER OF PRESENTATIONS:** 8 oral, 5 poster, 6 cancelled or no-shows

**SYMPOSIUM SUMMARY:** The symposium summarized some results of the IGCP-514 (Fluvial palaeo-systems: evolution and mineral deposits) and new data relevant to this problem. The main idea of the symposium was to consider evolution of fluvial systems, their age and inheritance, structural setting, facies environments, spatial-temporal relationship of different types of mineralization, modelling of ore-bearing (palaeo)valleys. River valleys and channels (both modern and ancient) stand as collectors of a wide assortment of mineral accumulations: from gravity-controlled placer deposits (Au, PGE, Sn, Di, etc.) to accumulations of mobile elements (U etc.). Large and superlarge and even giant objects are known among them. Therefore, it is clearly necessary to consider the full spectrum of palaeo-environmental conditions which controlled ore-forming processes in valleys, including their structural and palaeo-environmental setting and age.

The following topics were discussed: - types of palaeo-





channel mineralization and their space and temporal position; - use of drainage patterns analysis as a tool for mineral exploration: - evolution and exploration of palaeo-channels/shorelines and their mineral potential (on the South Australia example); - the role of palaeo-rivers and secondary collectors (Dwyka Formation) for diamond placer formation (Western Angola); - interaction of fluvial, aeolian and marine processes in the heavy mineral sand placer deposits on examples of: (a) Somaliland coast and (b) Oligocene member of the Western Siberia; - a new type of uranium mineralization in the Jurassic palaeo-channels of the Ordos basin (China); - CHIM techniques in palaeo-channel deposits exploration; etc. In addition the symposium included the presentation of the collected papers issue "Fluvial palaeo-systems: Evolution and mineral deposits" (2008).

**GENERAL COMMENTS:** The quality of both oral and poster presentations was high; the total number of people attending the symposium was about 30 persons from 9 countries. The symposium was concluded with a short discussion. The discussion showed that: - the traditional single-purpose approach to palaeo-channel deposits study (aimed at a single type of mineral) has certain restrictions; it excludes highly diversified phenomena and processes taking place in valley systems; it limits possibilities of spatial and evolutionary analysis of minerageny applied both to individual valleys and to that entire group of deposits associated with the principal types of the earth's crust structure; it does not comply with requirements for integrated estimate of ore potential of valley and palaeo-valley systems. Joint efforts of experts in the fields of paleogeography, sedimentology, geochemistry, mineralogy, placer and uranium geology open wide opportunities of multi-disciplinary analysis of mineral deposits of palaeo-valleys systems.

**ANNOUNCEMENTS:** It was decided to hold the next IGC-514 meeting in South China (Gulin) in October 2009 approximately. The plan, structure, possible schedule time and final issues were also considered.

### **MRD-13 Ore deposits associated with black shales: from their origin to their environmental impacts**

**CONVENERS:** Jan Pašava, Czech Geological Survey, Czech Republic; Hartwig Frimmel, University of Wuerzburg, Germany

**NUMBER OF PRESENTATIONS:** 7 oral, 10 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** Black shale formations occur in different geological environments throughout the geological record. Black shales are of interest in exploration since they host numerous types of ore deposits such as base metals (copper, lead zinc  $\pm$  barite), noble metals (gold and platinum group elements), uranium, molybdenum, nickel, manganese, vanadium, mercury, antimony, tin, phosphorus and others. Previously, some of the deposits were sub-economic, containing large amounts of low-grade mineralized black shale, but with the recent development of ore processing methods like bioleaching, many of these low-grade prospects became economically profitable. Both scientific results into the genesis and environmental issues

related to mining and processing of black shale-hosted ores were a major focus of this session.

Altogether seven oral papers were presented and briefly discussed, addressing major black shale-hosted commodities (Ni-Mo-PGE, Mn, Ni-Cu-Zn, Zn-Pb, Cu-Ag, Au). New data were presented in support of the importance of exhalative processes in the origin of Ni-Mo-PGE deposits hosted in lower Cambrian black shales and also Ni-Cu-Zn deposits hosted in upper Proterozoic black shales. Re-Os ages of black shales in the glaciogenic Vazante Group brought evidence for a Mesoproterozoic ice age in Brazil. An example of successful development of sub-economic deposit into economically profitable operation was given from the Talivaara Ni-Cu-Zn deposit (Finland), where bioleaching was launched to extract major metals. New environmentally oriented data on impacts of mining and processing of the Cd-rich sediment-hosted Pb-Zn deposit at Jinding were presented.

**GENERAL COMMENTS:** The session was very well attended. All scheduled presentations except two no-shows were delivered and most were remarkably well-prepared and illustrated.

**ANNOUNCEMENTS:** A special session on "Sediment- and volcanic-hosted Cu, Cu-Zn and Pb-Zn deposits" will be organized within the 10th SGA Biennial Meeting (2009, Townsville, Australia) - see [sga2009.jcu.edu.au](http://sga2009.jcu.edu.au) for more details.

### **MRD-14 Ophiolites, greenstone belts and ore deposits**

**CONVENERS:** Paul T. Robinson, Yildirim Dilek

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** This symposium will explore the petrological, geochemical and structural differences and similarities between ophiolites and greenstone belts, and investigate their relationship to plate tectonics and plate boundary processes. In what environments do these features form? Why are greenstone belts apparently common in the Archean, whereas ophiolites are generally restricted to the Neoproterozoic and Phanerozoic? Is there evidence of crustal extension in greenstone belts similar to that in ophiolites? Most ophiolites are related to subduction zones along plate boundaries; did greenstone belts also form in suprasubduction zone environments analogous to Phanerozoic marginal basins? What is the role of high-Mg komatiites and boninites in the origin of these bodies? Both ophiolites and greenstone belts host major ore deposits and are important exploration targets. How are the different types of mineralization related to the formation and evolution of these bodies and their tectonic environments, and what can they tell us about models and processes for their formation? This symposium is intended to bring together scientists with a range of expertise to discuss these fundamental problems related to the evolution of Precambrian and Phanerozoic oceanic crust and related ore deposits.



**MRD-15 Ni-Cu-PGE sulphide deposits**

*CONVENERS:* Heikki Papunen, University of Turku, Finland; Anthony J. Naldrett, University of Toronto, Canada

*NUMBER OF PRESENTATIONS:* 10 oral, 7 poster, 4 no-shows

*SYMPOSIUM SUMMARY:* The historic high prices of nickel and platinum-group metals (PGE) aroused worldwide interest in the exploration and exploitation of magmatic Ni-Cu-PGE deposits, which are related to mafic-ultramafic intrusive rocks and ultramafic extrusives. Tectonic environments and magmatic evolution vary from one deposit type to the other, but a number of common rules control the formation of sulphides in magmatic systems and the distribution of metals between co-existing phases.

Papers dealing with general aspects of magmatic Ni-Cu-PGE ore formation and descriptions of new discoveries were invited. Nickel has a long history in Fennoscandia: the metal was first discovered in Sweden 1756, and Norway produced the bulk of the world's nickel in the 19th century. Norwegian Caledonian deposits and the numerous deposits in the Svecofennian area of central Fennoscandia are examples of orogenic Ni-Cu deposits; hence papers on this Ni-Cu ore type worldwide were specially invited. Due to their high exploration potential in Fennoscandia Ni-Cu-PGE deposits related to mafic layered intrusions were also favoured in the session.

We had two excellent keynote papers, the first dealing with the tectonic setting of Ni-Cu deposits by Michael Lesher and the second with PGE deposits in layered intrusions, examples from the Bushveld Complex presented by Allan Wilson. The Fennoscandian Ni-Cu-PGE deposits and their exploration methods were presented in three oral presentations; we also got interesting new information on Noril'sk and Jinchuan world-class Ni-Cu deposits as well as orogenic deposits in SE Canada. An interesting poster presented the unconventional Ni-Cu occurrences in central Kamchatka.

*GENERAL COMMENTS:* The session was scheduled to start at 8:30 on Saturday morning, but since there were only a few trains from Oslo at this time many of the participants did not attend at the beginning. As at 8:30 only a keynote speaker, convener and two other people were in the audience, I decided to postpone the start until 8:45 when about 15 flustered people had arrived. Later on the number of participants went up to 70-80. The organizers made a mistake in the Saturday scheduling: they would need to give Saturday morning traffic information or organize an extra train at 8:00 between Oslo S and Lillestrøm.

Another problem was that I prepared a couple of slides to inform the audience about the SGA sponsorship and program, but the slides could not be presented since the computers were locked. Now only a large poster informed the audience about BOLIDEN sponsorship, which was totally new to me - nobody informed us that Boliden would sponsor our session! In my view visual information in addition to our oral information about the SGA financial sponsorship to the session would have been polite towards

the Society.

The session finally went well, we had a number of top-class scientists and lively discussion on different topics, especially metamorphic alteration of PGE spectra of the deposits.

*ANNOUNCEMENTS:* Our subject continues to thrive: Sisir Mondal will soon see his special number of the Indian Journal of Geology devoted to mafic and ultramafic mineralization in press; Professor Tang is organising a meeting next year in X'ian, China, devoted to nickel sulfide mineralization; and the next Platinum Symposium will be organised in Sudbury by Michael Lesher and others at Laurentian University in 2010, so even though some of the Ni-Cu-PGE geologists were not present at the Oslo conference, we will have other opportunities to meet in the future.

**MRD-16 Iron oxide copper gold deposits**

*CONVENERS:* Robert Marschik, University of Munich, Germany; Lluís Fontboté, University of Geneva, Switzerland

*NUMBER OF PRESENTATIONS:* 9 oral, 3 poster

*SYMPOSIUM SUMMARY:* The special symposium was opened with a keynote of Olof Martinson on iron oxide-Cu-Au deposits in the northern part of the Fennoscandian Shield. The presentations devoted to regional overviews, characteristics, genetic aspects, and IOCG deposit exploration reflected the current state of understanding. Descriptions of deposits or districts in Brazil, Australia, Chile, China, Kazakhstan, or Sweden allowed deep insights into these IOCG systems and the variations of characteristics among them. The topics attracted the interest of numerous colleagues from academia and the metal mining industry. Constructive questions from the audience sparked lively discussions particularly on the nature and evolution of fluids involved in IOCG deposit formation.

*GENERAL COMMENTS:* According to the comments gathered after the session and our own impression, the quality of the presentations and the various views on the discussed subjects made this symposium a great success.

**MRD-17 Gold deposits: Reflections of their tectonic environments**

*CONVENERS:* Jeffrey Hedenquist, University of Ottawa, Canada (not present); Richard Goldfarb, USGS, USA

*NUMBER OF PRESENTATIONS:* 6 oral, 4 poster, 9 no-shows

*SYMPOSIUM SUMMARY:* This symposium brought together experts working on gold systems on six different continents to present their views on the tectonic controls on the localization of important gold resources. Two opening keynote talks, one by Harwig Frimmel on the unique Witwatersrand ores of South Africa and one by Rich Goldfarb on the lodes of the North American Cordillera, were unfortunately given to very small audiences because many of the trains did not run on Saturday. Nevertheless, they were able to repeat their talks at the end of the session to a much larger crowd that remained after the regular program. Poul Emsboo



presented another keynote talk on the critical geological features that might help explain the exceptional gold endowment of Nevada's Carlin province. Juhani Ojala and his colleagues gave a detailed and impressive overview of the Precambrian gold deposit systems and their controlling features throughout the Fennoscandian Shield. Fluid flow in modern mountain ranges was modelled by Dave Craw and Phaedra Upton in an attempt to demonstrate the geohydrological processes that likely characterized many presently exposed lode gold deposits. A highlight of the symposium was a keynote presentation by Sasha Yakubchuk that described the distribution of world-class gold resources in central Asia relative to the Paleozoic evolution of this complex region. Poster presentations associated with the session provided additional interesting material on the controls of gold systems elsewhere in central Asia, Russia, the Middle East, and other global gold provinces.

**GENERAL COMMENTS:** There were too many no-shows, about 50%. The train problem on Saturday was not good and should have been avoided. Also, the rooms were poorly sound-proofed so that loud speakers in neighbouring sessions sometimes could be heard over our speakers. Nevertheless, attendance was good after the trains arrived and there was indeed a lot of discussion and interaction.

#### **MRD-18 Iron deposits**

**CONVENER:** Mark Barley, The University of Western Australia, Australia

**NUMBER OF PRESENTATIONS:** 3 oral, 9 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** Historic high prices for iron ore have resulted in world-wide interest in exploration for and exploitation of a variety of types of iron ore deposits. This session was devoted to oral and poster presentations on the full range of ore deposit types including Banded Iron Formation-hosted Iron Ore Deposits (BID), Magmatic Iron Ore Deposits (Kiruna-type), Channel Iron Ore Deposits (CID), and Detrital Iron Ore Deposits (DID) as important sources of iron ore. The presentations concerned deposits, as well as whole belts and provinces, and described their geological, mineralogical, geochemical, isotopic and tectonic characteristics, resource assessments and exploration potential. We strongly encouraged the presentation of innovative genetic models and a focus on deposits worldwide. The oral presentations focused on Paleoproterozoic iron ore deposits in Western Australia, South Africa and Brazil, with poster presentations covering a wider range of deposit types.

**GENERAL COMMENTS:** Although being a small session late in the afternoon, the oral symposium was very well attended.

#### **MRD-19 Uranium deposits**

**CONVENERS:** Michel Cuney, Nancy University-CNRS, France; Claude Caillat, AREVA NC, France; Olli Äikäs, Geological Survey of Finland, Finland

**NUMBER OF PRESENTATIONS:** 11 oral, 7 poster

**SYMPOSIUM SUMMARY:** The session devoted to the

uranium deposits was highly attended (about 100 persons) and the discussions were very animated, reflecting recent years' boom in academic research and exploration activities in this field. A large variety of uranium deposit types from worldwide occurrences were covered by the contributions. After an evaluation of world uranium resources by R. Vance, the global uranium potential of Mongolia was reviewed by Y. Mironov, and of China by Z. Jindai. A majority of the talks and posters concerned the uranium metallogenesis of the Baltic shield (from Russia: E. Afanasieva, V. Kushnerenko, and Finland: O. Äikäs, M. Cuney, P. Sorjonen Ward), with a reappraisal of the genetic models concerning extremely different types of deposit. I. Annesley and P. Bhaskar emphasized the role of basement structures and geochemistry on the genesis of the Athabasca-related uranium deposits. A series of posters evaluated the uranium deposit models of southern Siberia with the unconformity-related deposit potential of this region (G.N. Cherkasov), the very large caldera-related deposits of Streltsovka (A. Nikolskiy), the huge and totally new district of Elkon (E. Solntseva), minor uranium occurrences hosted by pegmatites in Egypt (E. Essam) and phosphates in a granite from Portugal (M. Marques da Silva Cabral-Pinto).

**ANNOUNCEMENTS:** Future meetings concerning uranium resources will be held in Keystone, USA, U2009 Global U Symposium, May 11-13th 2009; in Vienna, Austria, URAM2009, IAEA, June 22-26th 2009; and in Townsville, Australia, SGA meeting August 17-20th 2009.

#### **MRD-20 Porphyry copper (-gold-molybdenum) deposits: Formation, characterization and exploration**

**CONVENERS:** David Cooke, CODES, University of Tasmania, Australia; Pete Hollings, Lakehead University, Canada

**NUMBER OF PRESENTATIONS:** 14 oral, 8 poster, 6 no-shows

**SYMPOSIUM SUMMARY:** This session covered aspects of tectonic, magmatic, structural and/or hydrothermal processes that result in the formation of porphyry copper, gold and molybdenum deposits. Speakers and poster presenters emphasized the complex interplay between tectonic, magmatic, structural and hydrothermal processes in the generation of porphyry deposits. Several presenters provided detailed deposit descriptions, mineralogical investigations and exploration case histories.

**GENERAL COMMENTS:** A very pleasing session to chair. The technical content was on the whole excellent, and there were lots of useful discussion and lively questions after the presentations. We received some great feedback from the audience afterwards, some of whom stated that this session was the highlight of the conference.

**ANNOUNCEMENTS:** A special issue on Philippine porphyry copper deposits is currently planned for Economic Geology, and some of the contributions to session MRD-20 are likely to appear in that special publication



## OCEAN SCIENCES

## OS

MARINE GEOSCIENCE AND  
PALEOCEANOGRAPHY OSP**OSP-01 General contributions to marine geoscience and paleoceanography**

*CONVENERS:* Haflidi Haflidason, University of Bergen, Norway; Angelo Camerlenghi, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Spain; Jerry McManus, Woods Hole Oceanographic Institution, USA

*Note:* Due to the absence of all conveners, either on cruises or for family reasons, the convener for the session (oral and poster) was Atle Nygård, University of Bergen, Norway.

*NUMBER OF PRESENTATIONS:* 9 oral, 17 poster

*SYMPOSIUM SUMMARY:* During the last two decades a large advance has been made within the development of marine instrumentation (including seismic/acoustic, drilling technique/platforms, core logging/scanning etc.) and in our understanding of marine sedimentation and paleoceanographic processes. More and more high-quality 2D and 3D seismic data are also becoming available to academia through industry, and the increasing number of new high-quality geological/geotechnical borings available through the IODP platform and industry consortium has revolutionised marine geoscience and paleoceanography. The recent discoveries of complex geo-biogenic systems in deep-water ocean margin environments are also a result of new marine instrumentation and knowledge. Marine geoscience and paleoceanography are linked to several disciplines and often difficult to define. Marine basin and margin development is strongly influenced by changes in the earth climate and the tectonic evolution through time. This session therefore also included contributions in fields that may be considered to be outside traditional marine geoscience and paleoceanographic studies, and papers presenting quantified reconstruction within marine science. The session focused on the state-of-the-art of marine geoscience and paleoceanographic disciplines and results of integrated thematic studies. The broad aspect of this session was meant to attract marine geologists/geophysicists, oceanographers and paleoclimatologists in order to improve our understanding of these systems.

*GENERAL COMMENTS:* Talks touched on a variety of issues, such as paleoceanographic tracers in and tracers of anthropogenic pollution and studies of paleocirculation patterns in the west Pacific. Presentations were in general of excellent quality, and were followed up by one or two questions each. Between 10 and 30 people attended the session, with the number growing through the day.

**OSP-02 Marine geophysics: State-of-the-art and a look ahead - a tribute to Manik Talwani**

*CONVENERS:* Olav Eldholm, University of Bergen, Norway; Knut Heier, Geological Survey of Norway, Norway; Jörn Thiede, Alfred-Wegener-Institut für Polar-

und Meeresforschung, Germany

*NUMBER OF PRESENTATIONS:* 12 oral, 4 poster

*SYMPOSIUM SUMMARY:* Professor Manik Talwani has been an eminent scientist and a leader in marine earth science for almost five decades. He has pioneered highly sophisticated disciplinary work, as well as integrated thematic studies focusing on the development and evolution of ocean basins and continental margins. He has collaborated with colleagues worldwide during his career. Many scientists have, in particular, benefited from his great insight and experience. Hence, he was honoured with a symposium during the 33rd IGC. The symposium focused on state-of-the-art marine geophysical research as well as results of integrated thematic studies. After an introduction summarizing Talwani's background and achievements, Professor Hans-Juergen Goetze (Kiel, Germany) gave an excellent keynote talk on the development of gravity methods and algorithms, setting the stage for a series of talks covering a wide range of themes. The oral presentations and posters documented that Talwani's work had inspired several generations of marine scientists. Finally, Manik Talwani shared some scientific and personal thoughts with the audience.

*GENERAL COMMENTS:* The overall quality of the presentations was well above average. Attendance: 50-70. Some talks resulted in lively discussion, whereas others were followed by brief questions.

**OSP-03 Ocean margin and ocean island sediment mass movements and their consequences: Where? When? Why?**

*CONVENERS:* Roger Urgeles, Universitat de Barcelona, Spain; Jürgen Mienert, Universitetet i Tromsø, Norway; Jacques Locat, Université Laval, Canada; Anders Solheim, Norges Geotekniske Institutt, Norway; Vasilios Lykousis, Hellenic Centre for Marine Research, Greece

*NUMBER OF PRESENTATIONS:* 20 oral, 9 poster

*SYMPOSIUM SUMMARY:* During the last decades a large advance has been made in our understanding of submarine mass-wasting processes and their consequences. Sponsoring by UNESCO of project IGCP-511 (Submarine Mass Movements and Their Consequences) has brought a worldwide perspective to this field. This session explored the findings made during the last years in relation to the setting, timing and mechanisms involved in submarine mass wasting. During the session, abstracts addressing topics such as modelling of failure initiation, post-failure evolution and tsunamogenesis, the geometry and architecture of deposits, dating, industry and applied case histories, application of new methodologies, and measurement and monitoring of physical properties relevant to determining submarine slope stability were presented. Two keynote lectures by Nabil Sultan (IFREMER, France) and Tore J. Kvalstad (NGI, Norway) presented the state-of-the-art in offshore geotechnics, submarine slope instability and interaction between researchers and industry. A significant number of contributions presented data from major scientific programs such as IODP, which demonstrates an increasing interest in oceanic geohazards. Most of the contributions



presented numerical results on the basis of very high-quality data. There was an overall impression amongst OSP-03 participants that knowledge in this field is evolving from simply describing the processes associated with submarine slope failure to trying to understand the factors controlling such processes and further implications, which attests to the high quality of the contributions.

**GENERAL COMMENTS:** The session was attended by 20 to 45 people. For future events it should be considered listing a particular session in more than one session group; e.g. this session was listed on the ocean sciences program, but it is also clearly related to geohazards. We were approached by some congress participants expressing regret at not spotting that session at the time of abstract submission.

**ANNOUNCEMENTS:** A follow up event of this session is the "International Workshop on Seafloor Mapping for Geohazard Assessment" that will be held in Ischia Island, Italy in May 11-13, 2009.

After the last talk was given, an announcement was made for another major event related to the topic of the session: the "4th International Symposium on Submarine Mass Movements and Their Consequences" that will be hosted by the Bureau of Economic Geology, Jackson School of Geosciences in Austin, Texas in November 8-11, 2009 (<http://www.beg.utexas.edu/indassoc/dm2/Conference2009/home.htm>).

Both events are part of the International Geoscience Programme (a joint endeavour of UNESCO and the International Union of Geological Sciences) project 511 which also sponsored session OSP-03 at the 33rd International Geological Congress.

#### **OSP-04 Contourites**

**CONVENERS:** Jan Sverre Laberg, University of Tromsø, Norway; Adriano R. Viana, PETROBRAS, Brazil; Michele Rebesco, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Italy

**NUMBER OF PRESENTATIONS:** 9 oral, 5 poster, 1 no-show

**SYMPOSIUM SUMMARY:** Contourites are sediments deposited or substantially reworked by the action of bottom currents. The study of contourites is crucial in at least three main respects: 1) palaeoclimatology, since these fairly continuous and relatively high-resolution sediments hold the key for priceless information on the variability in circulation pattern, current velocity, oceanographic history and basin interconnectivity; 2) hydrocarbon exploration, since accumulation of source rocks may be favoured by weak bottom currents, whereas 'clean' deep sea sands may be formed by robust flows; 3) slope stability, since low-permeability fine-grained contourites provide overpressured glide planes when their high water content is rapidly loaded or their rigid biosiliceous microfabric is collapsed by diagenesis.

Talks and posters on all three topics were presented. This included new case studies from both the northern and southern hemisphere as well as reviews on the importance of contourites for slope stability (keynote), on the estimation of bottom current velocity from bedform

observations and on the seismic identification of contourites.

An introduction to the discussion at the end of the symposium was presented by the organisers, and this triggered discussions on terminology as well as future targets for research on contourites.

**GENERAL COMMENTS:** The overall quality of both oral and posters presentations was high. A maximum of 30-35 people were attending and the symposium ended with 30-45 minutes of discussion.

#### **OSP-06 Causes of oxic-anoxic changes in Cretaceous marine and non-marine environments and their implications for Earth systems**

**CONVENERS:** Chengshan Wang, China University of Geosciences, Beijing, China; Michael Wagreich, University of Vienna, Austria; Bradley Sageman, Northwest University, USA

**NUMBER OF PRESENTATIONS:** 11 oral, 2 poster

**SYMPOSIUM SUMMARY:** The yearly meeting and workshop of the IGCP 555 was held for year 2008 at the 33rd International Geological Congress in Oslo, Norway, on August 8, 2008. Five invited talks set the topic and gave new results on rapid environmental and climate changes in the Cretaceous. Bill Hay (USA) started with a thorough comparison of Cretaceous climate and today's climate change scenario, pointing to the fact that today we have already reached a Cretaceous CO<sub>2</sub> concentration and returned to Cretaceous climatic conditions, and discussing possible consequences of such a rapid climate change yet unknown from earth history. Oliver Friedrich (Germany) et al. gave an overview about Cretaceous paleoceanography and paleoclimate of the tropical proto-north Atlantic and inferred long-term development versus short-term events. Especially new data about the impact of the mid-Cenomanian event and the puzzling short-term ice event in middle Turonian were discussed and gave a perfect framework for work within IGCP 555. Wang Chengshan (China) et al. gave an overview of Cretaceous Oceanic Red Beds (CORBs) and their significance for global oceanic/climate change. The group of Brad Sageman (USA), represented by Brian Lockwood, gave an overview on recent advances in the study of Cretaceous OAE's, especially on OAE 3 timing and cyclostratigraphy, which serves as a framework for IGCP 555 chronostratigraphy. Finally, Ines Wendler (Germany) et al. gave an in-depth report on mid-Cretaceous cyclic oscillations in oxygenation based on benthic foraminifera, XRD data, and cyclostratigraphy.

Hu Xiumian (China) et al. then reported on Aptian-Albian cyclic oceanic red beds in the ODP Hole 1049C, North Atlantic, where new geochemical and isotope data allow inferences on timing and significance of cyclic CORBs. Yuri Zakharov (Russia) reported isotope and palaeontological evidences for Cretaceous climatic oscillations in the Bering area (Alaska and Koryak Upland), giving a detailed palaeoclimate record for that area and speculating on consequences for paleoceanography. Mihaela Melinte (Romania) introduced oxic-anoxic changes in Cretaceous marine deposits of the Romanian





Carpathians and indicated new high-resolution stratigraphic data. Wan Xiaoqiao (China) reported on the lacustrine Cretaceous sequence and climate signal revealed by the Chinese scientific drilling project SK-I and new isotope data for correlation of non-marine and marine signals. Michael Wagreich (Austria) et al. revealed the story from OAE 2 anoxia to oxic CORBs in the Cenomanian to Santonian of the Ultrahelvetic (Austria). Geochemical data indicate the origin and environments of anoxic-oxic transition. Finally, Li Guobiao (China) reported on new foraminiferal biostratigraphy of the Cretaceous Xialabolin Formation, Zada, southwestern Tibet, and the stratigraphy of that key section. Two posters were also announced for that session: Huang Yongjian et al. on the characterization of iron partitioning in Cretaceous shales and oceanic red beds of the Chuangde section, Gyangze, South Tibet, and María Najarro et al. on sedimentological, diagenetic and chemostratigraphic evidences of environmental change in a carbonate platform related to the early Aptian Oceanic Anoxic Event (OAE 1a).

**ANNOUNCEMENTS:** The participants met in the evening for discussion of results and the ongoing work-plan for IGCP 555. It was agreed that next year's meeting (2009) will be in the framework of the 8th International Cretaceous Symposium (Plymouth, UK), including a special field workshop to study chalk successions. Papers presented for the 33IGC will be published in a major international journal, *Marine Geology*.

#### **OSP-07 Oceanic hypoxia: Present and past**

**CONVENERS:** Elisabeth Alve, University of Oslo, Norway (session chair); Hiroshi Kitazato, JAMSTEC, Japan; Bruce Corliss, Duke University, USA

**NUMBER OF PRESENTATIONS:** 9 oral, 2 poster

**SYMPOSIUM SUMMARY:** Understanding the processes and effects of oceanic hypoxia on biota and depositional environments is crucial when interpreting ancient as well as more recent environmental change. Many important biogeochemical processes in the past, as well as in the contemporary biosphere, take place only under anaerobic conditions. Still, we have limited information about biogeochemical cycling in strongly oxygen-depleted environments and how it affects eukaryotes. Only recently, it was shown that specific benthic foraminifera are taking part in the nitrogen cycle under dysoxic-anoxic environmental settings. What about sulphur cycles and bacterial endosymbiosis? From a practical/applicable point of view, a closer understanding of how benthic foraminifera respond to hypoxia, based on information in the sedimentary record, is of prime importance when interpreting the effects of climate change and human impacts on the marine environment.

Topics of particular interest to this session included observations and interpretations of biotic responses to both present-day and past hypoxia and the interactions between organisms and their biogeochemical environment under hypoxic conditions. Some questions posed and discussed were: How do benthic organisms respond to modern hypoxia and how did they respond in the past? Which biological proxies reflect hypoxia and what are the

adaptive strategies for organisms dwelling in strongly oxygen-depleted environments? In terms of the biology of benthic organisms, results from both molecular analyses and physiological observations were documented for understanding adaptive strategies against hypoxic conditions. Benthic foraminifera that dwell under hypoxic conditions commonly adapt by means of specific organelles and/or endosymbiotic organisms. Pore shape and size of epifaunal organisms change in relation to oxygen concentration in the deep sea. This may be a sensitive proxy for hypoxia. Population responses during seasonal, ephemeral and more long-term hypoxia were reported from the Mediterranean and Gulf of Mexico. Specific species were recurrent after seasonal hypoxia. Deep-sea benthic foraminiferal faunal responses were discussed for Mediterranean sapropel layers through high-resolution analyses. Similar responses to hypoxic environments are shown between fossil and modern assemblages/species. The results indicate that common responses or adaptation processes for hypoxia may exist among benthic organisms.

**GENERAL COMMENTS:** The overall quality of the presentations was very good with informative well-prepared slides and some magnificent SEM-pictures of benthic foraminifera. There were no cancellations and most speakers kept their time limit. The advancements in this fundamental and applied research theme is obviously of worldwide interest as, at times, more than 50 people from five continents gathered in the session room (A 1-4). Before the first talk, we encouraged people to have a look at the posters in the coffee break, and we encouraged those who would not be able to pose questions between talks to save them to our discussion session after the last talk. This worked perfectly well. There were some questions between talks but most were saved for the final discussion. After the talks, the first authors of the posters gave a summary of their studies. About 10-15 people took active part in the final discussion which was fruitful, well-focused, and lively. It was kept in a constructive atmosphere and lasted for more than 30 minutes. Afterwards we went over to the posters where the discussions continued. Overall, we felt that this was a very successful session on a topic that is of wide interest to geoscientists, and we thank the organizers for including this topic at the 33rd International Geological Congress.

**ANNOUNCEMENTS:** The symposium was supported by the International Palaeontological Association.



## PLANETARY SCIENCES, IMPACT STRUCTURES PI

### COMPARATIVE PLANETOLOGY PIP

#### PIP-01 General contributions to comparative planetology

*CONVENERS:* Alfred McEwen, Lunar and Planetary Lab, University of Arizona, USA; Henning Haack, Natural History Museum, University of Copenhagen, Denmark

*NUMBER OF PRESENTATIONS:* 9 oral

*SYMPOSIUM SUMMARY:* Geology is no longer a purely terrestrial discipline. A continuous stream of remote sensing data from planets, moons, asteroids and even comets allow us to study geological processes under conditions very far from those encountered on Earth. The solid bodies range in composition from almost pure ice to dry rocky or even metallic bodies. Some of the bodies have been inactive for billions of years whereas others are far more active than the Earth. Although many of the spectacular images sent back to us show features unlike anything seen on Earth we also find evidence of processes that are well known on Earth. Examples of these processes include volcanoes, lava flows, canyons, impact craters, dune fields, layered sediments, and ice caps. Using our understanding of these processes from Earth we may use the observations to reconstruct the geological evolution of the host body.

Models of geological processes may also be tested under conditions very different from those encountered on Earth, and thus provide better models to study the processes on our own planet. A comparison of volcanoes on Venus, Io, Mars and the Earth show remarkable diversity reflecting the very different conditions at the surfaces of these four bodies. The presentation at the meeting in Oslo covered a broad variety of Solar System objects: the Earth, the Moon, Mars, Phobos, Eros, Itokawa, Iapetus, Io, Europa, and the icy moons of Jupiter and Saturn. The processes discussed included impact cratering, volcanic processes, sedimentation, weathering and formation of boulder fields. Geophysical data applied to the inner structure of the Galilean satellites were also presented.

*GENERAL COMMENTS:* There were 30-40 people in attendance and typically about two questions per talk. Compared to other meetings the majority of the talks were not of the highest quality.

#### PIP-02 The geology of Mars and Venus - recent results

*CONVENERS:* Jouko Raitala, University of Oulu, Finland; Marko Aittola, University of Oulu, Finland; Petri Kostama, University of Oulu, Finland

*NUMBER OF PRESENTATIONS:* 8 oral, 4 poster, 1 no-show

*SYMPOSIUM SUMMARY:* By now there are three Mars orbiters and three Mars landers active and producing new

data on Martian geology, environment and climate. The oral presentations were chosen from the Mars topic. Venus has only one orbiter and therefore Venus topics were directed to the poster session.

The oral presentations included an introduction to the recent Mars topics (Jouko Raitala); "Erosion levels in the Dao, Niger and Harmakhis area, Mars" (V.-P. Kostama); "A rapidly emplaced, turbulent lava flow in Athabasca Valles, Mars" (Windy Jaeger); "Pit Craters: An evaluating tool for rift processes on Mars" (Mauro Gabriel Spagnuolo); "A review of flood lavas across the solar system" (Laszlo Keszthelyi); "Exploring Mars at sub-meter scales with MRO/HiRISE" (Alfred McEwen); "The structural control of impact craters: Evidence from the terrestrial planets" (Teemu Öhman); and "Hydrology phases of Claritas Fossae, Mars" (Jouko Raitala). They provided a good overview to some important areological topics.

The poster session included the following posters: "Time duration of astra-novae activity on Venus" (A.T. Basilevsky), "Erosion levels in the Dao, Niger and Harmakhis area, Mars" (V.-P. Kostama), "Venusian polygonal impact craters vs. tectonics" (M. Aittola), "Results of new survey of coronae and arachnoids on Venus" (T. Törmänen).

*GENERAL COMMENTS:* The oral session was overwhelmingly full of visitors. The poster presentations were okay but the poster session in the evening was slow with only a few visitors. I would recommend daytime hours for poster presentations.

#### PIP-04 From gas and dust to planets

*CONVENERS:* Martin Bizzarro, University of Copenhagen, Denmark; Thorsten Kleine, ETH, Zürich, Switzerland

*NUMBER OF PRESENTATIONS:* 4 oral, 4 poster

*SYMPOSIUM SUMMARY:* Meteorites provide a direct time window into the physical and chemical processes that defined the earliest evolution of our Solar System, including the formation of the oldest solids and the accretion and differentiation of planetesimals and terrestrial planets. Moreover, recent technical advances now allow for the study of presolar materials included in primitive meteorites that contain direct information on the stellar sources that produced the raw building material of our Solar System, and how this was processed in the interstellar medium as well as within the solar protoplanetary disk. The aim of this session was to provide observational and theoretical constraints to help unravel the early history of the Solar System in the context of its astrophysical setting, from collapse of the molecular cloud through condensation and evolution of primitive solids and, ultimately, formation of terrestrial planets. The symposium was well-attended given the small number of presentations and, thus, our objectives were met.

#### PIP-06 Origin and evolution of the Moon

*CONVENERS:* Timothy J. Fagan, Waseda University, Japan; Tomoko Arai, National Institute of Polar Research, Japan



**NUMBER OF PRESENTATIONS:** 5 oral, 1 poster

**SYMPOSIUM SUMMARY:** The origin and evolution of the Moon was addressed in three main themes in this session: (1) theoretical modelling of impacts in the inner solar system; (2) scientific results of the ongoing Kaguya-SELENE mission; and (3) comparison of lunar meteorites with remote sensing data and terrestrial rocks to understand igneous differentiation on the Moon.

**GENERAL COMMENTS:** Impact modelling shows that large impacts, similar to the impact that produced the Moon, are not anomalous; rather, large impacts between differentiated bodies are to be expected during the formation of terrestrial planets. A model low-angle collision between a 'proto-Earth' and another differentiated body produces many features of the Earth-Moon system, including a metal-depleted Moon. Core material from the impactor may have been dynamically emplaced into the Earth's core, raising the question of extent of equilibration between the Earth's core and mantle.

The Kaguya-SELENE mission to the Moon has successfully returned spectral and image data from the main orbiter and two satellite spacecraft. Radar sounding has identified shallow reflectors in Mare regions that differ from Apollo era results. Zones in permanent shadow near the south and north poles of the Moon are being investigated for the presence of water. Because these areas are always dark, reflected sunlight must be used as the light source for emitted radiation. Thus, spectral data from dark regions are relatively weak and have broad peaks. In spite of these difficulties, the ongoing Kaguya-SELENE mission may yet collect sufficient spectra to determine whether water ice exists in permanently shadowed regions on the Moon.

Remote sensing shows that the Apollo and Luna samples come from a region of the Moon enriched in incompatible trace elements, and give us a biased view, particularly of the highlands crust. The lunar far-side, which is dominated by highlands, may consist mostly of magnesian anorthosite, which is more primitive than the near-side ferroan anorthosite. Clasts of magnesian anorthosite have been identified in some brecciated meteorites from the Moon (e. g. Dhofar 489). Other lunar meteorites contain clasts of late-stage products of igneous differentiation and highlight differences between terrestrial and lunar magmatic processes. Though late-stage igneous rocks are enriched in incompatible elements on both the Earth and the Moon, the paucity of water on the Moon leads to late-stage rocks that are distinct from terrestrial pegmatites. Lunar late-stage magmatic rocks tend to be fine-grained, glassy and trapped as relatively small bodies within less-differentiated host rock.

## IMPACT STRUCTURES PIS

### PIS-01 Contributions to impact structures

**CONVENERS:** Birger Schmitz, University of Lund, Sweden; Christian Koeberl, University of Vienna, Austria; Henning Dypvik, University of Oslo, Norway

**NUMBER OF PRESENTATIONS:** 11 oral, 14 poster, 1 no-show

**SYMPOSIUM SUMMARY:** Impact cratering is now recognized as one of the most important geological processes in our Solar System, and this symposium allowed an integrated approach to a broad spectrum of impact-related issues. Francois Paquay gave the first presentation discussing the possibility to use Os-isotopic signatures in pelagic sediments to locate major impacts in Earth's stratigraphic record, and to determine the size of the impactors. Galen Gisler discussed model simulations for oblique impacts into volatile sediments. Filippos Tsikalas talked about the overlooked process of post-impact structural crater modification due to sediment loading. The Ritland crater and its possible impact origin was discussed by Fridtjof R  is. Elin Kalleson discussed impactites from the confirmed Gardnos impact structure, and how deformation patterns correlate with different target lithologies. The Cerro do Jarau structure in southern Brazil was discussed by Alvaro Crosta, who suggested that this may be the sixth impact crater known in Brazil. The geophysics and paleogeography of the marine Mj  lnir impact crater was described by Stephanie Werner. Two talks on the mineralogy of impact deposits were given by Claudia Trepman, who showed how shock effects in quartz can give information on stress conditions, and Harvey Belkin, who informed on zirconium-bearing phases from suveite-like rocks from the Chesapeake Bay impact structure. Birger Schmitz ended the session with a summary of research developments on the disruption of the L chondrite parent body 470 Ma.

**GENERAL COMMENTS:** The session was attended by ca. 60 people, and most seats in the session room were occupied most of the time. The presentations held a generally high quality and the symposium was a success, well above expectations, considering in particular that it coincided in time with other impact meetings around the world.

## SEDIMENTOLOGY SE

## SEDIMENTOLOGY SES

### SES-01 General contributions to sedimentology

**CONVENERS:** Knut Bj  rlykke, University of Oslo, Norway; Ron Steel, University of Texas at Austin, USA; William Helland-Hansen, University of Bergen, Norway  
**NUMBER OF PRESENTATIONS:** 13 oral, c. 40 poster, c. 15 no-shows

**SYMPOSIUM SUMMARY:** The session included very diverse fields of research from recent sedimentation to the sedimentology of Precambrian rocks. The contributions were also from a very large number of countries.

**GENERAL COMMENTS:** There were many good presentations and several were related to petroleum exploration. It is difficult to point out main issues but there



were some questions and debate. This session was relatively well attended with up to about 80 people.

### **SES-03 Intra-basaltic sediments and weathering horizons as monitors of climate change**

*CONVENERS:* Mike Widdowson, The Open University, UK; Mohammed Rafi G. Sayyed, Poona College, Pune, India

*NUMBER OF PRESENTATIONS:* 6 oral, 3 poster

*SYMPOSIUM SUMMARY:* In attempting to unravel past climate change it is clearly of pivotal importance to understand the complex record preserved in terrestrial material. Useful terrestrial climate proxies have often proved elusive, but volcanic stacks, such as those produced during continental flood basalt episodes, offer just such a record. Moreover, these are closely linked with the unusual climatic and environmental fluctuations recorded during extreme volcanism. Accordingly, sediments, weathering horizons and associated palaeosols intertrapped between the lava flows have recently captured the attention of earth scientists globally. Their interpretative value is tremendous because of the homogeneous nature of the basaltic parent materials, and possibility of comparing palaeosol characteristics to well-constrained examples of modern soils formed on similar substrates. The session offered a platform to present the cross-disciplinary research ranging from field observation through to the geochemistry of intra-basaltic materials from flood basalt provinces and the complexities of associated isotopic systems. The high-quality presentations not only covered examples from around the world, but also from throughout at least 1 Ga of geological time. The use of paleosols as proxies for the evolution of the early Earth atmosphere was admirably demonstrated. In addition, geochemical proxies for past climate were discussed, with refinements demonstrating that temperature and rainfall data could be extracted. Moreover, because these types of materials are considered as analogues of the Martian surface, altered palaeosols are now becoming of considerable interest to planetary scientists. Accordingly, the session significantly aided in identifying possible direction for ongoing and future studies of intra-basaltic weathering in countries around the globe, and for the investigation of the Martian surface.

*GENERAL COMMENTS:* To summarise, the session was highly stimulating to all those presenting. It was also well-attended, with up to 50 IGC delegates present in the audience for many of the talks. There was a wider-ranging discussion during and especially following the scheduled session. These discussions and exchange of ideas broadened into debate regarding future studies on intrabasaltic sediments and palaeosols. The conveners would like to thank all of those who participated in SES-03; its success is largely due to their cooperation and contributions. The possibility of combining the session contributions, and other papers requested from experts elsewhere, into a special volume was discussed. Negotiations are now in progress to identify a suitable publisher.

### **SES-05 Dynamics of complex intracontinental basins**

*CONVENERS:* Ralf Littke, RWTH-Aachen, Germany; Ulf Bayer, GFZ-Potsdam, Germany; Dirk Gajewski, University of Hamburg, Germany

*NUMBER OF PRESENTATIONS:* 9 oral, 7 poster, 1 no-show

*SYMPOSIUM SUMMARY:* The area of the Central European Basin has been in the focus of research for more than a decade. Many geoscience disciplines have been involved, ranging from geophysics to sedimentology and geochemistry. It is timely to summarize the results from different programs like EUROPROBE, PACE and the SPP Dynamics of sedimentary basins by example of the CEBS, and to compare the results with other basins. It is still challenging to develop an understanding of continental basins which evolved over long geologic periods and which are often extremely complex in terms of structural style, rock and fluid inventory. The main objective of this session is to identify and quantify the major processes that control or affect the formation and evolution of complex continental sedimentary basins, including the fluid inventory. In order to achieve this goal, presentations on geological, geophysical, and geochemical basin research are sought including numerical modelling studies. Of special interest are studies dealing with: Issues of global climate change and sea-level change; Basin formation within the framework of plate tectonics and mantle convection; Thermal history and coupled hydrocarbon generation and migration; Groundwater flow and coupled diagenetic reactions; Sedimentary record as a mirror of tectonic environments; Compaction and spatial and temporal variations of subsurface porosity and permeability.

*GENERAL COMMENTS:* Scheduled on the last day, the number of attendants was rather limited. A further complication arose because the posters were presented one day before the oral presentations, limiting the number of attendants further.

### **SES-07 Dynamics of sedimentary basins**

*CONVENERS:* Susanne Buiter, Geological Survey of Norway, Norway; David Egholm, University of Aarhus, Denmark

*NUMBER OF PRESENTATIONS:* 11 oral, c. 20 poster, 1 no-show

*SYMPOSIUM SUMMARY:* In simple scenarios basins are formed by extension in an intraplate setting or at a passive margin and can be inverted if the local stress field reverses, while flexural foreland basins are formed and influenced by orogenic loading. However, this simple picture can be complicated by crustal- to lithospheric-scale factors and processes, such as phase changes, pre-existing structure, influence of the underlying mantle, rheological stratification, surface processes, oblique forcing (transtension and transpression), and strain weakening or hardening, among others. Studies of the dynamic evolution of sedimentary basins therefore require an integrated approach that incorporates findings and techniques of many Earth Science disciplines. The presentations of this session discussed coupling of surface processes to models of crustal dynamics, numerical models of sedimentation





and deformation processes, and field-based studies from more than ten localities all over the world that provide valuable constraints on stratigraphy, sedimentation processes, ages, palaeogeography and subsidence history.

Most oral presentations were followed by questions from the audience. In a pause caused by a missing presentation there was a lively general discussion and in that way the session maintained continuity.

**GENERAL COMMENTS:** The oral part of the session was attended by 30 to 60 persons (the numbers varied during the morning). The poster session featured more than 20 posters, with many brought along spontaneously. The posters were well visited, both during the lunch break and at the end of the day.

### **SES-08 New insights into basin analysis: Palaeoenvironments, geochemistry and depositional processes**

**CONVENERS:** Bettina Reichenbacher, Ludwig-Maximilians-University Munich, Germany; Philip Ringrose, StatoilHydro, Trondheim, Norway

**NUMBER OF PRESENTATIONS:** 6 oral

**SYMPOSIUM SUMMARY:** The first three presentations ("Higher latitude depositional systems - changes in latitudes, changes in attitudes", presented by John Suter [keynote]; "Sediment diagenesis in high latitude sedimentary systems: Climate influences on mineral and geochemical processes during early diagenesis" by Richard Worden [presented by Philip Ringrose]; and "Submarine channels in high latitudes: Why are they so different to their equatorial counterparts?" [presented by Jeffrey Peakall]) considered the hypothesis that high latitude basins are significantly different from mid-to-low latitude basins. Although the issues are complex it was shown that enough differences occur (due to climate, biodiversity at higher latitudes and the effect of the Coriolis forces on ocean currents) to make these basins distinctive. Future studies on high latitude basins are needed and are expected to further demonstrate the uniqueness of this setting.

The following three presentations ("Sequence stratigraphy of the fluvial Wapiti Formation, Grande Prairie region, Alberta, Canada" (presented by Federico Fanti and O. Catuneanu); "Evolution of the peripheral foreland basin and the Siberian craton deformation as a result of Cadomian orogeny" (presented by Julius Sovetov), and "Transgressive-regressive cyclicity of the Eastern Paratethys from the Oligocene to Pliocene and eustasy" (presented by A. Zastrozhnov and S. Popov) focused on foreland basins as tectonically active areas that are characterized by rapidly changing sedimentation dynamics and patterns. It was shown that a reliable time control is essential for a more complete understanding of the processes occurring in foreland basins, but that chronostratigraphic control in foreland basins is often poor. The relation between uplift and climate change in foreland basins was discussed. Also the question as to whether it is possible to recognize global climate signals in these tectonically active areas was announced. Future multi-proxy studies including magnetostratigraphy, isotopes, palaeontology, and sedimentology are required in

order to attain a more reliable approach for time control in the sedimentologically dynamic areas of foreland basins.

**GENERAL COMMENTS:** The overall quality of presentations was high. The number of people attending was about 40 and the discussion was lively. SES-08 was merged from three proposed symposia: SES-06 Foreland basins: Palaeoecology, climate, and chronostratigraphy, SES-04 Organic geochemical archives of paleoenvironmental conditions, and SES-02 Processes in high-latitude depositional systems and basins.

## **STRUCTURAL GEOLOGY, TECTONICS ST**

### **NEOTECTONICS STN**

#### **STN-01 General contributions to neotectonics**

**CONVENERS:** Odleiv Olesen, Geological Survey of Norway, Trondheim, Norway; Michel Sébrier, Université Pierre et Marie Curie - Paris VI, France; Anthony Crone, US Geological Survey, Denver, USA

**NUMBER OF PRESENTATIONS:** 22 oral, 16 poster, 2 no-shows

**SYMPOSIUM SUMMARY:** This symposium focused on the field of neotectonics, including neotectonic studies in diverse geologic and tectonic environments, and the application of new technologies and methodologies to neotectonic investigations. We invited contributions that utilize data from the disciplines of plate tectonics, structural geology, geophysics, geodesy, Quaternary stratigraphy and dating, and geomorphology to address neotectonic problems.

We welcome geologists, geophysicists and modellers to present results of their studies of active faults and folds in diverse tectonic environments. We encourage presentations that use geological and geophysical data to characterize the location, dimensions and kinematics of active geological structures that can be reasonably associated with one or more historical or recent earthquakes. We invite investigations that utilize different types of geophysical surveys to image active faults and growth folding at scales ranging from the outcrop to the entire crust.

This symposium also aimed to address the implications of neotectonics to societal issues. We encouraged both overview presentations and case studies that can address basic scientific and social questions such as: 1) How can recent crustal deformation and fault activity be characterized in time and space? 2) Which types of crustal and subcrustal processes drive neotectonic deformation? 3) What role does the presence and migration of fluids in upper crustal bedrock have when evaluating the geohazard-related risk associated with the design and construction of critical infrastructure?

**GENERAL COMMENTS:** Approximately 30-40 persons attended the session.

**ANNOUNCEMENTS:** We plan to publish a joint volume in Tectonophysics with the 33IGC STP-02 session "Neotectonics and stress state in formerly glaciated





regions"

### **STN-02 Neotectonics and stress state in formerly glaciated regions**

*CONVENERS:* Christophe Pascal, Geological Survey of Norway, Norway; Iain Stewart, Plymouth University, UK; Bert Vermeersen, Delft University, Netherlands

*NUMBER OF PRESENTATIONS:* 10 oral, 3 poster, 1 no-show

*SYMPOSIUM SUMMARY:* The melting of large ice caps in relatively short time produces significant mass redistributions on the surface of the Earth, affects sea levels and land uplift, and alters lithospheric stresses in formerly glaciated areas and adjacent regions, resulting eventually in powerful earthquakes. The effects from the last deglaciation, some 10 ka ago, are still felt today through rapid uplift rates and enhanced seismicity in North America and Fennoscandia. Because of the dramatic ongoing global warming, similar processes are expected to affect presently glaciated regions before the end of this century. The progress made in the field of 'glacially-induced tectonics' since the discovery of the first post-glacial faults in the 60s and 70s provide us today with a better understanding of the interplay between cryosphere and lithosphere. The purpose of the STN-02 symposium was to bring together researchers involved with neotectonic deformation having affected and affecting formerly ice-covered regions during the Quaternary. Excellent presentations were given and addressed all aspects of the topic from the viewpoint of structural and earthquake geology, seismology, geodesy, geomorphology, stress measurements and mechanical modelling. Complementary contributions reporting results from present-day glaciated regions (i.e. Greenland and Antarctica) were particularly appreciated by the audience. One of the major outcomes of the symposium was to show the fast progress made recently by means of improved remote sensing techniques (i.e. satellite-based) and thanks to large programmes on nuclear waste management in Fennoscandia.

*GENERAL COMMENTS:* Although STN-02 was a relatively small and specialized symposium and despite the fact it took place the very first day of the conference, we could note that the meeting room was permanently filled with more than 60-70 people. The oral presentations were generally of excellent quality and the audience very responsive in commenting and asking questions. In particular, we could smoothly manage one oral no-show thanks to very lively and interesting discussions that involved a large part of the audience.

*ANNOUNCEMENTS:* During the symposium we announced our intention to publish a book at the Geological Society of London.

### **STN-03 Morphotectonics of lowland areas**

*CONVENERS:* Jonas Satkunas, Lithuanian Geological Survey, Lithuania; Andrzej Piotrowski, Polish Geological Institute, Poland; Marek Graniczny, Polish Geological Institute, Poland

*NUMBER OF PRESENTATIONS:* 12 oral, 17 poster

*SYMPOSIUM SUMMARY:* The symposium was initiated

by the Polish Geological Institute and supported by IUGS Commission on Geoscience for Environmental Management (IUGS-GEM) and other organizations. This symposium dealt with problems of activities of subsurface structures in connection with active subsurface and surface processes, impact of tectonic structures on glacial morphology and glacial processes, techniques and methodologies of morphotectonic investigations, mapping and modelling. The symposium presented main results of the current EU project Morphotectonic Map of the European Lowland Area - MELA ([www.mela.3dsign.pl/](http://www.mela.3dsign.pl/)). The MELA project foresees integration of knowledge on stratigraphy, tectonics, hydrogeology and, on the basis of new scientific experiments, elaboration of an interdisciplinary method of studying environmental changes in Quaternary, in the past and present. With reference to the goals of the MELA project, presentations of the symposium STN-03 can be grouped into the following subjects: impact of the various tectonic structures on the glacial processes in Pleistocene, in connection with multiphase liquid flow in the basement (Zuchiewicz et al.; Holzbecher et al.; Schröder & Oehm; Piotrowski et al.; Urbanski; Cyziene & Satkunas, Pikies & Piotrowski, Lehne & Sirocko; Bregman; Kasinski & Kramarska); morphotectonic analysis of tunnel (fossil) valleys (Oehm & Schröder, Piotrowski et al.; Satkunas; Piotrowski J. et al.); correlation of the direct and remote sensing techniques used in the analysis of the young Alpine glaciotectionic and neotectonic structures to define zones with especially intensive disturbances, influencing hydrodynamic field and initiating mass movements (Graniczny et al.); coastal processes and neotectonics (Jeglinski & Koszka-Maron; Bitinas; Zaleszkiewicz; Piotrowski); development of bio- and lithostratigraphical methods (Brose; Krzyminska et al.); elaboration of a new technique for prospecting of oil and gas deposits and geothermal resources (Fuszara & Piotrowski, Piotrowski et al.); 3D-Modelling and visualization of subsurface (Juschus; Oehm et al.; Brose F.).

*GENERAL COMMENTS:* Andrzej Piotrowski on behalf of the MELA project team summarized the symposium and emphasized that the project has enabled to create an interdisciplinary research team involved in elaboration of new methodologies for construction of a Morphotectonic Map of European Lowland Area. As the symposium demonstrated, various research methods were applied, different environments of the vast European Lowland area were examined. The pilot sheet of the map of the 'model area' is available in the format GIS database.

The symposium was attended by 60 participants (not counting visitors of the poster session), who contributed with questions, comments and discussions.

*ANNOUNCEMENTS:* Papers from the symposium are under preparation for publication in different scientific journals (e.g. Boreas). The report of the symposium (with illustrations) will be published in IUGS-GEM News, PGI bulletin etc.



#### **STN-04 Stress/strain partitioning in active orogens, with emphasis on geomorphic/geologic signature of bounding blind thrust faults**

*CONVENERS:* Franck Audemard, FUNVISIS, Venezuela; Alejandro Escalona, University of Stavanger, Norway

*NUMBER OF PRESENTATIONS:* 7 oral, 3 poster, 4 no-shows

*SYMPOSIUM SUMMARY:* This symposium, under the auspices of the INQUA Neotectonics-Paleoseismology Focus Area and the International Association of Geomorphologists (IAG), took place in the afternoon of August 8th. Of the nine planned oral presentations, two speakers did not show up, although they were partly funded by the Geohost programme. Likewise, only 3 posters were posted out of 5 in the same afternoon. However, we feel the symposium was a success since the two invited speakers and the other 5 lecturers caught the attention of a pretty large audience, considering how specific this subject actually is. Not many orogens in the world would satisfy these conditions, although awareness on these processes is increasing rapidly worldwide. The time gap left by the absence of one of the speakers was filled with a longer but very interesting invited talk on analogue modelling of blind thrusts, however the second gap could not be avoided, introducing an additional interruption to the coffee break.

*GENERAL COMMENTS:* Most talks were followed by a fruitful discussion, due to the interesting questions and remarks.

*ANNOUNCEMENTS:* Due to the final small amount of contributions, in order to produce an eventual Geological Society Special Publication we are seeking at present to gather a larger number of high-quality papers from several subject-related STN and STP symposia by contacting their conveners.

regions. This general symposium was aimed at complementing two subsequent special symposia in paleoseismology, one on "Deducing nature and magnitude of paleoearthquakes" and one on "Deducing timing and return periods of paleoearthquakes". To this symposium we invited abstracts for oral presentations and posters on topics that are of a more general nature, including methodological and theoretical papers, and contributions that are of a more multi- and cross-disciplinary nature.

#### **STP-02 Deducing nature and magnitude of paleoearthquakes: Finding paleoevents and quantifying them**

*CONVENERS:* Alessandro M. Michetti, Italy; Karl Müller, USA; Klaus Reicherter, Germany

*NUMBER OF PRESENTATIONS:* 14 oral, 9 poster

*SYMPOSIUM SUMMARY:* The most recent evolution of paleoseismological studies clearly demonstrates that in order to properly understand the seismic potential of a region, and to assess the associated hazards, broad-based and multidisciplinary studies are necessary to take full advantage from the geological evidence of past earthquakes. A major challenge in future paleoseismic research is to build detailed empirical relations between various categories of coseismic effects in the natural environment and earthquake magnitude/intensity. To this end, the INQUA Subcommission on Paleoseismicity developed a new macroseismic intensity scale only based on environmental effects, which has been formally named ESI 2007 (Environmental Seismic Intensity scale). Global and regional paleoseismological relations should be compiled in a way that is fully representative of the wide variety of natural environments on Earth, in terms of climatic settings, Quaternary tectonic evolution, rheological parameters of the seismogenic crust, and stress environment. For instance, available data indicate that between earthquake magnitude and surface faulting parameters different scaling laws exist, depending on the local seismotectonic environment (including plate tectonic setting, style of faulting, strain rates, typical focal depths, fault rock properties, fluid pressure, and heat flow). In this regard, the concept of seismic landscape provides the necessary background for developing paleoseismological research strategies. Each earthquake source creates a signature on the geology and the geomorphology of an area that is unequivocally related to the order of magnitude of its earthquake potential. This signature is defined as the seismic landscape of the area. Likewise, assessing the coseismic nature of a deformational feature largely depend on the completeness of the information available on the local seismic landscape. The session has included, but was not restricted to, the topics delineated above. The contributions have been based on results from fieldwork, high-resolution geophysical measurements, detailed structural and geomorphic analysis, and the comparison between the paleoseismic record and environmental effects during strong historical and contemporary earthquakes.

### **PALEOSEISMOLOGY**

### **STP**

#### **STP-01 General contributions to paleoseismology**

*CONVENERS:* Hilmar Bungum, Norway; Alessandro M. Michetti, Italy; John Adams, Canada

*NUMBER OF PRESENTATIONS:* 9 oral, 8 poster

*SYMPOSIUM SUMMARY:* Dynamic processes in the Earth occur on a wide range of energy and time scales. Seismological data cover periods from milliseconds to days, geological and geomorphological data cover the longest time periods, while geodetic data cover both short and long periods. As the frequency ranges and the dynamic resolution of data from all of these disciplines are extended, the rewards from cross-disciplinary research within these fields are similarly increasing. This extension of the seismological time frame has facilitated a better understanding of long-term geodynamic processes both at plate margins and in the interior of plates, including spatio-temporal variations in slip rates. Paleoseismology has moreover contributed significantly to the understanding of crustal dynamics in presently and formerly glaciated



### STP-03 Paleoseismology for seismic hazard: Constructing paleo-earthquake histories and deducing seismic hazard implications

*CONVENERS:* Nils-Axel Mörner, Sweden; John Adams, Canada; Tom Rockwell, USA

*NUMBER OF PRESENTATIONS:* 13 oral, 3 poster

*SYMPOSIUM SUMMARY:* The geodynamics of the Earth is controlled by several processes at various time scales and depth ranges. Modern seismology reveals these processes through earthquake sequences, spatio-temporal variations in slip rates, and stress and strain accumulation on fault planes. However, objective instrumental monitoring is only 110 years old and historical records span 200-3000 years. Paleoseismology, beginning about 30 years ago, provides an important extension to the seismological time frame, using geological and tectonic structures to reveal earthquake histories. An extended time frame facilitates a better understanding of long-term geodynamic processes - cyclic shallow crustal movements at plate margins, long-return period events in plate interiors, and crustal dynamics in presently and former glaciated regions. Furthermore, large earthquakes impact human safety. A better understanding of their timing and their return periods will improve seismic hazard assessments. To this symposium we therefore invited abstracts for oral presentations and posters on (i) identification and dating of paleo-earthquakes, (ii) sequences and return intervals of earthquakes, (iii) continuity or discontinuity of seismic activity over time, and (iv) implications of extended earthquake histories for seismic hazard assessment. A pre-conference excursion to Sweden was organised in relation to this symposium.

*CONCLUSIONS:* Paleoseismology represents an important approach to meaningful long-term assessments of pre-instrumental and pre-historical earthquake occurrence and seismotectonics, including seismic hazard implications. This was vividly demonstrated during all these three symposia in paleoseismology. The problem of continuity and discontinuity in seismic activity was especially highlighted. In conclusion, the symposia (and the related short course and excursions) have clearly demonstrated the power and importance of studies in paleoseismology. Paleoseismology is clearly a multidisciplinary field of science which has been significantly growing in importance over the last years.

*GENERAL COMMENTS:* Odleiv Olesen gave an invited talk in STP-01, Antonio Godoy and Koji Okumura in STP-02, and Tom Rockwell in STP-03. We note in general a very high standard of the papers presented in all of the paleoseismology symposia. The room was full most of the time, indicating some 50-60 persons. At the end of the first day there was a discussion and a guided tour to the posters, and the second day ended with a general discussion in paleoseismology which was both lively and constructive. The symposia in paleoseismology were followed up by a successful Short Course (SCS-06) in Paleoseismology.

*ANNOUNCEMENTS:* Excursion 11 and Short Course 06 were directly linked to the STP-03 symposium.

## TECTONICS

## STT

### STT-01 General contributions to tectonics and structural geology

*CONVENERS:* Hemin Koyi, Uppsala University, Sweden; Roy Gabrielsen, University of Oslo, Norway

*NUMBER OF PRESENTATIONS:* 29 oral, 30 poster, 4 no-shows

*SYMPOSIUM SUMMARY:* Regional and global aspects of tectonics must be integrated to understand the geodynamic system of our planet. The foundation of tectonic studies often includes the combination of field geological and geophysical data. The strength of such combinations lies in their ability to link surface and subsurface observations to understand tectonic phenomena - often at crustal scale. Analogue, numerical and analytical models are additional important approaches in understanding the structural and tectonic framework of orogens, basins and associated mantle dynamics. In this session, we welcomed contributions from any field of tectonics and structural geology at any scale. The main focus was on the combination of field geological and geophysical data to understand any tectonic regime or process.

*GENERAL COMMENTS:* Most of the presentations were of very good quality. However, a couple of speakers had difficulties with the language. Many of the presentations created a good level of discussion. Since there were about four no-shows, the time was used to encourage more discussion.

### STT-02 Structure and formation of rift basins and passive margins from surface to depth: Observations and modelling

*CONVENERS:* Ritske Huismans, University of Bergen, Norway; Nina Simon, University of Oslo, Norway; Lars Ruepke, IFM-Geomar, Germany; Yuri Podladchikov, University of Oslo, Norway

*NUMBER OF PRESENTATIONS:* 20 oral, 13 poster

*SYMPOSIUM SUMMARY:* The formation of rifted continental margins by extension of continental lithosphere leading to seafloor spreading is a complex and still poorly understood component of the plate tectonic cycle. New observations and modelling allow us to investigate the underlying processes. Key questions that need to be resolved are factors that control the style of extension, the role of strain localisation and strain partitioning throughout the rift history, processes responsible for anomalous vertical motions during basin evolution such as phase changes or small scale convective instability of the mantle lithosphere, and fundamental controls on the magmatic or a-magmatic nature of passive margins. For instance, on volcanic margins the relative timing of extension and magmatism, the origin of excess magmatism during break-up, and its role for lithosphere rheology need further understanding. On magma-poor margins it is still unclear what controls the absence of magmatism. Also many rift basins appear to be characterized by anomalous subsidence patterns in the late syn-rift and post-rift history. We encourage abstracts that offer new insights into large-scale



crustal and lithospheric processes underlying rifting and passive margin formation as well as smaller scale studies of individual sedimentary basins, using constraints from observations and modelling.

Main objective of the symposium was to organise a session focusing on extensional processes with contributions from a wide range of relevant scientific fields. The symposium was organised around 7 keynote presentations that introduced themes ranging from magmatic petrology and melting, seismology, tectonics and regional focused studies, to exhumation of rift flanks and surface processes modelling.

The wide range of presentations illustrates the need for interdisciplinary research in this area joining tectonics, magmatic petrology, seismology, marine geophysics, and various modelling approaches.

**GENERAL COMMENTS:** The overall quality of both oral and poster presentations was high and the symposium was very well attended.

### **STT-03 Accretionary orogens: Character and processes (ERAS project)**

**CONVENERS:** Raimo Lahtinen, Geological Survey of Finland, Finland; Yukio Isozaki, University of Tokyo, Japan

**NUMBER OF PRESENTATIONS:** 11 oral, 3 poster

**SYMPOSIUM SUMMARY:** Classic orogens involve a Wilson cycle of ocean opening and closing, culminating in continental collision. However, this scenario fails to explain the evolution of many orogenic belts in which deformation, metamorphism and crustal growth took place in an environment of ongoing plate convergence. These belts are termed accretionary orogens. Accretionary orogens form at sites of subduction of oceanic lithosphere and consist of magmatic arcs systems along with material accreted from the down-going plate and eroded from the upper plate. Accretionary orogens have been active throughout Earth history and have been major sites for the growth of continental lithosphere. We invite contributions on all aspects of the formation and stabilization of accretionary orogens including crustal growth in space and time, evidence for Precambrian accretionary orogens, cratonization of accretionary orogens, evolution of the sub-continental lithospheric mantle of accretionary orogens, similarities and differences in accretionary processes from the Archean to Recent, seismic images of accretionary orogens, LP-HP and HP-LT metamorphism of accretionary orogens, metallogeny of accretionary orogens and developments in the understanding of modern accretionary orogen.

Isozaki gave a keynote lecture on lessons learned from the Phanerozoic accretionary orogen of Japan; an example of how collision-free active margin grows and how the leading edge of an accretionary orogen looks before the continental collision. This example can be used when studying the Precambrian analogues, but a major problem is the preservation potential of ancient accretionary complex. Massone presented numerical experiments where they simulated how frontal or basal accretion affected thermal equilibration of an accretionary prism and how

these are imaged in a fossil prism in Chile. Miskovic presented a coupled laser ablation (MC) ICPMS U-Pb and Lu-Hf isotopic study on zircons from intrusives of Peru which reveal 1.15 Ga of magmatic activity along a 1200 km long segment. His results suggest crustal reworking as the dominant process and that continental growth along non-collisional accretionary orogens takes place vertically. Wintsch proposed that crustal-scale wedging was a major mechanism of continental assembly and crustal thickening during Paleozoic orogenesis of southern New England Appalachians. Kosuge correlated the Jurassic and Cretaceous nonmarine deposits in Korea with the Japanese accretionary events.

Glen challenged the traditional Lachlan orogen evolution model and showed how a combination of thrusting and major strike-slip faulting within inboard and outboard of an accreted island arc sandwich the arc between quartz-rich continental margin turbidites. O'Brien described felsic volcanism and coeval migmatization in a peri-Gondwanan island arc complex, Newfoundland Appalachians, and Jia described timing of syn-tectonic granites in the early Paleozoic Wuyishan fold belt (South China). Petterson presented the geochronological grouping of granitoids in the 1.2 Ga Namaquan Orogen (South Africa), and concluded that majority of the granitoids formed in two periods, the syntectonic tectonothermal event and the post-tectonic, largely thermal event. Korja presented interpretations of deep seismic reflection data from the FIRE profiles in Finland suggesting that images of an accretionary process at 1.9-1.8 Ga can be identified from the seismic data as paleosubduction, obduction, continental transforms, collision of soft and rigid terranes and collapse structures. Campa-Uranga discussed concepts of terrane analysis and continental growth of the North America subcontinent.

**GENERAL COMMENTS:** Overall, the symposium proved to be successful in achieving its aims.

### **STT-05 Ocean-continent transitions at rifted margins**

**CONVENERS:** Erik Lundin, Jan Inge Faleide, Gianreto Manatschal, Nick Kusznir

**NOTE:** A post-Congress summary was not received. The summary below is pre-Congress.

**SYMPOSIUM SUMMARY:** The session will cover processes of continental break-up leading to formation of oceanic basins, with focus on similarities as well as differences between non-volcanic and volcanic margins. Key questions include: What are the main controls governing the different margin types; mantle temperature, plate separation rate, or mantle fertility? What can observations from ultraslow spreading ridges tell us about processes at non-volcanic margins? Particularly, does mantle exhumation necessarily require detachment faults? Can we quantify the degree and depth of serpentinization along non-volcanic margins? How rapid is the serpentinization process? Can serpentinization occur beneath thinned continental crust? What is the magnetic signature of serpentinized areas - is it always associated with a positive magnetic anomaly or can it contain polarity reversals? While it is clear that non-volcanic margins grade



into volcanic margins along strike, can a non-volcanic margin evolve into a volcanic margin as the oceanic basin develops (and vice versa)? Outcrop studies have revealed up to 12% melt impregnation in exhumed mantle. Can the source of such stored melts act as a source for excessive magmatism should plate separation rate increase? At volcanic margins does the commonly observed high P-wave velocity layer at the base of the crust necessarily reflect underplated material? If so, how can one assess the proportion of underplate added to these 'bodies'? How can we distinguish between underplate and high velocity remnants from an earlier orogenic root? How can we determine whether a margin and its OCT are volcanic, 'normal', or magma poor?

#### **STT-06 Marine and continental fold and thrust belts**

*CONVENERS:* Hermann Lebit, Marathon Oil Company, USA; Rob Butler, University of Aberdeen, UK; Signe Ottesen, StatoilHydro, Norway; Chris Hedlund, Shell International, USA; Stefano Mazzoli, University of Naples, Italy

*NUMBER OF PRESENTATIONS:* 12 oral, 5 poster, 6 no-shows

*SYMPOSIUM SUMMARY:* Continental fold and thrust belts spectacularly express lithospheric deformation processes, and their study pioneered our understanding in modern Structural Geology and Plate Tectonics. Marine fold and thrust belts, no less spectacular, have become increasingly eminent during the past decades due to extensive geophysical data acquisition pursued by off-shore hydrocarbon exploration along various continental margins. Though individual fold and thrust systems may have developed under considerably different boundary conditions (gravitational driven versus tectonic shortening) they reveal remarkable similarities in internal architecture and style of deformation. The symposium brought together scientists from research and industry to discuss these similarities in fold and thrust belt architectures, the underlying kinematics and mechanics in context of the different settings and geological developments. We welcome contributions from a multi-disciplinary spectrum of relevant approaches focusing on fold and thrust belt development that may regard local to regional studies, analog/numerical experiments or application of innovative technologies.

*GENERAL COMMENTS:* The presentations were of high scientific standard and attracted considerable audience throughout all session segments. Each oral presentation had 1-3 questions to discuss, and the symposium was concluded with about 30 minutes of final remarks and lively discussion. The symposium started with a 30 minute delay (9:00 instead of 8:30) due to unavailability of public transportation (weekend summer schedule) between Oslo's city centre and the conference venue.

*ANNOUNCEMENTS:* The Geological Society of London is interested in a special publication on the topic of the session. At the symposium 17 expressed interest in submitting a manuscript. A similar symposium will be held at the 2008 Joint annual assembly of the Geological Society of America (GSA), SSSA, ASA, CSSA, GCAGS, HGS.

#### **STT-07 Three-dimensional aspects of subduction zone processes: Insight from dynamic modelling, tectonic reconstructions and observational studies**

*CONVENERS:* Wouter P. Schellart, Monash University, Melbourne, Australia; Dave Stegman, University of Melbourne, Melbourne, Australia; Gideon Rosenbaum, University of Queensland, Brisbane, Australia

*NUMBER OF PRESENTATIONS:* 10 oral, 10 poster

*SYMPOSIUM SUMMARY:* Subduction zones are limited in trench-parallel extent and vary in width from only a few hundred kilometres (e.g. Scotia, Calabria) to more than seven thousand kilometres (South America). In addition, subduction zones display a wide variety in geometry from concave (e.g. Scotia) to sub-linear (e.g. Tonga-Kermadec) to convex (e.g. Central South America). Furthermore, kinematic investigations imply that subduction zones are not static features but migrate laterally due to retrograde and prograde motion of the slab through the mantle, thereby inducing complex three-dimensional flow patterns in the mantle. It is thus evident that subduction and subduction-induced mantle flow are intrinsically three-dimensional processes. To gain new insight into the kinematics and dynamics of subduction and subduction-induced mantle flow, it is thus of primary importance to investigate these processes in three-dimensional space.

This symposium contained contributions of three-dimensional dynamic modelling (both analogue and numerical modelling) of subduction, slab-mantle interaction, and subducting plate-overriding plate interaction. Other contributions included tectonic reconstructions of subduction zone evolution and three-dimensional models of subduction zones and subducted slabs through structural, seismological and tomographic investigations. The contributions all demonstrated the complex three-dimensional nature of subduction zone environments, and the need for subduction zone investigations to be conducted in three-dimensional space.

*GENERAL COMMENTS:* 9 out of 10 oral presentations were very good, one was rather poor. The first half of the oral session was attended by some 40 people, the second half by some 25 people. All the poster presentations were good. There were good discussions during both the oral and poster presentations.

#### **STT-08 Numerical and analogue modelling of deformation - from the micro- to the crustal scale**

*CONVENERS:* Sudipta Sengupta, Jadavpur University, India; Paul D. Bons, Universität Tübingen, Germany; Hemin Koyi, Uppsala University, Sweden

*NUMBER OF PRESENTATIONS:* 10 oral, 4 poster, 5 no-shows

*SYMPOSIUM SUMMARY:* Modelling is an indispensable tool in the study of rock deformation, where direct observations or physical experiments on rocks are hampered by the time and length scales of geological deformation processes. Recent years have seen the application of many new methods and materials (EBSD, (synchrotron) tomography, chocolate, yeast, phase-field modelling, particle codes, etc.). This session brought together modellers to present the latest approaches and





results in modelling and their application to rock deformation. Special focus was on the hierarchical nature in length and time scales of rock deformation (from individual dislocations to orogens) and the integration of different methods and techniques (numerical modelling, analogue experiments, field geology, geophysics, petrology, materials science, etc.).

*GENERAL COMMENTS:* Most of the presentations were of very good quality. Many of the presentations created a good level of discussion. The no-show time was used for additional discussion.

*ANNOUNCEMENTS:* Tectonophysics showed interest in publishing a volume from the contributions to this symposium.

### **STT-09 New concepts in global tectonics**

*CONVENERS:* Dong Choi, Raax Australia Pty Ltd, Australia; Karsten Storetvedt, University of Bergen, Norway; Forese Carlo Wezel, University of Urbino, Italy

*NUMBER OF PRESENTATIONS:* 18 oral, 7 poster, 11 no-shows

*SYMPOSIUM SUMMARY:* The session intended to explore a new paradigm of global tectonics. Based on the rapidly increasing geophysical information obtained mainly by seismic tomography and satellite imagery in addition to a wide range of both classical and modern surface data, the presented papers commonly discussed the fatal flaws of the currently dominating geodynamic paradigm. New theories accounting for deep Earth structures and processes, with emphasis on internal energy sources triggering tectonic/magmatic activities at the surface, were presented. With new perspectives on the structure and constitution of the inner Earth, some papers discussed abiotic hydrocarbons -

emphasizing the close connection of major hydrocarbon accumulations with deep crust-cutting dislocations, the increasing finds of hydrocarbon masses in crystalline rocks, and the fact that crude oil, natural gases, salts and water frequently occur in close association. Other presentations gave in-depth treatment of the deep earthquake-surface geology relationship. One of the papers presented a new concept on electrical relation between earthquakes and tsunamis. Using the time allotted for unattended speakers, the symposium was rounded off by a one-hour broad discussion of fundamental aspects in global geology.

*GENERAL COMMENTS:* We have to point out several serious difficulties which we experienced prior to and during the congress, and would like to bring the matters to IUGS' attention. 1) Our session date was changed (from 12th to 13th) only about one month before the congress without notification to the session conveners. This caused confusion and stress among our participants who already had booked flights and accommodation; 2) Judging from the embarrassment at the Information desk our session room had apparently been left undecided until 11th August, the day before the final session date; 3) One of our invited speakers was removed from our oral program without consultation with the conveners. As far as we know, these are unprecedented events in any international congresses in the past.

*ANNOUNCEMENTS:* Selected papers will appear in New Concepts in Global Tectonics Newsletter ([www.ncgt.org](http://www.ncgt.org)). We also intend to recapture abstracts of the presented papers in the same journal, and have already asked permission for this from the 33IGC organizer.

## WORKSHOP REPORTS

### **WSS-03 Delivery of geoscience information using web services**

Bruce Simons, John Laxton (CGI-IUGS)

10 August, 09.00 - 14.00

Contact: [Bruce.Simons@dpi.vic.gov.au](mailto:Bruce.Simons@dpi.vic.gov.au)

Number of participants: 59

This workshop will provide participants with an understanding and demonstration of the latest developments in the CGI-IUGS GeoScience Mark-up Language (GeoSciML2). GeoSciML2 is a geoscience specific XML-based GML (Geography Markup Language) application that supports interchange of geoscience information. GeoSciML2 is being developed through the Interoperability Working Group of the Commission for the Management and Application of Geoscience Information (CGI), a commission of the International Union of Geological Sciences (IUGS). The Working Group consists of geology and information technology specialists from agencies in North America, Europe, Asia and Australia. The GeoSciML2 application is a standards-

based data format that provides a framework for application-neutral encoding of geoscience thematic data and related spatial data. Ultimately participants in the OneGeology project will use GeoSciML to deliver geological map data via web feature mapping and coverage services. The proposed workshop outline is: 1. Introduction What are the aims of GeoSciML 2. What does GeoSciML2 cover 3. Testbed demonstration What Use cases are being delivered 4. A description of the data model content 5. Examples of how different testbed organisations have mapped their data to the model 6. Examples of how different organisations have used WFS/WMS technology to deliver the data 7. How OneGeology is using GeoSciML2 8. Using GeoSciML in 3D 9. How to achieve semantic interoperability

### **WSS-04 Funding geological research - the challenges for Earth system science**

Harold R. Lane, Yupeng Yao, Sören Dürr

10 August, 09.00 - 18.00, Contact: [hlane@nsf.gov](mailto:hlane@nsf.gov)

Number of participants: 9



**WSS-05 Geoconservation for sustainable development and Earth science propagation, geoheritage, geosites, geoparks**

Bill Wimbledon, Joy Jaqueline Pereira, Todor Todorov,  
Il'ya Fishman, Lars Erikstad,  
Francesco Zarlenga (IUGS-ProGEO, IUGS-GEM)  
10 August, 09.00 - 18.00  
Contact: igrkas@nursat.kz; yulia.kazakova@mail.ru  
Number of participants: 28

**WSS-06 Geoscience education in colleges and universities in Africa**

Rosemary Olive Mbone Enie, Barth N. Ekwueme  
10 August, 09.00 - 18.00  
Contact: camvisiontrust@yahoo.co.uk  
Number of participants: 16

The field of Geosciences Education in Africa is undergoing a period of rapid change: At school level the Geosciences has, in addition to Human and Social Sciences or Geography, become incorporated into the Natural Sciences. Practicing Science teachers will need in-service training to teach this new topic and student teachers will require pre-service training in how to teach the geosciences as part of the Natural Sciences. Education at all levels is changing to an Outcomes Based Education format and must comply with National requirements. Higher education organizations are merging. Disciplines like Environmental Geosciences are becoming more important. Many qualified geoscientists are having to find employment outside of large corporate companies as consultants. It is for these reasons that we would like to propose the formation of a Pan African Geosciences Educators Association that will bring primary, secondary and tertiary geosciences teachers to discuss the changing face of the discipline as well as the best methods of teaching Geosciences at different levels. This workshop will be particularly historic as it will mark the formation of the Pan African Association of Geosciences Educators. The one day workshop will be addressing the following issues: "How best can fieldwork be used in Geosciences Education?" In addition, we are hoping to have a number of international specialists in Geosciences Education from across Africa sharing their experience with us. You are therefore invited to attend the workshop or to make a presentation on one of two themes. "The possible role that an organization for Geosciences Educators" could play, "Success stories in Geosciences Education" and "How best fieldwork can be used in Geosciences Education?" The workshop will be a particularly prestigious occasion as it will form part of the Africa Celebrations of the 33 IGC and will incorporate the first meeting of the Pan Africa Geological Society bringing geoscientists from across Africa.

**WSS-07 Impact structures**

Henning Dypvik, Alex Deutsch, Elin Kalleson  
10 August, 09.00 - 18.00  
Contact: henning.dypvik@geo.uio.no  
Number of participants: 28

In this workshop we would gather scientists interested in the studies of impact cratering; focusing on mechanisms of cratering and ejecta formation, impact modelling and case studies. One aim of the workshop would be to bridge the gap between the observational (field and lab) studies, modelling and numerical analyses, in order to better understand the mechanisms of cratering and ejecta formation. In the workshop contributions may range from detailed geochemistry and microscopical studies, via textural and structural characteristics of special cases, and all the way to theoretical modelling and simulations of the information. We in addition will arrange, if of interest, discussion groups within topics suggested by the participants. In relation with the Gardnos excursion, to be visited the following Sunday, we hope to present the latest scientific results from the Gardnos structure.

**WSS-08 Integrated basin-play prospect risk and resource assessment for oil and gas exploration**

Darrel Norman, Per Audun Hole  
10 August, 09.00 - 18.00, Contact: per@geoknowledge.com

The workshop will focus on new methods and ideas for quantitative assessments of Resources in Basins, Plays and Prospects of different maturity. The idea being exploring and sharing the current best practise and future ideas on how to improve current methodologies and workflows for quantification of resources in both mature and frontier areas. Experts from industry and academia will be invited to submit papers related to the listed topics.

Workshop Topics: -Modelling volume and risk dependencies between plays and prospects using probabilistic assessments -Aggregation of Resources with dependencies Basin Play - Prospect -Qualitative versus Quantitative play assessments -Uncertainty in volume estimates in unexplored basins and plays (arctic regions), methods for quantification.

**WSS-09 Lapland Granulite Belt (LGB) and 1.9 Ga assembling of the Northeastern Baltic (Fennoscandian) Shield**

Pekka Tuisku, Pekka Heikkinen, Hannu Huhma  
(IGCP 509)  
10 August, 09.00 - 18.00, Contact: pekka.tuisku@oulu.fi

Description: The field trip will take four days and contain both field examples and additional evening sessions for presentation of the data, including cross large scale structure from seismic reflection, airborne and surface geophysics and field mapping, to microscopic features and thin section study. The workshop is focused on the ~ 1.9 Ga evolution of the Lapland granulite belt (LGB) and its role in the assembling of the Fennoscandian shield. The



topics will include provenance of the metasediments, nature of the sedimentary basin, the burial and high-grade metamorphism of them, subduction processes and arc magmatism of the LGB and exhumation of the belt and the isotopic dating and the significance of these processes in the assembling of the Shield and Global Correlation. The structure of the area will be presented and volcanism and ophiolite obduction preceding the formation of the LGB and assembling of the continent will be demonstrated, as well as overprinting by granulite event. Also, the origin of gold, platinum and other heavy minerals will be discussed according to previous and current research. A visit to Gold Prospector Museum at Tankavaara will be included. Duration: 4 days.

### **WSS-11 New developments in stratigraphic classification**

Maria Bianca Cita, Chris Kendall, Andreas Strasser, Stan Finney (ICS)  
10 August, 09.00 - 18.00, Contact: maria.cita@unimi.it  
Number of participants: 67

Stratigraphic classification is an important tool for deciphering the complex sedimentary records of Earth History and a means of communication among scientists. The workshop wants to bring together specialists in litho-, bio-, chemo-, magneto-, cyclo-, sequence-, and chronostratigraphy to discuss ways to adapt the classification to the new developments in stratigraphic research. At the same time, the nomenclature should be attractive and easy to apply. The workshop is organized by the Subcommission on Stratigraphic Classification of the International Commission on Stratigraphy, but is open to the Earth community at large. The workshop will be run in a Penrose conference style, starting with a series of keynote presentations on the various subdisciplines of stratigraphy, some of which derive from the introduction of new methodologies.

Discussion groups will be organized for the more controversial issues, followed by an open forum discussion. Aim of the workshop is to reach a consensus, or at least a large majority on some critical points that will allow a better understanding of the history of our planet. The ultimate goal is an update of the International Stratigraphic Guide, which should become a widely used and respected reference for stratigraphers worldwide.

### **WSS-13 Paleontological data analysis and modelling**

Øyvind Hammer et al.  
10 August, 09.00 - 18.00, Contact: ohammer@nhm.uio.no  
Number of participants: 31

Modern data analysis and modelling are now standard components of descriptive paleontology, and also open up exciting research possibilities within analytical paleontology. We will review the main directions within this field, and discuss new methods. The focus will be on practical aspects, for paleontologists without special background in statistics or mathematics, but we also hope to provide a forum for expert discussion. Subjects include:

1. Multivariate studies of communities in space and time. Paleobiogeographical regions and gradients.
2. Biodiversity. Richness, turnover and diversity estimation, sampling bias.
3. Morphometrics, systematics. Shape, ontogeny, microevolution, intraspecific variation.
4. Quantitative biostratigraphy. CONOP, RASC, UA, AEO and other new approaches.
5. Spatial data analysis to study fossil distribution on all scales.
6. Time series analysis. Spectral analysis of fossil data (cyclobiostratigraphy). Trends and transients (breaks).
7. Theoretical morphology, morphogenetic modelling, morphospaces.
8. Evolutionary and ecological modelling. Abundance estimation.
9. Paleoclimatic reconstruction from fossil data (transfer functions etc.).

Conveners are Øyvind Hammer and Mikael Fortelius. Important software packages will be demonstrated, including the popular PAST program. The workshop will be an opportunity for PAST users to discuss the software with the developer. Experts will be invited to discuss particular subjects. All participants are invited to give short presentations.

### **WSS-14 PaleoParks: The conservation and preservation of paleontological sites worldwide**

Jere H. Lipps et al.  
10 August, 09.00 - 14.00, Contact: jlipps@berkeley.edu  
Number of participants: 24

A workshop, in a continuing a series started at IGC 32, to bring together paleontologists and others who are informed about the need for and status of the conservation and preservation of paleontological sites worldwide that have heritage, educational, touristic, or scientific values. The workshop will consist of presentations about such sites, discussion of them, and of the process of identifying such sites and how to get them recognized and preserved. Such fossil sites range from small, locally significant ones to large national parks and preserves. This workshop intends to develop the rationale for preserving sites and the mechanisms to identify, establish, and protect them, as well as ways to involve the local citizens and other stakeholders. Legal preservation could be at the national, regional or local levels. The workshop also intends to develop scientific, educational and recreational aims applicable to paleontological resources. It will also identify existing paleontological sites that are currently protected in various ways in order to understand the range of situations, values and endeavors underway now. The effort is supported by the International Paleontological Association.

### **WSS-16 Representative sampling - an ongoing geoscience challenge**

Kim H. Esbensen  
10 August, 09.00 - 13.00, Contact: kes@aaue.dk

Sampling is the unique link between field occurrence of all types of geological objects: formations, rocks, minerals, mineralisations ... and the laboratory. The interaction between the geologist and the wide-spread laboratory



facilities & analytical methods available is the SAMPLE: petrographic, mineralogical, geochemical. Sampling is the defining active element in the geoscience process in the field, but equally important is the various steps of mass reduction carried out in the laboratory on the way towards the often miniscule mass or volume actually analysed. Sampling rates (from field occurrence to analysis) often covers six orders of magnitude (or more). What then is a representative sample? The issue is - paradoxically - far from a consensus in geology as indeed in many related sciences, in technology and industry. It is often not appreciated that sampling errors routinely reach 50 - 100 times the analytical error per se - making the world's continuing efforts of ever diminishing analytical error practically irrelevant (sic). The theory of Sampling (TOS) is the only complete scientific theory of sampling for all types of heterogeneous materials and for time-dependent, dynamic process sampling. This 1-day workshop presents TOS in the entire theoretical and practical context of representative field -, process - and laboratory sampling (mass reduction). Participants will be presented overview lectures by some of the world's leading sampling experts from mining, geology, process industries and technology in which all basic principles of TOS will be elucidated and illustrated by practical examples and case histories. Participants have the opportunity to interact in round-table discussions at the conclusion of the workshop. It is possible to formulate TOS as set of only seven.

#### **WSS-17 Sustainable mineral resource management - industrial minerals and aggregates**

Deborah Shields, Slavko Solar

10 August, 09.00 – 19.00

Contact: dshields@lamar.colostate.edu

Number of participants: 38

Geologists are fully aware of the importance of achieving a sustainable future, but often are unclear how their skills, and geologic information, can contribute to the sustainability debate. It is crucial that geologists - from students to those already practicing or teaching - have a clear understanding of the concepts and practice of sustainability if they are to help solve the environmental, social and resource threats facing the world. The purpose of this workshop is to give geologists a thorough grounding in sustainable development theory as it relates to mineral resources by reviewing how firms address sustainability at the corporate and site level, and how governments address these issues through policy and regulation. The workshop will begin with a brief introduction to the need for and language of sustainability. Next, these concepts are applied to mineral resources, with particular emphasis on industrial minerals and aggregates. The first part of the workshop will be concluded with a comparison of governmental and corporate sustainability policies, including consideration of how they interact and influence each other. In the second part of the workshop, case studies will be used to illustrate what nations and firms are currently doing. We will end with a short visit to an industrial minerals/aggregate company, where management

will describe the actions they have taken to implement sustainable management practices.

#### **WSS-18 Trondhjemites, tonalites, plagiogranites and adakites: Similarities, differences and petrogenesis**

Jan Hertogen, David Roberts, R.B. Pedersen,

Joseph Cotton

10 August, 09.00 - 18.00

Contact: jan.hertogen@geo.kuleuven.be

Number of participants: 12

#### **WSS-19 Urban geochemical mapping methods**

Rolf Tore Ottesen, Kaj Lax, Timo Tarvainen

10 August, 09.00 - 18.00, Contact: rolf.ottesen@ngu.no

Number of participants: 11

The Geological Surveys of Finland, Norway and Sweden will convene a workshop at the 33rd IGC to focus on harmonisation of geochemical methods applied in urban environmental studies. Invited speakers from different parts of the world (USA, Asia, Africa and Asia will give examples of applications of geochemical methods in urban areas. The applied methods will be grouped according to the targets of the survey. Research targets include: baselines, systematic geochemical mapping in urban scale (at what depth should samples be collected, how to select the sampling sites, how to handle organic/mineral soil, what analytical methods should be used, organic pollutants (PAH, PCB, dioxins, phthalates, brominated flame retardants), specific kinds of site specific studies such as day care centres and problems related to the dynamic nature of urban soil. The need for close co-operation between geochemists, medical doctors, city officials will be stressed and presented by city representatives. The outcome will be a report on recommended methods to be applied in specified targets and a suggestion of future activities.

#### **WSS-20 Radon risk mapping: From soil-gas to indoor concentrations**

Peter Bossew, Grégoire Dubois, Tore Tollefsen,

Ivan Barnet, Mark Smethurst

14 August, 09.00 - 18.00, Contact: tore.tollefsen@jrc.it

Number of participants: 70

Within the context of its institutional scientific support to the European Commission, the Radioactivity Environmental Monitoring (REM) group at the Institute for Environment and Sustainability (IES), DG JRC, started in 2005 to explore the possibility of generating European Radon maps in the frame of preparing a European Atlas of Natural Radiations. While most European countries first agreed to contribute to this project by sharing local statistics of indoor measurements that are currently collected on a 10 by 10 km grid covering Europe, they also felt that a geogenic radon map of Europe should be produced to explain the main sources (geology, soil types, meteorology) of spatial variations in the measured indoor radon concentrations. It is the purpose of this workshop not only to discuss pending technical and scientific issues



related to preparing the European map of indoor radon concentrations, but also - and mainly - to agree on a method that could be used to derive a single European map of the geogenic radon potential. Although potentially interesting to anyone working in the field of radon, the workshop is primarily targeted at European authorities and researchers involved in radon mapping related fields. The one-day workshop will mainly be organized as a round table moderated by the Organizing Committee, but a few presentations will be made to steer the discussions.

**WSS-21 Issues for geologists in 21<sup>st</sup> century - mitigation of man's influence and serving society's needs**

Isabel Fernandez Fuentes, Herald Ligtenberg (EFG)  
9 August, 09.00 - 14.00, Contact: efgbrussels@gmail.com  
Number of participants: 48

The impact of society on the environment increases every year. As a result the influence of man on his environment, and the environment on man, becomes more intimate. One consequence is that conflict over use or priority and hazards appear more frequently. The demands that man puts upon our world are increasing rapidly and yet society also demands that the cost of this is minimised. Geologists have a major role to play in satisfying society's demands, whether this is in understanding and mitigating climate change, in the finding and sustainable use of natural resources or mitigating anthropogenic and controlling hazards. The session will discuss what the geological profession can do in the service of society, by raising awareness of the issues, and encouraging regulators to incorporate appropriate actions in regulations relating to man's use of the subsurface. We envisage that contributions could include awareness of natural hazards, mitigation of climate change (CO<sub>2</sub> sequestration, geothermal energy),

and maintenance of sustainable resources.

**WSS-22 The future workforce of the geosciences – a global crisis?**

Christopher M. Keane et al.  
10 August, 09.00 - 14.00, Contact: keane@agiweb.org  
Number of participants: 44

The geosciences on a near-global basis are facing issues related to the future workforce and continuity of the profession. A large proportion of working geoscientists are nearing retirement, with as much as 50% of the US industry workforce retiring within 10 years. This situation has been coupled by well-documented reductions in primary, secondary, and university geosciences education programs in many countries. This has constrained much of the new supply of geoscientists to replace the retiring professionals. This session proposes to bring together members of the global community who are focused on these workforce issues. The American Geological Institute (AGI) has led the collection and analysis of workforce information in the United States for nearly 60 years, and with its partners in government, industry and academia, has a unique and informed US perspective of the current situation as well as how global dynamics feed into the US workplace. Through this session, perspectives from Europe, Asia, and the developing world about the issues of supply and demand for geoscience workers will be solicited and melded together with an understanding of the North American market to establish a global perspective on the issue, to compare efforts to address future workforce needs, and to develop synergies across international borders to strengthen those efforts.

## SHORT COURSES REPORTS

**SCS-01 Geology from the air - Introduction to airborne exploration geophysics**

**Markku Peltoniemi**

10 August, 09.00-18.00

Contact: Markku.Peltoniemi@tkk.fi

Number of participants: 6

Significant progress in the technology, methods and applications of airborne geophysics has taken place during the 60 years that the capability has been available, and important advances are still to be expected. Understanding the links between the geophysical parameters measured with airborne surveys, petrophysical properties, and the relevant geological properties such as soil and bedrock composition and structure is essential for a successful regional mapping or exploration project.

**Audience:** The course is designed for geologists and geophysicists working in geological mapping, minerals exploration and engineering projects.

**Prerequisites:** The level of presentation is introductory, with main emphasis on understanding the prerequisites, strengths and limitations of airborne survey methods. Participants are expected to have a basic knowledge and experience in geological mapping and exploration projects, but no prior experience in airborne geophysical survey techniques is assumed.

**Objective:** Participants to the course will understand the essentials of airborne geophysics so that they can evaluate the usefulness and application potential of the methods and results in their projects, and can contribute to the design of new airborne surveys to meet their project needs.

**Contents:** Introduction Support technologies, cost & safety issues Aeromagnetic method Earth magnetism Airborne measurements of the Earth's magnetic field Magnetic anomalies Interpretation and examples Airborne electromagnetic method Electromagnetic induction Implementation in frequency and time domain Interpretation and examples Airborne gamma-ray





spectrometry Natural radioactivity and gamma radiation  
Gamma-ray measurements Interpretation and examples  
Airborne gravity method Why is it so difficult? Practical examples

### SCS-02 Medical geology

Olle Selinus, Edward Derbyshire, Jose Centeno,  
Robert Finkelman

10 August, 09.00-18.00, Contact: olle.selinus@gmail.com

Number of participants: 25

The scope of this short course in medical geology is to share the most recent information on the relationship between impacts of toxic metal ions, trace elements, natural dusts, and their impact on the environmental and public health issues. The scientific topics of the short course will include environmental toxicology, environmental pathology, geochemistry, geoenvironmental epidemiology, extent, patterns and consequences of exposures to toxic metal ions and dust in the general environment (with the stress on the water quality), biological risk assessment studies, modern trends in metal analysis and updates on the geology, toxicology and pathology of metal ion and dust exposures.

The course in different lengths and versions has been held with great success in almost 40 countries. Many thousand participants have followed the course organised by the International Medical Geology Association (IMGA).

### SCS-03 Quantitative aspects of medical mineralogy

**A. Umran Dogan & Meral Dogan**

10 August, 09.00-18.00

Contact: umran-dogan@uiowa.edu

Number of participants: 6

Medical mineralogy is a subdiscipline of medical geology and deals with quantitatively characterizing health related (hazard/benefit) minerals and elements in rocks, soil, air, and water. These minerals and elements require state-of-the-art techniques and must be characterized by certified labs or individuals. The World Health Organization classified erionite (a zeolite group mineral with three different species as erionite-K, erionite-Na, and erionite-Ca); chrysotile (a serpentine type asbestos); and tremolite, actinolite, runerite (amosite), riebeckite (crocidolite), and anthophyllite (amphibole type asbestos); and cristobalite (silica group mineral) as human carcinogens. These minerals and some recently recognized health hazard minerals including edenite, winchite, richterite, magnesioriebeckite, magnesio-arfvedsonite, etc. (not classified as carcinogens yet) when inhaled, taken orally, or on dermatological contact, may play major roles in a range of human health problems. To assess the potential toxicity of any of these minerals quantitative parameters including size, shape, aspect ratio, composition, crystal structure, surface structure, surface reactivity, surface area, solubility, durability, tensile strength, porosity, and permeability are important considerations. Together with the quantitative characterization of minerals, the exposure data is required before any mineral-induced pathogenesis can be

determined. Understanding the possible mechanisms that may induce, or could preclude unwanted biological responses, and to suggest and evaluate prevention, cure or remediation from mineral induced diseases is an active area in medical mineralogy. The Short Course will be specifically devoted to Quantitative Aspects of Medical Mineralogy. Virtual Medical Geology Research Center(s) will aid to characterize these health-hazard minerals and elements (whether or not classified as carcinogens) quantitatively.

### SCS-04 Modern prospect assessment: Risk and uncertainty for today's prospect evaluations

Darrel Norman, Per Audun Hole

8 August and 9 August, 09.00-18.00

Contact: per@geoknowledge.com

Objectives: This course is an introduction to the methods required for assessment of the risks and uncertainties in a contemporary prospect evaluation. Participants will learn the principles that should be applied when assessing both simple and complex prospects. The course combines lectures, discussion and numerous exercises. Exercises are designed to promote understanding and mastering of the fundamentals of methodologies and analytics. The exercises therefore involve simple calculations using hand-calculators and manual simulators.

Content Philosophy of modern prospect assessment Basic prospect volumetrics Volume uncertainty and risking Introduction to Monte Carlo simulation Prospect segmentation concepts Aggregating multiple-segment prospects Complex risk and volume relationships Interpreting prospect assessment results Alternative assessment models Bayesian risk modification Assessment performance tracking Basic economic evaluation

### SCS-06 Paleoseismology

Nils-Axel Mörner, Jim McCalpin, Frank Audemard, Sue Dawson

10 August, 09.00-18.00, Contact: morner@pog.nu

Number of participants: 34

Paleoseismology arose as a new, separate subject with the creation of a Sub-commission on "Paleoseismicity" of the INQUA Commission on Neotectonics in 1981. The subject has rapidly increased and matured as testified by the multiple activities at this congress. Geology is the key to a meaningful inventory of past seismic activity, and from that, a long-term seismic hazards assessment. The data come from geomorphology, structural geology, sedimentology and from various geophysical records. Both primary (faults, fractures) and secondary (liquefaction, slides, tsunamis, etc) evidence have to be considered. Ideally, a paleoseismic event is recorded by multiple types of field evidence. Dating plays a central role in the establishment of a reliable chronology allowing meaningful seismic hazard assessment. Sometimes, the seismic activity differs significantly between the present and the past; as in the case of Sweden in deglacial vs present times. This course is directly linked to the pre-congress excursion



“Paleoseismicity and Uplift of Sweden” (No. 11) and the three symposia within “Paleoseismology”.

Preliminary program (the participants may interact with their own case-studies):

INTRODUCTION Paleoseismology (Mörner)

PRIMARY EVIDENCE 1: Evidence of repeated paleoseismic activity along major faults in northern South America (Audemard)

PRIMARY EVIDENCE 2: Neotectonics and Paleoseismics as recorded by trenching (McCalpin)

SECONDARY EVIDENCE 1: Liquefaction as evidence of paleoseismic events (Mörner)

SECONDARY EVIDENCE 2: Tsunamis as evidence of paleoseismic events (Dawson)

METHODS 1: DATING in paleoseismology (Mörner & Audemard)

METHODS 2: GEOPHYSICS; The use of magnetic methods (Mörner & Sun)

SPECIAL CASE 1: Neotectonics, paleoseismicity and methane venting (Mörner)

APPLICATIONS 1: Application of the INQUA Intensity Scale to Paleoseismic Studies (Audemard & Michetti)

APPLICATIONS 2: Records of regional discontinuity in seismic activity over time (Mörner & Penna)

APPLICATIONS 3: Long- and short-term hazard assessments (Mörner, Audemard & McCalpin) The course will end with a general discussion.

#### **SCS-07 Salt tectonics**

**M.P.A. Jackson**

10 August, 09.00 - 18.00

Contact: martin.jackson@beg.utexas.edu

Number of participants: 23

#### **SCS-10 Numerical modelling in Earth sciences**

**Daniel W. Schmid, Marcin Dabrowski, Lars H.**

**Rüpke, Boris J.P. Kaus**

4 August – 8 August, 09.00-18.00

Contact: d.w.schmid@geo.uio.no

Number of participants: 36

Numerical models are becoming progressively more important in the quantitative analysis of problems in Earth science. Commonly used “black box” models do not allow for an in depth insight in how the problems are solved. We therefore offer this short course where we develop numerical models from scratch. The programming language will be MATLAB and the numerical method used the finite difference method. It is recommended (but not necessary) that the participants familiarize themselves

before the course with MATLAB, linear algebra, and partial differential equations. We will develop models for diffusion in one, two, and three dimensions and also learn how to solve deformation (Stokes flow) problems. Finally, these codes will be combined to study simple models of mantle convection and development of shear zones.

#### **SCS-11 ExxonMobil Play assessment methodology - Turning regional geologic interpretations into a hydrocarbon resource assessment**

Kenneth C. Hood

9 August, 10.00-14.00, 12.00-18.00, 10 August, 09.00-18.00, 13 and 14 August, 08.30-17.30

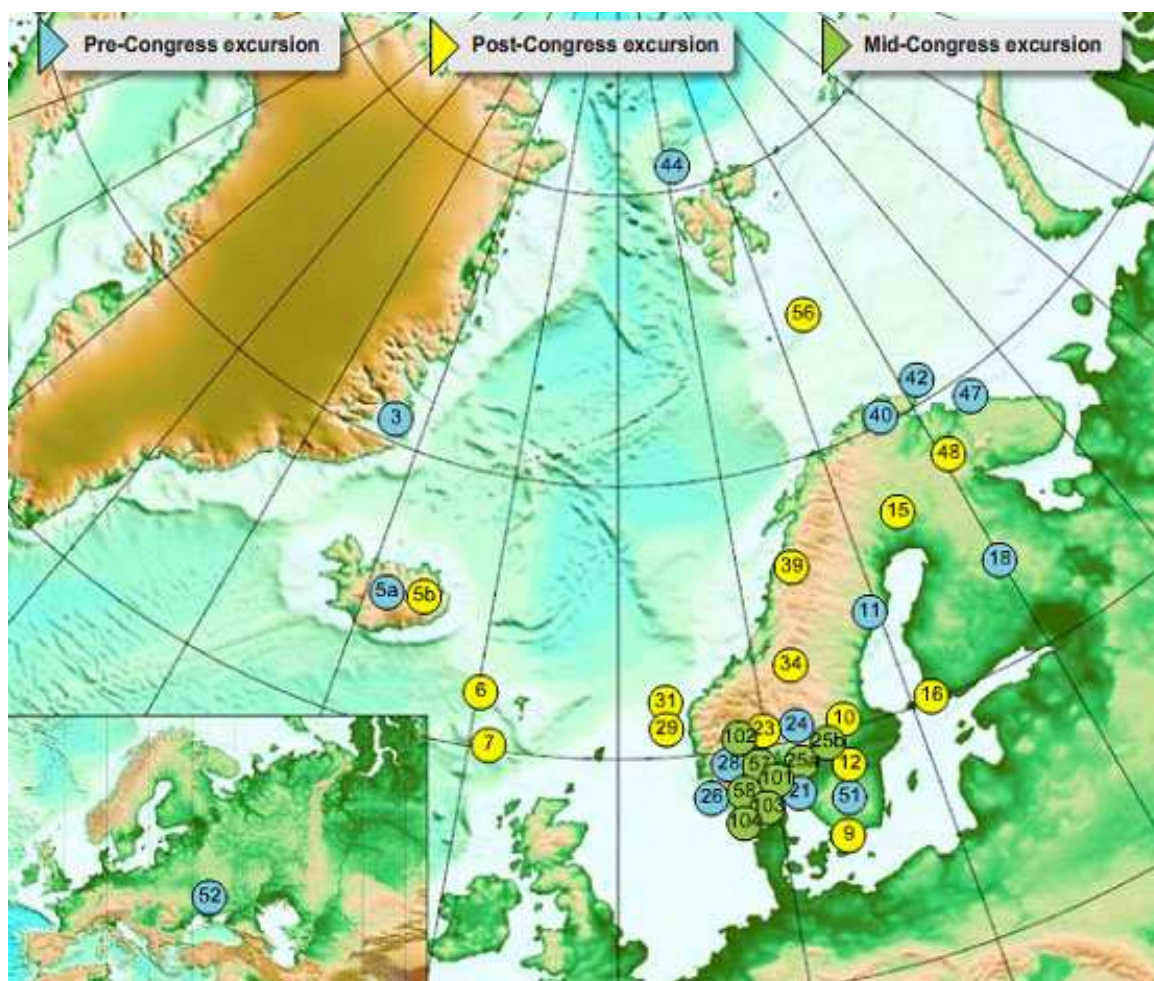
Contact: richard.sinding-larsen@ntnu.no

Number of participants: 18

This two-day short course covers ExxonMobil’s integrated play assessment concepts and methodologies. Our assessment process allows for projection of undiscovered hydrocarbon resource potential, taking into account both shared regional controls and local, prospect-specific complexities. A key focus of the short course is how to explicitly couple assessment inputs and results to fundamental geologic interpretations for geologic plays in different stages of exploration maturity. Topics include alternative methods for estimating number, sizes, and hydrocarbon types of future discoveries, with consideration given to strengths and weaknesses of each approach and how to tailor the approach based on available data. The short course also illustrates how GIS can be used to facilitate the work processes, particularly in maintaining linkages between the underlying geologic interpretations and the assessment results. GIS also plays a critical role in building assessment inputs and using assessment results to identifying favorable areas within individual plays or across multiple plays. A variety of displays, such as risk profiles and key risk maps, provide a means to extract critical insights from assessment results. Although primarily focused on conventional hydrocarbon accumulations, some consideration is also given to assessing unconventional plays. The short course is designed for geoscientists performing play assessments, geoscientists providing regional geologic maps and other inputs for play assessment, and managers or others wanting to understand and utilize play assessment results.



## FIELD TRIPS REPORTS



*Copy of the interactive portal map of the 33IGC website. The numbered circles indicate the approximate locations of the excursions. The excursion reports below refer to this numbering.*

### Excursions of the 33IGC, Oslo 2008

The 33IGC aimed at organising excursions in all the Nordic countries and neighbouring areas as appropriate. A total of 38 excursions were run: 14 pre-Congress, 16 post-Congress and 8 mid-Congress (see map above). These represent the final selection of a pool of more than 100 early excursion proposals; the selection criterion being a specific minimum number of participants registered by March/April 2008. The excursions covered all the five Nordic countries: Iceland, Finland, Sweden, Norway with its Arctic islands, and Denmark with Greenland and Faroe Islands, as well as areas in north-western Russia and central Ukraine. The excursions were of very high professional standard; organised by interested individuals mainly from academic and research institutions, but also from industry and government bodies. The Congress is sincerely grateful to these individuals and their affiliations for making available their time and expertise in such an extraordinary generous way.

In the following each excursion is briefly summarised for easy reference. More details can be found on the 33IGC website at [www.33IGC.org](http://www.33IGC.org)





## Pre- and post-Congress excursions

### No. 3. Jameson Land East Greenland, a petroleum geology analogue for the Arctic and Norwegian continental shelf

**Leader:** Michael Larsen (micla@dongenergy.dk) Dong Energy, Denmark. Logistic support from Danish Polar Center (DPC) and the Geological Survey of Denmark and Greenland (GEUS)

Time: 28 July - 6 August

Participants: 8

Nationalities: 5

The transport was arranged as a return trip from Oslo via Reykjavik on Iceland to Constable Pynt airstrip in Jameson Land, Greenland. Accommodation was arranged at the hostel located at the airstrip at Constable Pynt.

The subject of the excursion was the Upper Palaeozoic-Mesozoic succession of the East Greenland rift basin, which is a classic analogue for the oil-bearing strata of the North Sea and Norwegian Shelf and provides important data for new challenges in North Atlantic exploration. The Mesozoic rift basins of Greenland and Norway were thus closely related prior to Palaeogene break-up in the North Atlantic, and long distance correlation between formations on the Norwegian shelf and East Greenland are possible. The area also forms a key data point for petroleum assessment in the North Atlantic Arctic shelf offshore North-East Greenland.

The group studied the following parts of the succession:

- \* The Lower Jurassic Neill Klint Group, which provides a one-one correlation with the Tilje, Ror and Ile Formations on the Halten Terrace of the mid-Norwegian shelf.
- \* The Pelion Formation, which forms an important analogue to the Garn Formation on the Norwegian shelf. The backstepping pattern of the Pelion-Fossilbjerget couplet has also been recognised in the Brent Group of the northern North Sea, suggesting regional tectonic control on depositional systems.
- \* The Hareelv Formation, which is an important analogue for the Magnus Field of the northern North Sea.

The group was brought into the field by daily helicopter transport. Due to good weather the logistics went very well and the excursion was very successful.



*The Upper Jurassic Raukelv Formation of deltaic and fluvial sandstones, Jameson Land  
(Photo N. R. Sandstå)*



## No. 5a & 5b. The Geology of Iceland

**Leaders:** Hreggviður Norðdahl, Ármann Höskuldsson and Ólafur Ingólfsson, Earth Science Institute, University of Iceland

Time: 28 July - 4 August (5a), and 15 - 22 August (5b)

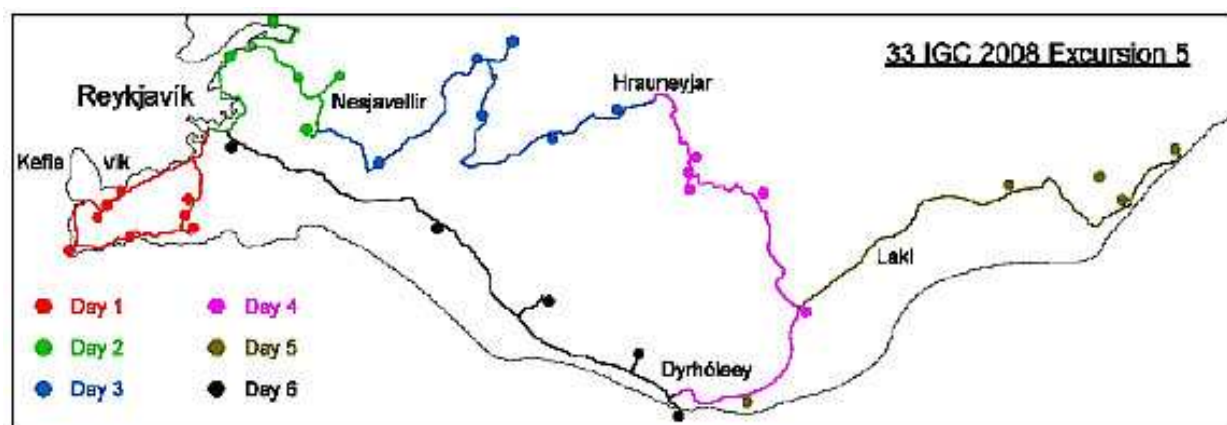
Participants: 32 (5a), 44 (5b)

Nationalities: 12 (5a), 14 (5b)

This excursion was run twice; one as a pre-Congress excursion (5a) and one as a post-Congress excursion (5b). The excursions were prepared by an organising committee consisting of: Hreggviður Norðdahl, Ólafur Ingólfsson and Olgeir Sigmarsson (Earth Science Institute, University of Iceland), Grétar Ívarsson (Reykjavik Energy), Ragnheiður Ólafsdóttir (Landsvirkjun), Bjarni Richter (Geysir Green Energy) and Sigurrós Friðriksdóttir (Umhverfisstofnun)

The aim of the excursion was to give participants an insight into the fascinating geology of Iceland - a high-latitude volcanic island situated across a rifting plate boundary. The excursion concentrated on rift tectonics and volcanism, as well as glaciers and glaciations through time. Volcanic and glacial/subglacial landscapes were studied, in addition to geothermal fields, geysers and high-energy fluvioglacial and coastal environments. The approach adopted by the organisers and excursion leaders was general in nature, suited for earth scientists of varying backgrounds, but there was a strong emphasis on what makes Icelandic geology so unique - the interaction of ice and fire through time.

The excursion was done by bus starting and ending in Reykjavik. Accommodation was arranged in hotels and hostels along the excursion route covering parts of southwestern and Southern Iceland.



*River and lake in a landscape of eroded lavas and rootless spatter cones between Nesjavellir and Hrauneyjar. (Photo from excursion guide)*





## No. 6. The volcanic and sedimentary evolution of the Palaeogene Faroe Islands Basalt Group

**Leader:** Simon Passey (simon.passey@jf.fo), Jarðfeingi (Faroese Earth and Energy Directorate), Faroe Islands

Time: 16 - 22 August

Participants: 20

Nationalities: 10

The transport was arranged as a return trip from Oslo via Copenhagen to Vágar Airport in the Faroe Islands.

The aim of the excursion was to give a comprehensive view of the complexities involved in the development of the Faroe Islands Basalt Group (FIBG), which is an exposed remnant of part of the North Atlantic Igneous Province. The FIBG represents a predominantly subaerial, tholeiitic continental flood basalt domain with a gross stratigraphic thickness of at least 6.6 km. The trip encompassed the southern island of Suðuroy with the oldest volcanic formations and the central and north-eastern islands where the youngest lava flow sequences are exposed. The excursion investigated how the morphologies of the lava flows evolve through time, as well as the volcano-sedimentary events (fluvial, lacustrine and mass flows) that punctuate the volcanism and their implication for offshore hydrocarbon exploration.

The excursion was done by bus and, except for two nights on Suðuroy, the party stayed overnight in Tórshavn.



*Tinganes, Tórshavn, Faroe Islands (Photo: Stig Nygaard, [www.rockland.dk](http://www.rockland.dk))*

## No. 7. The oceanic glaciation of the Faroe Islands

**Leader:** Lis Mortensen (lis.mortensen@jardfeingi.fo), Jarðfeingi (Faroese Earth and Energy Directorate), Faroe Islands

Time: 16 - 22 August

Participants: 20

Nationalities: 11

The transport was arranged as a return trip from Oslo via Copenhagen to Vágar Airport in the Faroe Islands.

The aim of the excursion was to present the impact of quaternary climate changes on the landscapes of the Faroe Islands, both onshore and offshore. The excursion focused on the characteristics of the glaciations in the Faroe Islands and its impact on the volcanic plateau landscapes in a severe oceanic subarctic environment. Today, there are only sparse remains of the large former basaltic plateau. The excursion saw a landscape strongly influenced by glaciations and dominated by deep valleys and fjords, steep valley sides and sharp mountain peaks, resulting from a thin ice cover and numerous nunataks.

The excursion was done by bus and boat visiting 6 of the 18 Faroe islands and staying overnight along the route.



## No. 9. Mesozoic of Southern Scandinavia

**Leaders:** Vivi Vajda, Lund University, Sweden; Peter Gravesen, Geological Survey of Denmark and Greenland

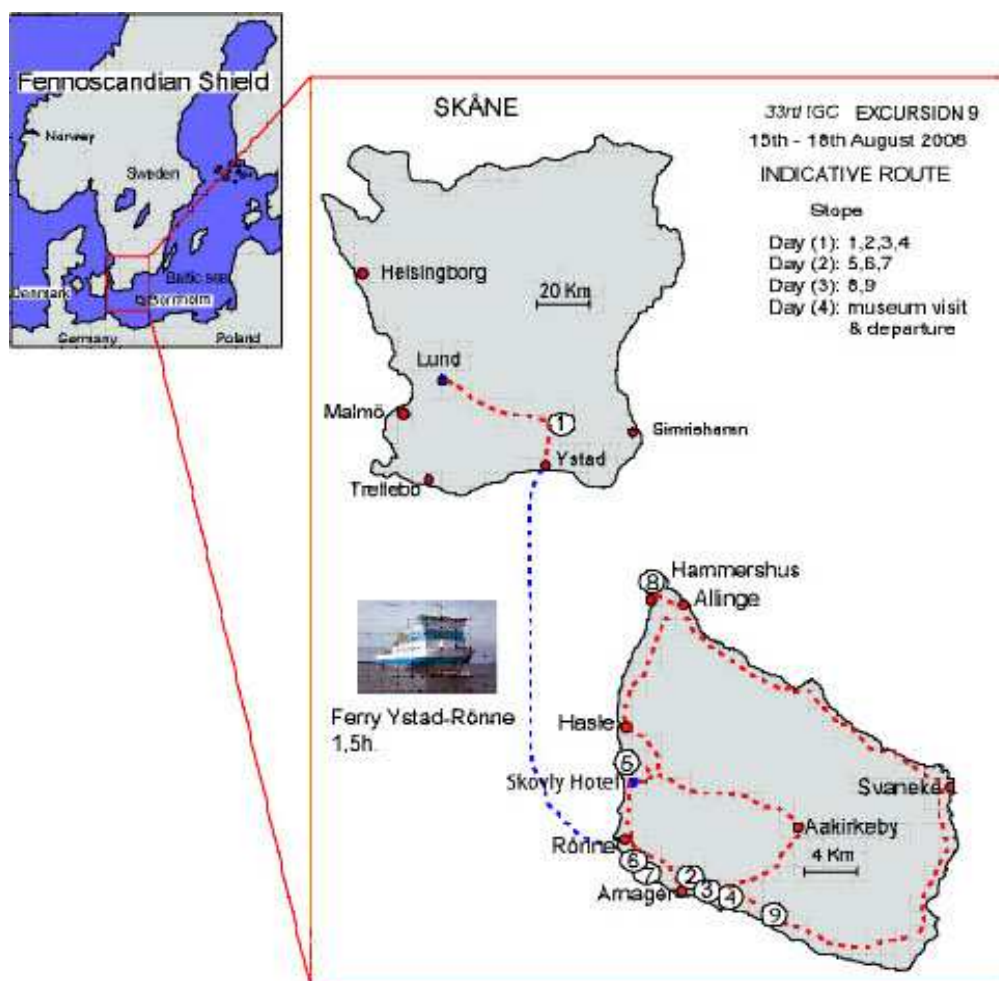
Time: 15 - 18 August

Participants: 9

Nationalities: 8

The field trip gave geoscientists from the international scientific community an opportunity to visit the best outcrops of the Triassic to Cretaceous sedimentary succession of southernmost Scandinavia. One outcrop, covering Early to Late Jurassic, was located at Eriksdal in southernmost Sweden, while the rest of the outcrops visited were located on the island of Bornholm, Denmark. The excursion covered a range of palaeo-environments; from arid terrestrial late Triassic sandstones through Jurassic coals formed in a warm and humid environment to open marine Upper Cretaceous sandstones and limestone.

The excursion was done by bus staying overnight in the town of Rønne on Bornholm.



*Route of Excursions No 9, from Skåne (Swedish mainland) to the Island of Bornholm (Denmark).  
(Map from excursion guide)*

## No. 10. Palaeozoic Impact Craters

**Leaders:** Maurits Lindström (maurits.lindstrom@geo.su.se), Department of Geology and Geochemistry, Stockholm University, Sweden; Birger Schmitz, Center for GeoBiosphere Science, Lund University, Sweden; Erik Sturkell, Institute of Earth Sciences, University of Iceland; Jens Ormö, Centro de Astrobiología, Instituto Nacional de Técnica Aeroespacial, Spain

Time: 15 - 20 August

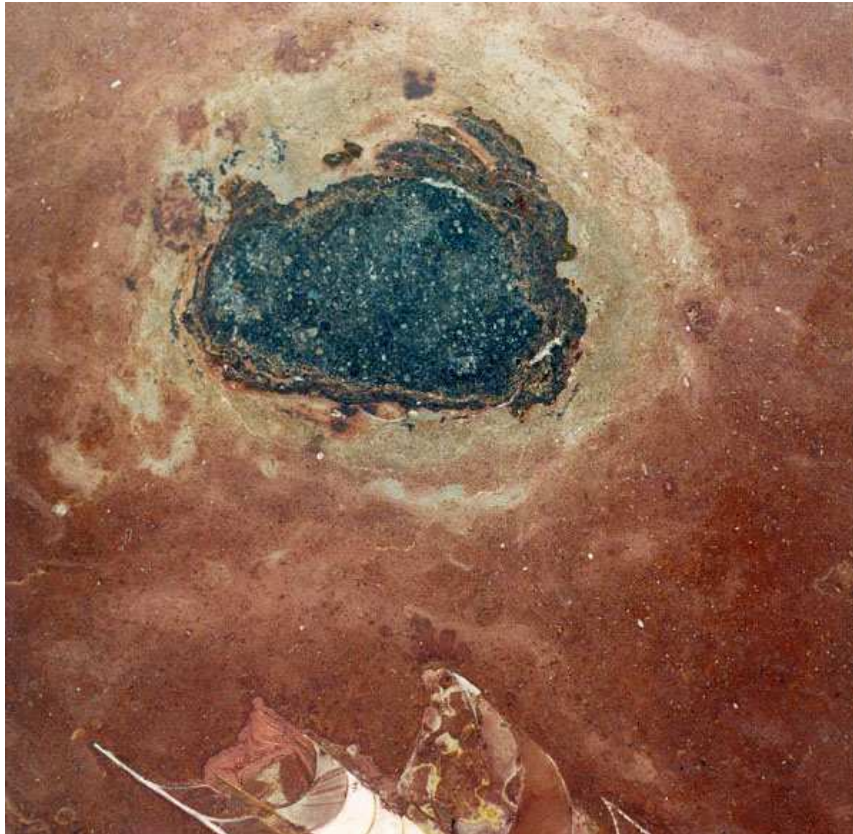
Participants: 8

Nationalities: 4



The aim of the excursion was to demonstrate Palaeozoic meteorite impacts of which excellent geological evidence is known from Sweden. The excursion first visited the Thorsberg Quarry at Kinekulle which holds a collection of the oldest known fossil meteorites in Middle Ordovician limestones. It then visited the well-known Siljan impact structure which is the largest known in Western Europe. The structure formed in the second half of the Devonian Period within the range of direct geological influence from the Caledonian mountain building that culminated at that stage, helping to lay the ground for one of the most beautiful landscapes of Sweden. Lastly, the excursion visited the over 100 million years older Lockne impact which formed a crater in the open sea of the early Late Ordovician. Cratering at sea is a highly complex and dynamic process that is spectacularly illustrated by the well-preserved Lockne crater.

The excursion was done by bus starting in Oslo and ending in Östersund. Overnight stays along the route.



*The fossil meteorite Österplana 035 (syn. name Sex 001) from the Sextummen bed in the Thorsberg quarry at Kinekulle. (Photo: Birger Schmitz)*

### No. 11a & 11b. Palaeoseismicity and uplift of Sweden

**Leader:** Nils-Axel Mörner (mörner@pog.nu), Paleogeophysics & Geodynamics, Sweden, in collaboration with Rabbe Sjöberg, Sweden; Franck Audemard, Venezuela; Sue Dawson, Scotland; and Guangyu Sun, China

Time: 30 July - 4 August (11a), and 15 - 19 August (11b)

Participants: 11 (11a), 7 (11b)

Nationalities: 6 (11a), 3 (11b)

The purpose of the excursion was to demonstrate the effects of the deglaciation of Scandinavia, in particular the classical Fennoscandian Uplift and the new concept of deglacial high seismicity (palaeoseismicity). The excursion was run in two parts; one pre-Congress part (A) and one post-Congress part (B). Part A was run along the east coast and put most emphasis on the uplift history and palaeoseismicity. It started in Umeå and visited a number of localities to combine varve chronology, young faults, liquefaction phases and evidence of palaeo shorelines and tsunami events. Part A ended in Stockholm for convenient travel to Oslo by train. Part B put more emphasis on sea level change and climate, visiting many of the best-known shore level localities. However, part B also included localities similar to those of part A relevant to palaeoseismicity. Part B started in Stockholm and spent one day on the east coast in the Mariefred-Åker area. The next day the excursion travelled to Helsingør on the west coast. The excursion ended in Båstad where transport was arranged to Kastrup Airport.

Both part A and part B were done by bus. Overnight accommodation was arranged in hostels along the route.







*The Turinge gravel pit (at Ryssjöbrink); new sections in 2005-2006 exhibiting strong liquefaction and venting, including venting of gravel, which calls for a magnitude >8.5.  
(Photo: N-A . Mörner)*

## **No. 12. Palaeoproterozoic volcanic- and limestone hosted Zn-Pb-Ag-(Cu-Au) massive sulphide deposits and Fe oxide deposits in Bergslagen, Sweden**

**Leaders:** Rodney Allen, Boliden Mineral AB and Luleå University of Technology, Sweden; Magnus Ripa, Geological Survey of Sweden; Nils Jansson, Luleå University of Technology, Sweden

Time: 14 - 20 August

Participants: 25

Nationalities: 14

The purpose of this field excursion was to discuss the stratigraphy, structure, regional geological setting and origin of volcanic- and limestone-hosted Zn-Pb-Ag-(Cu-Au) massive sulphide deposits in Bergslagen, and their relationships to Fe oxide deposits. The excursion was a collaboration between the 33rd IGC and the IGCP-502 project "Global comparisons of volcanic-hosted massive sulphide districts". The excursion visited the Garpenberg and Sala limestone-, skarn and volcanic-hosted stratabound Zn-Pb-Ag-(Cu-Au) sulphide deposits; the Zinkgruvan volcanic-hosted stratiform Zn-Pb-Ag-(Cu-Au) deposit; the Viker-Älvsången limestone-hosted stratiform Zn-Fe-Mn mineralization; and the Dannemora and Stollberg limestone-hosted manganiferous magnetite-skarn iron ore deposits. En route, outcrops of greenschist to amphibolites facies volcanic rocks, stromatolitic limestones and skarns that host the ore deposits were also visited.

The excursion started and ended at Stockholm International Airport, Arlanda. Transport was by bus and overnight stays were arranged in hotels along the route.

*Stora Stöten copper mine, Falun. (Photo: Arco Ardon)*





## No. 15. Metallogeny and tectonic evolution of the Northern Fennoscandian Shield

**Leaders:** Tuomo Törmänen (tuomo.tormanen@gtk.fi), Geological Survey of Finland; Stefan Bergman (stefan.bergman@sgu.se), Geological Survey of Sweden; Olof Martinsson (olof.martinsson@ltu.se), Luleå University of Technology, Sweden; Roger Nordin (roger.nordin@boliden.com), Boliden Mineral AB, Sweden

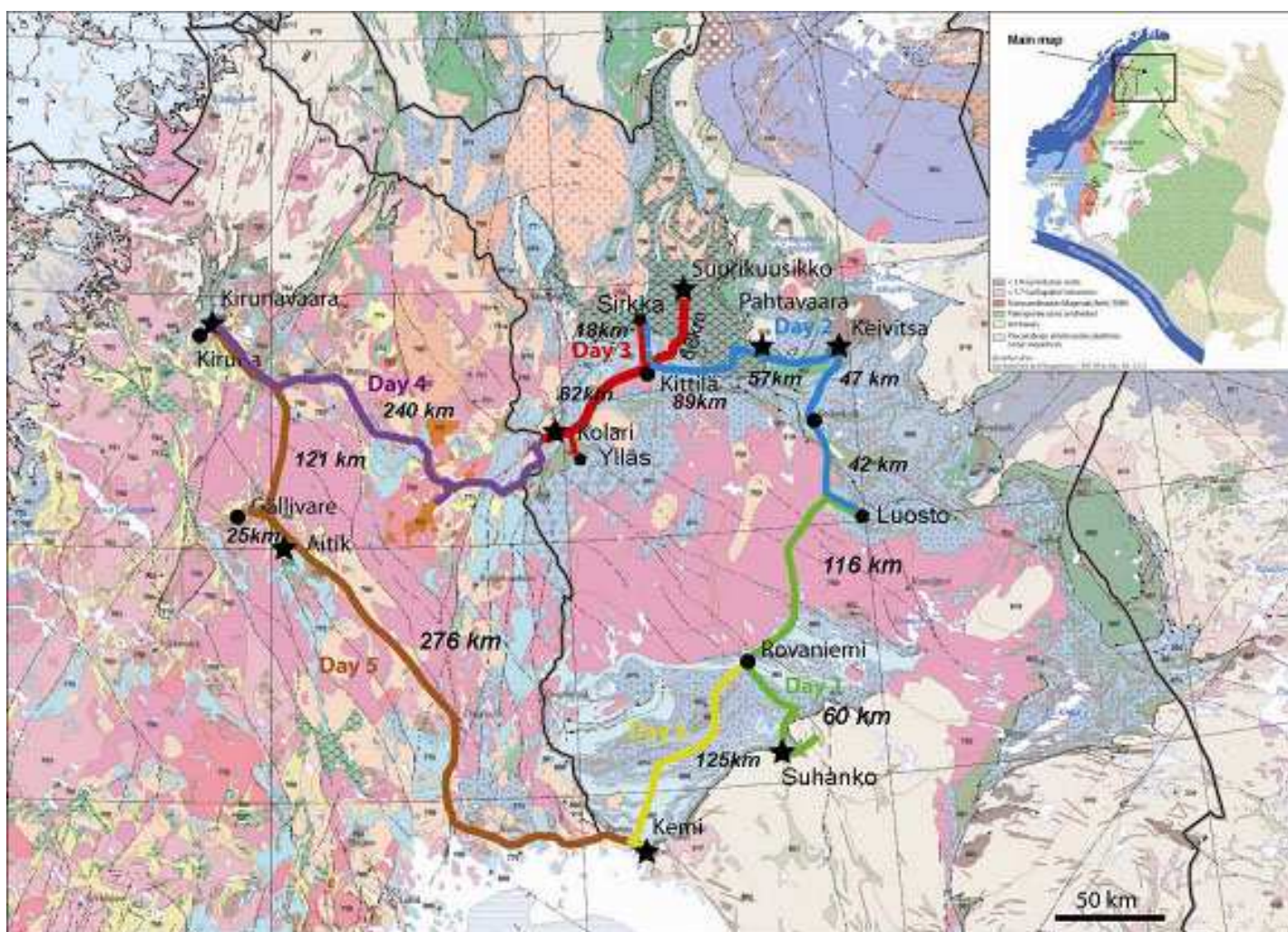
Time: 15 - 21 August

Participants: 29

Nationalities: 11

The purpose of the excursion was to present the various types of Precambrian ore mineralization of the Fennoscandian Shield, which is one of the most important mining areas in Europe. Mineral deposit types include VMS (Volcanogenic Massive Sulfide), Kiruna-type apatite-iron, orogenic Au, epigenetic Cu-Au ore, mafic and ultramafic-hosted Cr, Ni-(Cu), PGE (Platinum Group Elements) and BIF (Banded Iron Formation). Palaeoproterozoic parts of the shield are better mineralized than the Archaean areas. The excursion visited localities representative of the different types of deposits and mineralization, including the PGE mineralization of the Portimo Complex, the Ni deposits of Keivitsa, the gold deposits associated with the Central Lapland Greenstone Belt at Suurikuusikko and Kolari, the volcanism related iron mineralization at Kiruna and Gällivare, and the ultramafic chromium mineralization at Kemi. In this context, several of the well known mines of Finland and Northern Sweden were visited, including the Pahtavaara gold mine, the Kittilä gold mine, the Kiruna and Gruvberget iron mines, the Aitik Cu-Au-Ag mine, and the Kemi chrome mine.

The excursion started and ended in Rovaniemi. Transport was by bus and overnights were arranged in hotels along the route.



*Route of Excursion No 15 plotted on the geological map of the northern Fennoscandia. (Map from excursion guide)*





**No. 16. 100 years of migmatite - In Sederholms footsteps**

**Leaders:** Olav Eklund (chief organizer: olav.eklund@utu.fi), University of Turku, Finland; Peter Sorjonen-Ward, Geological Survey of Finland; Tapani Rämö, University of Helsinki, Finland; Carl Ehlers, Åbo Akademi University, Finland; Pentti Hölttä, Geological Survey of Finland; Markku Väisänen, University of Turku, Finland; Matti Kurhila, University of Helsinki, Finland

Time: 16 - 21 August

Participants: 18

Nationalities: 8

The excursion was inspired by the 100 year anniversary in 2007 for the publication of J. J. Sederholm's paper "On granite and gneiss, their origin, relations and occurrence in the Pre-Cambrian complex of Fenno-Scandia". This paper can be seen as the trigger of research in crustal melting processes. Sederholm's contribution was remarkable because of its wide scope, from analysis of processes in outcrop to the regional scale. The excursion was designed to visit some of Sederholm's key localities, enabling the participants to compare his 100-year-old observations with the latest data and interpretations from the same area. The excursion concentrated on the regional evolution of the accretionary arc-complex of southern Finland, with particular emphasis on the formation of migmatites during the regional high grade metamorphism between 1,840 and 1,805 million years ago. The excursion also covered other aspects of Sederholm's work, such as the earliest known well preserved volcanic and sedimentary rocks in southern Finland at Enklinge, and several key localities that illustrate Sederholm's classification of four granite generations in southern Finland. The excursion included a one day workshop on recent research on migmatite.

Since the areas are situated in the archipelagos of southern and south-western Finland, the excursion was made by boat. The excursion started and ended in Helsinki. The overnight accommodation was arranged in tourist cottages and hostels along the route.

**No. 18. Karelian Craton transect (Finland, Russia): Precambrian greenstone belts, ophiolites and eclogites**

**Leaders:** Petri Peltonen and Pentti Hölttä, Geological Survey of Finland; Alexander Slabunov, Institute of Geology, Russia; assisted by Asko Kontinen, Tapio Halkoaho, Asko Käpyaho, Oleg Volodichev, Alexandra Stepanova Alexandra, Alexander Samsonov and Andrey Schipanskiy

Time: 28 July - 4 August

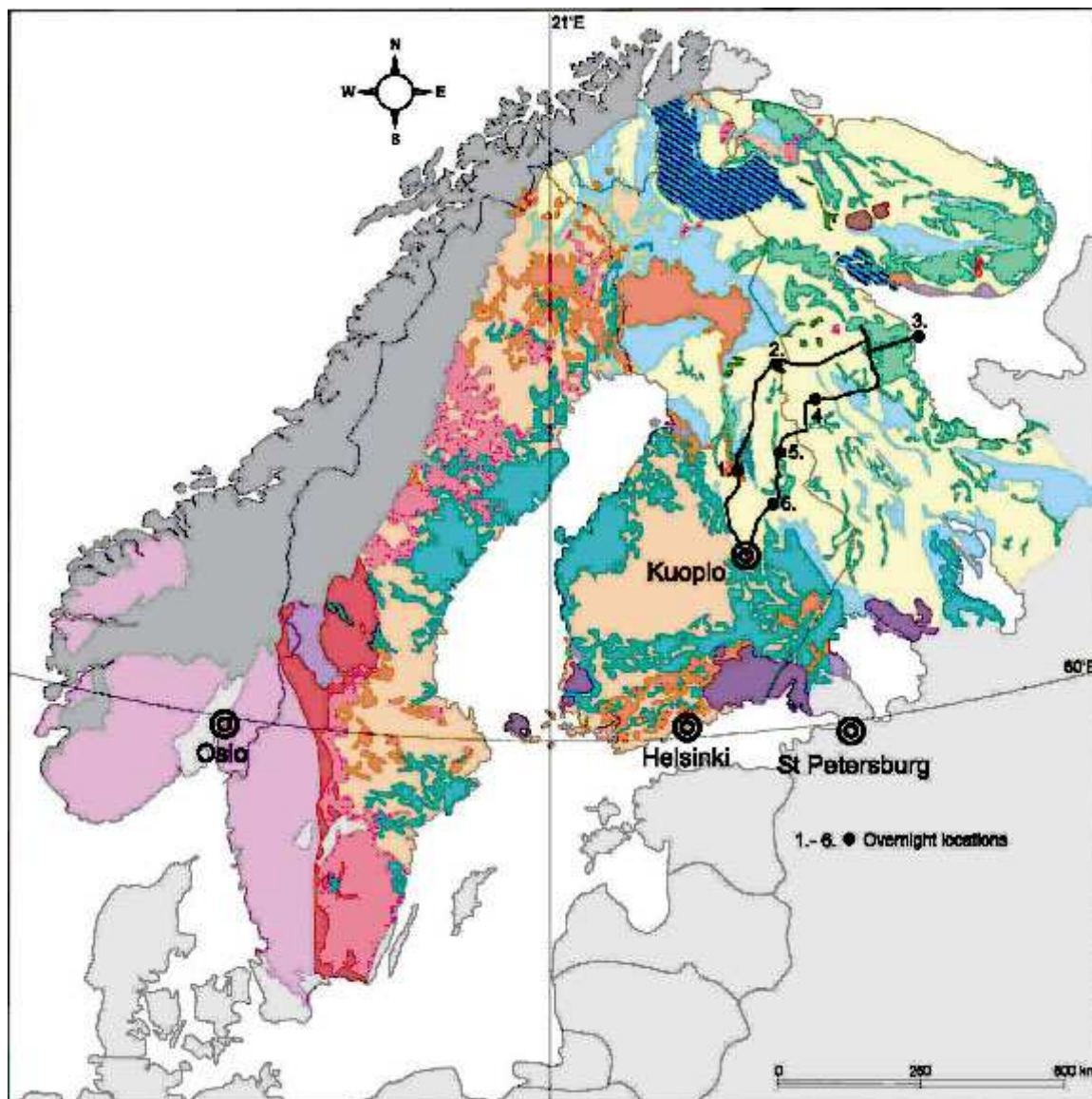
Participants: 12

Nationalities: 6

The aim of this field trip was to demonstrate the recent discoveries made in Archean Karelian Craton that are relevant to the operation of modern-like accretion tectonic and seafloor spreading processes in the Meso- and Neoproterozoic times. The Khizovaara structure, recently described as a collage of a part of the Archean Iringora SSZ-ophiolite and an arc complex, was examined in detail. The excursion visited the Kostomuksha and Kuhmo greenstone belts in order to discuss the various geodynamic settings proposed for Archean volcanic successions. The excursion moved further on to examine the spectacular Archean eclogites in the Gridino area on the White Sea. They belong to a Neoproterozoic melange interpreted to have formed in a subduction zone and exhumed due to a collisional orogeny. A full day was devoted to the 1.95 Ga old Jormua Ophiolite Complex. This is a complete Precambrian ophiolite sequence recently reinterpreted as transitional passive-margin type ophiolite with truly unique Archean subcontinental mantle outcropping covering tens of square kilometers.

The excursion started and ended in Kuopio in Finland. Transportation was arranged by bus and boat (on the White Sea). Overnight accommodation was arranged in hotels along the route except for one night in tents by the White Sea.





*Route of Excursion No 18 plotted on the geological map of the Fennoscandian Shield. (Map from excursion guide)*

## **No. 21. Gea Norvegica Geopark, a UNESCO European Geopark in Southern Norway**

**Leaders:** Sven Dahlgren and Mona Holte, Gea Norvegica Geopark, Norway

Time: 3 - 5 August

Participants: 15

Nationalities: 9

The purpose of the excursion was to present the Gea Norvegica Geopark, which recently (20th September 2006) was awarded status as a member of the European Geoparks Network (EGN) and UNESCO's Global Geopark Network (GGN). The geopark comprises 3000 km<sup>2</sup> on the southwestern flank of the onshore part of the Oslo rift (about 2 hours drive south of Oslo). The excursion visited the exceptionally diverse records of Scandinavian geology from the last 1,600 Ma present in the park, including:

- \* A large variety of landscapes reflecting the diverse bedrock geology and quaternary deposits
- \* Meso-Proterozoic gneisses, mafic intrusions and metasomatic rocks
- \* The Fen Carbonatite Complex
- \* The Proterozoic-Cambrian unconformity
- \* Cambrian, Ordovician, Silurian, and Late Carboniferous sediments
- \* Ultramafic (melilitites and nephelinites) and rhomb porphyry volcanics (mainly lavas)
- \* Faults and plutons of larvikite, nepheline syenite and alkali syenite belonging to the Oslo Rift
- \* Glacial geomorphology and deposits from late Weichsel
- \* Holocene marine clay deposits.



The excursion started and ended in Oslo. Transportation was by bus and overnight accommodation was arranged in hotels along the route.

### No. 23. The Carboniferous - Permian Oslo Rift, the northernmost Rotliegendes and Variscan in Europe

**Leaders:** Bjørn T. Larsen, Det Norske, Norway; Snorre Olaussen, Eni Norge, Norway; Bjørn Sundvoll, University of Oslo, Norway

Time: 15 - 17 August

Participants: 9

Nationalities: 9

The purpose of the excursion was to present the Oslo Rift as an example of continental rifting within the Pangea Continent and adjacent to the orogenic events of the Hercynian. The Oslo Rift, including the Oslo Graben, was studied in terms of its rift architecture and extensional aspects, volcanism and plutonism, sedimentology, and its overall development in time and space, including:

- Tectonics and Lower Palaeozoic sediments of the inner Oslofjord (by boat)
- The unconformity between the Lower and Upper Palaeozoic, and the overlying Upper Carboniferous/Lower Permian sediments and volcanics, including the rhomb porphyry lava plateaus
- Permian alluvial fan, Aeolian and fluvial red beds
- Batholith and sill intrusion complexes, including the famous larvikite syenite batholiths

The excursion started and ended in Oslo. Transportation was by bus (2 days) and boat on the Oslo Fjord (1 day). Overnight accommodation was arranged in hotels along the route.



*Red sandstone from aeolian sand trapped between the blocky surface of an alkali olivine basaltic lava flow in the Gzelian/Asselian of the outer Oslo Fjord. (Photo: B. T. Larsen)*





## No. 24. From Epicontinental Sea to Foreland Basin - the Early Palaeozoic of the Oslo Region

**Leaders:** Bjørn T. Larsen, Det Norske, Norway; Snorre Olausen, Eni Norge, Norway; Fredrik Bockelie, Sagex Petroleum, Norway

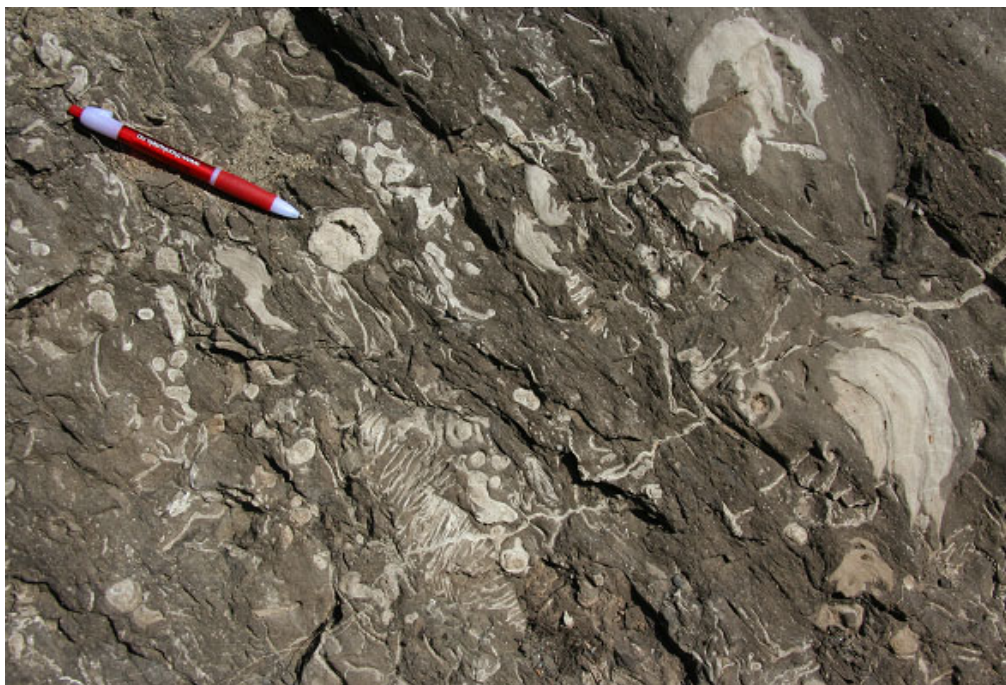
Time: 3 - 5 August

Participants: 10

Nationalities: 6

The excursion was aimed at demonstrating the transition, in time and space, from the Cambrian shallow epicontinental sea transgressing the Baltic peneplain to the Late Ordovician/Late Silurian foreland basin of the Caledonian Orogen. For this purpose, the excursion was guided through a series of outcrops around the shores of the inner Oslo Fjord and by boat on the lake Tyrifjorden, reflecting the transition from the Lower Cambrian to Middle Ordovician transgressive to shallow water deposits of black shales, mudstones and limestones passing through Upper Ordovician to Lower Silurian deposits of a shallowing carbonate sea with increasing clastic input, ending up with the earliest foreland basin sandstone infill in the Late Silurian. The nature of folds, imbricated thrusts and back thrusts observed through the sequence testified to the frontal, parautochthonous position with regard to the Caledonian Orogen.

The excursion started and ended in Oslo. Transportation was by bus (2 days) and boat on Tyrifjorden lake (1 day). Overnight accommodation was arranged in hotels along the route.



*Corals and stromatoporoids of the Wenlockian, inner Oslo Fjord. (Photo: B. T. Larsen)*

## No. 26. Magma Geopark - The Rogaland Anorthosite Province

**Leaders:** Pål Thjømøe (chief organizer; pal.thjomoe@dabb.no), Brian Robins (ngebr@geo.uib.no), University of Bergen, Norway; Richard Wilson (jrw@geo.au.dk), University of Aarhus, Denmark

Time: 31 July - 5 August

Participants: 12

Nationalities: 7

The purpose of the excursion was to present the "Magma Geopark", proposed for approval by UNESCO. The Rogaland Anorthosite Province forms the most important part of this geopark. The magmas of the Rogaland Anorthosite Province were intruded into gneisses of the Sveconorwegian orogenic belt in southern Norway, resulting in three major anorthosite massifs (Egersund-Ogna, Åna Sira and Håland-Helleren), Norway's largest layered intrusion (Bjerkreim-Sokndal), two smaller anorthosite bodies, several broadly mangeritic (hypersthene monzonite) intrusions, charnockites, and many minor intrusions of jotunite (hypersthene monzonite). The igneous activity took place over a surprisingly short period of time (at  $931 \pm 3$  Ma) at a depth of ~16-20 km. There is a long history of exploitation of iron-titanium ores in the province hosting



Europe's largest titanium mine, Titania. The participants of the excursion were introduced to the magmatic rock types, the mining history of the area, and the unique glacial landscape of rounded hills and glacial deposits.

The excursion started and ended in Stavanger. Overnights were spent in Egersund with daily excursions by bus.



*View of Jøssingfjord from Hellersheia in the anortosite massif. (Photo: Pål Thjemøe)*

## **No. 28. Structural geology and tectonic evolution of the Sognefjord transect, Caledonian Orogen, southern Norway**

**Leaders:** A. Geoffrey Milnes, GEA Consulting, Switzerland; Fernando Corfu, University of Oslo, Norway

Time: 29 July - 5 August

Participants: 11

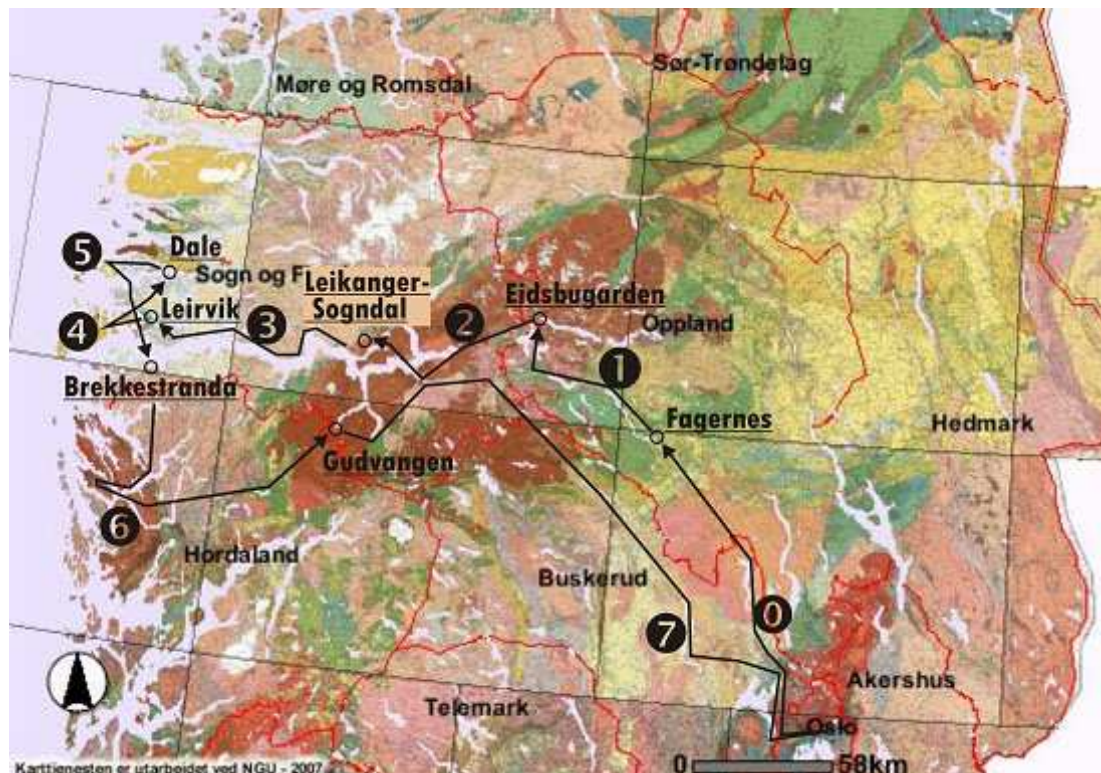
Nationalities: 8

The purpose of the excursion was to present the Sognefjord transect through the South Norwegian Caledonides, one of the most spectacular orogenic cross-sections in the world, with a whole spectrum of major structures (e.g. Jotun nappe, with a demonstrable displacement of 200-300 km, Nordfjord-Sogn Shear Zone, with up to 50 km of normal displacement) and many well-known eclogite localities. It is exceptionally well exposed, whether in tree-less high mountain areas or along wave-washed shorelines and on naked rock islands. The field trip started in the foreland of the orogen and traversed the Jotun Nappe Complex over the first two days, then continued along the increasingly more tectonized basement along Sognefjord to the islands on the Atlantic coast, reaching eclogite bearing basement units and then the Nordfjord-Sogn detachment on the third day. The fourth and fifth days were dedicated to the units immediately below and above the Nordfjord-Sogn detachment, including ophiolitic and marginal basin elements of the Upper Allochthon and Devonian sedimentary basins. The sixth day was focused on the boundary between basement and Bergen Arc, also visiting the unique shear-zone-bound eclogites of the Lindås Nappe, before heading east, crossing again the Jotun Nappe Complex and the foreland on the way back to Oslo.

The excursion was by bus starting and ending in Oslo. Overnight accommodation was arranged in hotels along the route.







*Geological map of southern Norway showing the route taken on the Excursion No. 28 and the location of the overnight stops. (Map from excursion guide)*

**No. 29. The Caledonian infrastructure in the Fjord region of Western Norway; with special emphasis on formation and exhumation of high- and ultrahigh-pressure rocks, late- to post-orogenic tectonic processes and basin formation**

**Leaders:** Torgeir Bjørge Andersen (chief organizer [t.b.andersen@geo.uio.no](mailto:t.b.andersen@geo.uio.no)); Håkon Austrheim, Physics of Geological Processes, University of Oslo, Norway

Time: 15 - 22 August

Participants: 24

Nationalities: 10

The aim of the excursion was to present geoscientists from around the world with a comprehensive overview of the dynamics related to formation and exhumation of the high- and ultra-high pressure rocks of the Scandinavian Caledonides. For this purpose, the route of the excursion covered the classical region of eclogite facies rocks between Bergen and Stadlandet along the fjords of Western Norway. The excursion was designed to demonstrate the small- to large-scale tectonic processes by combinations of detailed small-scale observations and spectacular large-scale examples of geological processes from the base to the top of the crust during mountain building and collapse.

It started by studying fluid-controlled densification related to initial and incomplete eclogitization of exhumed lower crustal rocks in the Bergen region. This included the demonstration of transitions from brittle, eclogite facies palaeo-earthquakes in the continental root zone of the Caledonian mountains, to formation of ductile eclogite shear zones related to formation thrust sheets and stacking of lower continental crust. In the Fjord region between Sognefjorden and Stadlandet the excursion visited large and spectacular eclogite tectonite bodies, and discussed how to put their age, mineralogies and internal structures in relation to the crustal thickening and thinning events during Caledonian collision and subsequent extension. The participants were also presented the relationships between eclogite facies rocks and the mylonites of one of the largest extensional detachment zones in the world, the Nordfjord-Sogn Detachment (NSDZ). In the Solund - Sunnfjord Region a complete vertical traverse was made thorough the Caledonian tectono-stratigraphy, from the eclogite bearing Western Gneiss Complex to the low-grade, Late Ordovician to Early Silurian ophiolite of the Upper Allochthon, and the overlying Devonian supra-detachment basins. Within the basins themselves, one could observe evidence of the structural control on the sedimentary structure of the basins and study transitions from sedimentary to the anchi-metamorphic processes in the basins. In the Nordfjord region the excursion examined the transition from the low-grade Caledonian nappes to the high- and ultrahigh-pressure rocks in the footwall of the NSDZ, with particular focus on the metamorphic history of igneous and metamorphic protoliths to HP and UHP metamorphic rocks and mantle peridotites in



the Åheim-Kråkenset-Stadlandet area.

The excursion started in Bergen and ended in Selje. Transport was by bus and ferry. Overnight accommodation was arranged in hotels along the route.



*Late Ordovician - Early Silurian shelf sequence of the Upper Allochthon at Brurestakken, Atløy.*

### **No. 31. UNESCO FJORDS: From Nærøfjord to Geirangerfjord**

**Leaders:** Inge Aarseth, University of Bergen, Norway; Atle Nesje, University of Bergen and Bjerknes Research Centre, Norway; Ola Fredin, Geological Survey of Norway

Time: 14 - 20 August

Participants: 20

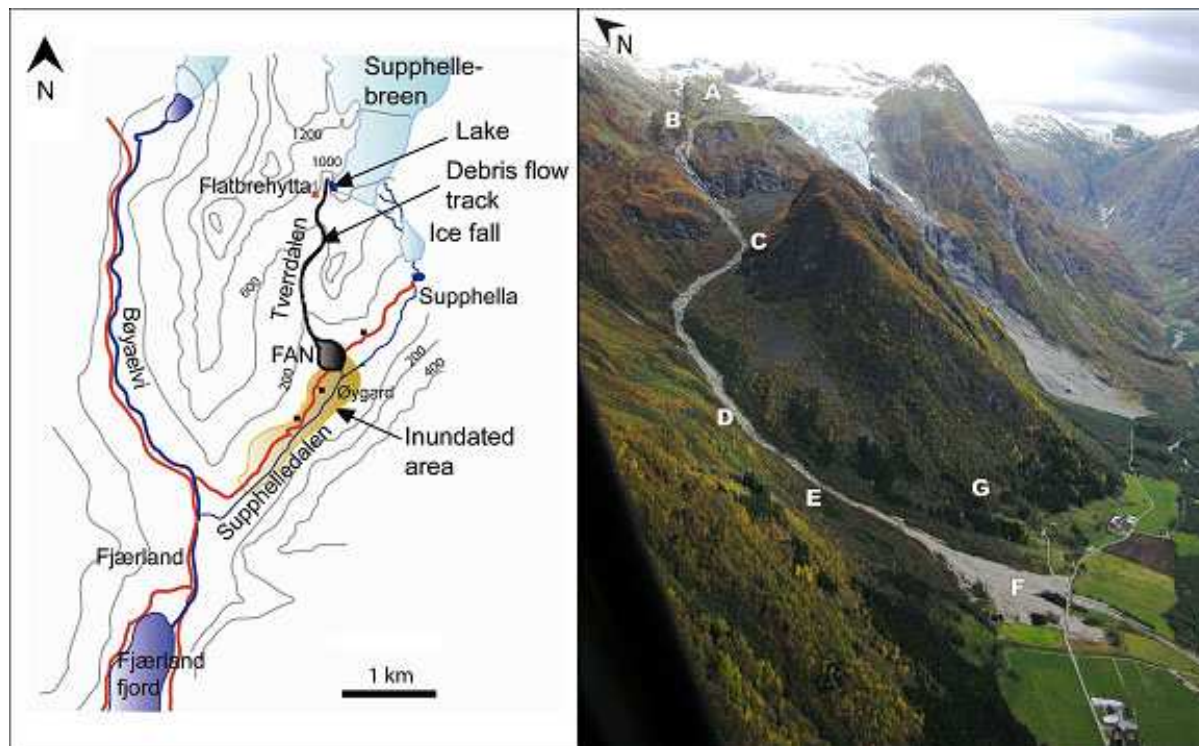
Nationalities: 11

The purpose of the excursion was to present the surface processes and landscape development in the heartland of the western Norwegian fjords. In 2005 UNESCO included two fjords in western Norway on their World Heritage List. The selection of these two fjords was mainly done for geological and geomorphological reasons. Because of the great relief, both terrestrial and submarine, they are subject to dramatic exogenic processes. This excursion provided a detailed and integrated overview of processes, deposits, landforms, human impact and landscape development in this area. This included an overview and a detailed insight in the formation of fjords in addition to the geological processes taking place in the fjord environment today. The excursion also gave insight into how glaciers respond to climatic change and how man is preparing for natural disasters from snow avalanches as well as from tsunamis caused by rockslides.

The excursion started in Bergen and ended in Oslo. Transportation was by bus and boat. Overnight accommodation was arranged in hotels along the route.







*Map of the Øygard jökulblaup 2004, and photo of the flow path. (Photo: A. Elverhøi 2007, map from excursion guide)*

#### **No. 34. A Tectono-stratigraphic transect across the central Scandinavian Caledonides**

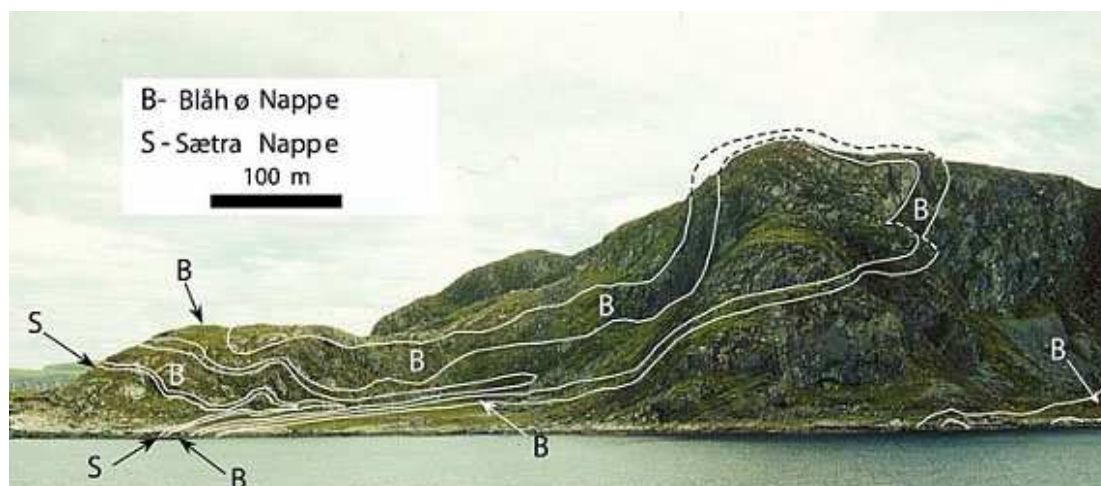
**Leaders:** Peter Robinson and David Roberts, Geological Survey of Norway; David Gee, Uppsala University, Sweden

Time: 14 - 24 August

Participants: 32

Nationalities: 12

The purpose of this trip was to give geoscientists from other countries a comprehensive view of the Scandinavian Caledonides in this central region, by making the classical transect across the mountain belt from the orogenic front near Östersund, Sweden, to Trondheim and Ålesund in Norway. It started in the clearly defined lower thrust sheets and followed them westwards deep into the hinterland region of severely attenuated tectono-stratigraphic units and eclogite-facies and UHP metamorphism. The coverage was general in nature, but with a strong emphasis on important results from paleontology, structural fabrics, metamorphic petrology, geochronology and geophysics, linked to outcrops and field observations. The excursion started in Östersund and ended on Lepsøya near Ålesund. Transportation was by bus and ferry. Overnight accommodation was arranged in hotels along the route.



*Along-axis view of a refolded recumbent fold defined by rocks of the Blåhø and Sætra nappes on northern Lepsøya. (Photo: Mike Terry & Peter Robinson)*



**No. 39. Karst and landform development of North Norway****Leader:** Stein-Erik Lauritzen, University of Bergen, Norway

Time: 9 - 17 August

Participants: 8

Nationalities: 5

The excursion was linked to Symposium GSM-03 "Karst as a global phenomenon - a tribute to Derek Ford and Paul Williams", visiting caves, karst and other landforms developed in the marble formations of central northern Norway. The excursion started and ended in Bodø. Transport was by bus and overnight accommodation was arranged in hotels along the route.



*Cave profile. (Photo: Stein-Erik Lauritzen)*

**No. 40. Raised beaches, falling-stage deltas, river terraces and postglacial fjord-valley fill, arctic Norway****Leaders:** Geoff Corner, University of Tromsø, Norway; Raymond Eilertsen, Geological Survey of Norway

Time: 1 - 4 August

Participants: 15

Nationalities: 9

The purpose of the excursion was to introduce the coast and fjord district of arctic Norway, which is a classic area for the study of postglacial raised shorelines, to sedimentologists interested in clastic depositional processes and facies, and to Quaternary geologists interested in postglacial sea-level change. The excursion visited inner and outer coastal areas of Varanger and the lower Tana valley, where deglacial, postglacial and modern raised shorelines and deltas are exceptionally well-preserved and easily accessible. The participants were also presented to the history of postglacial sea-level change, delta progradation, fjord-valley-filling and river terrace development through field observations supported by reference to various morphological, sedimentological and geophysical studies.

The excursion was done by bus starting and ending in Kirkenes. Overnight accommodation was arranged in hotels and guest houses along the route.





*Raised shorelines on the front slope of the Brannsletta delta. Selected elevations (in m a.s.l.) and the Tapes (T) and Main (L0) shorelines are labelled. (Photo: Geoff Corner)*

#### **No. 42. Neoproterozoic glacial and associated facies in the Varanger (ex-type) area**

**Leaders:** A. Hugh N. Rice (organiser: alexander.hugh.rice@univie.ac.at), Vienna University, Austria; Marc B. Edwards and Tor Arne Hansen, StatoilHydro, Norway

Time: 1 - 4 August

Participants: 10

Nationalities: 7

The aim of the excursion was to give the participants an insight into as wide a range of geology as possible within the remit of the excursion title, promoting exchange of ideas through comparisons with other regions. The trip, part of the IGCP 512 "Neoproterozoic Ice Ages" project, examined glacial (sensu-lato) deposits and associated carbonate units relevant to ongoing discussions on the extent, causes and correlations of late Neoproterozoic glaciations. Both lower (Smalfjord Formation) and upper (Mortensnes Formation) glacial, glaciomarine and fluvioglacial deposits, respectively likely Marinoan and Gaskiers equivalents, were studied in the Laksefjordvidda-Tanafjord-Varangerfjord area. Sections through dolostones tentatively correlated with the 'Bitter Springs' anomaly (Båtsfjord Formation) were also examined. The excursion also offered localities in which one could observe facies variations in the Smalfjord Formation cap-dolostone (Marinoan type, lower Nyborg Formation) due to variable clastic influences. The glacial striations at the base of the Smalfjord Formation at Oaibaccanjar'ga (Bigganjar'ga) were included in the excursion.

The excursion started and ended in Kirkenes. Transport was by bus, boat and hiking. Overnight accommodation was arranged in Seida school house.



*Boundary between well bedded sandstones and shales of the pre-Neoproterozoic glacial Veinesbotn Formation (tilted gently to the left which is to the north) and the massive diamictites and conglomerates at the base of the glacial Smalfjord Formation (ca. 640 Ma old), forming the main cliff above. Western end of Vieranjar'ga, W. Varangerbotn. The excursion will be visiting these outcrops by boat, from Grasbakken. (Photo: A. Hugh N. Rice, Vienna)*





## No. 44. Svalbard (Spitsbergen) Round Trip - Post Caledonian Tectono-stratigraphic and Paleogeographic Development

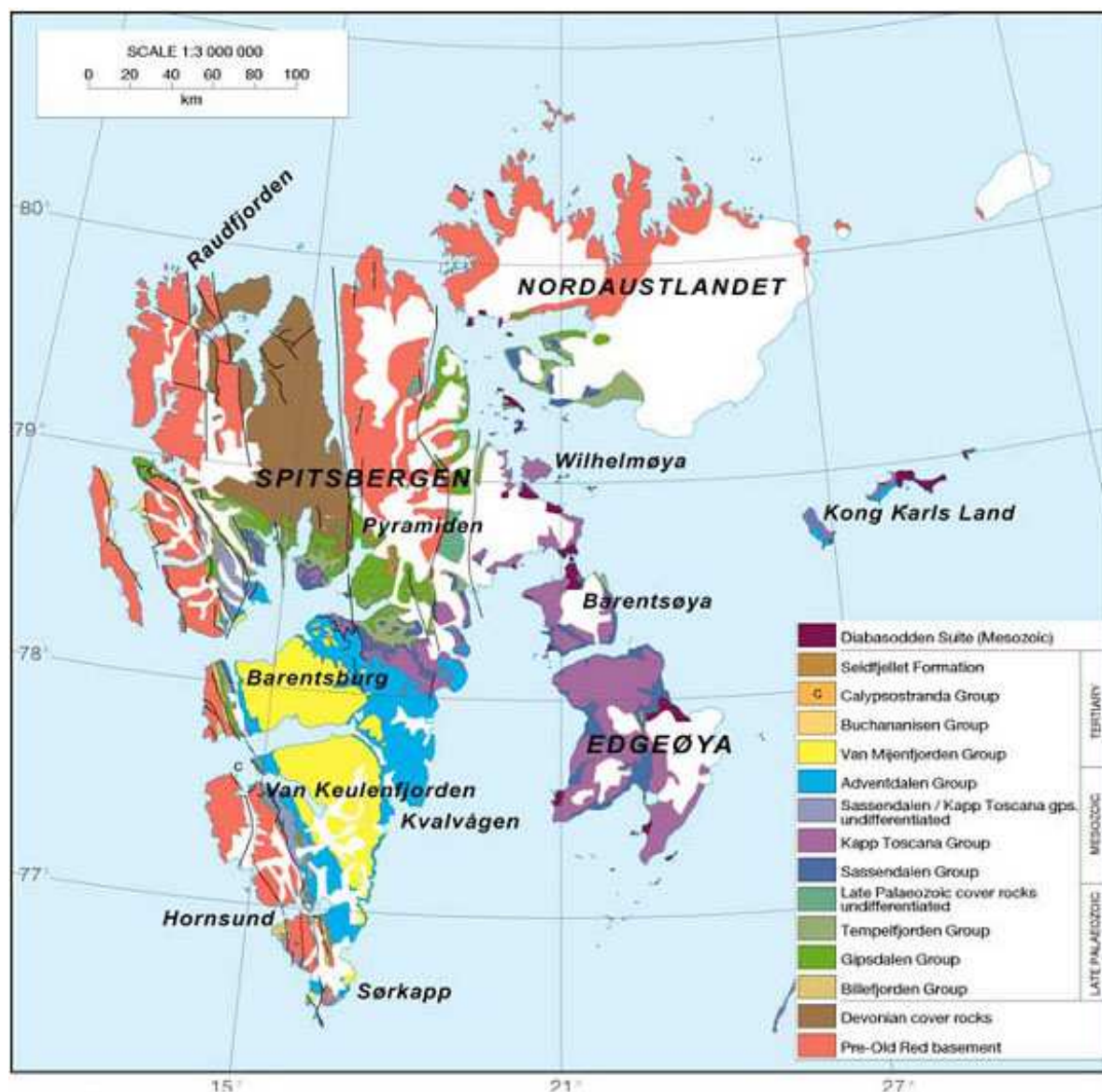
**Leaders:** Erik P. Johannessen (chief organizer: EPJ@StatoilHydro.com), Geir B. Larsen, Tormod Henningsen and Bjarne Rafaelsen, StatoilHydro, Norway

Time: 27 July - 5 August

Participants: 16

Nationalities: 7

The aim of the excursion was to give geoscientists from other countries a comprehensive view of the Post Caledonian Tectonostratigraphic and Paleogeographic development around Svalbard. This was done by an eleven day cruise along the western eastern coasts of Spitsbergen as far north as the ice permitted using the ship Orion as a mobile home base, and landing onshore localities by zodiac along route. The trip started and ended in Longyearbyen in Isfjorden. At first, a complete stratigraphic overview from Lower Carboniferous to base Tertiary was presented at the Festningen profile in Isfjorden. For the rest of the cruise, main emphasis was placed on the lower Carboniferous (coal bearing succession), Middle Carboniferous (Alluvial fans and sabkhas), Upper Carboniferous (shallow marine carbonates), Triassic/Jurassic/Cretaceous (deltaic to shallow marine succession) and Tertiary (a shelf/slope/basin clinoformed succession). Comparison to the rest of the Barents Sea and Sverdrup Basin in Arctic Canada was discussed.



*Simplified geological map of Svalbard. (Map from Dallmann 1999 in excursion guide)*





*The northern slopes of Midterbuken in Bellsund provide a striking example of structural styles within the Tertiary deformation zone. The exposed sequence young's from right (west) to left (east) from Early Permian to Late Triassic and deformation is concentrated within the incompetent shale dominated Sassendalen Group. (Photo: A. Andresen, Svalex)*

#### **No. 47. Khibina and Lovozero alkaline massifs: geology and unique mineralization**

**Leaders:** Dr. Andrei Arzamastsev (chief organizer: [arzamas@geoksc.apatity.ru](mailto:arzamas@geoksc.apatity.ru)); Dr. Victor N. Yakovenchuk, [yakovenchuk@geoksc.apatity.ru](mailto:yakovenchuk@geoksc.apatity.ru), Dr. Yakov A. Pakhomovsky and Dr. Gregory Yu. Ivanyuk, Geological Institute of the Russian Academy of Sciences, Russia

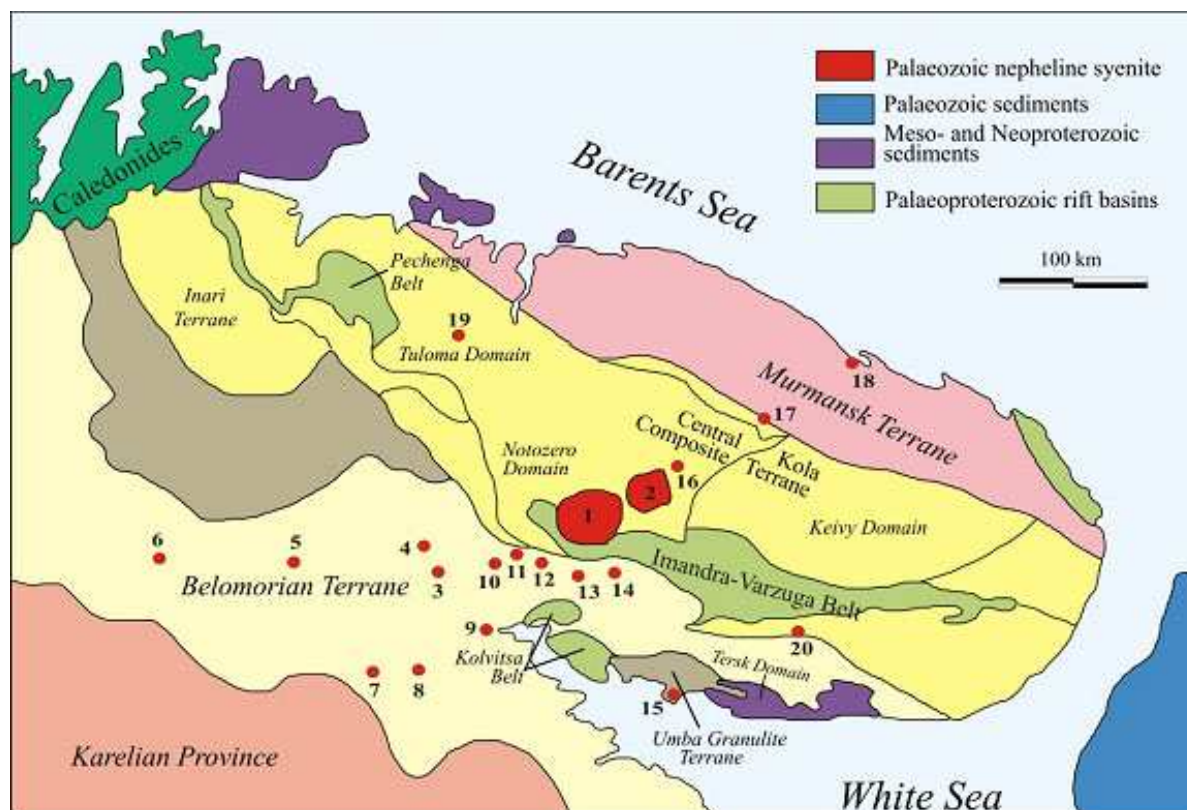
Time: 22 July - 2 August

Participants: 4

Nationalities: 3

The trip was aimed at providing an opportunity for igneous petrologists and geochemists to ponder the role of plume-lithosphere interaction processes responsible for the origin of enormous amounts of apaitic magmas and deciphering the circuitous routes of alkaline magma evolution. Participants examined the main rock complexes of the two world biggest apaitic intrusions of the Khibina and Lovozero, which are the key magmatic centers of the Paleozoic Kola Alkaline Province. In the Khibina the excursion visited apatite-nepheline and titanite ore deposits. In Lovozero the participants studied classical outcrops of lujavrite-foyaite-urtite rhythms with loparite (Nb, Ta) and eudialite (Zr, Hf) commercial mineralization. In the open pits of both massifs (like Niorkpakhk and Koashva mines) one could examine widespread small pegmatite bodies with nice alkaline minerals, as well as dykes of alkaline lamprophyres and tinguaitite. The trip furthermore gave a rare opportunity to visit unique localities of the famous mineralogy of Khibina and Lovozero: over 550 mineral species are present here; more than 100 of them were world-first discoveries. Most of the rare minerals are sodium titanio-, niobo- and zirconsilicates, which could be found in pegmatites and hydrothermal veins. Alteration of earlier minerals under hydrothermal and supergene conditions produces newly formed mineral phases, and this process continues up to the present day.





The locations of various alkaline intrusions in the Kola Peninsula. The Palaeozoic complexes: 1 - Khibina, 2 - Lovozero, 3 - Niva, 4 - Mavraguba, 5 - Kovdor, 6 - Sokli, 7 - Sallanlatva, 8 - Vuoriyarvi, 9 - Kandaguba, 10 - Afrikanda, 11 - Ozernaya Varaka, 12 - Lesnaya Varaka, 13 - Salmagora, 14 - Ingozero, 15 - Turiy Mys, 16 - Kurga, 17 - Kontozero, 18 - Ivanovka, 19 - Seblyavr, 20 - Pesochny. (Map of Precambrian basement after Balagansky et al., [2006] in excursion guide)

#### No. 48. The Cu-Ni-PGE and Cr deposits of the Monchegorsk area, Kola Peninsula, Russia

**Leaders:** Dr. Yury L. Voytekhovskiy and Dr. Yury N. Neradovsky, Geological Institute, Kola Science Centre, Russian Academy of Science, Russia

Time: 15 - 21 August

Participants: 6

Nationalities: 4

The aim of the excursion was to give an opportunity for both mining geologists and geologists of broad interests to examine the genesis settings of Cu-Ni, Cr and PGE ore related to the layered mafic-ultramafic massifs intruded into the supracrustal Archean complexes at the 2,500-2,400 Ma boundary, as well as the marked productive phase of mantle plume activity at the Archean-Proterozoic boundary. The excursion route included eight outcrops close to the town of Monchegorsk and one outcrop near the town of Apatity. The Monchegorsk pluton and the Imandra lopolith are the typical representatives of the Paleoproterozoic ore-bearing layered intrusions on the Fennoscandian Shield, and due to the nice exposures and availability they are also unique sites for investigation.

The excursion started and ended in Murmansk. Transport was by off-road cars and bus. The participants of the excursion were accommodated at the hotel at the Imandra lakeside.





## No. 51. The Sveconorwegian orogen of southern Scandinavia: setting, petrology and geochronology of polymetamorphic high-grade terranes

**Leaders:** Jenny Andersson, Geological Survey of Sweden; Bernard Bingen, Geological Survey of Norway; David Cornell, Göteborg University, Sweden; Leif Johansson and Ulf Söderlund, Lund University, Sweden; Charlotte Möller, Geological Survey of Sweden

Time: 2 - 5 August

Participants: 12

Nationalities: 6

The Sveconorwegian orogen in southern Scandinavia is the result of a collision between Fennoscandia (the southwestern continental segment of Baltica) and another continent in late Mesoproterozoic time. The excursion dealt with the eastern parts of the Sveconorwegian orogen, aiming to highlight the combination of field geology, metamorphic petrology and different applications of geochronological-geochemical analytical techniques to constrain the timing and character of metamorphic and tectonothermal events in high-grade metamorphic complexes. A primary goal with the excursion was to bring together structural geologists, metamorphic petrologists, isotope geochemists, geochronologists, and other geoscientists to combine their expertise and discuss how to model tectonic cycles, and thereby how to understand the crustal evolution of our continents. The excursion was organised as a four days field trip to cover three principal themes regarding the tectonic build-up of this part of the Sveconorwegian orogen. (I) "Transect across the Sveconorwegian orogenic front", dealing with the tectonic build-up of the orogenic front and the geochronology of structures and metamorphism related to the tectonic evolution of the easternmost high-grade parts of the orogen; (II) "Eclogites, high-P granulites and charnockites", with focus on the timing and tectonic setting of high-P and high-P-T metamorphic events in the high-grade gneiss complex of the Eastern Segment; (III) "Tectonic boundaries and lithotectonic build-up of the Sveconorwegian orogen", concerning the age and tectonic style of metamorphic terrane boundaries and the crustal evolution of allochthonous lithotectonic units overlying the high-P rocks of the Eastern Segment. For these purposes, the excursion was done as a traverse through the orogen, from well preserved rocks of the pre-Sveconorwegian Fennoscandian craton across the Sveconorwegian deformation front into the high-grade gneiss complex of the partly parautochthonous Eastern Segment and further west into the Sveconorwegian allochthon. The excursion participants were taken to well exposed high-grade metamorphic domains, including the Southwest Swedish granulite region that exhibits a polymetamorphic high-grade gneiss complex with charnockites, high-pressure granulites and tectonically emplaced eclogites. The individual excursion stops were selected to include key localities that have been used to construct, characterise and directly date the P-T evolution and tectonic build-up of this part of the orogen.

The excursion started at Landvetter International Airport, Gothenburg, and ended at Gardermoen International Airport, Oslo. Transportation was by bus and ferry. Overnight accommodation was arranged in hostels along the route.



*Intermingled coarse- and fine-grained charnockite in the Varberg Granitecharnockite plutonic suite. (Photo: Leif Johansson)*



## No. 52. Geology, Radiological Age, and Metallogeny of Greenstone Complexes in the Ukrainian Shield

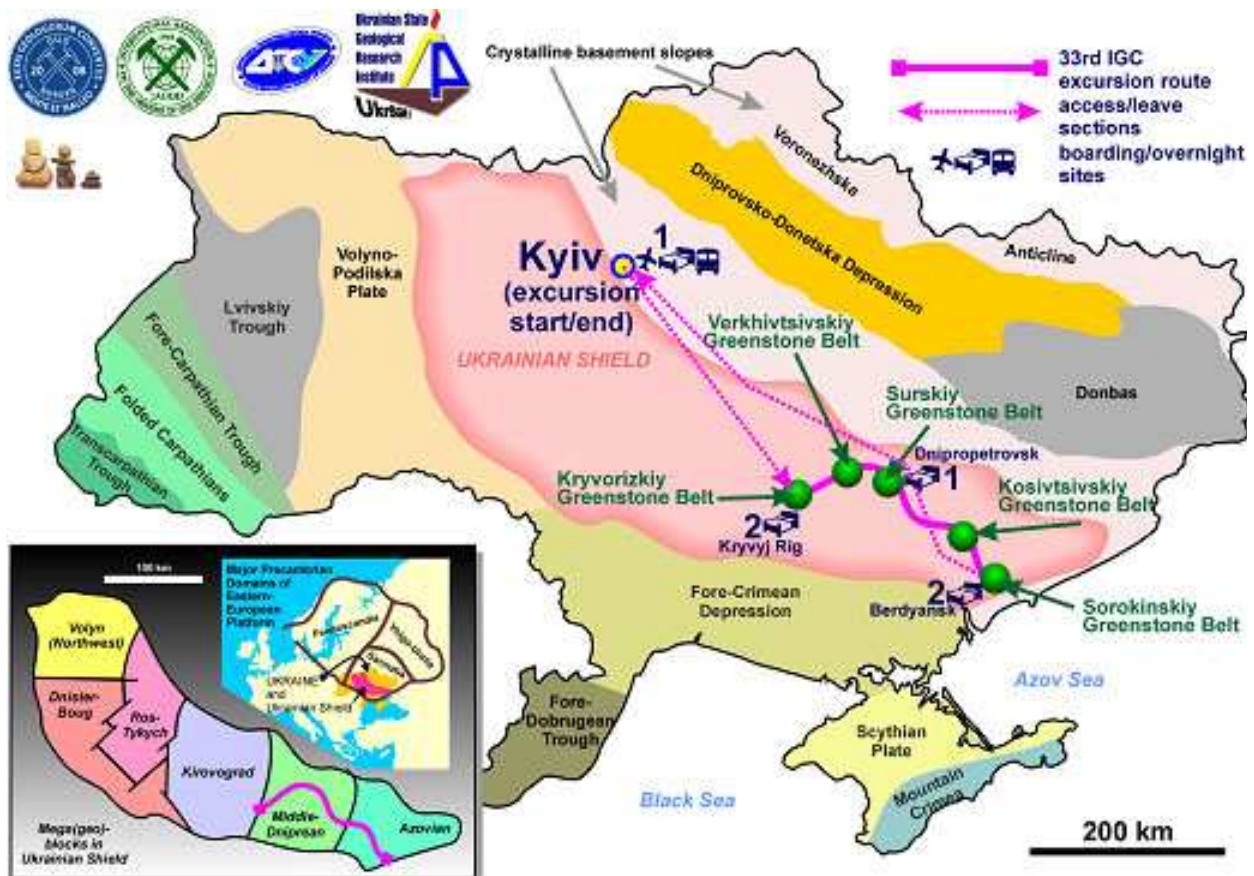
**Leaders:** Alexander B. Bobrov and Boris I. Malyuk, Ukrainian State Geological Research Institute, Ukraine

Time: 31 July - 6 August

Participants: 6

Nationalities: 5

The Ukrainian Shield comprises the south-western parts of the crustal segments that constitute the oldest basement of the Eastern-European Platform. The purpose of the excursion was to introduce the participants to the principal features of geology, geochronology and metallogeny of greenstone belts developed in the eastern part of the Ukrainian Shield, which is a key region for understanding its Archean and Proterozoic history. It is also the major mineral producing region of Ukraine accounting for the gross national output of the iron and manganese ores, uranium, mineral sands, and is the principal region of mineral and exploration for gold, copper, nickel, molybdenum, rare metals, rare earths, and diamonds. The excursion went across two Mega-Blocks of the Shield - Middle-Dniprean tonalite-greenstone and Azovian granulite-greenstone. Major attention was paid to the greenstone rock complexes that provide information mainly on the Archean and Proterozoic magmatism, sedimentation, tectonics and mineralization in the time span 3.2-2.1 Ga. The rocks developed in the greenstone basement (various granite-gneisses, migmatites etc.) were more briefly examined in conjunction with the issues of geochronology.



*Excursion route plotted on sketch map of main tectonic elements of the Ukrainian Shield. (Map from excursion guide)*





## No. 56. Bjørnøya, an Upper Palaeozoic-Triassic window into the Barents Shelf

**Leaders:** Atle Mørk (atle.mork@iku.sintef.no), SINTEF Petroleum Research, Norway; Hans Arne Nakrem, Natural History Museum, University of Oslo, Norway

Time: 15 - 22 August

Participants: 5

Nationalities: 1

The purpose of the excursion was to study the geology of the island of Bjørnøya as a reference for the geology of the Barents Sea Shelf. The Precambrian to Triassic succession on Bjørnøya appears in a continuous series of spectacular cliff exposures of which the following parts were studied:

Devonian - Lower Carboniferous sequences with fluvial deposits and flood plain coal bearing sediments. A visit to the old mining town of Tunheim (1916-1925) is included (E coast, Røedvika Fm)

Lower Carboniferous porous sandstones (Nordkapp Fm) and Permian limestones (Miseryfjellet Fm) on the N coast

The continental to marine transitional Landnordingsvika Fm (Mid-Carboniferous) on the SW coast

The marginal marine rhythmic sequences and marine carbonates of the Moscovian Kapp Kåre Fm (N and SW coasts)

Tectonically influenced clastic deposits of the Upper Carboniferous Kapp Hanna Fm (N and W coasts)

Lower Permian palaeoaplysiniid reefs and stacked bioherms of the Kapp Dunér Fm (W coast)

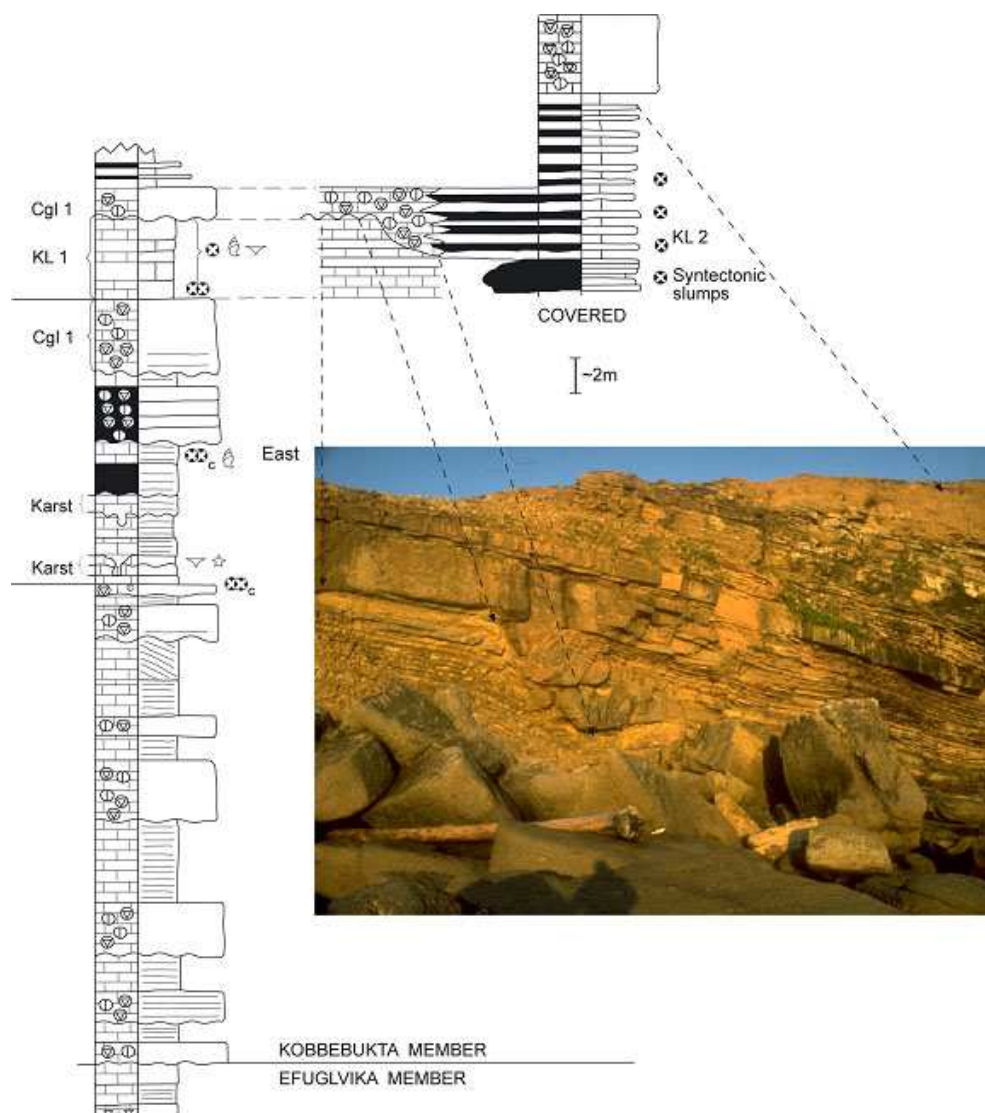
Mixed carbonates and clastics of the Hambergfjellet Fm, the only land exposure of the Bjarmeland Group (SW cliffs)

Upper Permian fossil-rich platform carbonates of the Miseryfjellet Fm (N coast and Miseryfjellet)

The Triassic Urd and Skuld fms forming the highest points of Bjørnøya, top at 536 m above sea level

The excursion started and ended in Tromsø. Transport and accommodation was by ship.

*Intra-formational conglomerates in the Kobbekbukta Member (Upper Carboniferous), uppermost Kapp Kåre Formation show a syn-depositional fault that reflects renewed tectonic activity producing small half-grabens which then channelled debris flows and turbidites from the newly emergent eastern high.*



## Mid-Congress one-day excursions

### No. 25 a. The Palaeozoic geology of the Oslo Region - The Outer Oslo Fjord area

**Leaders:** Bjørn T. Larsen, Det Norske, Norway; Snorre Olaussen, Eni Norge, Norway

Time: 8 August

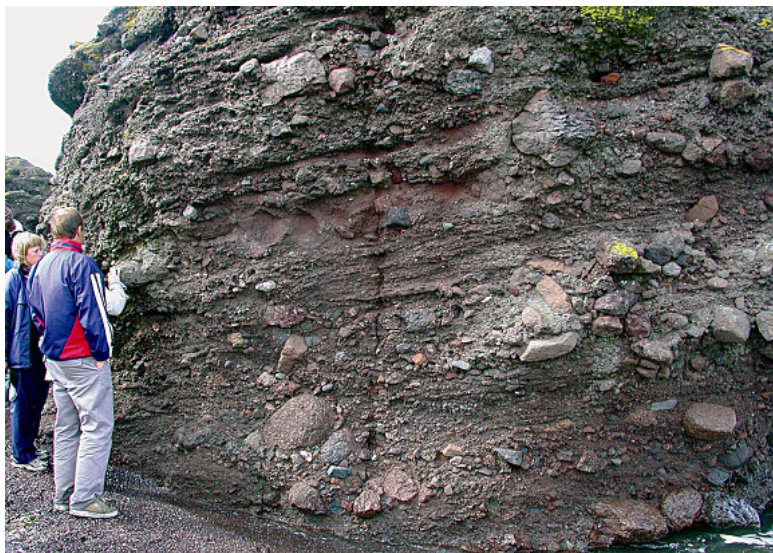
Participants: 20

Nationalities: 8

The purpose of the excursion was to present some main aspects of the Palaeozoic geology of the Oslo region, i.e. the Caledonian foreland and the Carboniferous-Permian continental rift development. The excursion visited only four localities, which were all excellent costal exposures. Two of them, in the upper part of the Lower Palaeozoic section, showed the youngest part of the marine limestones of Wenlockian age, and the youngest part of the foreland basin sandstones of Pridolian age. The other two localities exposed Upper Palaeozoic volcanics and volcanoclastic sediments from the early rift stage and the climax rift stage of the Oslo Rift development in latest Carboniferous and Early Permian.

The excursion was by boat in the outer part of the Oslo Fjord. Return transport from Oslo was by bus.

*Lower Permian alluvial fan conglomerates on the Sletter Island.  
(Photo: B. T. Larsen)*



### No. 25 b. The Palaeozoic geology of the Oslo Region - The Inner Oslo Fjord area

**Leaders:** Bjørn T. Larsen, Det Norske, Norway; Snorre Olaussen, Eni Norge, Norway

Time: 12 August

Participants: 35

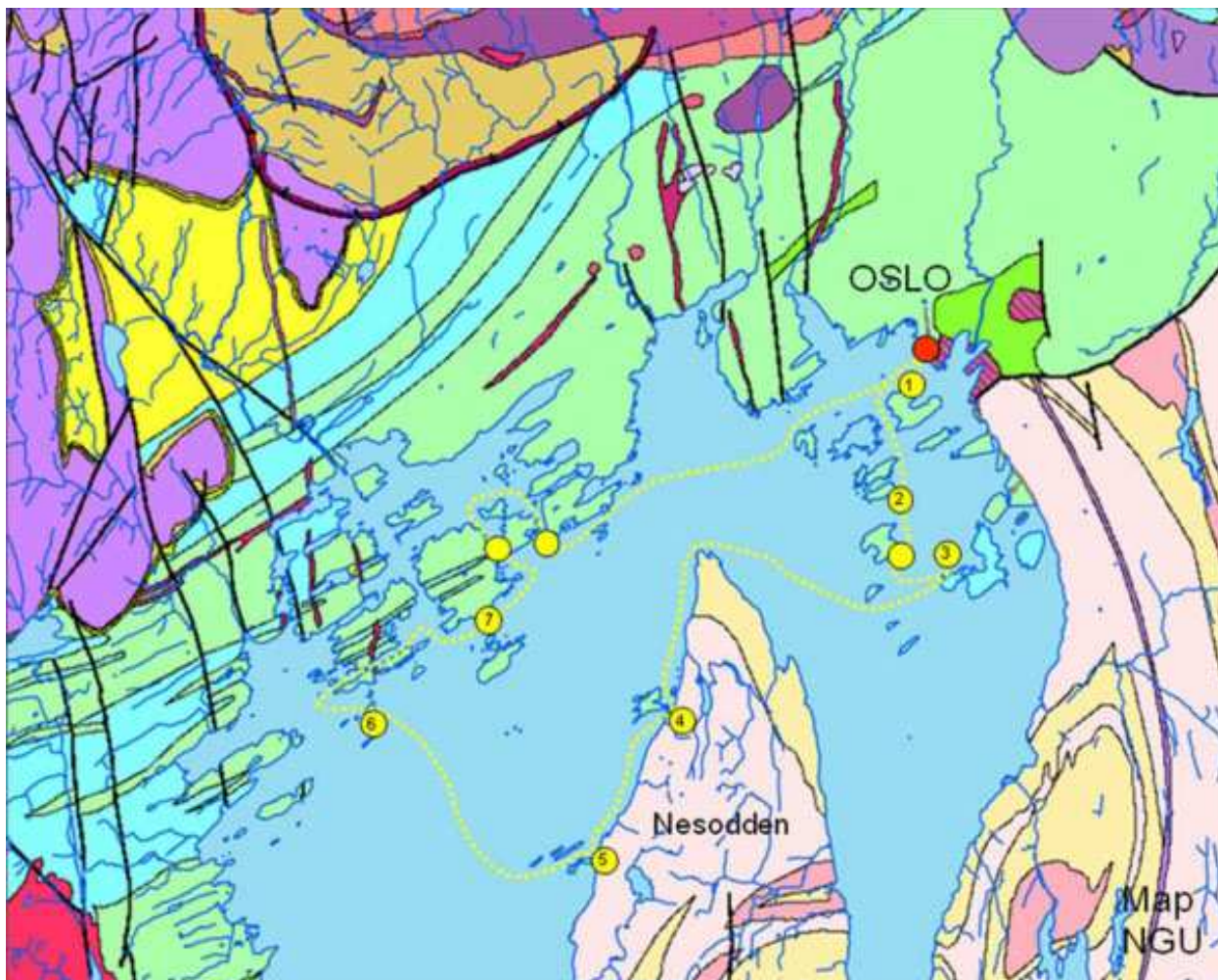
Nationalities: 16

The purpose of the excursion was to introduce a large group of scientists to the Lower Palaeozoic geology of the Oslo Region, with special emphasis on sequence stratigraphy, sedimentology and palaeo-ecology particularly related to the upper Ordovician and the lower Silurian, including the nature of the Ordovician/Silurian boundary. The excursion was by boat visiting six localities at excellent costal exposures. The majority of the outcrops were in the Lower Palaeozoic. In addition, a variety of Permian dykes and the prominent rift boundary fault of the Oslo Rift, the Nesodden Fault, were visited.

The excursion started and ended in the harbor in the centre of Oslo.







*Excursion boat "Nordsol". Excursion route in inner Oslo Fjord*

## No. 57. Geoenergy

**Leaders:** Kirsti Midttømme (Kirsti.Midttomme@ngu.no), Geological Survey of Norway

Time: 10 August

Participants: 32

Nationalities: 18

The purpose of the excursion was to introduce the participants to the use of geothermal energy in the Nordic countries. Both Iceland and Sweden are ranked on the top five list of geothermal direct utilization worldwide. Since Sweden and Norway are part of the Baltic Shield with heat flow density below continental average, ground-source heat pumps (GSHP) are used to provide heating, cooling and domestic hot water for private and commercial buildings. Some large GSHP installations are in operation in the Oslo area. The excursion visited two of them, Ahus hospital, where 230 boreholes in rock provides heat and cold to the new hospital, and the Oslo airport Gardermoen where heat and cold are extracted from the groundwater. The excursion also stopped at a drilling site to show the "Scandinavian way" to drill an energy well and demonstrate a Thermal Response Test (TRT), which allows in-situ determination of ground thermal properties. The last stop was at the hospital Rikshospitalet in Oslo where, in 1999, an attempt was made to develop a Hot Dry Rock (HDR) pilot plant with a closed loop system to 5,000 m depth.

The excursion was by bus starting and ending at the conference center at Lillestrøm outside Oslo.



**No. 58. Radon geology excursion****Leaders:** Britt-Marie Ek, Geological Survey of Sweden

Time: 15 August

Participants: 52

Nationalities: 24

A one-day radon geology excursion was held in the Oslo area for participants of the 9th International Workshop on Geological Aspects of Radon Risk Mapping (EGG-03) and the workshop of Radon Risk Mapping. In the Oslo area radon problems are connected to Precambrian uranium rich granites, 900 my old, and the Upper Cambrian alum shale, on which large parts of central Oslo is built, and the very permeable fluvial glacial and talus material. The participants of the excursion visited areas with alum shale as well as granites, and were presented with different methods for radon remediation.

The excursion was made by bus starting and ending in Oslo.

**No. 101. Neoproterozoic Moelv Tillite and the Hedmark Basin, the Mjøsa Area, South Norway****Leader:** Johan Petter Nystuen (j.p.nystuen@geo.uio.no), University of Oslo, Norway

Time: 10 August

Participants: 31

Nationalities: 13

The object of the excursion was the type area for the Neoproterozoic Hedmark Group north of Oslo. This more than 5,000 m thick succession is dominated by feldspathic sandstones ("sparagmites") and contains a prominent glacial formation, the Moelv Tillite. The tillite was formed during the Varangerian Glaciation and correlates to the tillite formations in the Varanger Region in Eastern Finnmark of northern Norway. The Hedmark Group was deposited during the rift to post-rift stage of the Hedmark Basin at the northwestern margin of continent Baltica, from about 750 Ma to the onset of the Cambrian, in response to break up of Rodinia. The excursion gave an overview of the stratigraphy of the succession in which the Moelv Tillite lies, putting emphasis on the Varangerian tillite in the Moelv area and to localities showing outcrops of different syn-rift turbidite fan deposits along the route.

The excursion was done by bus starting and ending in Oslo.

**No. 102. The Gardnos meteorite crater****Leaders:** Elin Kalleson, Tom Jahren and Henning Dypvik (henning.dypvik@geo.uio.no), Department of Geoscience, University of Oslo, Norway

Time: 10 August

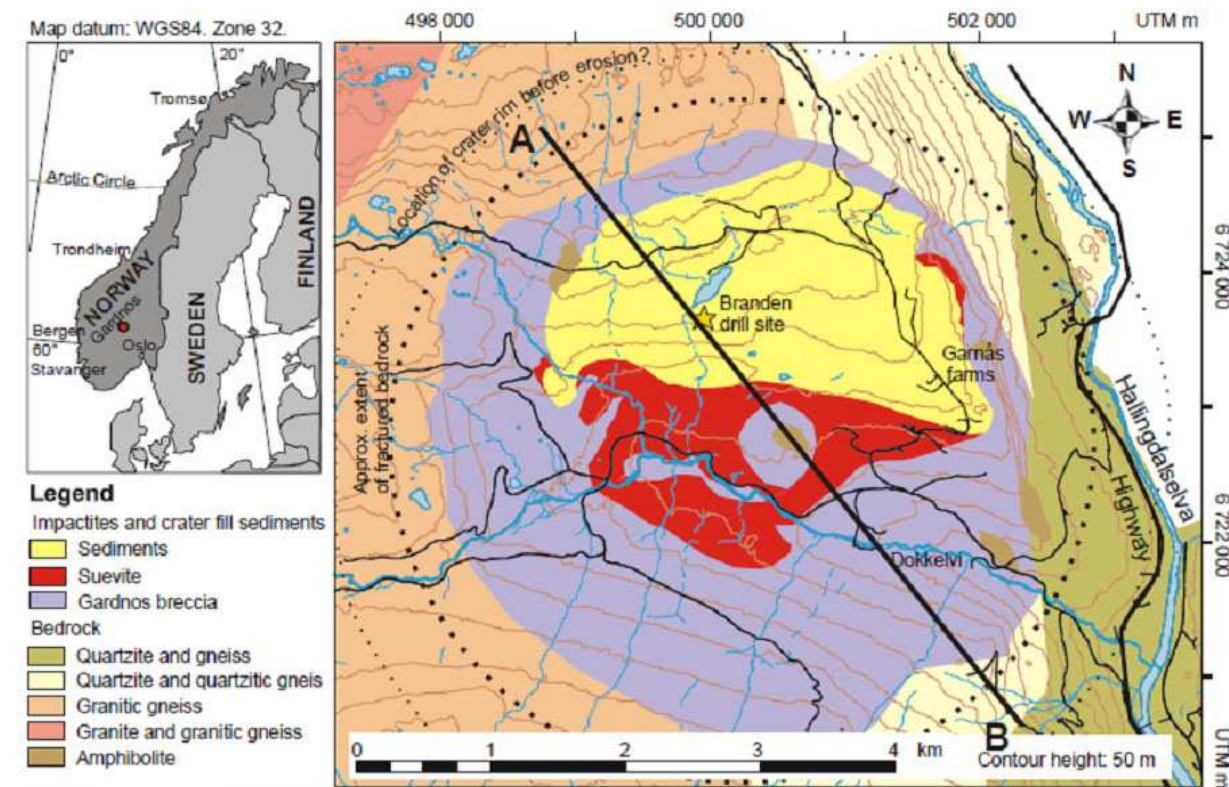
Participants: 48

Nationalities: 22

The purpose of the excursion was to present the field evidence for the late Precambrian (?) Gardnos impact structure. It is represented by outcrops of impact-produced breccia and post-impact sediments within a roughly circular area of 5 km in diameter. The main types of impact breccias are the autochthonous Gardnos breccia and the overlying allochthonous suevite breccia. The excursion visited localities of the different target rocks, impact- and post-impact lithologies. The stratigraphic relations were illustrated and the participants were given an overview of the structure as it is preserved today.

The excursion was by bus starting and ending in Oslo.





*Geological map of the Gardnos impact structure. (Map from excursion guide)*

### No. 103. Urban geochemistry in Oslo

**Leaders:** Rolf Tore Ottesen (rolf.ottesen@ngu.no), Geological Survey of Norway; Kaj Lax, Geological Survey of Sweden; Timo Tarvainen, Geological Survey of Finland

Time: 10 August

Participants: 12

Nationalities: 8

The excursion was arranged in relation to the Symposium EGC-03, which was held on the previous day (6 August) and convened by the Geological Surveys of Finland, Norway and Sweden. The half-day excursion concentrated on urban geochemistry in Oslo, demonstrating the results of a three-year successful project carried out by the Geological Survey of Norway in co-operation with Oslo city, under which geochemical methods have been applied inter alia in day care centres, and a new administration system for polluted soil in urban environment has been developed.

The excursion was by bus starting and ending in Oslo.

### No. 104. Classical fossil localities in the Oslo area

**Leaders:** David Bruton (d.l.bruton@nhm.uio.no), University of Oslo, Norway; J. Fredrik Bockelie, Sagex Petroleum ASA, Norway; Hans Arne Nakrem, University of Oslo, Norway

Time: 10 August

Participants: 26

Nationalities: 11

The Oslo Fjord with its Permian and Precambrian backcloth is scattered with numerous islands with beaches orientated in a characteristic Caledonian northeast-southwest direction. These islands and adjacent coastal sections make up the classical localities of the Oslo area, with its Lower Palaeozoic rocks and fossils known internationally since 1844. Between 1855 and 1878 the names Cambrian and Silurian were used for these rocks and not before 1916 was the name Ordovician introduced. The purpose of the excursion was to give a brief insight to the local geology with stops at a selected number of classical fossil bearing localities where Cambrian and Ordovician rocks are exposed. One locality of Silurian interest was





included. In the 1980s and 90s the Ordovician and Silurian rocks were subjected to intensive study resulting in new definitions of units. Stratotypes and localities were selected and these today provide a solid foundation for future studies. Many of the classical sections in the Oslo area are small in extent and have been subjected to intensive collection throughout the years. In June 2008 a bill confirming the full protection of sites in the inner fjord area went through Parliament. This now applies to a number of the excursion stops prohibiting collecting and use of hammers. At the remaining localities, however, the excursion participants were free to take samples of their choice.

The excursion was by bus starting and ending in Oslo.



*The Cambrian unconformity at Slemmestad pointed out by the excursion leader, Prof. David Bruton.  
(Photo: Karl Bruton)*





We wish to extend thanks to our sponsors



**DONG**  
energy



**NORECO**

**BOLIDEN**

**EUROPEAN  
SCIENCE  
FOUNDATION**  
SETTING SCIENCE AGENDAS FOR EUROPE



**Elkem**



**IRIS**  
International Research Institute of Stavanger

**MAERSK OIL**

**TALVIVAARA**

**RWE**  
The energy to lead



ارامكو السعودية  
**Saudi Aramco**



**AREVA**

**Lundin**



Under the Patronage of UNESCO



**SGU**  
Sveriges geologiska undersökning  
Geological Survey of Sweden



We also wish to thank the following public organisations which have given significant financial support: Norwegian Ministry of Foreign Affairs, Norwegian Ministry of Trade and Industry, Norwegian Ministry of Petroleum and Energy, Norwegian Ministry of Education and Research, The Research Council of Norway, The City of Oslo, Ministry for Foreign Affairs of Finland, Swedish Research Council, Swedish International Development Cooperation Agency