



INTERNATIONAL UNION OF GEOLOGICAL SCIENCES
INTERNATIONAL COMMISSION ON STRATIGRAPHY



February 2011

Compiled ICS Subcommittee Annual Reports for 2010

SUBCOMMISSION ON QUATERNARY STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Quaternary Stratigraphy (SQS)

Philip GIBBARD *Chairman, SQS*

Cambridge Quaternary, Department of Geography, University of Cambridge, Downing Street,
CAMBRIDGE CB2 3EN, England.

Tel: +44 (0)1223 333924; Fax: +44 (0)1223 333392, E-mail: plg1@cam.ac.uk

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

1. Rationalisation of global chronostratigraphical classification.
2. Intercalibration of fossil biostratigraphies, integrated zonation and recognition of global datum points.
3. Definition of Subseries/Series boundaries and selection of global stratotype sections.
4. Correlation of Quaternary rock successions and events, including terrestrial to marine sequences.

The objectives satisfy the IUGS mandate of fostering international agreement on nomenclature and classification in stratigraphy; facilitating international co-operation in geological research; improving publication, dissemination, and use of geological information internationally; encouraging new relationships between and among disciplines of science that relate to Quaternary geology world-wide; attracting competent students and research workers to the discipline; and fostering an increased awareness among individual scientists world-wide of related programmes are being undertaken.

3. ORGANISATION

ISQS is a Subcommission of the International Commission on Stratigraphy.

Officers (chairman, one vice-chairman, secretary), voting members (18). (*see Appendix for complete listing*). There are currently four Working Groups established the remit of three of which is the definition of GSSPs for the Early-Middle, Middle/Late Pleistocene and Late Pleistocene/Holocene boundaries and the fourth is to investigate the validity and applicability of the term Anthropocene. A fifth working group is currently being convened that will examine the utility of formal definition of short-time divisions.

These individuals represent a broad spectrum of specialised stratigraphical disciplines from throughout the World. Publication of information is by the group's website.

3a. Nominated Officers for 2010-2012:

Chairman: Professor Philip Gibbard

Cambridge Quaternary

Department of Geography, University of Cambridge

Downing Street, Cambridge CB2 3EN, England

E-mail: plg1@cam.ac.uk

Vice-Chair: Professor Jerry McManus

Wood's Hole Oceanographic Institute

Wood's Hole, MA, USA

E-mail: jmcmanus@ldeo.columbia.edu

Secretary: Professor Thijs van Kolfschoten

Faculty of Archaeology, Leiden University

Reuvenplaats 4, 2300 RA Leiden, The Netherlands

E-mail: T.van.Kolfschoten@rulpre.leidenuniv.nl

4. EXTENT OF NATIONAL/REGIONAL/GLOBAL SUPPORT FROM SOURCES OTHER THAN IUGS

Support of the Chairman's University (University of Cambridge), and the International Association of Quaternary Research (INQUA). Also support from national stratigraphical bodies, including in particular the Geological Society Stratigraphical Commission (GB).

5. CHIEF ACCOMPLISHMENTS IN 2010

Of the three GSSP Working Groups established in 2002, two of the three (Middle Pleistocene and Late Pleistocene) continue to have fully functioning formal working groups (see below for membership lists). The Anthropocene working group, established in 2009, continues to function very actively this year. In addition to these groups, the chairman invited Professor Maria Bianca Cita to compile a proposal for establishment of a basal GSSP for the Calabrian Stage. It was decided to wait before developing fledgling working groups into fully functioning organisations until the principal GSSP goals had been settled.

The Working Group on the Lower/Middle Pleistocene Subseries boundary currently comprises: Luca Capraro (Italy), Neri Ciaranfi (Italy), Craig Feibel (USA), Martin Head (Canada, Co-Chair), Hisao Kumai (Japan), Luc Lourens (The Netherlands), Lui Jiaqi (China), Anastasia Markova (Russia), Tom Meijer (The Netherlands), Muneki Mitamura (Japan), Brad Pillans (Australia, Co-Chair), Cesare Ravazzi (Italy), Charles Turner (UK), Thijs Van Kolfschoten (The Netherlands).

The past year has seen some changes to the composition of the Working Group. Prof. Martin Head joined Prof. Brad Pillans as co-chair, and two colleagues are new to the Working Group: Prof. Neri Ciaranfi of the University of Bari, Italy, and Prof. Muneki Mitamura, Osaka City University, Japan.

Three sections are under consideration, the Montalbano Jonico section in the Province of Matera, Southern Italy (proponent, Neri Ciaranfi), the Valle di Manche section in the Crotona Basin, Southern Italy (proponent, Luca Capraro), and the Chiba section in Japan (proponent, Hisao Kumai).

Unfortunately, each section has its problems. The Montalbano Jonico section is in many ways ideal but efforts to obtain a magnetostratigraphy have not been successful owing to diagenetic overprinting. This is a crucial problem because it has long been accepted that the Matuyama–Brunhes boundary should serve as the principal guide to the Early–Middle Pleistocene boundary. Nonetheless, progress is being made on this section. For example $^{40}\text{Ar}/^{39}\text{Ar}$ dating shows an age of $805.42 \text{ ka} \pm 12\%$ for the volcanoclastic V3 layer of Montalbano, which is close to that of the Matuyama–Brunhes boundary. Plans were being made to drill a borehole through the section this September as a final attempt to obtain a magnetostratigraphy (N. Ciaranfi pers. comm. to MJH on 16 July) but we have no further news on this.

The Valle di Manche section has magnetostratigraphy and the Matuyama–Brunhes boundary is clearly demarcated. Detailed bio- and isotope stratigraphies are available for this section, although there seem to be problems with the interpretation of the pollen record. Luca Capraro and colleagues are willing to submit a formal proposal on this section at relatively short notice.

The Chiba section in Japan has a recorded magnetostratigraphy, with the Matuyama–Brunhes boundary clearly shown, and significant additional studies have been conducted. However, there is no easy synthesis (in English at least) to evaluate the section. A one-day symposium to be held in Ichihara City, Chiba Prefecture, Japan followed by a field trip to the section, is planned in mid-January 2010. Brad Pillans and Martin Head have been invited to attend and will evaluate the section.

The Working Group on the Middle/Upper Pleistocene Subseries boundary has continued throughout the year under the chairmanship of Professor T.Litt (Bonn). The aim was to find an agreement about the selection of a geological section for a potential boundary stratotype (GSSP).

The full formal GSSP proposal defining the Middle/Upper (Late) Pleistocene boundary was prepared in 2008 at the Amsterdam Terminal (the Eemian Stage parastratotype). This boundary should constitute the Global Stratotype Section and Point (GSSP) for the base of the Upper (Late) Pleistocene Subseries (Quaternary System/Period). The International Commission of Stratigraphy has approved this GSSP proposal. The voting by the Quaternary Subcommittee was 100% in favour (18 voting). The votes received from the ICS voting membership were 10 in favour (71%), and 4 against. The request for IUGS ratification of this GSSP definition was considered by the IUGS Executive Committee in September 2008, however, the IUGS EC did not ratify this proposal as presented by the SQS/ICS, mainly based on procedural matters, protocol and principle. Work on this boundary has fallen into abeyance ever since and is unlikely to be re-presented until the Subcommittee have decided upon a course of action concerning the proposal of a ‘standard stage’ division for the Late Pleistocene Subseries interval.

The Working Group on the Pleistocene-Holocene boundary, chaired by Professor M. Walker (Lampeter), completed its primary task of defining the base of the Holocene Series in the new Greenland NorthGRIP (NGRIP) ice core in 2008. Following publication of the GSSP information (Walker, M.J.C., *et al.* 2009 *Journal of Quaternary Science*, 24, 3-17) the working group has ceased activity. However, as noted in last year's report, the Holocene working group will remain constituted to examine the potential utility of possible formal subdivision of the series.

The Anthropocene Working Group, chaired by Dr J. Zalasiewicz (Leicester) established in 2009 to examine the potential value of the term and its underlying stratigraphic basis in more detail and to consider, and subsequently make recommendations on, its possible formalisation. The group has continued to be very active.

Much of this year's work has involved compiling and editing (by Williams, Zalasiewicz, Haywood & Ellis) a thematic volume of papers for the *Philosophical Transactions of the Royal Society of London, Series A on The Anthropocene – a new epoch of geological time?* The authorship includes many of those in the Working Group, and the work included might be considered as an initial exploration of some of the aspects that the Working Group will be aiming to examine more closely. Copies of the papers of this volume will be available following publication (in January 2011, according to the Royal Society).

A 2-day meeting on the Anthropocene at the Geological Society of London on 11th-12th May 2011. The programme will include Paul Crutzen, Will Steffen, Erle Ellis, Dennis Dimick, James Syvitski, Dorothy Merritts and Davor Vidas.

Erle Ellis and colleagues this year published a key paper detailing how anthropogenic modification of the terrestrial biosphere developed through immediately pre-industrial times to the present:

Ellis, E.C., Goldewijk, K.K., Siebert, S., Lightman, D. and Ramankutty, N. 2010. Anthropogenic transformation of the biomes, 1700 to 2000. *Global Ecology and Biogeography*. DOI: 10.1111/j.1466-8238.2010.00540.x.

The concept of the Anthropocene has been quoted as a possible influence on the Law of the Sea in the newly published book *Law, Technology and Science for Oceans in Globalisation*, edited by Davor Vidas (Martinus Nijhoff Publishers: 2009), the opening section of three papers being entitled 'The World Ocean in the Anthropocene Epoch'. The companion volume, to be published next year, will discuss these possible implications further.

The historian of science Jacques Grinevald (who has newly joined the Working Group) is in the process of completing a new and updated version of his 2007 book *La Biosphère de L'Anthropocène* (Georg, Genève), which details, in chronological order, the history of the concepts (starting from Sadi Carnot, William Tyndall, George Perkins Marsh, Antonio Stoppani, Svante Arrhenius *et alii*) that have led to the modern (if still emerging) concept of the Anthropocene, following Paul Crutzen's work. The new edition is due to be published soon, in French.

An invited article, focussing in part on stratigraphic principles, is:

Zalasiewicz, J., Williams, M., Steffen, W. & Crutzen, P. 2010. The new world of the Anthropocene. *Environmental Science and Technology* **44**, 2228-2231.

In the coming year, the Working Group will focus on all aspects of stratigraphical implications of human influences on the record of the Anthropocene interval.

As mentioned in last year's report, 2009 was an historic year for the SQS; the definition of the basal Quaternary/Pleistocene boundary being finally brought to a conclusion, with the base of the Quaternary/Pleistocene being defined at the base of the Gelasian Stage at *c.* 2.558 Ma (Gibbard *et al.* 2010). The results of this voting and the detail of the boundary redefinitions have been compiled and published in *Episodes* for September 2010 (Finney 2010; Gibbard & Head 2010).

Three papers have been published detailing the definitions of the Quaternary /Pleistocene :

Gibbard, P. Head, M.J., Walker, M.J.C. & The Subcommittee on Quaternary Stratigraphy 2009 Formal ratification of the Quaternary System/Period and the Pleistocene Series/Epoch with a base at 2.58 Ma. *Journal of Quaternary Science*, **25**, 96-102.

Finney, S.C. 2010 Formal definition of the Quaternary System/Period and redefinition of the Pleistocene Series/Epoch. *Episodes* 33, 148-152.

Gibbard, P.L. & Head, M.J. 2010 The newly-ratified definition of the Quaternary System/Period and redefinition of the Pleistocene Series/Epoch, and comparison of proposals advanced prior to formal ratification. *Episodes* 33, 152-158.

As noted above, one matter was omitted from the formal voting by the SQS and therefore IUGS, the GSSP for the Calabrian Stage. The 'Quaternary' proposal requested, *inter alia*, that the Calabrian Stage be officially recognised with its base defined by the Vrica GSSP in Calabria (the previous base of the Pleistocene). Although this request was included in the ballot voted on and accepted by the SQS, it failed to appear on the ballot sent to the ICS voting membership due to an oversight. Hence, while all scientific and technical requirements for acceptance of the Calabrian Stage have otherwise been met (Cita et al., 2008), it must be approved by the ICS and then ratified by the IUGS. As already noted, in September the chairman invited Professor Maria Bianca Cita to compile a proposal on behalf of the Subcommittee for establishment of a basal GSSP for the Calabrian Stage for the first time. This proposal was submitted to ICS for ratification on 29 November 2010.

In addition to the Working Group activities noted above, the Subcommittee website continues to be expanded at: <http://www.quaternary.stratigraphy.org.uk> This site is used as the main form of communication for the Subcommittee. It continues to be sponsored by the *Journal of Quaternary Science* and *Boreas* (published by Wiley-Blackwell publishers). The pages are maintained by Phil Gibbard.

Following the ratification of the base of the Quaternary/Pleistocene at the base of the Gelasian Stage and publication of the definitive statement, a new, updated version of the highly successful *Global chronostratigraphical correlation table for the last 2.7 million years* compiled by the chairman and Dr Kim Cohen (University of Utrecht, Netherlands) was published for download on-line on the SQS website in September 2010. At the request of Professor Stan Finney, the chart file was also sent to the ICS so that it could be installed for download from the ICS' own website.

6. SUMMARY OF EXPENDITURE IN 2010:

| | | |
|-----------------------------|-------|--------|
| Cost of website domain name | | £10.0 |
| | TOTAL | £10.00 |

7. SUMMARY OF INCOME IN 2010:

| | | |
|--------------------------|-------|---------|
| Amount received from ICS | | £637.00 |
| | TOTAL | £637.00 |

8. BUDGET FROM ICS IN 2009

Currency in British Pounds (£)

Actual costs 2010

| | | |
|---------------------------------|--|-----------------|
| Amount carried over from 2009 | | £820.97 |
| Current bank balance (30.11.10) | | <u>£1460.85</u> |

Proposed costs for 2011

| | | |
|--|--|------|
| Contribution towards cost of website (5 year subscription) | | £50 |
| Contributions to Working Groups | | £100 |
| Support for meetings (INQUA) | | £500 |

9. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR:

All three (four) working groups will continue to function in 2011. The Working Group on the Pleistocene-Holocene Boundary will change focus to examine the possibility of defining formal subdivisions for the Holocene. Other groups will also continue their deliberations. As noted above, other working groups remain 'on hold' at present.

Potential funding sources outside IUGS

Apart for on-going sponsorship of the website, financial support will be sought by individual members from their grant-awarding bodies for specific projects, such as research projects and meetings, but support has also been received from INQUA through continued interaction with the INQUA Commission on Stratigraphy and Geochronology.

10. OBJECTIVES AND WORK PLAN FOR NEXT 2 YEARS (2010-2012)

The Science plan to be completed before the year 2012 will be as follows:

- a. Formalisation of Global Stratotype section and Points (GSSP) for the Lower/Middle and for the Middle/Upper subseries/subepoch boundaries of the Pleistocene Series/Epoch. The formal nomenclature for the subseries/subepoch divisions of the Pleistocene will be Lower/Early, Middle/Mid, and Upper/Late.
- b. No international stage-level subdivisions for the Holocene will be formalised as yet.
- c. The voting members, and make-up of each GSSP task group, should strive to provide a uniform coverage of terrestrial, shallow-marine and pelagic settings with global coverage.
- d. As noted above, the Subcommittee will investigate the need and potential value in establishing the term Anthropocene for the last 200 yr or so, i.e. the period during which human modification of natural systems has become predominant.
- e. As noted above, a fifth working group will assess the case for formal definition of short-time divisions of the Quaternary.
- f. Progress and discussions within the Subcommittee are summarised and communicated through the SQS website.

Together the officers “will compile a list of active persons willing to act as voting members. The latter will consist of individuals who will represent the widest-possible range of Quaternary stratigraphical expertise and will include no more than two persons from each geographical region”. The full list is given below.

PL GIBBARD, Cambridge, 22.11.10

APPENDIX [Names and Addresses of Current Officers and Voting Members)

Nominated officers

Chairman: Professor Philip Gibbard
Cambridge Quaternary
Department of Geography, University of Cambridge
Downing Street, Cambridge CB2 3EN, England
E-mail: plg1@cus.cam.ac.uk

[Courier address: Gracefield Research Centre
69 Gracefield Road, Lower Hutt, New Zealand]
Direct phone: +64-4-570 4847
Fax: +64-4-570 4600
E-mail: a.beu@gns.cri.nz

Vice-Chair: Professor Jerry McManus
Lamont-Doherty Earth Observatory
Columbia University
239 Comer 61 Route 9W - PO Box 1000
Palisades, New York
10964-8000, USA
Tel.: +1 (845) 365-8722
Fax.: +1 508 289 2175
E-mail: jfm2163@columbia.edu

Professor Mauro Coltorti
Dipartimento di Scienze della Terra
Via di Laterina, 8
53100 Siena, Italy
tel +39- (0)577-233814
fax +39-(0)577-233938
email: coltorti@unisi.it

Secretary: Professor Thijs van Kolfschoten
Faculty of Archaeology, Leiden University
Reuvenplaats 4, 2300 RA Leiden, The Netherlands
E-mail: T.van.Kolfschoten@rulpre.leidenuniv.nl

Professor Valerie Hall
School of Archaeology and Palaeoecology
Queen's University
BELFAST
N. Ireland
BT7 1NN
UK
Tel. +44 (0)28 90973226
E-mail: V.Hall@queens-belfast.ac.uk

List of Voting Members

Dr Brent Alloway
Aurelian Resources Inc.
1100 - 350 Bay St.
Toronto, Ontario
M5H 2S6, Canada
Phone: +1 416-868-9100
Fax: : +1 416-868-1807
E-mail: balloway@aurelian.ca

Professor Martin J. Head
Department of Earth Sciences
BROCK UNIVERSITY
500 Glenridge Avenue
St. Catharines, Ontario L2S 3A1
CANADA
Tel 905-688-5550 ext. 5216
Fax 905-682-9020
Email mjhead@brocku.ca

Dr Alan Glenn Beu
Institute of Geological & Nuclear Sciences
P O Box 30368, Lower Hutt, New Zealand

Professor Dr. Liu Jiaqi

Institute of Geology and Geophysics
Chinese Academy of Sciences
Beituchenglu, Qijiahuozhi
P.O.Box 9825, Beijing
100029 China
Tel. +86 10 62008005(0)/62008240(h)
Fax. +86 10 62052184/62010846
email: liujq@mail.igcas.ac.cn/liujiaqi2001@
yahoo.com.cn

Professor Karen Luise Knudsen
Department of Earth Sciences
University of Aarhus
C.F. Mollers Alle 120
DK-8000 Aarhus C
Denmark
Tel: +45 8942 3557
Fax: +45 8618 3936
E-mail: karenluise.knudsen@geo.au.dk

Professor Thomas Litt
Institute of Paleontology
University of Bonn
Nussallee 8
D-53115 Bonn, Germany
Phone: +49 228 732736
Fax: +49 228 733509
E-mail: t.litt@uni-bonn.de

Professor Leszek Marks
Polish Geological Institute
Rakowiecka 4, PL 00-975 Warsaw, Poland
Phone: +4822 849 5096
Fax: +4822 849 4921
lmar@pgi.waw.pl
lmarks@geo.uw.edu.pl

Professor Tim Partridge
Climatology Research Group
University of the Witwatersrand
12 Cluny Road
Forest Town
Johannesburg 2193
South Africa
Phone (+2711) 646-3324
Fax (+2711) 486-1689
E-mail: tcp@iafrica.com

Professor Jan A. Piotrowski
Department of Earth Sciences
University of Aarhus
C.F. Moellers Alle 1120
DK- 8000 Aarhus C
Denmark

Tel.: +45 8942 2555
Tel.: +45 8942 9402
Fax: +45 8613 9248
Skype: jan.a.piotrowski

Professor Brad Pillans
Research School of Earth Sciences
The Australian National University
Canberra, Act, 0200,
Australia
Ph: +61-2-6125 9644 (Office)
+61-2-6249 1507 (Lab)
+61-2-6232 4687 (Home)
Fax: +61-2-6125 3683
E-mail: brad.pillans@anu.edu.au

Dr Denis-Didier Rousseau
Ecole Normale Supérieure
Laboratoire de Meteorologie Dynamique
& CERES-ERTI
24 rue Lhomond
F-75231 Paris Cedex 5
France
tel +33-(0)14432 2724
fax: +33-(0)14432 2727
E-mail: rousseau@lmd.ens.fr

Professor Jean-Pierre Suc
Directeur de Recherche CNRS
Laboratoire Paléoenvironnements et Paleobiosphère
Université Claude Bernard - Lyon 1
27-43 boulevard du 11 Novembre
F-69622 Villeurbanne Cedex,
France
Tel. (33).(0)4.72.44.85.90
Fax. (33).(0)4.72.44.83.82
E-mail: jean-pierre.suc@univ-lyon1.fr
jean-pierre.suc@wanadoo.fr

Dr. Alexey S. Tesakov
Geological Institute
Russian Academy of Sciences
Pyzhevsky, 7
119017 Moscow
Russia
Tel.: +7 495 230-8085
E-mail: tesak@ginras.ru

Dr. Charles Turner,
Department of Earth Sciences,
The Open University,
Milton Keynes MK7 6AA,
UK
Tel: +44 1908 652889
Fax +44 1908 655151
E-mail chassturner@aol.com

Professor M.J.C. Walker

Department of Archaeology and Anthropology
University of Wales, Lampeter
Ceredigion, SA48 7ED,
Wales, UK
Email: walker@lamp.ac.uk
Phone: +44 1570 424736
Fax: +44 1570 423669

Professor Cari Zazo
Departamento de Geologia
Museo Nacional de Ciencias Naturales (CSIC)
Jose Gutierrez Abascal 28006-Madrid (Spain)
Tel. +34.91.4111328 (ext.11899)
Fax. +34.91.5644740
e-mail. - mcnzc65@mncn.csic.es

Dr Sune Olander Rasmussen
Centre Coordinator
Centre for Ice and Climate
Niels Bohr Institute
University of Copenhagen
Denmark
Ph:)
Fax:
E-mail: olander@nbi.ku.dk

Working group leaders and corresponding members

Working Group on the Pleistocene/Holocene
Boundary

convenor: Professor M.J.C. Walker (Lampeter)
members:
INTIMATE group members

Working Group on the Middle/Late Pleistocene
Boundary

convenor: Professor Thomas Litt (Bonn, Germany)
t.litt@uni-bonn.de

members:

Dr. Art Bettis (Iowa, USA) art-bettis@uiowa.edu
Dr. Aleid Bosch (Utrecht, The Netherlands)
A.Bosch@nitg.tno.nl
Professor Philip Gibbard (Cambridge, UK)
plg1@cus.cam.ac.uk
Prof. Liu Jiaqi (Beijing, China)
liujiaqi2001@yahoo.com.cn
Prof. Peter Kershaw (Clayton, Australia)
Peter.Kershaw@arts.monash.edu.au
Prof. Wighart von Koenigswald (Bonn, Germany)
koenigswald@uni-bonn.de
Dr. Jerry McManus (Wood's Hole, USA)
jmcmanus@whoi.edu
Dr. Charles Turner (Milton Keynes, UK)
c.turner@open.ac.uk

Working Group on the Early/Middle Pleistocene
Boundary

convenor: Professor Brad Pillans (Canberra)

members:

Professor Thijs van Kolshoten (Leiden),
Professor Anastasia Markova (Moscow),
Professor Jiaqi Lui (Beijing),
Dr Charles Turner (Cambridge),
Professor Luc Lourens (Utrecht),
Dr Martin Head (Cambridge),
Dr Cesare Ravazzi (Bergamo),
Dr Craig Feibel (New Jersey)
Dr Tom Meijer (Leiden).
Professor Hisao Kumai (Osaka, Japan)
Professor Neri Ciaranfi (Bari, Italy)

Working Group on the Anthropocene

convenor: Dr J. Zalasiewicz (Leicester)

members (to date):

Paul Crutzen (Mainz, Germany)
Eric O'Dada (Nairobi, Kenya)
Erle Ellis (Baltimore, USA)
Mike Ellis (BGS, UK)
Philip Gibbard (Cambridge; Chair SQS)
Alan Haywood (Leeds, UK)
Andrew Kerr (Cardiff, UK)
Carlos Nobre (INPE, Brazil)
Simon Price (BGS, UK)
Will Steffen (ANU, Australia)
Mark Williams (Leicester, UK; Secretary)
An Zhisheng (Xi'an, China)
Eric O'Dada (Nairobi)

Working Group on the short-time divisions

convenor: Professor Martin Head (Brock University,
St. Catherines)

potential members:

Professor Allan Mix (Oregon State University,
Corvallis, USA)
Professor Michal Kucera (Tübingen, Germany)
Dr Sune Olander Rasmussen (University of
Copenhagen, Denmark)
Professor Christian Turney (University of New South
Wales, Australia)
Professor Philip Gibbard (Cambridge; Chair SQS)

PL GIBBARD

Cambridge

1.12.10

SUBCOMMISSION ON NEOGENE STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Neogene Stratigraphy (SNS)

Frederik J. Hilgen, Chairman SNS

Faculty of Geosciences, Utrecht University

P.O. Box 80021, 3508 TA Utrecht, Netherlands. E-mail: fhilgen@geo.uu.nl.

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

The SNS is the primary body responsible for providing optimum clarity and stability in the Neogene Chronostratigraphic Scale by selecting and defining Global Stratotype Sections and Points (GSSPs) for Series and Stages.

3. ORGANIZATION

The SNS is a subcommission of the ICS, founded in 1971. Reference is made to the annual report of 1995 for a brief historical resume of the SNS. The subcommission has four regional committees (Mediterranean, Pacific, Atlantic and Nordic) and keeps close contacts with the Russian Neogene Commission chaired by Prof. Yuri B. Gladenkov. Apart from the executive bureau, the SNS has 21 voting members and 35 corresponding members (*see Appendix for full list of officers and voting members*). The SNS has presently one active working group for defining the GSSP remaining for the Langhian and Burdigalian chaired by Isabella Raffi. The SNS web site (www.geo.uu.nl/SNS) is used for news release and contains the following sections: Home, News, Board, Members, Newsletters, GSSP's, and Links.

3a. Officers for 2008-2012:

Chair: Frits Hilgen, Utrecht, The Netherlands

Vice-Chairs: Francisco Javier Sierro, Salamanca, Spain
David Hodell, Cambridge, UK

Secretary: Elena Turco, Parma, Italy

Support for the SNS comes from the Chairman's Institute in the Netherlands (Faculty of Geosciences, Utrecht University). This institute also hosts the SNS web-site.

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

There is a close link with (IODP) because of its important role in the development of integrated time scales for the Neogene, in testing the global correlation potential of bio-events, and in a better understanding of climate and ocean history during this time span.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

A short paper about the formal definition of the Serravallian GSSP following ratification by IUGS was published in *Episodes* last year (Hilgen et al., 2009).

Italian research teams are working on a special volume in *Stratigraphy*, which will contain papers about the two main candidate sections for defining the Langhian GSSP, namely the La Vedova section in central Italy and St. Peter's Pool on Malta. Both sections were presented in considerable detail at the RCMNS congress last year in Naples. The study of these sections is part of the ongoing Italian research project (PRIN 2006 - prot. 2006047534 - "In search of the Global Stratotype Sections and Points of the Burdigalian and Langhian Stages and paleoceanographic implications") directed at defining the remaining GSSPs (Langhian and Burdigalian) in the Neogene.

The papers (Foresi et al., *subm*; Turco et al., *subm.*) dealing with the integrated stratigraphy (magnetostratigraphy and calcareous plankton stratigraphy) of the two candidate sections have been submitted. A main point of discussion among specialists remains the taxonomic concept of the *Globigerinoides trilobus* - *Praeorbulina* lineage, which has consequences for positioning the *Praeorbulina* datum, traditionally associated with the base of the Langhian.

The La Vedova section is the downward extension of the La Vedova beach section which has already been studied in detail and for which an astronomical tuning has been established (Hüsing et al., 2009). The alternative section is St. Peter's Pool on Malta. Both sections are continuous across the boundary interval. The La Vedova section has a

reasonably good magnetostratigraphy which allows detection of the C5Br/C5Cn reversal boundary (the other criterion for recognizing the base Langhian), while the preservation of the calcareous plankton is better at St. Peter's Pool. The final proposal for the Langhian GSSP has to await further studies directed at the astronomical tuning and stable isotope stratigraphy of the sections. These studies are currently being carried out. No suitable sections have yet been identified for defining the Burdigalian GSSP.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

A remaining problem is the possible lack of suitable sections in the Mediterranean for defining the Burdigalian GSSP. This is certainly the case if we prefer to have the Burdigalian GSSP defined in an astronomically tuned deep marine section in the Mediterranean that directly underlies the geologic time scale. The alternative option to have this boundary defined in (I)ODP cores is being seriously considered by the Working Group on the Langhian and Burdigalian GSSPs, and a decision about this issue will probably be made the coming year.

The other problem that remains is the outcome of the ICS vote on the Quaternary issue and the formal ratification by IUGS which is unacceptable for many SNS members, including the chair.

7. SUMMARY OF EXPENDITURES IN 2010:

| | | |
|---------------------------|-------------|----------------|
| Credit on Nov 2009 | Euro | 3738,85 |
| costs SNS publications | Euro | -773,50 |
| Credit on Nov 2010 | Euro | 2965,35 |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

The study of the two potential boundary stratotype sections of La Vedova and St. Peter's Pool for defining the Langhian GSSP will be continued and it is anticipated that a workshop will be held next year about the definition of the Langhian and Burdigalian GSSPs. The search for suitable sections and/or cores for defining the Burdigalian GSSP will continue. In absence of suitable Mediterranean sections for defining the Burdigalian GSSP, the option to formally designate this boundary in an ODP core will be seriously considered.

9. BUDGET AND ICS COMPONENT FOR 2011

| | |
|--|-----------|
| Organization workshop on Langhian and Burdigalian GSSPs, Italy | Euro 2500 |
| Optional: Fieldtrip to the La Vedova section (base-Langhian) | Euro 1500 |

10. SUMMARY OF CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2006-2010)

See Accomplishments in 2010 (above) for additional details.

2006

Serravallian GSSP proposal was sent out to SNS voting members; a quorum of about 86% was reached and all votes were positive except for one which was positive but with reservations. Submission of revised proposal to ICS and acceptance of proposal by ICS with a 83% majority. Submission of the Serravallian GSSP proposal to IUGS for formal ratification.

2007

Ratification of the Serravallian GSSP proposal by IUGS. Pilot study of the La Vedova section, a candidate section for the Langhian GSSP. Revision and update of SNS website.

2008

Integrated stratigraphic studies of the La Vedova section and its downward extension by Italian and Dutch research teams, the latter section being candidate for defining the Langhian GSSP. Revision and update of SNS website. Preparation of several papers on the definition and status of the Quaternary and Neogene. Preparation of a "Neogene" proposal for the formal ICS voting procedure on the Quaternary-Neogene issue.

2009

Publication of several papers by members of SNS on the issue of the Quaternary issue (Aubry et al., 2009; McGowran et al., 2009; Van Couvering et al., 2009). Publication in Episodes about the formal definition of the Serravallian GSSP (Hilgen et al., 2009). Ongoing research on the La Vedova and St. Peter's sections.

2010

Preparation of papers on the two candidate sections for defining the Langhian GSSP for publication in a special volume of Stratigraphy.

11. OBJECTIVES AND WORK PLAN FOR NEXT 2 YEARS (2011-2012)

Organization of a workshop on the selection of boundary criteria and sections for defining the 2 remaining stage boundaries in the Miocene, namely the base-Langhian and the base-Burdigalian. Potentially suitable sections in the Mediterranean region that may serve as Langhian GSSP have been identified (La Vedova; St. Peter's Pool). Crucial questions to be addressed during the workshop are: 1) which section is most suitable to be proposed as Langhian GSSP, 2) which prime guiding criterion should be selected, and 3) should we abandon the ambition of having the Burdigalian GSSP directly tied within an astrochronologic framework in order to have the GSSP defined in a Mediterranean land-based section, or should we define this GSSP in drilled ODP sequences at Ceara Rise or any other tuned sequence drilled by (I)ODP.

Selection of most suitable section/ODP core and guiding criteria for defining the Langhian and Burdigalian GSSPs before 2012. Writing of proposals for the Langhian and Burdigalian GSSPs in 2011-2012.

APPENDIX [Names and Full Addresses of Current Officers and Voting Members]

Subcommission officers

Chairman: Frederik J. Hilgen, Faculty of Geosciences, Utrecht University, P.O. Box 80021, 3508 TA Utrecht, The Netherlands, e-mail: fhilgen@geo.uu.nl

Vice Chairmen: David Hodell, Department of Geological Sciences, University of Florida, Gainesville, FL 32611, USA. Email: dhodell@geology.ufl.edu

Now at: University of Cambridge, UK

Francisco Javier Sierró Sánchez, Departamento de Geología, Facultad de Ciencias, Universidad de Salamanca, 37008 Salamanca, España. Email: sierro@usal.es

Secretary: Elena Turco, Dipartimento di Scienze della Terra, Università degli Studi di Parma, Viale G.P. Usberti 157A, 43100, Parma, Italia. Email: elena.turco@unipr.it

List of Voting Members

Agusti, J., Spain, jordi.agusti@icrea.es

Aubry, M.P., USA, aubry@rci.rutgers.edu

Backman, J. Sweden, backman@geo.su.se

Berggren, W.A., USA, wberggren@whoi.edu

Bernor, R., USA, rbernor@howard.edu

Beu, A.G., New Zealand, a.beu@gns.cri.nz

Gladenkov, Y.B., Russia, gladenkov@ginras.ru

Hilgen, F.J., Netherlands, fhilgen@geo.uu.nl

Hodell, D.A., USA, dhodell@geology.ufl.edu

Iaccarino, S., Italy, iaccarin@unipr.it

Kent, D.V., USA, dvk@rci.rutgers.edu

Nagyvarosy, A., Hungary, gtorfo@ludens.elte.hu

Semenenko, V.N., Russia, ---

Sierró, F.J., Spain, sierro@usal.es

Sprovieri, R., Italy, rspr@unipa.it

Turco, E., Italy, elena.turco@unipr.it

Vai, G.B., Italy, vai@geomin.unibo.it

Van Couvering, J., USA, vanc@micropress.org

Wang, P., China, pxwang@online.sh.cn

Zachariasse, W.J., Netherlands, jwzach@geo.uu.nl

References:

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P.O. Box 80021, 3508 TA Utrecht, Netherlands. E-mail: fhilgen@geo.uu.nl.

SUBCOMMISSION ON PALEOGENE STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommittee on Paleogene Stratigraphy

Submitted by:

Eustoquio Molina, Chairman
Departamento de Ciencias de la Tierra
Universidad de Zaragoza
Calle Pedro Cerbuna, 12
E-50009 Zaragoza
Spain.
Tel. 34 976 761077, Fax. 34 976 761106
Email: emolina@unizar.es

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Mission statement

The Subcommittee is the primary body for facilitation of international communication and scientific cooperation in Paleogene Stratigraphy, defined in the broad sense of multidisciplinary activities directed towards better understanding of the evolution of the Earth during the Paleogene Period. Its first priority is the unambiguous definition, by means of agreed GSSPs, of a hierarchy of chronostratigraphic units, which provide the framework for global correlation.

Goals

- a) to agree on an international set of stages and series for the Paleogene.
- b) to establish basal boundary stratotypes (GSSPs) of the Paleogene stages and series.
- c) to encourage research into the Paleogene by setting up and supporting Working Groups and Regional Committees to study and report on specific problems.
- d) to organize symposia and workshops on subjects of Paleogene stratigraphy.
- e) to maintain a website informing on progress and coming events in Paleogene stratigraphy.

Fit within IUGS Science Policy

The objectives of the Subcommittee relate to three main aspects of IUGS policy:

- 1) Establishment of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs. A set of Paleogene stages has been voted and agreed on by the ISPS in 1989. Subsequently, Working Groups have been set up to find a Global Stratotype Sections and Points (GSSPs) for the boundary of each of these stages.
- 2) Establishment of frameworks and mechanisms to encourage international collaboration in understanding the evolution of the Earth during the Paleogene Period.
- 3) Working toward an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs. This relates to, inter alia, the IUGS Geosites Programme and the UNESCO Geoparks Programme.

3. ORGANIZATION

ISPS is a Subcommittee of the International Commission on Stratigraphy. The Subcommittee is organized by an Executive consisting of Chairman, Vice-Chairman and Secretary, who are all Voting members of the Subcommittee. There are 20 Voting Members (Mikhail Akhmetiev, Marie Pierre Aubry, Rodolfo Coccioni, Vlasta Cosovic, Richard H. Fluegeman, Jean Pierre Gely, Philip D. Gingerich, Yuri B. Gladenkov, Jan Hardenbol, Christopher J. Hollis, Jerry J. Hooker, Kenneth G. Miller, Eustoquio Molina, Simonetta Monechi, Carolina Nañez, Heiko Palike, Birger Schmitz, Ellen Thomas, Noël Vandenberghe and Dalila Zaghib-Turki) elected for their personal expertise and experience and about 100 Corresponding Members, who have a responsibility for communication in both directions between the Subcommittee and researchers on Paleogene topics in their region. Voting and Corresponding Members were selected regionally to provide expertise in the Paleogene stratigraphy of each major area and according to their speciality in order to cover the main fields of stratigraphic tools used in the Paleogene.

Under the umbrella of the Subcommission, we set up Working Groups and Regional Committees. At present are active the following:

- 1) Paleocene Working Group. Chairman: Birger Schmitz, Sweden.
- 2) Ypresian/Lutetian Boundary Stratotype Working Group. Chairman: Eustoquio Molina, Spain. Secretary: Silvia Ortiz, Spain.
- 3) Lutetian/Bartonian Boundary Stratotype Working Group. Chairman: Richard Fluegeman, USA.
- 4) Bartonian/Priabonian Boundary Stratotype Working Group. Chairwoman: Isabella Premoli Silva, Italy.
- 5) Rupelian/Chattian Boundary Stratotype Working Group. Chairwoman: Isabella Premoli Silva, Italy.
- 6) Paleogene Planktonic Foraminifera Working Group. Chairwoman: Bridget Wade, USA. Secretary: Hellen Coxall, UK.
- 7) Paleogene Larger Foraminifera Working Group. Chairman: Lukas Hottinger, Switzerland.
- 8) Paleogene Deep-Water Benthic Foraminifera Working Group. Chairman: Michael Kaminski, UK. Secretary: Laia Alegret, Spain.
- 9) Paleogene Calcareous Nannofossils Working Group. Chairwoman: Simonetta Monechi, Italy.
- 10) Regional Committee in North-European Paleogene Stratigraphy. Chairwoman: Gitte Vestegaard Laursen, Norway. Secretary: Rui da-Gama, Netherlands.
- 11) South-American Regional Committee on Paleogene Stratigraphy. Chairman: Carlos Jaramillo, Panama. Secretary: Carolina Nañez, Argentina.
- 12) Russian Paleogene Commission. Chairman: Mikhail A. Akhmetiev, Russia. Secretary: G.N. Aleksandrova.
- 13) Working Group on Paleogene Stratigraphy of the North Pacific. Chairman: Yuri B. Gladenkov, Russia.

Furthermore, the Subcommission sponsors and International Meeting on the Paleogene about every two years: Zaragoza, Spain (1996); Göteborg, Sweden (1999); Powell, USA (2001); Leuven, Belgium (2003); Luxor, Egypt (2004); Bilbao, Spain (2006); Wellington, New Zealand (2009).

Officers for 2008-2012:

Chair: Prof. Eustoquio Molina. Departamento de Ciencias de la Tierra. Universidad de Zaragoza. Calle Pedro Cerbuna, 12. E-5009 Zaragoza. Spain. emolina@unizar.es

Vice-Chair: Prof. Noël Vandenberghe. Department Geografie-Geologie. Afdelig Geologie. Redingenstraat, 16. B-3000 Leuven. Belgium. noel.vandenberghe@ees.kuleuven.be

Secretary: Prof. Simonetta Monechi, Dipartimento di Scienze della Terra. Università di Firenze. 4, Via la Pira. I-50121 Firenze. Italy. monechi@unifi.it

Procedure used for selection: The procedure was the suggested by the Secretary of ICS. Consequently, we sent an e-mail to all Subcommission voting members that invites nominations for Chair and Vice-Chair: *“In order to comply with the ICS procedures for the composition of the board of ISPS, in the light of the IGC 2008 next year, ISPS needs to communicate to ICS the composition of its board. At present Eustoquio Molina is chairman, Jan Hardenbol is vice chairman and the secretary is Noël Vandenberghe. The secretary being a non elected office, we have to propose to ICS only a chairman and a vice-chairman. The present board proposes to reappoint Eustoquio Molina for a second 4 years term (2008-2012). Jan Hardenbol having served 8 years would like to be replaced as vicechairman. The present Chair and vice Chair nominate Noel Vandenberghe, the current secretary, to the position of Vice Chair. If you concur or want to nominate someone else let us know ASAP and at the latest before 11/15. We will inform you of the nominations obtained and the consequent proposition the present board will do to ICS, who needs our proposition by 15th of November”*. The result was: No other nominees apart from us, 12 responded supporting our nominations and 8 did not respond. The new Secretary was appointed with the support of the current Chairman, Vicechairman and Secretary.

Website status and activities: The Web address for ISPS site is: <http://wzar.unizar.es/isps/index.htm> The web site content is the following: Home (overall objectives, organization), Past & Future (accomplishments, problems and plans), Working Groups and Regional Committees (annual reports), Literature (a selection of monographies on the Paleogene). News/Books (two monographies on Paleogene Stratigraphy edited by Luterbacher and Vandenberghe in 2004) and News/Events (Symposium on the Paleogene of South, Central America and the Caribbean, La Plata, Argentina, 20-24th September, 2010).

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

Some of our members participate also in the work of the following International projects:

Ocean Drilling Programme.

International Subcommissions on Cretaceous and Neogene Stratigraphy.

International Geoscience Programme (IGCP).

ProGEO, Geosites and Geoparks Initiatives.

UNESCO World Heritage Sites.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

5a. Progress with selection of GSSPs for Paleogene Stages.

Danian (Cretaceous/Paleogene boundary): The GSSP for the base of the Danian was defined in the El Kef Section (Tunisia) and ratified by the IUGS in 1991. However, this GSSP was not officially published in a prestigious stratigraphical journal of wide distribution. Since that time, some problems arose because the detailed proposal was unknown to many scientists working on the K/Pg boundary, new sections in Mexico were found and controversial interpretations were proposed. Therefore, in order to resolve these problems, the ICS has required the ISPS to finally publish the proposal and it was published in *Episodes*:

Molina E., Alegret L., Arenillas I., Arz J.A., Gallala N., Hardenbol J., Von Salis K., Steurbaut E., Vandenbeghe N. & Zaghbib-Turki D. (2006). The Global Boundary Stratotype Section and Point for the base of the Danian Stage (Paleocene, Paleogene, "Tertiary", Cenozoic) at El Kef, Tunisia - Original definition and revision. *Episodes*, 29(4), 263-278.

Molina, E., Alegret, L., Arenillas, I., Arz, J.A., Gallala, N., Grajales-Nishimura, J.M., Murillo-Muñetón, G. & Zaghbib-Turki D. (2009). The Global Boundary Stratotype Section and Point for the base of the Danian Stage (Paleocene, Paleogene, "Tertiary", Cenozoic): auxiliary sections and correlation. *Episodes*. 32 (2), 84-95.

Rodríguez-Tovar, F.J., Uchman, A., Molina, E. y Monechi, S. (2010). Bioturbational re-distribution of Danian calcareous nannofossils in the uppermost Maastrichtian across the K-Pg boundary at Bidart, SW France. *Geobios*. 43(5), 569-579.

Paleocene (Selandian and Thanetian): In spring 2010, on May 6, the formal inauguration ceremony for the two GSSP's, basal Selandian and basal Thanetian, were held at Zumaia. The arrangement was very well coordinated by Asier Hilario. Many representatives of the press and the local and regional municipality attended. The ICS was represented by its Chairman, Stan Finney, and the ISPS was represented by its Chairman Eustoquio Molina and its Secretary, Simonetta Monechi. The event was highly successful, thanks foremost to the excellent arrangements by Asier Hilario. Markers have now been placed for the GSSP's in the rock record and close to the section there is much information displayed to the public. In August 2010 Birger Schmitz contacted the new *Episodes* office in India, and made suggestions for improvement of the *Episodes* home page and publication procedures. These suggestions were considered by the Editor, and appropriate improvements were made. Following this a draft of the final report of the PWG on the basal Selandian and Thanetian GSSP's was sent to all the members of the PWG for approval. Deadline for comments and suggestions is September 25. After this a revised draft based on all PWG comments will be submitted to *Episodes*.

Ypresian (Paleocene/Eocene boundary): The Working Group completed its task and proposed to place the GSSP for the base of the Eocene Series in the Dababiya Section near Luxor in Upper Egypt. The GSSP is located at the base of the Carbon Isotope Excursion, which was selected as the criterion for the recognition of the Paleocene/Eocene boundary in 2002. The proposed boundary section has a good chemostratigraphic (stable isotopes) and biostratigraphic record. The "Benthic Foraminiferal Extinction Event", the peculiar planktonic foraminiferal and calcareous nannoplankton assemblages linked to the Initial Eocene Thermal Maximum are well represented in connection with the Carbon Isotope Excursion. The proposal for this GSSP was accepted by the ISPS (May 2003) and the ICS (August 2003) and ratified by the IUGS (August 2004). A complete documentation of the proposed GSSP was published by Micropaleontology Press and the official definition was published in *Episodes*:

Aubry M.P., Ouda K., Dupuis, C., Berggren W.A., Van Couvering J.A. and the Members of the Working Group on the Paleocene/Eocene Boundary (Ali J., Brinkhuis H., Gingerich P.R., Heilmann C., Hooker J., Kent D.V., King C., Knox R., Laga P., Molina E., Schmitz B., Steurbaut E. and Ward D.R.) (2007). The Global Standard Stratotype-section and Point (GSSP) for the base of the Eocene Series in the Dababiya section (Egypt). *Episodes*. 30(4), 271-286.

Lutetian: The Ypresian/Lutetian boundary Stratotype was defined at the Gorrondatxe section, which is an excellent very expanded and continuous section. The Ypresian/Lutetian Working Group decided, during the final Workshop in

Getxo (near Bilbao, Spain) on September 26, 2009, to propose the Lutetian GSSP at meter 167.85 of the Gorrondatxe section in a dark marly level where the nannofossil *Blackites inflatus* lowest occurs, approximately 47.76 Ma ago. Two candidate sections, Agost and Gorrondatxe, were proposed and the Lutetian GSSP at Gorrondatxe was elected by consensus after fruitful discussions. The proposal was voted in 2010 by the ISPS voting members and was approved. Recently the proposal was sent to ICS in order to be voted. The following papers co-authored by the members of the Y/L Working Group were published or are in press:

- Rodríguez-Tovar F.J., Uchman A., Payros A., Orue-Etxebarria X., Apellaniz E. and Molina E., (2010). Sea-level dynamic and palaeological factors affecting trace fossil distribution in Eocene turbiditic deposits from the Gorrondatxe section, N Spain. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 285, 50-65.
- Ortiz, S., Alegret, L., Payros, A., Orue-Etxebarria, X., Apellaniz, E. and Molina, E., (*in press*). Distribution patterns of benthic foraminifera across the Ypresian-Lutetian Gorrondatxe section, Northern Spain: response to sedimentary disturbance. *Marine Micropaleontology*, doi:10.1016/j.marmicro.2010.09.004
- Payros, A., Dinareš-Turell, J., Bernaola, G., Orue-Etxebarria, X., Apellaniz, E. and Tosquella, J., (*in press*). On the age of the Early/Middle Eocene boundary and other related events: cyclostratigraphic refinements from the Pyrenean Otsakar section and the Lutetian GSSP. *Geological Magazine*, doi:10.1017/S0016756810000890.

Bartonian: Several scientists, coordinated by Coccioni (University of Urbino), re-investigated the Middle Eocene interval from the classical Contessa Highway section, near Gubbio, a possible candidate for the Bartonian GSSP.

In search of a possible candidate section for the base Bartonian GSSP, the Middle Eocene sedimentary succession of the Contessa Highway section (CHS, near Gubbio, central Italy), was re-visited. Historically, this section has been the focus of important biostratigraphic studies on calcareous plankton (foraminifera and nannofossils) and magnetostratigraphy (e.g., Lowrie et al., 1982; Napoleone et al., 1983; Monechi & Thierstein, 1985). In the new study (Jovane et al., 2010) the Middle Eocene interval at CHS was sampled at much higher resolution than in previous works (every 5 cm in average). According to the different lithologies, washed residues were obtained following the standard procedures for the marly and soft marly-limestone samples, while planktonic foraminifera from the hard marly limestone and limestone samples were successfully extracted using ethanolic acid (highly concentrated acetic acid, ca. 80%) and all washed through a 40 mm mesh sieve. Study of free specimens, instead of thin sections as in most previous works, allowed to a more accurate taxonomical identifications and more precise distribution of planktonic foraminiferal taxa. Then, the major planktonic foraminiferal bioevents have been directly re-calibrated to the magnetic chrons revised by Jovane et al. (2007). Through a cyclostratigraphic analysis of the rhythmic sedimentary alternations and combination with the results of time series analysis of the proxy record, an orbital tuning of the Middle Eocene and astronomical calibration of the bio-magnetostratigraphic events (particularly for the C19n/C18r Chron boundary) recognized at CHS was provided. The criteria proposed as reliable for the definition of the Lutetian/Bartonian boundary are: (1) the first occurrence (FO) of planktonic foraminifer *Turborotalia cerroazulensis*, that occurs in the upper part of Chron C19r, (2) the last occurrence (LO) of planktonic foraminifer *Guembelitrioides nuttalli* which is found just below the base of Chron C19n, (3) the base of Chron C19n, (4) the top of Chron C19n or (5) the FO of calcareous nannofossil *Reticulofenestra* (= *Cribrrocentrum*) *reticulata*, that falls in the lower part of Chron C18r. The lithologic cyclostratigraphy combined with the ~7 My-long astronomically driven climate proxy records, provided a first astronomical calibration of the Middle Eocene epoch, allowing refinement of Eocene biostratigraphic dating with minimal correction to chronostratigraphy. Based on both, the available high resolution bio-, isotope-, magnetostratigraphy and the astronomical tuning of the sedimentary record, and according to IUGS recommendations, it results that the CHS represents an excellent GSSP candidate for the Lutetian/Bartonian boundary. Jovane et al. (2010) concluded in proposing the top of Chron C19n as the most useful and best potential criterion (criterion 4) for global correlation and an astronomically calibrated age for that event of 41.25 Ma. The following paper was published:

- Jovane L., Sprovieri M., Coccioni R., Florindo F., Marsili A., Laskar J., (2010). Astronomical calibration of the middle Eocene Contessa Highway section (Gubbio, Italy). *Earth and Planetary Science Letters*, v. 298, p. 77–88.

Priabonian: The Italian scientific community was very active in 2010. Investigations on GSSPs of the Middle-Upper Eocene transition have been completed by a number of researchers from several Italian Universities (i.e. Padua, Ferrara, Florence, Urbino, Milan) and CNR Institutes as well as from some European and USA Universities and Institutions of the “ALANO NET”, coordinated by Rio (University of Padua).

The multidisciplinary studies on the Alano di Piave section (Veneto region, NE Italy), the potential candidate for defining the GSSP of the Middle/Upper Eocene, equated to the base of the Priabonian Stage, have been presented in an article entitled “Integrated bio-magnetostratigraphy of the Alano section (NE Italy): a proposal for defining the Middle/Late Eocene boundary” (co-authors Agnini, Fornaciari, Giusberti, Grandesso, Rio and Stefani (Univ of Padua), Lanci (Univ. of Urbino), Luciani (Univ. of Ferrara), Muttoni (Univ. of Milan), Palike & Spofforth (Univ. of Southampton, UK). Submitted and revised in Fall 2009, the article was accepted early this year by the Geological Society of America Bulletin. However, its publication was delayed by the GSA Editor pending the acceptance of the paper by Fornaciari et al., dealing with a detailed nannofossil biostratigraphy and chronostratigraphy, on which the main article deeply relies on. Fornaciari et al.’ paper is now accepted, then the Agnini et al. paper is expected to be published hopefully before the end of 2010 (galley proofs are on the way). In addition, Spofforth and co-authors published in 2010 the detailed oxygen and carbon isotope curves for the entire Alano section. The Alano section consists of ca. 120-130 m of bathyal gray marls interrupted in the lower part by 8 m-thick package of laminated dark to black marlstones. Intercalated in the section there are prominent marker beds, six of which are crystal tuff layers, whereas the other two are bioclastic rudites, useful for regional correlation and for an easy recognition of the various intervals of the section. The section is easily accessible, crops out continuously, is unaffected by any structural deformation, is rich in calcareous plankton and contains an expanded record of the critical interval for defining the GSSP of the Priabonian. Integrated calcareous plankton quantitative biostratigraphy (nannofossils and foraminifera), and a detailed magnetostratigraphic analysis have been conducted in high resolution especially across the critical intervals for defining the Priabonian Stage. The high resolution and solid biomagnetostratigraphic framework established at Alano has been compared with the coeval data already available (Wade, 2004) or acquired specifically from the deep sea ODP Site 1052. It is shown that the extinction of large muricate planktonic foraminifera, a major step in the evolution of this group during the Cenozoic, occurred in mid Chron C17n.3n and is probably a synchronous event over wide areas. Concomitant with this event major changes have been observed in the calcareous nannofossil assemblages with six biohorizons occurring across the Middle to Late Eocene transition, i.e. the highest occurrences (HOs) of *Sphenolithus obtusus* and *Chiasmolithus grandis*, the beginning and end of the Acme of *Criboecentrum erbae*, and the beginning and end of the *Isthmolithus recurvus* spike. Meanwhile, it is pointed out that the lowest occurrence (LO) of *Chiasmolithus oamaruensis* and the HO of *C. grandis* must be used with extreme caution for accurate correlations and the LO of *I. recurvus* is much older than in previously estimates.

Proposed Priabonian GSSP at Alano and its correlation potencial:

The major result of the multidisciplinary study is the proposal of designating the base of the Tiziano bed, a prominent crystal tuff layer in the Alano section, NE Italy, as the GSSP of the Priabonian Stage, the standard chronostratigraphic unit of the Upper Eocene. For approximating the base of the Priabonian in the marine stratigraphic records over large areas and depositional settings the following events can be considered, (1) the extinction of the large muricate planktonic foraminifera, (2) the beginning of the Acme of the distinctive *Criboecentrum erbae*, (3) the base of Chron C17n that allows also correlation with the continental records. Finally, it is very possible that the first appearance of *Nummulites fabianii* would remain a useful criterion for recognising the Priabonian in shallow water marine settings, even though the correlation between the larger foraminifera biostratigraphy to the GPTS must be improved. Work on the Alano section will continue in an attempt to establish an orbital tuning of the proposed GSSP and isotopic dating of the Tiziano bed, both of which would allow a much better time framing of the base of the Priabonian and improve the time scale of the Late Eocene. The following papers were published or accepted:

Spofforth, D.J.A., C. Agnini, H. Pälke, D. Rio, E. Fornaciari, L. Giusberti, V. Luciani, L. Lanci, and G. Muttoni, (2010). Organic carbon burial following the middle Eocene climatic optimum in the central western Tethys. *Paleoceanography*, 25, PA3210, doi:10.1029/2009PA001738.

Agnini C., Fornaciari E., Giusberti L., Grandesso P., Lanci L., Luciani V., Muttoni G., Palike H., Rio D., Spofforth D.J.A., Stefani C., (accepted). Integrated bio-magnetostratigraphy of the Alano section (NE Italy): a proposal for defining the Middle-Late Eocene boundary. *Geological Society of America Bulletin*.

Fornaciari E., Agnini C., Catanzariti R., Rio D., Bolla E.M., Valvasoni E., (accepted). Mid-latitude calcareous nannofossil Biostratigraphy and Biochronology across the middle to late Eocene transition. *Micropaleontology*.

Rupelian (Eocene/Oligocene boundary): The GSSP for this boundary was selected in the Massignano Section (central Italy), ratified by the IUGS in 1992 and was officially published in *Episodes*:

Premoli Silva and Jenkins (1993). Decision on the Eocene-Oligocene boundary stratotype. *Episodes*. 13(3), 379-382.

Chattian: The formal proposal of the GSSP for the Rupelian/Chattian boundary at the Monte Cagnero section (Umbria-Marche basin, NE Apennines, Italy) is in progress under the leadership of R. Coccioni and A. Montanari, two of the co-authors of the published paper in which the proposal was put forward. The following paper was published:

Coccioni R., Marsili A., Montanari A., and Others, (2008). Integrated stratigraphy of the Oligocene pelagic sequence in the Umbria-Marche basin (northeastern Apennines, Italy): A potential Global Stratotype Section and Point (GSSP) for the Rupelian/Chattian boundary. *GSA Bulletin*, v. 120; no. 3/4, p. 487–511, 17 figures, 4 tables. doi: 10.1130/B25988.1.

5b. Annual reports 2010 of the other working groups:

Paleogene Planktonic Foraminifera Working Group.

Chairwoman: Bridget Wade, USA. Secretary: Helen Coxall, UK.

The Paleogene Planktonic Foraminifera Working Group held their 8th meeting on the taxonomy and evolution of Oligocene planktonic foraminifera at the Goldfuß-Museum, Steinmann Institut, Bonn, Germany (hosted by Martin Langer and convened Bridget Wade and Michal Kucera) in early September before the Forams 2010 meeting at the University of Bonn. Updates on research progress were presented by lead authors responsible for writing chapters on individual Oligocene lineages. For some groups a draft phylogeny and list of species with revised diagnoses and range information is at an advanced stage, whereas other groups still require further work to stabilize the taxonomy at the species (e.g. *Paragloborotalia*) but also genus level (e.g. *Dentiglobigerina*, *Globigerina*, *Globoturborotalita*). Dick Olsson has identified new wall texture groups that may help resolve some of the problems of apparent polyphyly that are responsible for some of these problems. Draft versions of chapter text, plates, phylogenies and range charts are the goal for the next meeting to be held at UMass August 2011. Additionally a subgroup working on *Dentoglobigerina* and *Subbotina* met in January 2010 at UMass, Amherst, hosted by Mark Leckie. The whole suite of taxa were discussed with SEM images of well preserved specimens to resolve issues related to wall structures.

Paleogene Larger Foraminifera Working Group.

Chairman: Lukas Hottinger, Switzerland.

I have been discharged two years ago from the responsibility of leading the working group of larger foraminifera. Therefore I can give you only my personal contributions of the matter at hand. My state of health does not permit me to do fieldwork anymore but there are many corpses in the cellar awaiting a decent burial. Thus, I have finished and published a monograph on the Miscellaneidae and am working now on a revision of the larger Tethyan Paleogene Rotaliidae, mainly from Pakistan and Oman. This paper is scheduled to go to print in the same place in spring next year. Publications on paper take more and more time and increasing amounts of funding to be published. I have no more energy and time to wait. At request of the Museum Basel I just finished a bibliographic list:

Hottinger, L. (2009). The Paleocene and Earliest Eocene foraminiferal family Miscellaneidae: neither nummulitids nor rotaliids. *Carnets de Géologie*, article 2009/06, PDF p. 1-41.

Bassi, D., Hottinger, L. & Iryu, Y. (2009). Reassessment of "Boueina" pacifica Ishijima 1978 (Orbitolininae, Foraminiferida). Formerly considered as a green halimedacean alga. *Journal Foraminiferal Research*. 39 (2), 120-125.

Hottinger, L. & Caus, E. (2009). Meandropsinidae, an ophtalmidid family of Late Cretaceous K-strategist foraminifera endemic in the Pyrenean Gulf. *Neues Jahrbuch Geologie Paläontologie, Abhandlungen*, vol. 253, no. 2-3, p. 249-279.

Boix, C., Vilalonga, R., Caus, E. & Hottinger, L. (2009). Late Cretaceous rotaliids (Foraminiferida) from the Western Tethys. *Neues Jahrbuch Geologie Paläontologie, Abhandlungen*. 253, 197-227.

Vicedo, V., Aguilar, M., Caus, E. & Hottinger, L. (2009). Fusiform and laterally compressed alveolinaceans (Foraminiferida) from both sides of the Late Cretaceous Atlantic. *Neues Jahrbuch Geologie Paläontologie, Abhandlungen*. 253 (2-3), 229-247.

Paleogene Deep-Water Benthic Foraminifera Working Group.

Chairman: Michael Kaminski, UK. Secretary: Laia Alegret, Spain.

This year, the working group has concentrated on analyzing the effects of Paleocene warming events (hyperthermals) on deep-sea benthic foraminifera. These results may serve as an analogue to understand the causes and potential consequences of the recent global warming. In addition, advances on the taxonomy of Paleocene and Eocene benthic foraminifera are being made. The group met during the 3rd International Paleontological Congress in London, and

agreed to organize the next International Workshop on Agglutinated Foraminifera (IWAf-2012) in Zaragoza (Spain). The workshop will be held in September 2012, and will consist of three days of technical sessions at the University of Zaragoza, followed by a two-day field excursion in the picturesque Basque-Cantabrian flysch deposits in Northern Spain. The first circular of the workshop has been sent.

Paleogene Calcareous Nannofossils Working Group.

Chairs: Simonetta Monechi, Italy and Paul Bown, UK.

During this year the Paleogene calcareous nannofossil working group has continued its researches, investigating the major calcareous nannofossil turnover and distribution across the Danian-Selandian boundary, the PETM interval, the Ypresian/Lutetian and the Eocene/Oligocene boundary. Furthermore, in 2009-2010 a comprehensive Paleogene species list was uploaded to the online taxonomic resource 'Nannotax' (nannotax.org) and descriptions and images have been added for most species. The working group will develop this resource over the next year as well as planning a hard copy taxonomic atlas. In September 2010 a subset of the working group met during the INA 13 Meeting in Yamagata, Japan, and initiated a discussion on the reticulofenestrids. This was the dominant coccolithophore group for much of the Paleogene and the coccoliths are widely used in biostratigraphy and paleoceanography. We aim to rationalise the complex taxonomy of the reticulofenestrids and present a scheme for wider discussion amongst the working group in 2011.

Regional Committee on North-European Paleogene Stratigraphy.

Chairwoman: Gitte Vestegaard Laursen, Norway. Secretary: Rui da Gama, Netherlands.

The committee held one meeting this year, in Fribourg Switzerland. The meeting was quite successful and it shows that the stratigraphic community of Northern Europe is still active, trying to combine the different stratigraphic methods and correlate to/from other basins as well. The 11th joint Meeting of RCNPS/RCNNS in 2009 was held in the city of Fribourg, situated in the Molasse Basin in Switzerland from Thursday, August 27 till Saturday, August 29. The number of attendants were 31. The lectures and posters represented a broad spectre of stratigraphy from the Northern Hemisphere, ranging from problems when creating a new lithostratigraphic chart for the Paleogene and Neogene of Switzerland; overview of the molasse of W.-Switzerland and E.-France; the possible identification of early Eocene hyperthermals in the Corbières in SW France by means of Foraminifera and Ostracoda; construction of a new database of Tertiary index fossils for the Mainz Basin; incursions of Nummulites in the Belgian Ypresian to Early Lutetian; orbital forcing that can be recognised in the marly parts of the Oligocene Boom Clay of Belgium; Iran, where micropaleontology is being used to solve the age of the Asmari Formation (Chattian/Aquitania), calibrated with Sr87/Sr86 dating; Mammalia stratigraphy represented by relatives of Tapirs from the Swiss Molasse Basin, and by the Ruminantia, which shows several changes during the Oligocene and at the transition Oligocene-Miocene. All posters were briefly presented as powerpoint/pdf in the lecture room, so that discussion at the posters themselves flowed freely in the coffee breaks. This meeting, although the group was small, was very successful. There was a good exchange of opinions in a very relaxed atmosphere, and, although it did not concern the North Sea Basin strictly speaking, this is a region, which is important in the understanding of possible connections to other parts, together with the effects of the Alpine orogeny. It was decided to continue the work of the Regional Committee, and a process for finding a venue for the next meeting in 2011 has started.

South-American Regional Committee on Paleogene Stratigraphy.

Chairman: Carlos Jaramillo, Panama. Secretary: Carolina Nañez, Argentina.

This year was dedicated to the organization of a symposium on the Paleogene of South and Central America and the Caribbean, to be held at the X Argentinean Congress of Paleontology and Biostratigraphy and VII Latin American Congress of Paleontology (La Plata, Argentina, 20-24th September, 2010). The aim of the symposium, conveyed by Guiomar Vucetich and Carolina Nañez, was to have an overview of research related to the Paleogene of South and Central America, and to provide an opportunity for the meeting of members of the Regional Committee to discuss current activities and working plans for 2011-2012. The web page for the Regional Committee (<http://striweb.si.edu/jaramillo/committee/index.html>) has been maintained and actualized, including news, research activities and a list of recent publications concerning the Paleogene of South and Central America.

Russian Paleogene Commission.

Chairman: Mikhail A. Akhmetiev, Russia. Secretary: G.N. Aleksandrova. Russia.

Participation on the International and Russian Conferences and Meetings:

Annual Meeting Russian Paleogene Commission took place on April 6 2010 in Saint Petersburg (All Russian

Geological Institute, VSEGEI). 17 Members of Commission visited to this Meeting. Agenda of this Meeting: Akhmetiev M.A. (Geological Institute RAS, Moscow. Introduction. Information on_Paleogene Commission activity, 2009. Nikolaeva I.A. (VSEGEI, Saint Petersburg). Early and Middle Eocene deep-water ostracodes ._(North Caucasus monocline and Russian plate). Iakovleva A.I., Aleksandrova G.N. (Geological Institute RAS, Moscow) Preliminary_palynological data studying Paleocene-Eocene deposits borehole 10 (Russko-Polyansky area,_Omsk district, South Siberia). Beniamovsky V.N. (Geological Institute RAS, Moscow) Paleocene-Eocene foraminifera of the section Bore-hole 10 (Russko-Polyansky area, Omsk district, South Siberia), (taxonomical, stratigraphical and palaeogeographical aspects). Akhmetiev M.A., Zaporozhets N.I. (Geological Institute RAS, Moscow). Palynological data of the Tavda formation (including Azolla-beds) of the section Bore-hole 8 (Russko-Polyansky area, Omsk district, South Siberia). Vassilieva O.N. (Institute Geology and Geochemistry RAS, Ekaterinburg) Paleogene biostratigraphy of the Pre-Caspian basin on dinocysts (zones, correlation). Zakrevskaya E.Yu. (Vernadsky Geological Museum, Moscow). Problems of correlation Lutetian lower boundary by nummulites, planktonic foraminifera and nannoplankton at the Crimea and Caucasus sections. Fregatova N.A. (All Russian Oil-Prospecting Institute (VNIGRI, Saint Petersburg). Foraminifera and stratigraphy of the Paleocene-Eocene key-section Mamechinsk peninsula (Okhotsk-sea zone, South Koryakia, North- West Kamchatka). Bakieva L.B. (Tyumen Oil-Gas University, West Siberia). Informational Report of joint_magisters program between Tyumen Oil-Gas University (Russia) and Royal Holloway_University of London (Great Britain).

II. Symposium Paleogene events on Middle-High latitudes of Central Eurasia, (Annual Meeting of the Palaeontological association of Moscow department All Russian Palaeontological Society) Palaeontological Institute RAS. Moscow January, 25-26. 2010: Akhmetiev M.A., Zaporozhets N.I. Middle-Late Eocene transition Azolla beds at the Tavda Formation West Siberian Plate (Conditions of origin). Aleksandrova G.N., Iakovleva A.I., Oreshkina T.V., Radionova E.P. PETM -events the West-Siberian key - sections by dinocysts and diatoms studying. Beniamovsky V.N. Paleoecosystem reorganization Early Paleogene foraminifera associations of the Turgay trough and West Siberian plate. III. Scientific Readings by Memory professor M.V. Muratov "Problem of North Eurasia regional geology". Geological-Prospecting University, Moscow April 15, 2010. Zakrevskaya E.Yu. Significance of the Nemkov G.I. investigations of Paleogene Stratigraphy by nummulites. Gladenkov A.Yu. Date and correlation Cenozoic deposits North East and Far East Russian Regions by diatoms. Beniamovsky V.N. Infracalcaus Earle Paleogene scale by planktonic_foraminifera. Check of lower boundaries Zelandian, Thanetian and Lutetian stages. (South_Russia Paleogene).

IV International Symposia: International Symposium on Foraminifera Forams 2010, September 5-10 2010: Zakrevskaya E.Yu. New data about Paleogene nummulites and orthophragmines in Black Sea Lowland and Ukrainian platforme.

4-eme Congress Francais de Stratigraphie (beginning of September 2010), Paris: Aleksandrova G.N., Iakovleva A.I. Paleogeographical reconstructions of Southwestern Siberia during the Early Paleogene by dinocysts. Iakovleva A.I. Palynological reconstruction of the Eocene paleoenvironments in south of Western Siberia. Musatov V.A. Early Paleogene Nannoplankton of the Volga-River area.

VIII European Palaeobotanical Congress (Budapest, Summer, 2010). (Topic by T.M. Kodrul). At Oktober-Noveber 2010 Members of Paleogene Commission must be take part else two Meeting: Kryshstofovich A.N. Reading Memories (Saint Petersburg, October 26-27 2010) (topics Akhmetiev M.A., Herman A.B., Kodrul T.M., Moisseeva M.G.. Aleksandrova G.N.). Meyen S.V. reading Memories 75 - Birthday (Moscow, November, 17-18) (topics by Akhmetiev M.A., Kodrul T.M.)

Doctors Thesis (More high, second level): Zykin V.S. (Novosibirsk, February, 2010) Late Cenozoic West Siberia (Oligocene, Neogene). Zakrevskaya E.Yu. Paleogene Nummulitidae of Russia (preliminary presentation of Doctor Thesis, October 2010).

In 2010, 27 papers and 3 Monographies were published Members of Paleogene Commission of Russia. 2010 Paleogene Commission of Russia number 43 and 6 Foreign Members from 13 towns, 22 Organizations (Ac. Sci. of Russia, Universities, Geological-prospecting expeditions, States and Governments Museums).

The main tasks for Members of Paleogene Commission investigation in nearest future: Final Investigations of bore hole Paleogene sections (NN 2, 8, 9, 10) Russko-Polyansky area,_Omsk district West Siberia) by dinocysts, diatom, radiolaria, foraminifera,_magnetostratigraphy. Continuation of paleontological investigations Paleogene deposits of new bore-holes key-sections at the Omsk district West Siberian plate. Check in main Russian key-sections the boundary positions Lower Paleogene Stratigraphic_stages by new interpretations, (according to decisions International Paleogene Subcommittee).

Working group on Paleogene Stratigraphy of the North Pacific
Chairman: Yuri B. Gladenkov, Russia

A working meeting on Paleogene stratigraphy was held in Sakhalin, August 2010. It considered a new model of the Paleogene correlation scheme for the shelf basins of Japan and the Sakhalin-Kamchatka region. Special attention was given to the Early-Middle Eocene geological events: the greatest Cenozoic climatic optimum of Early Eocene and the tectonic and paleogeographic changes in the initial Middle Eocene). Investigations of the North Kamchatka Paleogene sequences continued. Abundant assemblages of mollusks (7 local zones with over 70 species), planktonic and benthic foraminifers (5-7 zones) of Thanetian and Ypresian have been distinguished for the first time. A monographic description and plates of this paleontological material are prepared. Analysis of the material shows that the Kamchatka assemblages are very similar to those from the California formations. A monograph on problems of the Upper Paleocene—Lower Eocene transitional beds is planned to be published next year. In parallel, paleomagnetic investigations of the same sequences have been carried out.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

The problems encountered this year are essentially the same as those discussed in the previous annual reports. ISPS can support only very insufficiently its working groups and regional committees. In particular, we would need a substantial increase in our budget in order to support and in part to reactivate regional committees in poorer areas (e.g. Africa, Indian Subcontinent, SE Asia). Most of the secretarial and other expenses have been covered by the institutions of the officers and other members of ISPS. Since money becomes tighter everywhere, these sources may dry up.

7. SUMMARY OF EXPENDITURES IN 2010:

INCOME

| | |
|---------------------------|-----------|
| Carried forward from 2009 | Euro 0 |
| ICS Allocation for 2010 | Euro 2338 |
| TOTAL | Euro 2338 |

EXPENDITURE FROM 2009 BUDGET

| | |
|--|-----------|
| General office expenses | Euro 338 |
| Professional help with the website | Euro 700 |
| Support for Working Groups and Regional Committees | Euro 1300 |
| TOTAL | Euro 2338 |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

Complete the work on the GSSPs of the base of the Priabonian and Chattian.
 Screen and rejuvenate the list of the Corresponding Members.
 Reactivate or close those Regional Committees and Working Groups which are asleep.
 Update periodically the ISPS website.
 Organize the Climate and Biota of the Early Paleogene in Salzburg (Austria), 5-8 June 2011.

9. BUDGET AND ICS COMPONENT FOR 2011

Projected Budget for 2011:

| | |
|--|-----------|
| General office expenses | Euro 500 |
| Professional help with the website | Euro 800 |
| Contributions to Officers travel costs | Euro 900 |
| Support for Working Groups and Regional Committees | Euro 2500 |
| TOTAL BUDGET PROJECTED | Euro 4700 |

Please note that the financial situation has deteriorated in recent years, particularly in Latin America and the former Soviet Union; an increase would help us to support the corresponding Regional Committees more actively. We also will need some seed money to start new regional committees or working groups.

10. SUMMARY OF ACTIVITIES OVER PAST FOUR YEARS (2007-2010)

At present, the GSSPs of the base of the Danian (= Cretaceous/Paleogene Boundary), the base of the Ypresian (= Paleocene/Eocene Boundary), the base of the Rupelian (= Eocene/Oligocene Boundary) and the base of the Aquitanian (= Paleogene/Neogene Boundary) have been established and ratified by the International Union of

Geological Sciences. Furthermore, in 2007 the base of the Selandian and Thanetian stages was defined by the Paleocene Working Group by unanimous majority, both GSSPs were approved by the ISPS and the ICS and finally were ratified by the IUGS in September 23, 2008.

In 2009 the base of the Lutetian was defined by the Working Group, the proposal was voted and approved by ISPS in 2010 and recently has been submitted in order to be voted by ICS.

Regarding the rest of the Paleogene Stages, good progress has been made in the search for the remaining GSSPs.

The detailed reports of activities during the past four years of the Working Groups and Regional Committees are included in the ISPS website: <http://wzar.unizar.es/isps/index.htm>

11. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2010-2013)

Complete and publish the GSSPs of the Paleogene. We hope to present proposals for the remaining GSSPs in the year 2011 (Priabonian and Chattian) and by the year 2012 (Bartonian), before the next International Geological Congress.

Support the organization of the Climate and Biota of the Early Paleogene in Salzburg (Austria), 5-8 June 2011.

Produce an updated version of an integrated Paleogene time scale.

Produce a state-of-the-art review of the stratigraphic tools used in the Paleogene.

Preparation of standardized regional correlation charts and paleogeographic maps by the Regional Committees.

APPENDIX (Names and Addresses of Current Officers and Voting Members, 2008-2012) INTERNATIONAL SUBCOMMISSION ON PALEOGENE STRATIGRAPHY

Subcommission officers

Chairman:

Eustoquio Molina, Departamento de Ciencias de la Tierra, Universidad de Zaragoza, Calle Pedro Cerbuna, 12, E-50009 Zaragoza, Spain.
emolina@unizar.es

Vice-Chairman:

Noël Vandenberghe, Departement Geografie-Geologie, Afdeling Geologie, Redingenstraat, 16, B-3000 Leuven, Belgium.
noel.vandenberghe@ees.kuleuven.be

Secretary:

Simonetta Monechi, Dipartimento di Scienze della Terra, Università di Firenze.
4 Via la Pira, I-50121 Firenze, Italy.
monechi@unifi.it

List of Working (Task) Groups and their officers

Paleocene Working Group. Chairman: Birger Schmitz, Sweden. birger.schmitz@geol.lu.se

Ypresian/Lutetian Boundary Stratotype Working Group. Chairman: Eustoquio Molina, Spain. emolina@unizar.es Secretary: Silvia Ortiz, Spain. silortiz@unizar.es Website: <http://wzar.unizar.es/perso/emolina/ypresian.html>

Lutetian/Bartonian Boundary Stratotype Working Group. Chairman: Richard Fluegeman, USA. fluegem@bsu.edu

Bartonian/Priabonian Boundary Stratotype Working Group. Chairwoman: Isabella Premoli Silva, Italy. isabella.Premoli@unimi.it

Rupelian/Chattian Boundary Stratotype Working Group. Chairwoman: Isabella Premoli Silva, Italy. isabella.Premoli@unimi.it

Paleogene Planktonic Foraminifera Working Group. Chairman: Bridget Wade, USA. wade@geo.tamu.edu
Secretary: Helen Coxal, UK. hkc@gso.uri.edu

Paleogene Larger Foraminifera Working Group. Chairman: Lukas Hottinger, Switzerland. lukas.hottinger@bluewin.ch

Paleogene Deep-Water Benthic Foraminifera Working Group. Chairman: Michael Kaminski, UK. m.kaminski@ucl.ac.uk Secretary: Laia Alegret, Spain. laia@unizar.es

Paleogene Calcareous Nannofossils Working Group. Chairwoman: Simonetta Monechi, Italy. monechi@unifi.it

Regional Committee in North-European Paleogene Stratigraphy. Chairwoman: Gitte Vestegaard Laursen, Norway. gila@statoil.com Secretary: Rui da-Gama, Netherlands.

South-American Regional Committee on Paleogene Stratigraphy. Chairman: Carlos Jaramillo, Panama. JaramilloC@si.edu Secretary: Carolina Nañez, Argentina. cnañez@fullzero.com.ar
Website: <http://striweb.si.edu/jaramillo/committee/index.html>

Russian Paleogene Commission. Chairman: Mikhail A. Akhmetiev, Russia. akhmetiev@ginras.ru Secretary: G. N. Aleksandrova.

Working Group on Paleogene Stratigraphy of the North Pacific. Chairman: Yuri B. Gladenkov, Russia. gladenkov@ginras.ru

List of Voting Members

Mikhail A. Akhmetiev, Russian Academy of Science, Moscow, Russia, akhmetiev@ginras.ru

Mary Pierre Aubry, Rutgers University, New Jersey, USA, aubry@rci.rutgers.edu

Rodolfo Coccioni, Università di Urbino, Italy, cron@info-net.it

Vlasta Cosovic, University of Zagreb, Croatia, vcosovic@geol.pmf.hr

Richard H. Fluegeman, Ball State University, Indiana, USA, fluegem@bsu.edu

Jean Pierre Gély, Museum d'Histoire naturelle Paris, France jean-pierre.gely@gazdefrance.com

Philip D. Gingerich, University of Michigan, USA, gingeric@umich.edu

Yuri B. Gladenkov, Russian Academy of Science, Moscow, Russia, gladenkov@ginras.ru

Jan Hardenbol, Global Sequence Chronostratigraphy, Houston, USA, jhardenbol@sbcglobal.net

Christopher Hollis, GNS Science, Lower Hutt, New Zealand, c.hollis@gns.cri.nz

Jerry J. Hooker, Natural History Museum, London, UK, jjh@nhm.ac.uk

Kenneth G. Miller, Rutgers University, New Jersey, USA, kgm@rci.rutgers.edu

Eustoquio Molina, Universidad de Zaragoza, Spain, emolina@unizar.es

Simonetta Monechi, Università di Firenze, Italy, monechi@unifi.it

Carolina Nañez, Servicio Geológico, Buenos Aires, Argentina cnañez@fullzero.com.ar

Heiko Pälike, University of Southampton, UK, heiko@noc.soton.ac.uk

Birger Schmitz, University of Lund, Sweden, birger.schmitz@geol.lu.se

Ellen Thomas, Yale University, Connecticut, USA, ellen.thomas@yale.edu

Noël Vandenberghe, K.U. Leuven, Belgium, noel.vandenberghe@ees.kuleuven.be

Dalila Zaghbib-Turki, University of Tunis, Tunisia, dalila.zaghbib@fst.rnu.tn

SUBCOMMISSION ON CRETACEOUS STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommittee on Cretaceous Stratigraphy (SCS)

SUBMITTED BY

Prof. Isabella Premoli Silva, Chair
University of Milano
Dipartimento di Scienze della Terra “Ardito Desio”
Via Mangiagalli, 34, 20133 MILANO, Italy
telephone: 39-02 5031 5528 (direct line)
telefax: 39-02 5031 5494
Email: isabella.premoli@unimi.it

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

- *To facilitate international communication in all aspects of Cretaceous stratigraphy and correlation*
- *To establish a standard global stratigraphic subdivision and nomenclature for the Cretaceous, as part of the ICS standard global stratigraphic scale;*
- *To produce a stratigraphic table displaying agreed subdivision to substage level and intervals of disagreement, marking boundaries that are defined by a GSSP.*

3. ORGANIZATION

SCS is a Subcommittee of the International Commission on Stratigraphy.

Membership: Chair: Prof. Isabella Premoli Silva, Italy
Vice Chair: Dr. Irek Walaszczyk, Poland
Secretary: Dr. Silvia Gardin, France

In addition, there are 16 Voting Members of the Subcommittee, from all the continents. Over 130 Cretaceous scientists from all over the world and in many different disciplines belong to one or more of the 9 Stage Working Groups of the SCS still active, or to the Kilian Group. All WG members are treated as Corresponding Members of the Subcommittee. Effectively, anyone with interest and expertise that can contribute to our objectives is welcome to do so. *The great bulk of the Subcommittee's work is carried out by these Working Groups.*

3a. Officers for 2008-2012:

| | |
|-------------|---|
| Chair: | Prof. Isabella Premoli Silva (Milan, Italy) |
| Vice-Chair: | Dr. Irek Walaszczyk (Warsaw, Poland) |
| Secretary: | Dr. Silvia Gardin (Paris, France) |

For technical reason the website for the Subcommittee had to migrate to the site of The Museum of Natural History in Paris. The new web site is now in preparation.

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

The Subcommittee has liaised with successive meetings of the *International Cretaceous Symposium*, which until 2004 have been promoted by the German *Subkommission für Kreide-Stratigraphie*. The SCS has now taken over the responsibility for selection of future venues, though the successful applicants will organize individual congresses. At the *8th International Symposium on Cretaceous System*, held in Plymouth in September 2009, it was decided that the *9th International Symposium on Cretaceous System* will be convened in 2013 at Ankara, Turkey. The Symposium is now scheduled for September 2013 and will be hosted by the Middle East Technical University in Ankara. For updated informations visit the WebSite <http://www.cretaceous2013.org/en/>. Contact Person: Ass. Prof. Dr. Ismail Omer Yilmaz <ioyilmaz@metu.edu.tr>.

The Subcommittee also liaises closely with the Subcommittee on Jurassic Stratigraphy, especially over the definition of the Jurassic/Cretaceous boundary.

When appropriate, the Subcommittee liaises also with IGCP projects. In particular, a strong liaison was established by our colleagues from IGCP 507 – “Cretaceous paleoclimatology”, and IGCP Project 506 - Marine and

Non-marine Jurassic: Global correlation and major geological events (Project Co-Leader W. Wimbledon).

ICS has always been directly or indirectly linked to important international Projects as IODP, IGCP, and CHRONOS (Mesozoic Planktonic Foraminifera Working Group, MPFWG).

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

General Activities

A wealth of data on various aspects of Cretaceous stratigraphy had continued to be published in 2010 providing a continuous amelioration of the multiple stratigraphic framework that today spans the whole Cretaceous in high to frequently very high resolution.

Increasing knowledge on carbon isotope stratigraphic patterns and magnetostratigraphy from continuous pelagic successions, especially deep-sea, through the Cretaceous, provoked an increase of interest in the scientific community for a more traditional stratigraphic aspects.

In 2010 this resulted in an increase of activities among the ammonite specialists as well as on other fossil groups and other proxy tools. In particular, the French and Spanish communities have been very active in revising ammonite taxonomy and stratigraphic distribution of key taxa; and field trips to solve specific topics have been organized visiting some key sections (i.e. Albian, Berriasian type-area, etc.). In addition, the Berriasian Working Group called two official meetings (Slovakia and Paris) and its chairperson (Wimbledon) with the collaboration of WG members prepared an exhaustive report (submitted) of the activities up to the 2009 Plymouth meeting.

Wimbledon W.A.P., C.E. Casellato, D. Reháková, L. G. Bulot, E. Erba, S. Gardin, R.M.C.H. Verreussel, D.K.

Munsterman, C.O. Hunt, submitted. Fixing a basal Berriasian and Jurassic/Cretaceous (J/K) boundary – perhaps there is some light at the end of the tunnel? *Rivista Italiana di Paleontologia e Stratigrafia*.

Of general interest:

B. Vincent, F. S.P. van Buchem, L. G. Bulot, A. Immenhauser, M. Caron, D. Baghbani & A. Y. Huc, 2010. Carbon-isotope stratigraphy, biostratigraphy and organic matter distribution in the Aptian – Lower Albian successions of southwest Iran (Dariyan and Kazhdumi formations). *GeoArabia Special Publication 4*, v. 1, p. 139-197.

The Kilian Group (Lower Cretaceous Ammonite Working Group).

The Kilian Group (Lower Cretaceous Ammonite Working Group) had the 4th meeting on 30 August 2010, that took place before the “8^o International Symposium on Cephalopods Present and Past” (September 1-3, 2010), both held at the University of Burgundy at Dijon (France).

According to the draft report, prepared by Reboulet (chair), Rawson and Moreno-Bedmar (reporters), the workshop was attended by 14 members from 9 countries. At the beginning of the meeting the chairman summarized briefly the decisions taken at the previous Kilian’s meetings and presented some proposals on the standard zonation received by some colleagues who could not attend. His presentation and that by Moreno-Bedmar were used as a basis for discussion, which focused on the Aptian and Albian zonal schemes. Several amendments and new subzones were introduced to both Aptian and Albian schemes.

Aptian: The discussion focused on the base of the stage and its subdivision. In terms of ammonites, the base of the Aptian is marked by the first appearance of *Prodeshayesites* (= base of *Prodeshayesites fissicostatus* Zone) in NW Europe and by the first appearance of *Deshayesites* (= base of *Deshayesites oglanlensis* Zone) in the Mediterranean area. According to several authors the *D. fissicostatus* Zone should be correlated with the *D. tuarkyricus* Zone (= *D. oglanlensis* Zone). An agreement was also reached in considering *Prodeshayesites* a synonym of *Deshayesites*. About the subdivision, the meeting adopted a two-fold division of the Aptian stage for the Mediterranean area with a boundary between the *Dufrenoyia furcata* and *Epicheloniceras martini* Zones, that agrees with the two-fold division of the NW European scheme. This boundary can be identified on a large scale on the basis of an important change in the ammonite fauna recorded in Tethyan (from Transcaspian to Caribbean areas) and sub-boreal realms. Moreover, the two-fold subdivision has also the advantage to overcome the uncertainties in correlating the French substages Bedoulian, Gargasian and Clasayesian to the Lower, Middle and Upper Aptian, respectively, as some disagreements exist in defining the Gargasian. The WG concluded that it would be preferable to abandon the terms Bedoulian, Gargasian, Clasayesian as they are not recognized internationally, but mainly used in France. In addition, their type sections do not offer good perspectives (low number and/or bad preservation of ammonoids) and they are not well exposed, being partly or completely inaccessible because of urbanization.

Albian: For the time being the *Leymeriella* (*Leymeriella*) *tardefurcata* Zone, based on the first appearance of the index-species (not by *L. (P.) schrammeni*, a strongly provincial and geographically limited taxon), is still regarded as the first zone of the Albian. However, the base Albian will fall within the *Leymeriella* series that is affected by taxonomical problems related to the genus itself and to its subgenera *Proleymeriella*, *Leymeriella* and *Neoleymeriella*. A new definition for the *Leymeriella* (*Leymeriella*) *tardefurcata* Zone was proposed without

reaching the consensus.

The full report with the new zonal scheme is expected to be submitted soon for publication presumably on Cretaceous Research. The Web Site of the Kilian Group is in preparation.

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The Kilian Group plans to have the next meeting in September 2013 at the 9th International Symposium on the Cretaceous System in Ankara (Turkey). For the new meeting the Kilian Group is expected to focus on the Berriasian, Valanginian and Hauterivian stages and to calibrate different ammonite zonations of the Tethyan, Boreal and Austral realms with the "standard", which is in fact the zonation for the Mediterranean Faunal Province.

The Berriasian GSSP and the J/K boundary.

The Berriasian Working Group had two well-attended WorkShops in 2010. The first one was in Smolenice, Slovakia, 6–9 April 2010, hosted by Jozef Michalik at the Slovak Academy of Science. The first two days have been dedicated to presentation of new data especially on the Northern Italian sections (Casellato, 2010; Channell et al., 2010) and comparison with other sections, followed by two-days field trip to three important localities, the Hiboda, Strazovce and Brodno sections in western Slovakia. The second meeting was in Paris, 3-5 November 2010, hosted by the University Pierre & Marie Curie and organized by Johann Schnyder, Silvia Gardin and Bruno Galbrun.

At the end of 2009 Wimbledon (WG chair) and Bulot returned to the Berriasian type-area in SE France. They visited few localities and collected ammonites in numbers from all beds at Le Chouet, which is more expanded than the Puerto Escano section (Spain) and most likely yields for the first time the overlap between the "Durangites fauna" and the "Berriasella fauna". Consequently, the WG starts to re-consider the Berriasian type area for the J/K GSSP, taking also into account that the Berrias type-section, even with some problems at its base, allows to correlate some biotic events to magnetostratigraphy. These new findings have been presented and discussed at length during the Paris meeting. Mohammed Benzaggah presented a synthesis of calpionellid events from Morocco Rifean sections, that yield also ammonites. His calpionellid taxonomy and event distribution compare well with Rehakova's data especially from Slovakia. Moreover, Wimbledon had field campaigns in Crimea surveying some sections across the J/K boundary and collecting ammonites and samples for micropaleontological investigations. Field work in Crimea will continue in 2011. In addition, new data have been gathered from Tibet and Argentina and studies on the base Berriasian were undertaken in Bulgaria.

The WG agreed to stick to the 6-monthly cycle of meetings, to keep up progress. The next planned meeting will be in Tunisia and the Russian Cretaceous Commission (Baraboshkin) have been asked if they could host a subsequent meeting at or near to Kashpir on the Volga region.

Casellato C.E., 2010. Calcareous nannofossil biostratigraphy of Upper Callovian–Lower Berriasian successions from Southern Alps, North Italy. *Rivista Italiana di Paleontologia e Stratigrafia*, v. 116/3, p. 357-404.

Channell J.E.T., C.E. Casellato, G. Muttoni, E. Erba, 2010. Magnetostratigraphy, nannofossil stratigraphy and apparent polar wander for Adria-Africa in the Jurassic–Cretaceous boundary interval. *Palaeogeography, Palaeoclimatology, Palaeoecology* 293, p. 51–75.

Base Valanginian GSSP.

In the absence of magnetic signals in the Montbrun-les-Bains section, so far the primary candidate for the Valanginian GSSP, and in general in all the southern France successions, scientists from Spain suggest that the alternate sections near Caravaca (SE Spain) should be reconsidered by the WG. The detail synthesis of the biostratigraphic and magnetic events provided by Aguado et al. (2000) shows that the Spanish sections, especially the Caneda Luega, are the only ones in the world where a direct correlation could be made between magnetic chrons and ammonite-nannos-calpionellid zones at this level. Meanwhile, Stephane Reboulet and colleagues are currently gathering new data at Montbrun-les-Bains (S. France) and, in addition, are planning to study with a multidisciplinary approach the Vergol section, which has the advantage to comprise also the base of the upper Valanginian.

The chair of the Valanginian WG, Luc Bulot, and the Spanish colleagues are looking if a WG meeting can be organized at short issue. Bulot is also exploring the possibility of having a field trip in the Caravaca area in Spring 2011 to look at the Caneda Luega-Cehegin sections.

Base Hauterivian GSSP.

At the beginning of October 2010 Luc Bulot (chair of the WG) and I. Premoli Silva (SCS chair) spent a full week in assembling the data available so far on La Charce section (Drome, France), the major candidate for the Hauterivian GSSP. A first draft of the proposal, even incomplete, was prepared that at this stage includes background and lithostratigraphy, ammonite biostratigraphy, belemnites, micropaleontological content (calcareous nannofossils, radiolarians, dinoflagellates, ostracods, benthic foraminifera), isotope stratigraphy, organic and inorganic

geochemistry, provided by the various specialists specifically involved in the study or along the years since late XX century. It was noticed that nannofossil data needed to be briefly controlled, whereas for planktonic foraminifera their presence and distribution needed to be checked more carefully. Both fossil groups are now under study and the new data are expected in a month or so. As the Early Cretaceous successions from Southern France did not register the magnetic signals and no magnetic zonation exists for the Boreal Realm, the best tool for correlation at least through the Tethys will result to be delta 13C isotope stratigraphy. We are confident to complete the Hauterivian GSSP proposal ready to be voted by mid 2011.

Base Barremian GSSP.

At the moment, there is a lot of investigations going on in France on the Barremian mostly under the "guidance" of Jean Vermeulen. A new section near Barreyme is currently under study. The ammonites are far more abundant and much better preserved than in any other sections studied so far in Spain or France. At this stage it should be wise to wait a little bit for the new ammonite datum and plan a study of that section in term of other proxies.

Base Aptian GSSP.

A wealth of data have been collected and published on the Aptian stage in the last few years by our French colleagues on the stratotype sections of Bedoulian and Gargasian substages including revised biostratigraphies, $\delta^{13}C$ curve and cyclostratigraphy. Sixteen papers, previously published on-line in Notebooks on Geology, have been assembled by Moullade et al. in volume 24/1 (2009) of Annales du Muséum d'Histoire Naturelle de Nice. Although magnetic signature in the French stratotype sections cannot be detected, carbon isotope data allowed a precise correlation between the base of magnetic chron M0, recommended at the 1995 Brussels Meeting for identifying the base of the Aptian, and the Aptian basal ammonite *Deshayesites oglanlensis* Zone. The formal proposal of the Aptian GSSP at Gorgo a Cerbara (central Italy) is in preparation by the chair and members of the WG.

Moullade M., Tronchetti G. & Granier B. (eds.), 2009. Ammonites, Microfaunes, Stratonomie et Geochimie de l'Aptien-type. Annales du Muséum d'Histoire Naturelle de Nice, v. XXIV/1, 394 pp., Nice, France.

Base Albian GSSP.

As reported in 2009, the formal proposal for the base Albian at Tartonne (SE France), prepared by J. Kennedy, never reached the quorum. Voting Members against the proposal commented that the change of lithofacies at the critical level (from marl to organic-rich laminated black shale), the regional/provincial distribution of the index-species *Leymeriella (L.) tardefurcata*, and the low stratigraphic value of ancillary markers (few, poorly diagnostic planktonic foraminifera; *Predicosphaera* taxonomic problems, etc.) make the Tartonne section unsuitable as the basal Albian GSSP. In addition, the sampling across the Aptian/Albian boundary was considered at a resolution not adequate for such critical interval and the proposed event (FO of *L. tardefurcata*) is poorly applicable to other sections, especially outside SE France.

In order to increase the possibility of worldwide correlations, in Spring 2010 members of the new Working Group, set up in Plymouth last year (Paul Bown, coordinator), re-sampled at high resolution the Pré-Guittard section near Tartonne. Multidisciplinary analyses of the new sample set are in progress by a number of scientists from various European Universities (i.e. UK, Italy, Switzerland, France).

At STRATI 2010 (Paris, 2-6 September 2010) the base Albian was discussed at length and the French Cretaceous Stratigraphic Commission concluded that for the base Albian the section at Hyèges, nearby Tartonne, should be considered; the French Cretaceous Group is ready to coordinate an integrated stratigraphic work. Another section at Peracals- should be also considered

Finally, it was suggested that also the Spanish sections of Peracals-Lluca (SE Pyrenees) might be considered. Robert et al. (2001) indicated the Peracals section, rich in Tethyan and cosmopolitan ammonites, as being one the most complete sections across the Aptian/Albian boundary. Since 2001, lack of fundings and time prevented to go back to the area for extending the study to comprise other proxies.

Robert E., Peybernes B., Bulot L.G., 2001. Caractérisation d'une nouvelle sous-zone d'ammonites au passage Aptien-Albien dans les 'Marnes noires ~ Hypacanthoplites' des Pyrénées espagnoles. GEOBIOS, v. 34/1, p. 53-62.

Base Coniacian GSSP.

The final report on the base of Coniacian is in revision and will be published in volume 60, n.3 of Acta Geologica Polonica and contemporaneously will be sent to the Subcommission before the end of 2010. Besides multiple updated biostratigraphies, the report also includes the isotope curves for both the Salzgitter-Salder (northern Germany) and Slupia Nadbrzenna (central Poland) sections. It is confirmed that the inoceramid-based lower Coniacian boundary (first appearance of *C. deformis erectus*), slightly post-dates the traditional ammonite (FAD of *Forresteria*

petrocoriensis) position of the boundary.

The same issue of *Acta Geologica Polonica* will contain another article by I. Walaszczyk and members of the Working Group, which deals with the Wagon Mound section (US Western Interior), another candidate section for the base Coniacian. Their additional studies on macro- and microfossil (calcareous plankton) contents prove that the Wagon Mound section is older than the base of Coniacian and belongs entirely to the upper Turonian.

- I. Walaszczyk, C. J. Wood, J. A. Lees, D. Peryt, S. Voigt & F. Wiese, in revision. Salzgitter-Salder Quarry (Lower Saxony, Germany) – Slupia Nadbrzema river cliff section (central Poland): a proposed candidate composite Global Boundary Stratotype Section and Point for the Coniacian Stage (Upper Cretaceous). *Acta Geologica Polonica*, v. 60/3:
- I. Walaszczyk, J.A. Lees, D. Peryt & W.A. Cobban, in revision. Testing the congruence of the microfossil versus microfossil record in the Turonian – Coniacian boundary succession of the Wagon Mound - Springer section (NE New Mexico, USA). *Acta Geologica Polonica*, v. 60/3.

Base Santonian GSSP.

The final proposal for the base Santonian at Olazagutia (Spain), prepared by the chair M. Lamolda, was distributed for approval and/or comments to the Voting Members three times since 2008, and finally reached the quorum of positive votes in 2010. On October 1, 2010 the proposal was returned to the WG chair for an up-date and few corrections. The final GSSP proposal is expected to be submitted to the ICS before the end 2010.

Base Campanian GSSP.

Members of the WG have been searching for a new section across the Santonian/Campanian boundary to be proposed as base Campanian GSSP. So far, the only section not affected by hiatus and/or major dissolution is the Bottaccione section (Gubbio, central Italy), in which the calcareous plankton bioevents are calibrated to magnetostratigraphy and carbon isotope stratigraphy. The main bias of the Bottaccione section is that planktonic foraminifera from the critical interval could not be properly disaggregated from the hard limestones, using cold acetolysate method, and are very poorly preserved.

Base Maastrichtian GSSP.

To overcome the problem of correlation, stable isotopes were measured in high resolution from Tercis les Bains GSSP. The Tercis isotope curve will be compared with those from the Vistula River section (Poland) and the magnetostratigraphically calibrated Bottaccione & Contessa sections (Gubbio, central Italy). Sample collection from the latter sections was completed this Fall and isotope analyses carried out by Silke Voigt and collaborators are in progress. Data should be published very soon.

6. CHIEF PROBLEMS ENCOUNTERED IN 2009

The need nowadays for a high-resolution framework to be exportable worldwide resulted in the necessity of re-visiting several candidate sections, already studied paleontologically, by implementing multiple biostratigraphies and stratigraphic tools other than fossils - those are profoundly affected by bioprovincialism in several intervals - like magnetostratigraphy, stable isotope stratigraphy, etc. In several cases, especially in the Late Cretaceous, the integration of multiple bio-, physical stratigraphies revealed that the candidate sections were unsuitable as GSSP. Consequently, new sections had to be searched and studied from the beginning. This resulted in a delay in submitting the GSSP proposals, taking also into account that scientists from different subdisciplines do not necessarily work at the same speed.

Another problem is the lack of fundings in most countries for carrying out studies strictly stratigraphic, apparently poorly fashionable, for attending workshops and/or conferences.

7. SUMMARY OF EXPENDITURES IN 2010 (ANTICIPATED THROUGH MARCH 2011):

I. INCOME

| | | |
|-----------------------------------|------|----------------|
| ICS subvention for 2010 (2000 \$) | Euro | 1674.00 |
| | | ----- |
| Total income | Euro | 1674.00 |

II. EXPENDITURE

| | | |
|---|------|--------|
| Contribution to J/K meeting, Smolenice (organization+lodging) | Euro | 500.00 |
|---|------|--------|

| | | |
|--|------|----------------|
| Participation to J/K meeting, Smolenice (Chair) | Euro | 388.00 |
| Participation to ICS-Prague (part) (chair) | Euro | 164.47 |
| 3 st Contribution to Russian scientists | Euro | 500.00 |
| Hauterivian - trip to Marseille, 4-9 Oct. (Chair) | Euro | 250.00 |
| Office (chair & secretary) expenses | Euro | 150.00 |
| Bank Expenses (twice) | Euro | 12.00 |
| | | ----- |
| Total expenditure | Euro | 1964.47 |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2010):

Membership of Cretaceous Subcommittee.

The Voting Membership of the Cretaceous Subcommittee have been implemented during 2010.

Meetings

- The 8^o meeting of the Berriasian and J/K boundary WG is planned in Tunisia. No specific date is available yet.
- The 9^o meeting of the Berriasian and J/K boundary WG hopefully will be in Russia, pending the answer from the Russian Cretaceous Commission.
- Valanginian Workshop and field trip, Caravaca area, Spain, Spring 2011, pending.

Work Plan and anticipated Results

- To bring recommendations for the remaining GSSPs to ICS as soon as possible.
- Submission of the Santonian GSSP to ICS
- Votes on the Coniacian GSSP and submission to ICS after Subcommittee approval
- Votes on the Hauterivian GSSP and submission to ICS after Subcommittee approval
- Preparation of the first draft on Aptian GSSP
- To complete the new analysis of the Pre-Guittard section for the Albian GSSP
- Definition of criteria for identifying the base of the Berriasian and the J/K boundary
- Choose the appropriate section for the Campanian GSSP

9. BUDGET AND ICS COMPONENT FOR 2011

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|--|-------------|-------------|
| Office expenses (Fax, phone, postage, etc) | Euro | 150 |
| Organization expense for the J/K Tunisia Meeting | Euro | 500 |
| Support to participants to the J/K Tunisia Meeting | Euro | 1000 |
| Support to participants to the Valanginian Workshop, Spain | Euro | 1500 |
| Contribution to the fieldtrip at Peracals-Base Albian | Euro | 1500 |
| | | ----- |
| Total estimated expenditure | Euro | 4650 |

10. SUMMARY OF CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2006-2010)

See *Accomplishments in ICS Annual Reports 2006 to 2010 (above)* for additional details.

- Renewed research by WG members (resulting in a great number of publications, still ongoing), based on research needs pinpointed by the 1995 Brussels, 2005 Neuchâtel, 2008 Oslo and Plymouth meetings.
- Workshop on the Aptian ammonite zonation, held in Lyon (Nov. 2005) focused the discussion mainly on the ammonite faunal turnovers and the Lower/Middle Aptian (Bedoulian/Gargasian) boundary in relation to the position of the Furcata Zone.
- Set up of the renewed Working Group on the Berriasian GSSP and the J/K boundary, chaired by W.A.W. Wimbledon (Dec. 2006-Spring 2007).

- 2nd Workshop of the Kilian Group on the Hauterivian-Barremian zonation, held in Digne-les-Bains (May 2007), from the **Radiatus** (base of the Hauterivian) to the **Sarasini** (top of the Barremian) zones.
- 3rd Workshop of the Kilian Group on the Hauterivian and Barremian zonation, held in Vienna (April 2008)
- 1st official meeting of the renewed Working Group on the Berriasian GSSP and the J/K boundary, chaired by W.A.W. Wimbledon in Bristol (July 2007).
- 2nd official meeting of the Working Group on the Berriasian GSSP and the J/K boundary, chaired by W.A.W. Wimbledon in Marseille (July 2008).
- 33rd Geological Congress, August 2008, Oslo: SCS Symposium on “Stratigraphic subdivisions of the Cretaceous System: State of the Art”. (Conveners: I. Premoli Silva, F. Surlyk & I. Walaszczyk).
- 3rd official meeting of the Working Group on the Berriasian GSSP and the J/K boundary, chaired by W.A.W. Wimbledon in Milan (March 2009).
- 4th official meeting of the Working Group on the Berriasian GSSP and the J/K boundary, chaired by W.A.W. Wimbledon in Plymouth (September 2009).
- 5th official meeting of the Working Group on the Berriasian GSSP and the J/K boundary, chaired by W.A.W. Wimbledon in Smolenice (Slovakia) (April 2010).
- 4th Workshop of the Kilian Group on the Hauterivian and Barremian zonation, held in Dijon (August 2010)
- 6th official meeting of the Working Group on the Berriasian GSSP and the J/K boundary, chaired by W.A.W. Wimbledon in Paris (November 2010).

The Chair and/or Vice Chair represented the SCS at:

- 1st meeting of the *Berriasian and J/K boundary Working Group*, Bristol (UK), July 2007
- 2nd meeting of the *Berriasian and J/K boundary Working Group*, Marseille, July 2008
- SCS Symposium HPS-10 on “Stratigraphic subdivisions of the Cretaceous System: State of the Art”. (Co-conveners: I. Premoli Silva, F. Surlyk & I. Walaszczyk), at 33rd Geological Congress, August 2008, Oslo:
- 3rd meeting of the *Berriasian and J/K boundary Working Group*, Milan, March 2009
- 4th meeting of the *Berriasian and J/K boundary Working Group*, Plymouth, September 2009
- 5th meeting of the *Berriasian and J/K boundary Working Group*, Smolenice, April 2010
- ICS Meeting, Prague, May 2010

11. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2010-2014)

Meetings

- Spring 2011 – the 7th Workshop of the Berriasian and J/K boundary WG is planned in Tunisia
- August 2012 - Subcommittee Official Meeting at the 34th International Geological Congress, Brisbane, Australia
- September 2013 – 9th International Symposium on Cretaceous System, Middle East Technical University, Ankara, Turkey. Convenor: Ismail Omer Yilmaz
- September 2013 – 4th Workshop of the Kilian Group at the 8th International Symposium on Cretaceous System, Ankara.

Details of other meetings are not yet available.

Objectives

- To submit the proposal of Santonian GSSP to ICS, and to submit it to Episodes for publication
- To submit the proposal of Coniacian GSSP to ICS, and to submit it to Episodes for publication
- To submit a new proposal of Albian GSSP to the Cretaceous Subcommittee voting members, then to submit it to ICS, and possibly to Episodes for publication
- To bring recommendations for the remaining GSSPs to ICS as soon as possible
- To propose the definition of criteria for identifying the base of the Berriasian and the J/K boundary.
- To communicate the results as widely as possible.
- To develop new directions for the Subcommittee as GSSP proposals are completed. Specifically, future objectives will concern the subdivision of stages, with definition of substages and related GSSPs.

Work Plan

2011 – Finalize the proposal for the base of the Albian

2011 - Finalize proposals for the base of Valanginian, Hauterivian, Barremian, Aptian, Coniacian, and possibly Campanian

2011-2012 - Finalize the proposal for the base of Berriasian (Jurassic/Cretaceous boundary)

2010 to 2013 – Definition of substages.

APPENDIX [Names and Full Addresses of Current Officers and Voting Members]

Subcommission officers (with addresses)

Chair: Prof. I. Premoli Silva

Dipartimento di Scienze della Terra "A. Desio", Via Mangiagalli, 34, 20133 Milano, Italy
isabella.premoli@unimi.it

Vice Chair: Dr. I. Walaszczyk

Faculty of Geology, University of Warsaw, Al. Zwirki i Wigury 93, PL02-089 Warsaw, Poland
i.walaszczyk@uw.edu.pl

Secretary: Dr. Silvia Gardin

CNRS-CR2P "Centre de Recherche sur la Paleobiodiversite et les Paleoenvironments", case 104, University of Paris VI, 4, Place Jussieu, 75252 Paris, FRANCE
silvia.gardin@upmc.fr

List of Voting Members

| | |
|-------------------------------------|--|
| E Baraboshkin (Russia) | barabosh@geol.msu.ru |
| Prof. Jim Channell (USA) | jetc@geology.ufl.edu |
| Dr. James Crampton (New Zealand) | J.Crampton@gns.cri.nz |
| Dr. Jim Haggart (Canada) | jhaggart@nrcan.gc.ca |
| Prof. Malcom Hart (UK) | M.Hart@plymouth.ac.uk |
| Dr. Peter Hochuli (Switzerland) | peter.hochuli@erdw.ethz.ch |
| Dr. Brian Huber (USA) | Huber.Brian@NMNH.SI.edu |
| Dr. Elena Jagt-Yazykova (Poland) | eyazykova@uni.opole.pl |
| Dr. Fumihisa Kawabe (Japan) | fkawabe@aoni.waseda.jp |
| Dr. Eduardo Koutsoukos (Brazil) | koutsoukos@petrobras.com.br |
| Prof. Marcos Lamolda (Spain) | mlamolda@ugr.es |
| Dr. Sarah Niebuhr (Germany) | niebuhr.birgit@googlemail.com |
| Prof. David Watkins (USA) | d Watkins@unlserve.unl.edu |
| Prof. Helmut Weissert (Switzerland) | helmut.weissert@erdw.ethz.ch |
| Dr. Frank Wiese (Germany) | frwiese@snafu.de |
| Dr. William A.P. Wimbledon (UK) | newaberdon@tiscali.co.uk |

List of Task Groups and their officers

Maastrichtian WG: GSSP ratified. Giles Odin, France. gilodin@moka.ccr.jussieu.fr

Campanian WG: jim.kennedy@oum.ox.ac.uk, Andy Gale (UK) Andy.Gale@port.ac.uk

Santonian WG: Marcos Lamolda, Spain. mlamolda@ugr.es

Coniacian WG: Irek Walaszczyk, Poland. i.walaszczyk@uw.edu.pl

Turonian WG: GSSP ratified. No chairman at present.

Cenomanian WG: GSSP ratified. No chairman at present.

Albian WG: Malcolm Hart, UK. mhart@plymouth.ac.uk

Aptian WG: Elisabetta Erba, Italy. elisabetta.erba@unimi.it

Barremian WG: Peter Rawson, UK. peter.rawson1@btinternet.com

Miguel Company, Spain. mcompany@ugr.es

Hauterivian WG: Jörg Mutterlose, Germany. Joerg.Mutterlose@rz.ruhr-uni-bochum.de

Valanginian WG: Luc Bulot, France. lucbulot@aol.com

Berriasian (JK boundary) WG: William A.P. Wimbledon, UK. newaberdon@tiscali.co.uk

Kilian Group [formerly Lower Cretaceous ammonite WG]:

Chairman: Stéphane Reboulet, France. stephane.reboulet@univ-lyon1.fr

Vise-chairmen: Peter Rawson, UK. peter.rawson1@btinternet.com,

Jaap Klein, NL. j.klein@amc.uva.nl

SUBCOMMISSION ON JURASSIC STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommittee on Jurassic Stratigraphy

SUBMITTED BY

József Pálffy, Subcommittee Chair
Department of Physical and Applied Geology,
Eötvös University (ELTE)
Pázmány P. sétány 1/C, Budapest, H-1117 Hungary
Tel. +36 1 372-2500 / ext. 8725
Fax: +36 1 338-2728
Email: palfy@nhmus.hu

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

2a. Mission statement

The Subcommittee is the primary body for facilitation of international communication and scientific cooperation in Jurassic stratigraphy, defined in the broad sense of multidisciplinary activities directed towards better understanding of the evolution of the Earth during the Jurassic Period. Its first priority remains the unambiguous definition, by means of agreed GSSPs, of a hierarchy of chronostratigraphic units that provide the framework for global correlation. This mission is well in progress at Stage level, and future plans tentatively include formal definitions of Substages (as Lower/Middle/Upper as appropriate). Updated definitions of standard and regional zones are also pursued, along with efforts towards improved correlation with the zonal schemes of different fossil groups and other stratigraphies (including magneto-, chemo- and cyclostratigraphy).

2b. Goals

These fall into four main areas:

- (a) The definition of basal boundary stratotypes (GSSPs) and the refinement of standard and regional hierarchical chronostratigraphical scales down to zonal and subzonal level, through the establishment of multidisciplinary Task (and/or Working) Groups;
- (b) Fostering chronostratigraphic research and international collaboration, including the application, where possible, of cyclostratigraphy to develop astrochronologic estimates of durations of chronostratigraphic units, and integration of radiometric dates to improve the numerically calibrated time scale of the Jurassic;
- (c) In the framework of IGCP Project 506, initiated by the ISJS and led by the vice chair of Subcommittee, the development of methods of correlation between the units of the standard chronostratigraphic scale, established in marine Jurassic successions, and non-marine successions, to enable reconstruction of the history of the global biosphere and the lithosphere during the Jurassic Period;
- (d) International coordination of and collaboration in research on Jurassic environments, through the establishment of Thematic Working Groups, for example on Paleobiogeography, Paleoclimate, Sequence Stratigraphy and Tectonics. Progress towards these goals are showcased and scientific communications between experts of various aspects of Jurassic stratigraphy is facilitated by the organization of the International Symposia on the Jurassic System, held in every fourth year and sponsored by ISJS.

In addition, the Subcommittee has developed lines of communication with a wider public through two initiatives (also called Working Groups for simplicity): one is concerned with conservation of Jurassic geological sites such as those selected as GSSPs; the second encourages collaboration and liaison with non-professionals, notably fossil collectors, who have valuable data to contribute towards the Subcommittee's goals.

2c. Fit within IUGS Science Policy

The objectives of the Subcommittee relate to three main aspects of IUGS policy:

1. The development of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs at Series and Stage levels and related to a hierarchy of units (Substages, Standard Zones, Subzones etc.) to maximize relative time resolution within the Jurassic Period;
2. Establishment of frameworks and mechanisms to encourage international collaboration in understanding the evolution of the Earth during the Jurassic Period;

3. Working towards an international policy concerning conservation of geologically and palaeontologically important sites such as GSSPs. This relates to, *inter alia*, the IUGS Geosites Programme and the UNESCO Geoparks Programme. The Subcommittee also has links to the Management Group of the UNESCO East Devon and Dorset Coast (The Jurassic Coast) World Heritage Site.

3. ORGANIZATION

The Subcommittee has an Executive consisting of Chairman, Vice-Chairman and Secretary, who are all Voting Members of the Subcommittee. There are twenty other Voting Members, and it is emphasized that they are not elected to represent a country or region, but for their personal expertise and experience. Renewal of the membership has been completed this year. Replacement of those who have served the maximum allowed three terms or otherwise wished to withdraw from duty has been ratified by the ICS Executive. Thus a total of ten new voting members started service in 2010.

In addition to the Voting Members, there is a network of Corresponding Members, who have a responsibility for communication in both directions between the Subcommittee and researchers on Jurassic topics in their region. Most are also active in one or more Working Groups.

The objectives of the Subcommittee are pursued by Task Groups and Working Groups. Task Groups pursue the goal of defining GSSPs for stage boundaries where no GSSP has been fixed yet. Working Groups are either stratigraphical or thematic in scope, furthering stratigraphic research of stages with ratified GSSPs, or dealing with a specific topic related to Jurassic stratigraphy. Each group is organized by a Convenor, sometimes assisted by a Secretary, who are Voting or Corresponding Members.

The Subcommittee sponsors an International Congress on the Jurassic System every four years. The 8th Congress was held in 2010 in China, and this major event have been a focal point of ISJS activities in the reported year. The Chairman of the Organizing Committee was the Vice Chair of ISJS, but the Committee is independent of the Subcommittee.

3a. Officers for 2008-2012:

Chair: József PÁLFY, Hungary
Vice-Chair: Jingeng SHA, China
Secretary: Stephen HESSELBO, UK

WEB address for Subcommittee: <http://jurassic.earth.ox.ac.uk/>

The site underwent a major update in 2009 and is now hosted at the Oxford University. The Secretary has kept it up-to-date and relevant new information has been continuously posted.

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

Members of the Jurassic Subcommittee are involved in a number of international projects, normally in an individual capacity but sometimes facilitated by contacts through activities related to the Subcommittee such as its Task and Working Groups and the Jurassic Congresses.

4a. International Geoscience Programme (IGCP).

4a IGCP Project 506: Marine and Non-marine Jurassic: Global correlation and major geological events. This Project, which is associated with the Jurassic Subcommittee, is led by Vice Chair SHA Jingeng (China), with one Voting Member (Nicol MORTON, France) and five Corresponding Members as Co-Leaders. Year 2010 was the concluding year of the project (officially on extended term). The project's main activity was its participation in the organization of the 8th International Congress on the Jurassic System, where a topical session was organized under the auspices of IGCP 506.

4b. ProGEO and Geoparks Initiatives.

The Subcommittee Geoconservation Working Group (Convenor Voting Member Kevin PAGE, UK) has several links with international and national Geoconservation bodies and advisory groups (including himself and Corresponding Members Maria Helena HENRIQUES, Portugal, Platon TCHOUMATCHENKO, Bulgaria and Bill WIMBLETON, UK).

This year's geoconservation highlight was undoubtedly the 6th International Symposium on Conservation of the Geological Heritage (ProGEO) in Hagen, Germany. Its program included the following presentation by ISJS-affiliated authors or in Jurassic topics:

The Geodiversity south-west website – developing an on-line resource for geoconservation in south-west England (by Kevin Page, Mel Border, Malcolm Hart, Chris Bolton, Craig Dixon, Nick Powe, David Roche, Sam Scriven)

World Heritage 'For Sale' – state supported trade in global palaeonto-logical heritage in Dorset, UK and its consequences (by Kevin N. Page)

Fossil-lagerstaetten, type-localities and the handling with fossils in the Geopark Swabian Alb (by Anton Hegele).

4c. UNESCO World Heritage Sites.

Several UK members of the Subcommittee, including Voting Member Kevin PAGE, Corresponding Members Robert CHANDLER, and William WIMBLEDON, and others, are members of the Science and Conservation Advisory Group (SCAG) advise and support the work the Management of the UNESCO East Devon and Dorset Coast (informally known as the Jurassic Coast) World Heritage Site. There are ongoing consultations and discussions about the balance of public outreach (with, for example, guided fossil-collecting days for the public) and the geoconservation of important sensitive sites.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

5a. Progress with selection of GSSPs for Jurassic Stages.

Six of the eleven Jurassic Stages now have ratified GSSPs (Hettangian, Sinemurian, Pliensbachian, Aalenian, Bajocian, and Bathonian). The first one, which is also the GSSP of the Triassic/Jurassic system boundary, was ratified this year. The status of the other five stages is summarized below.

Toarcian. There is generally accepted, albeit so far informal agreement, that the GSSP for the base of the Toarcian Stage be placed at the base of bed 15e in the Ponta da Trovao section, Peniche, Portugal. A formal proposal is now at an advanced editing stage. Work is coordinated by Task Group chair Rogerio Rocha, based on extensive previous compilation by the late Serge Elmi, the previous TG chair. Emanuela Mattioli has assumed the role of TG Secretary and an updated membership list is being prepared. New details from a key reference section at Almonacid de la Cuba in Spain were published in 2010 by Comas-Rengifo et al. A ballot within the Task Group shall be held in 2011, before submission to the Jurassic Subcommittee.

Callovian. Activities of the Callovian TG have been set back this year by the unexpected death of TG Convenor John Callomon. Eckhard Mönning has been asked to solicit proposals from the membership to fill the position of TG Convenor. With due respect to Callomon's legacy, his successor will be asked to take action to revitalize the GSSP selection process. The *Keplerites kepleri* horizon in the Albstadt-Pfeffingen, Swabia (S. Germany) section was identified as the best candidate already in the early 1990s. A formal proposal needs to be formulated.

Oxfordian (Middle/Upper Jurassic boundary). The Oxfordian Task Group, under guidance of Convenor Guillermo Melendez, has identified two candidate sections, at Sauronon (SE France) and Redcliff Point, Dorset (SW England). Detailed descriptions of both sections and their ammonoid biostratigraphy appeared this year (albeit with printed publication year 2009) in *Volumina Jurassica* no. 7. The TG is close to a stage when formal proposals should be assembled, although in the French stratigraphic community some workers propose reconsideration of an alternative section at Thoux.

Kimmeridgian. It has been agreed through formal votes within both the Kimmeridgian TG and the ISJS that the base of the Kimmeridgian Stage should be defined at the base of the Baylei Zone at the Flodigarry section, Isle of Skye, Scotland. However, a subsequent ballot was inconclusive regarding the exact horizon at which the GSSP should be fixed, either the *Pictonia flodigarriense* Horizon or the *Pictonia densicosta* Horizon. Ongoing work, under the guidance of TG Convenor Andrzej Wierzbowski, is aimed at shedding light on correlations with high northern paleolatitudes and also to South America. Together with new paleomagnetic data to be generated, this should resolve disagreements, which principally concerned ammonite-based correlations within Europe. As soon as such new results will be available, they will be submitted to the Task Group members for a new vote.

Tithonian. Progress in identifying a possible GSSP for the base of the Tithonian is the least advanced of any of the Jurassic Stages. The Task Group faces difficulties of precise correlation between sections as a result of provincialism of the ammonite faunas has caused problems with finding and selecting potential candidate sections for the

Kimmeridgian-Tithonian boundary. The TG is encouraging more work on a possible candidate sections at Canjuers (France). Efforts are underway to organize a field workshop in that area in 2011.

5b The 8th International Congress on the Jurassic System

One of the main activities of ISJS is to sponsor a major international congress every fourth year. The 8th International Congress on the Jurassic System took place in Shehong, Sichuan, Cina in August 2010. Sessions were all held in the Fuluowan Hotel, in a beautiful setting by a lake in the Fujiang River near the town of Shehong, approximately 15 km north of Suining City in the eastern part of Sichuan Province. The hotel had excellent facilities, enhanced for our Congress, with three conference halls enabling up to three parallel sessions.

Scientific program

Two plenary sessions were held, with 6 plenary talks featuring key topics of current Jurassic research, both internationally and in China.

Volunteered presentations were arranged into the following 8 topical sessions:

S1 Marine and non-marine Jurassic boundaries and stratotypes: 12 presentations, including 4 posters; 15 short papers published.

S2 Biostratigraphy, sequence stratigraphy, isotopic stratigraphy, magnetostratigraphy, cyclostratigraphy: 47 presentations, including 18 posters; 49 short papers published.

S3 Biodiversity and evolution of Jurassic life: 40 presentations, including 17 posters; 54 short papers published.

S4 Depositional facies, palaeogeography, palaeoenvironment and ecosystem reconstruction: 19 presentations, including 9 posters; 29 short papers published.

S5 Jurassic palaeoclimate and palaeo-atmospheric CO₂: 11 presentations, including 2 posters; 15 short papers published..

S6 Major geological events and their causes and mechanics: 10 presentations, including 4 posters; 12 short papers published.

S7 Mineral and energy resources of Jurassic deposits: 6 short papers published.

S8 Jurassic Geoparks and museums: their roles in geological heritage protection and public education, etc.: 3 short papers published.

An open business meeting of the International Subcommittee on Jurassic Stratigraphy was also in the last day of congress.

Field excursions:

A total of six field trips were offered, including two pre-congress (A1, A2), two mid-congress (B1, B2), and two post-congress (C1, C3) excursions.

Excursion A1: Terrestrial Mesozoic of Ordos Basin, Shaanxi Province, led Shenghui DENG and colleagues. 6 days, 15 participants.

Excursion A2: Non-marine Jurassic and Cretaceous, Jehol Biota, in Western Liaoning Province, led by Baoyu JIANG. 6 days.

Excursion C1: Marine Lower to Middle Triassic, non-marine Upper Triassic, Jurassic and Lower Cretaceous in Sichuan Basin, led by Yongdong WANG. 7 days, 33 participants.

Excursion C3: Marine and non-marine Jurassic of Thailand, led by Assanee MEESOOK. 8 days, 10 participants.

Excursion B1: Shehong Petrified Forest National Geopark and Museum and Suining City: led by Xiaoping XIE, half day.

Excursion B2: Dujiangyan City, Yingxiu of Wenchuan (2008 Earthquake site): led by Bihong FU, full day.

Publications

Several publications were prepared for the Congress and distributed to participants.

A total of 183 short papers and abstracts were published by China University of Geosciences (Beijing) and Peking University as:

Short Papers for the 8th International Congress on the Jurassic System – Marine and non-marine Jurassic, August 9-13, Shehong of Suining, Sichuan, China. 2010. Earth Science Frontiers, Special Issue, vol. 17, 412 pp.

A series of publications as Contributions to the 8th International Congress on the Jurassic System were published by University of Science & Technology of China Press:

WANG, Yongdong et. al. 2010. The Terrestrial Triassic and Jurassic Systems in the Sichuan Basin, China. In English 216 pp; in Chinese 178 pp.

DENG, Shenghui et al. 2010. The Jurassic System of northern Xinjiang, China. In English 279 pp; in Chinese 219 pp.

JIANG, Baoyu et al. 2010. Outline of the Jurassic and Cretaceous Systems in Western Liaoning, NE China. In English 84 pp; in Chinese 85 pp.

MEESOOK, Assanee & SHA, Jingeng 2010. The Jurassic System of Thailand. In English (only) 124 pp.

A palaeontological monograph was published by the Geological Publishing House (Beijing), also as a Contribution to the 8th International Congress on the Jurassic System:

YIN, Jiarun 2010. Jurassic ammonites of Tibet. 247 pp.

The following book includes the full texts and illustrations for all field trips, except the one to Thailand.:

Field Guides for the 8th International Congress on the Jurassic System. Shehong of Suining, Sichuan, China, August 2010. 166 pp.

Banquets, social events and media

The Congress had several banquets and social functions, including an “ice breaker, a welcome banquet, a cultural performance, a banquet in Suining City, and a farewell banquet.

The 8th International Congress on the Jurassic System was extensively reported on several television channels (including Sichuan TV, Suining TV and Shehong TV) and in the press (Xinhua News Agency, SCTV, Sichuan Daily, Suining Daily).

In summary, the 8th International Congress on the Jurassic System, held for the first time in Asia, was a great success, thanks to all the hard work and careful preparation by the Congress Organising Committee, chaired by Jingeng SHA and to the strong logistic support by the local governments of Shehong County, Suining City and the Sichuan Province.

5c Volumina Jurassica – publication of an ISJS-sponsored periodical

This year the ISJS entered into a strategic partnership with the periodical *Volumina Jurassica*. This journal is well positioned to emerge as a renowned publication medium for the entire international Jurassic research community. Therefore the ISJS decided to establish a long-term sponsorship of the journal, based on our mutual interest in promoting publication of original research papers of broad international interest on all aspects of the Jurassic System.

Volumina Jurassica is issued jointly by the Polish Geological Institute – National Research Institute (PGI), and Warsaw University. The editorial board is now based in the PGI, which secures a stable organizational framework and financial support (annually, about 30.000 EUR is allocated by PGI to maintain the editorial office of *Volumina Jurassica*). The current editorial board comprises Andrzej Wierzbowski (editor), Grzegorz Pieńkowski (deputy editor) and Anna Andraszek (secretary). Dr John Wright is an English language. *Volumina Jurassica* is a free-access journal (pdf's are fully and openly accessible on the website: www.voluminajurassica.org). Five hundred paper copies are printed, and are shipped without charge to authors, reviewers and selected libraries.

The Chair, Vice Chair and Secretary of ISJS have been invited to serve in the Editorial Board and help steer the journal towards establishing itself in the ISI list within the next few years. Publication of Volume 8 is scheduled for December 2010.

5d ISJS Newsletter and website

No. 36 of ISJS Newsletter was published and distributed fully electronically in October 2010. This year's 60 page issue was edited by ISJS Secretary S. Hesselbo. The date of issue was scheduled so that a full report on the 8th Congress could be published, as well as the announcement of the venue of the upcoming 9th Congress in 2014. Other items include reports of Task and Working Groups, Correspondence, Book Reports, and Obituary for John Callomon, chair of the Callovian TG.

At the ISJS business meeting in Sichuan, it was proposed that the publication of formal ISJS Newsletter be replaced by other forms of communications. Thus in the future, items of scientific interest would be published in *Volumina Jurassica*, whereas news items, announcements and other urgent matter would be released for immediate distribution to members of the Jurassic community via email and a News section on the ISJS website.

The ISJS website, revamped in 2009, continued to be updated on a regular basis in 2010. The website is hosted by the Oxford University, home institution of our Secretary, who is responsible for keeping the website up-to-date. It is accessible at <http://jurassic.earth.ox.ac.uk>

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

For other professional commitments, the executive has found their time and energy limited and not fully adequate to carry on ISJS businesses as originally envisioned. The chair served as head of department until August 2010, then started in a new and demanding teaching position at Eotvos University of Budapest. The Vice Chair was primarily

occupied with the organization of the 8th Congress. The Secretary served as Acting Master of a college at Oxford University, which position constrained his availability to attend ISJS matters.

7. SUMMARY OF EXPENDITURES IN FISCAL YEAR 2010 (UP TO DATE OF REPORT)

Finances of the ISJS are dealt with at University of Oxford, on a dedicated account set up by the Secretary and managed by the Finance Officer, Department of Earth Sciences, University of Oxford.

Income

ICS Allocation received in 2009 and carried forward to 2010 US\$ 2,500 = £ 1,469.59

Expenditures in 2010

Field work in Skye at Kimmeridgian GSSP candidate £ 300.21

Travel support for Congress in China £ 203.99

Subtotal £ 504.30

Balance as of 29 November 2010 £ 965.39

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED IN 2011

8a. Proposals for GSSPs of Jurassic Stages.

Completion of the project to define the basal boundaries of all eleven Jurassic Stages is the priority of the Jurassic Subcommittee, with five remaining to be defined: the Toarcian, Callovian, Oxfordian, Kimmeridgian and Tithonian. Activities are planned for 2011 towards the selection of each of these GSSPs.

- (i) The *Toarcian* is at an advanced stage. After the death of former convenor S. Elmi, the TG has been reconstituted under the leadership of R. Rocha. A proposal for the Peniche section in Portugal is at an advanced editing stage, with major stratigraphic research work completed. It is expected that the proposal will be finalized and the TG will conduct a vote in 2011. If successful, it will be followed by the vote within the Subcommittee.
- (ii) The *Callovian* suffered a major setback by the unexpected death of TG convenor J. Callomon in 2010. The new TG chair will be elected in 2011 and the TG membership reconstituted. The Albstadt section has been long regarded as the sole candidate for the Callovian GSSP. Steps will be taken in 2011 towards a formal proposal, identifying possible need for further research in fields other than ammonoid biostratigraphy, which was the main priority in previous research.
- (iii) For the *Oxfordian*, important details of two candidate sections (Redcliff Point, UK; Saurmon, France) were published recently. However, there has been renewed interest in another section at Thoux, recommended by some French workers. It seems warranted that the two sections in France be examined at a field workshop, which would also provide a forum for discussion about the respective merits of candidates. Organization of this event, in conjunction with a visit to a Tithonian section (see below), will be the main focus of ISJS in 2011.
- (iv) *Kimmeridgian*: The basal zone accepted by WG and SC vote, section selected and confirmed by WG vote; precise level/horizon and marker not yet decided. The resolution of this situation is expected from new data about the correlation potential of the debated ammonite markers with other bioprovinces, and new magnetostratigraphic work at the candidate section in the Isle of Skye.
- (v) *Tithonian*: The Saurmon section has been identified as a potential candidate GSSP. Further work is needed and the section should be visited by the TG members. Therefore a field meeting is planned, which could be held in conjunction with that of the Oxfordian TG, as the sections are relatively close to each other and several Upper Jurassic specialists have common interest in both the Oxfordian and Tithonian GSSP issue. Organization of this field meeting is planned as the focal activity within ISJS in 2011, for which financial support is requested.

8b. Proceedings of 8th International Congress on the Jurassic System, Suining, China, 2010.

Submissions have been solicited following the successful congress. Two volumes are planned, for which most editorial work should be completed in 2011.

1. Papers related to marine and non-marine Jurassic correlation (the key topic of IGCP 506), to be published in a special issue of Earth Science Frontiers. J. Sha will coordinate and edit the volume of this Chinese periodical.
2. Papers dealing with other issues of Jurassic stratigraphy, paleontology, palaeogeography, and palaeoclimate will be published in *Volumina Jurassica*, which is now sponsored by ISJS.

9. BUDGET AND ICS COMPONENT FOR FISCAL YEAR 2011

For year 2011 the main activities of the Jurassic Subcommittee will be focussed on the following:

- (i) With a notable exception of the Tithonian, most of the Stage Working Groups have completed the fieldwork related to the investigation of candidate GSSP sections and selection of preferred section to be proposed to the Subcommittee. To ensure progress in the base Tithonian, however, organization of a field workshop is necessary.;
- (ii) Stage Working Groups, which have completed Stage GSSP procedures will continue work on definitions of Substages and Standard Zones. There is a long tradition of using two substages in the Pliensbachian; their boundary definition would benefit from site visits by WG convenor and key experts;
- (iii) Re-design, regular update and maintenance of the ISJS website, to be hosted at the Oxford University;

9a Budget request. Provision is requested in the budget to meet the above goals, with priority given to the organization of a “Base Tithonian Workshop”.

| | |
|--|----------------|
| General office expenses | 150 |
| Contributions to ISJS and Task Group officers’ travel costs | 600 |
| Support for combined Oxfordian and Tithonian Task Group meeting in SE France | 3500 |
| TOTAL BUDGET PROJECTED | \$ 4250 |
| Carried forward from 2009/2010 | \$ 1642 |
| BUDGET REQUEST FOR 2011 | \$ 2600 |

10. OUTLOOK AND OBJECTIVES FOR THE YEARS AHEAD

The primary objectives for the immediate future for the Jurassic Subcommittee remain the completion of the long-standing project for definition of the Stages by GSSPs. Of the five stages lacking GSSPs agreed upon by formal votes within ISJS, four (Toarcian, Callovian, Oxfordian, and Kimmeridgian) are at an advanced stage so that formal proposals and a start of the voting procedure is expected either in 2011 or soon after. The Tithonian is at a less advanced stage and effort needs to be increased to find the most suitable marker event and location so that the definition of this stage boundary could also be completed within the next few years.

As the term of office for ISJS executive will end in 2012 by the 34th IGC in Brisbane, the nomination procedure for the election of officers for the 2012-2016 term needs to be started in 2011. Planning and preparation for adequate representation of Jurassic topics and stratigraphers at the Brisbane congress should also be a focus in year 2011.

SUBCOMMISSION ON TRIASSIC STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommittee on Triassic Stratigraphy

SUBMITTED BY

Prof. Marco BALINI, Chairman
Dipartimento di Scienze della Terra "Ardito Desio"
Università degli Studi di Milano
Via Mangiagalli 34, 20133 Milano, Italy
Tel. ++39 0250315512
E-mail: marco.balini@unimi.it

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Rationalization of global chronostratigraphical classification.
Intercalibration of fossil biostratigraphies, integrated zonations, and recognition of global data.
Establishment of magneto- and chemo-stratigraphic scales.
Definition of Stage boundaries and selection of global stratotype sections.
Correlation of Triassic rock successions and events, including marine to non-marine.
Climatic evolution and modeling.

The objectives satisfy the IUGS mandate of fostering international agreement on nomenclature and classification in stratigraphy; facilitating international co-operation in geological research; improving publication, dissemination, and use of geological information internationally; encouraging new relationships between and among disciplines of science that relate to Triassic geology world-wide; attracting competent students and research workers to the discipline; and fostering an increased awareness among individual scientists world-wide of what related programs are being undertaken.

3. ORGANIZATION

STS is a Subcommittee of the International Commission on Stratigraphy.
Officers (chairman, two vice-chairmen, secretary), Editor/ Webmaster of newsletter *Albertiana*, voting members (25), and corresponding members (~100). The Secretary hosts a web site for STS announcements and task group discussions.

Subcommittee members represent a broad spectrum of specialized stratigraphical disciplines from those countries or regions where Triassic rocks are extensively studied in relation to fundamental and/or applied geological research. Current research activities and future plans are communicated through publication of the bi-annual STS newsletter *Albertiana* as web release.

3a. Officers for 2004-2008:

Chair: Dr. Michael J. Orchard, Canada
Vice-Chair: Prof. Marco Balini, Italy
Vice-Chair: Prof. Yin Hongfu, China
Secretary: Prof. Christopher R. McRoberts, USA

3b. Officers for 2008-2012:

Chair: Prof. Marco Balini, Italy
Vice-Chair: Dr. Mark Hounslow, UK
Vice-Chair: Prof. Jinnan Tong, China
Secretary: Prof. Christopher R. McRoberts, USA

The official newsletter of the STS is *Albertiana*, printed once in the year in Utrecht (The Netherlands) and downloadable at the website:

<http://www.uu.nl/faculty/science/EN/organisation/depts/biology/research/chairs/Palaeoecology/projects/ALBERTIANA/Pages/default.aspx>

The web site of the STS is hosted at SUNY – Cortland, where all the information on the Subcommittee activities are available:

<http://paleo.cortland.edu/sts/>

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

IGCP Project 572: Restoration of marine ecosystems following the Permian-Triassic mass extinction: Lessons for the present (2008-2012).

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

Publications

“The Triassic Timescale” S.G. Lucas (ed.), Geological Society of London Special publications.

The volume, already announced in 2009, has been published in June 2010. It includes 15 contributions volume (515 pages) reviewing the state-of-the-art of the main tools for the definition of the Triassic time-scale, from classic fossil tools (ammonoids, bivalves, conodonts, radiolarians, palynomorphs, conchostracans, tetrapods and tetrapod footprint) to magnetostratigraphy, geochronologic data ages, isotope variations and cyclostratigraphy.

The proceedings of “The Triassic climate” workshop, Bolzano/Bozen, 2008 have printed in April 2010 as issue #290 of *Palaeogeography, Palaeoclimatology, Palaeoecology*, The volume includes 13 contributions spanning from the Permo-Triassic to the end of the Triassic.

Two volumes of *Albertiana* are scheduled for this year

#38. published in March 2010, 84 pages.

#39. Editing almost finished. The issue is dedicated to Palermo workshop and includes all the abstracts of the oral and poster presentations, as well as the field guide of the excursion. The issue will be distributed by November 2010.

The primary aim of *Albertiana* is to promote the interdisciplinary collaboration and understanding among members of the Subcommittee and within this scope serves as a platform for announcements, meeting reports, business minutes, reviews, and Triassic literature compilations as well as preliminary notes, progress reports, and articles on Triassic research. Electronic versions are also available in PDF format at:

<http://www.uu.nl/faculty/science/EN/organisation/depts/biology/research/chairs/Palaeoecology/projects/ALBERTIANA/Pages/default.aspx>

Meetings:

June 28-July 3, 2010, London, 3rd International Palaeontological Congress. Workshop W3: Restoration of marine ecosystems following the Permian-Triassic mass extinction: lessons for the present. Organizers R. Twitchett, S. Crasquin & S. Kershaw.

5-10 September 2010. Dolomites (Italy). 7th International Field Workshop on Triassic. Triassic of the Dolomites. The workshop consisted of 5 days of field trip, aimed at visiting some classical sites of the Dolomites as well as new localities and stratigraphic sections recently discovered. About 80 participants from 19 countries attended the workshop.

12-16 September 2010. Palermo, Italy. International workshop “New developments on Triassic integrated stratigraphy”. The workshop consisted of two days of talks on different aspects of Triassic stratigraphy and two days of excursion. The 2nd day of the field trip was entirely dedicated to the visit of the Pizzo Mondello section, candidate for the GSSP of the base of the Norian stage- 30 scientists from 7 countries attended the meeting.

Progress on outstanding Triassic GSSPs:

Induan-Olenekian

The Task Group was re-activated in October 2009, and its composition was updated. The discussion started at the beginning of 2010 by Hugo Bucher and Nick Goudeman (Switzerland), who obtained new data on ammonoids and conodonts from the Induan-Olenekian transition in both Salt Range in Pakistan (Nummal section) and Central Himalayas (Mud section). Other new data were provided by Brühwiler et al. (in press) and also by Orchard (2010), who analysed Induan-Olenekian conodont successions of Central Himalayas (Mud section) and South China. In summer the discussion on this topic involved specialists from Canada, China, England, Hungary, Italy, Japan, Russia, and USA. It will be recommenced at the end of 2010, when very important Bucher’s et al. papers on

paleontology, biostratigraphy and geochemistry of the Nummal section (Salt Range) will be published and additional information on Lower Triassic sections will be obtained. According to Hugo Bucher's last information, samples for palaeomagnetic analysis would be taken in the Nammal section in February 2011 (although he is still waiting for a concrete move from Pmag people), results of which, judging from available characteristics would be positive; it is known that the Permian has been published long ago, and therefore Bucher believes that the Triassic should be as good as Permian. At the same time he asks to concentrate our attention on that fact that data on sequence stratigraphy, palynology and palinofacies from the Lower Triassic of the Salt Range, important for global correlation both marine and non-marine sediments, are already obtained and are in the review process just now (Hermann et al., 2011a,b,c,d). In this connection it would be reasonably to organize the first ballot for the GSSP selection just after their publishing and/or palaeomagnetic analyzing of Pmag samples, if they will be collected in the Nammal section in good time.

Olenekian-Anisian

The progress towards the definition of the GSSP of the base of the Anisian has been very slow in the last years. The situation is not satisfactory, taking into account that the Task Group started the activities in the mid on the 90's. In the last 10 years, Desli Caira (Rumania) appeared to be the most suitable section for the definition of the base of the Anisian, with no other challenging candidate. For this reason from 2004 the leader of the research group working on Desli Caira section acted also as Task Group leader. In 2007 two boundary proposals were presented on the newsletter *Albertiana*, but since then no ballot has never been organized. No papers on Desli Caira have been published in the last 3 years, notwithstanding several suggestions and invitations by the past chairman and the present chairman of the STS.

Due to the lack of progress on the candidate section, as well as the report of the first occurrence of the candidate marker *Chiosella timorensis* in the Haugi Zone (Olenekian) of western US (Goudemend, submitted) it might be time to re-open the discussion on this boundary. By decision of the STS chairman a new Task Group chair is going to be selected, and afterwards the composition of the Task Group will be updated.

Ladinian-Carnian

The GSSP for the base of the Carnian stage has been defined in 2008 at level SW4 of the Prati di Stuores/Stuores Wiesen (Dolomites, Italy) with the first occurrence of the ammonoid *Daxatina canadensis*. The GSSP has been ratified in June, 2008 and the final paper for *Episodes* is in progress.

Carnian-Norian

In 2010, the Task Group for the Carnian/Norian boundary has been very active. Two field excursions were organized to visit the two candidate sections Black Bear Ridge (British Columbia, Canada) and Pizzo Mondello (Sicily, Italy). A workshop dedicated to present and discuss the new data of the ongoing research was held in Palermo.

The first field trip to Williston Lake (British Columbia) was organized in May (21-24) by J.P. Zonneveld (University of Edmonton, Alberta). Eight specialists, including the TG leader L. Krystyn, the members J.P. Zonneveld, M. Balini, C. McRoberts and M. Orchard, together with M. Levera, M. Mazza and M. Golding, attended the field trip. The participants visited Black Bear Ridge section as well as other important sections on the shoreline of the lake, as Pardonet Hill and *Juvavites* cove. Important opportunity for discussion was just before the field trip, when the European participants meet in Vancouver with M. Orchard and spent two days on the ammonoid and conodont collections from British Columbia, housed at the Geological Survey of Canada.

The second field trip was organized in the framework of the Palermo workshop on September 12-16. One session of the workshop was dedicated to the Carnian/Norian boundary with 8 oral and 6 poster presentations and the 2nd day of the excursion was entirely dedicated to the Pizzo Mondello section. Thirty participants attended the workshop and visited the section. The proceedings of the workshop will be printed in 2011 in the *Rivista Italiana di Paleontologia e Stratigrafia*.

The discussion on the Task Group was mostly focused on the possible marker event for the boundary. The correlation of the conodont events is still difficult, probably due to provincialism, and three main events are under discussion: first occurrence of *Metapolygnathus echinatus* at BBR and the first occurrence of *Epigondolella quadrata* and of *Metapolygnathus communisti* at Pizzo Mondello. Some specialists suggest to replace conodonts with *Halobia* as marker event. *Halobia austriaca* has been suggested as possible marker. This species shows a worldwide distribution and a stable taxonomy, but the main point that is under test is the correlatability of its first occurrence. This test cannot be solved by using only conodonts, because at the moment their correlation is problematic, but by using a combination of ammonoids and magnetostratigraphy. As no magnetostratigraphic record is known from BBR such an intercalibration is complex. In order to increase the option for such an intercalibration, in October M. Balini in cooperation with J. Jenks have carried out a sampling of the West Union Canyon succession (central Nevada). This succession shows the best ammonoid record of the boundary interval, but has never been

studied in the last 50 years. Conodonts are under study by M. Orchard, bivalves will be worked out by C. McRoberts, and M. Balini and J. Jenks will work on the ammonoids in cooperation with N. Silberling. In 2010 some papers have been published. A paper on the conodont genera turnover at the C/N boundary has been published in *Paleo3* by Mazza et al. A paper by Zonneveld et al. on the sedimentologic framework of the BBR section is in press in *Stratigraphy*. The monograph by McRoberts on the northamerican *Halobia* has been submitted to the *Memoirs of the Journal of Paleontology*. A paper on the Halobiidids from Pizzo Mondello is in preparation by M. Levera, to be printed in the Proceedings of the Palermo workshop. This volume will include also three other contributions on the Pizzo Mondello section.

Norian-Rhaetian

Recent discussions about a too low sedimentation rate in the proposed GSSP candidate Steinbergkogel (Austria) induced intense efforts to enlarge the biostratigraphic database below and above the boundary. This led to new discoveries of the lower Rhaetian zonal guide ammonoid *Paracochloceras* still 10 m above the boundary and thus to a clear disproof of stratigraphic condensation in the section. A refined magnetostratigraphy shows an additional reverse interval not far from the boundary, coeval to the entry of the conodont *Misikella hernsteini*. This short Reversal is known from other Tethyan sections too and allows an enlarged and more accurate magnetostratigraphic correlation within the boundary interval. Though no progress could be achieved in either a palynological or radiolarian correlation of the boundary, the finite proposal for Steinbergkogel is now in preparation and will be submitted to the Task Group by end of 2010.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

The 2010 has been one of the worst years for the STS, because of the deteriorating of problems already outlined in the past two reports. The main problems can be summarized as follows:

1. Severe cuts of budget for research at every level in many countries, due to the global economic crisis, notably reduce not only the research in the field, but also the possibility for the Task Group members to attend meetings and workshops. The definition of the GSSPs requires both the type of activities, then the work of the Task Groups is notably slowed down.
2. Decrease of interest on the STS activities of some experienced members close to retirement. This is a rather new problem but it is very severe as it affects directly the life and vitality of the Subcommittee, as scientific community living on joint research, meetings and discussions. Several STS members started their research carrier in the 1960's and are close to retirement, or retired in the very last years. Difficulties in getting full positions make the turnover with young scientists very difficult. At the present the main consequences of the decreasing of interest are:
 - a) Lack of suggestions for the activities and the program of the Subcommittee.
 - b) Difficulties in finding candidates for the organization of workshops and excursions.
 - c) Reduction of the contributions to the STS newsletter *Albertiana*, that was almost regularly published twice a year until 2007 (issue #36), while since then only 2 issues have been published in 3 years.
3. Lack of IGCP cover. After the end of the successful IGCP 467 in 2008, only the IGCP 572 still provides support for some of the activities of the STS, notably the investigations on the Early Triassic.

7. SUMMARY OF EXPENDITURES IN 2010 (in US\$)

| | |
|--|------|
| ICS FUNDING | |
| Subcommission allocation | 3500 |
| STS EXPENDITURES | |
| Contribution to participants to Williston Lake excursion | |
| May 2010 | 550 |
| Contribution to Palermo workshop | 2500 |
| Travel expenses of STS secretary | 450 |
| TOTAL | 3500 |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

Organization of the Subcommittee

In order to try to increase the vitality of the Subcommittee (see above point 6.2), in the 2010 the STS chairman has started a revision of the composition of the Subcommittee. The revision started from the base, that is to say from the Corresponding Members. By the end of 2010, about 15 specialists will be involved for the first time in the activities of the Subcommittee. The update will continue in 2011. This is the major revision of the Subcommittee since 2001.

Meeting/field workshop schedule

July 1-4, 2010, Perth, Australia, IGCP572, Fourth annual meeting and IGCP symposium joint with the “17th International Congress on Carboniferous and Permian” Organizer Z.Q. Chen.

Beginning of September 2011, 8th International Field Workshop on Triassic. Southern France. Organizer Marc Durand, Laxou France (mada.durand@wanadoo.fr).

Autumn 2011. Workshop on the Upper Triassic stages, to be organized in the Dolomites (Italy) or in Austria. This workshop is conceived in order stimulate and motivate the members of the Carnian-Norian Task Group, as well as the research groups working of the GSSP candidate sections, to keep momentum after the very good work done in 2010. This workshop will be an important the opportunity to deliberate on the C-N boundary. Organizers: Piero Gianolla (glr@unife.it), Leo Krystyn (leo.krystyn@univie.ac.at) and Marco Balini (marco.balini@unimi.it).

GSSP deliberations

The I-O Boundary: The Task Group, reactivated at the end of 2009, is expected to vote a proposal during 2011.

The O-A Boundary: The Task Group is going to be re-organized. It will be active at the beginning of 2011 (see point 5).

The L-C Boundary: The GSSP has been ratified by IUGS in June, 2008. The final presentation of the GSSP on Episodes is in progress.

The C-N Boundary: Good progress in the selection of the best events to mark the boundary. At the moment this selection includes the FAD of the bivalve *Halobia austriaca* and three FAD of conodont species: *Metapolygnathus echinatus*, *Epigondolella quadrata* and *M. communisti*. The Task Group is now checking the correlatability of these bioevents. This requires a rather complex cross correlations of several stratigraphic sections from the Tethyan realm to the North America. The Task Group might be ready for a vote during 2011.

The N-R Boundary: The primary marker event and the candidates section were already designated in 2008. Two years have been dedicated to test the correlatability of the proposed marker event, and now the final proposal is going to be submitted to the Task Group by the end of December 2010.

9. BUDGET AND ICS COMPONENT FOR 2011 (in US\$)

| | |
|---|------|
| Albertiana - STS Newsletter production | 800 |
| Workshop on Upper Triassic stage boundaries | 2500 |
| TOTAL | 3300 |

Potential funding sources outside IUGS

The situation is stable since the end of IGCP 467 (2008) and is as follows:

- Dept. of Geosciences, University of Utrecht provides facilities for the production of Albertiana and hosts its website.
- Dept. of Geosciences, Cortland, New York hosts the STS website.
- National research and travel grants provide support to individuals, and host institutions provide in-kind support to the executive and task group chairs.
- Some support is available through IGCP 572 for activities concerning the Lower Triassic stage boundaries.

10. REVIEW CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2005-2009)

Organization

Renewal of STS voting and corresponding membership in 2001. Voting membership was reduced from 31 to 26, and a broader geographical and disciplinary base established. This was the first significant turnover of voting members since the inception of the STS. A summary of all members' research interests was published in Albertiana 26. Four new GSSP Task Group chairs were appointed. A second renewal took place in the Fall of 2004 with 11 new voting

members amongst 25: this addressed the ICS recommended limit for terms served as well as lapsed members. A second web site was created to supplement that of *Albertiana* and host discussion groups.

Meetings/ workshops

1. Meeting on *Triassic Chronostratigraphy and Biotic Recovery*. Chaohu, China, May 23-25, 2005. Focus on I-O boundary
2. Symposium on *Circum-Panthalassa Triassic Faunas and Sequences*, at INTERRAD conference. Te Papa Tongarewa, Museum of New Zealand, in Wellington, Wellington, New Zealand. March 19-24, 2006.
3. Symposium on *Triassic Conodonts: Taxonomy and Time Scales*, at the First International Conodont Symposium (ICOS1), in Leicester, England, July 17-21, 2006.
4. Conference, *The Boreal Triassic*. Longyearbyen, Svalbard, Arctic Norway, August 16-20, 2006.
5. International meeting on *The Global Triassic*. Albuquerque, New Mexico, USA. May (19-)23-25, 2007.
6. Field workshop on the *Carnian-Norian boundary*, Williston Lake, NE BC, Canada. May 27-31, 2007.
7. Symposium, *The Triassic climate*, Bolzano/Bozen, Italy, June 3-6, 2008.
8. Symposium and field workshop, *Upper Triassic subdivisions, zonations and events*, Bad Goisern, Austria, September 28-October 2, 2008.

Publications

7 issues of *Albertiana* (#32-37) were published in 2005 thru 2009, for a total of 739 printed pages. Each of these issues was made available for download from the web.

Abstract volumes/ field guides prepared for meetings in Chaohu, Wellington, Leicester, Longyearbyen, Albuquerque, Bolzano, Bad Goisern.

Task groups

The **Permian-Triassic boundary** Task group ended the activities in 2001, with the ratification of the GSSP at the first appearance of the conodont *Hindeodus parvus* at the base of bed 27c, within the Yinkeng Formation at Meishan, Changxing County, Zhejiang Province, South China.

The **Induan-Olenekian boundary** Task Group, stated in 1997, reviewed the options for a GSSP in the Russian Far East but found them lacking because of strong remagnetization of Triassic rocks and poor recovery of I/O conodont assemblages. A section in Chaohu, Anhui Province, China subsequently became the focus of intensive study. Ammonoid and conodont biostratigraphy, magnetostratigraphy, and chemostratigraphy were undertaken. The FAD of the conodont *Neospathodus waageni* was identified as a potential GSSP datum: it lies 26 cm below the FAD of the Flemingitid ammonoids, and is located slightly prior to the top of the second Triassic normal magnetozone, and prior to the peak of the first Triassic positive excursion of $\delta^{13}\text{C}$. A preliminary conodont biostratigraphy for Chaohu was summarized in *Albertiana* #29 (2004), and the ammonoids described in *Albertiana* #31. This boundary and proposed GSSP was the focus of a meeting held in China during June 2005, at which time many members of the task group were able to examine the section. Several publications on Chaohu appeared in 2006 (see *Albertiana* #33 and 34), including an account of the conodont succession, and papers on the bivalves, ammonoids and palynomorphs.

After 2004 field work carried out in Mud, Spiti, an evaluation of the Mikin Fm. for establishing an Induan-Olenekian boundary GSSP candidate began (see *Albertiana* #35). The rocks include top *Gyronites*, complete *Flemingites*, and basal *Euflemingites* ammonoid intervals. Three boundary options based in ammonoids were suggested and provisionally tied to the FAD of *Neospathodus waageni* subspp. Initial conodont studies identified useful taxa common to Chaohu. The ammonoid record appears superior to that at Chaohu but the section lacks a magnetostratigraphy. Both the proposal and studies on the conodonts and C-isotopes from Spiti appeared in *Albertiana* #36, as did an account of the considerable discussion on this boundary that took place during and after the Svalbard meeting (2006).

Two ballots were organized in 2007, based on the FAD of *Neospathodus waageni sensu latu* at Mud and at Chaohu. Mud got the majority of votes at the end of 2007, with proposed GSSP at the base of level MO4-13A3 of Mud section 4. In 2008 further research on Mud samples, aimed at refining the taxonomic variability of *N. waageni*, leads to discover some specimens possibly belonging to morphotypes of the group of *N. waageni* also below the level MO4-13A3. In order to come to a stable conclusion one year of time was given to the research group working on Mud section, with dead line the ICOS 2009 (Calgary, July, 12-17). Two conodont specialists (M. J. Orchard and N. Goudemand) were involved in the study and they both come to the conclusion that *N. waageni sensu latu* first appears about 1 m below the level MO4-13A3. In October 2009 the Task Group is reactivated, its composition revised and the discussion re-opened.

A field workshop was held at Desli Caira, in Dobrogea, Romania, in June 2000, to view the **Olenekian-Anisian boundary** candidate. Major work was undertaken on ammonoid, nautiloid, conodont, and foraminiferid biostratigraphy. Both chemo- and magneto-stratigraphic analyses were largely completed. At the 2003 field workshop in St. Christina, a conodont workshop amongst task group members agreed that the appearance of the conodont *Chiosella timorensis* at the base of bed 7 was a suitable datum for GSSP definition. Further geochemical sampling was undertaken in 2004 to fill a perceived gap in the coverage at the principal section. Further work has been undertaken on correlative sections in South China, Spiti, and South Primorye, Russia. In particular, a section at Guandao in the Nanpanjiang Basin of Guizhou Province, South China produced an excellent dataset, including isotopic dates from about this boundary (~247 Ma).

At Desli Caira, the FAD of the conodont *Chiosella timorensis* corresponds to a significant change in the ammonoid fauna, and a little below a peak of a positive C isotope excursion; it falls within a short reversed polarity interval situated between two short normal intervals that follow the longer reversed interval in the upper Spathian. The Guandao section lacks rich ammonoid faunas but it is relatively expanded and has an excellent conodont succession and numerous dated ash beds that place the O-A boundary at 247.2 Ma. At the Svalbard meeting, E. Gr_dinaru presented data on the ammonoids and nautiloids of Desli Caira: the boundary is placed between beds with *Deslicairites simionescui* n. g. n. sp., *Procarnites kokeni* and other upper Spathian ammonoids below and the *Paracrochordiceras-Japonites* Beds of basal Anisian age above. Especially important for correlation with the Boreal Realm is the outstanding occurrence of olenekitids (*Deslicairites*, ?*Svalbardiceras*) in the topmost Olenekian of the Tethys and of ?*Karangatites* at the very base of the Anisian at Desli Caira. *Karangatites* is the zonal marker for the base of the Anisian in Arctic Siberia.

The use of the FAD of the conodont *Chiosella timorensis* as a datum for the O-A boundary was challenged due to variation in its taxonomic treatment and evolution in our understanding of the group leading to historical records of the species occurring within Olenekian strata. A study of *Chiosella* based on the collections from both Desli Caira and Guandao was undertaken in order to clarify its taxonomy and demonstrate its utility as a global index. A paper on this topic was published in *Albertiana* #34.

The proposal for the GSSP at Desli Caira on the first occurrence of *C. timorensis* at the base of the level GR7 was published in *Albertiana* #36 (Gradinaru et al.) that included also the report of ammonoid faunas. In the same issue of *Albertiana* a second GSSP proposal was presented by Hounslow et al. They suggested the base of the magnetozone MT1n at Desli Caira section to bypass bio-chronostratigraphic problem. This proposal is supported by an extremely interesting and detailed magnetostratigraphic correlation schemes including South China, Caira, Desli Caira, Spitzbergen, Spain, UK, Germany and Poland.

In 2009 the discussion in the Task Group stalled on test of the isochrony of the first occurrence of *C. timorensis*. Such a test is necessary to demonstrate the significance of this bioevent as primary marker for the GSSP, but on the other hand it is very difficult because the ammonoid record of the best O-A sections is poor or discontinuous. H. Bucher expressed some concerns on the completeness of the uppermost Olenekian at Desli Caira because some faunas correlative with part of the Haugi Zone of north America have not yet been found. For this reason this part of the section was sampled again in late summer by Gradinaru together with the latest Anisian, showing rather impoverished ammonoid faunas. The possibilities of gaps at the top of the Olenekian at Desli Caira leads some authors to reconsider other sections as Guandao (China), characterized by good conodont record accompanied by stable isotope variations and paleomag record, or Nevada, where all the late Olenekian to early Anisian ammonoid faunas are present but not in the same section. Unfortunately no good ammonoids have been reported so far from Guandao, while the Nevada successions are usually remagnetized. Another interesting section is Atlasov Cape in South Primorye (Russia). However the ammonoid record of this section is endemic and no data on conodonts are available.

The **Anisian-Ladinian boundary** was voted by the STS during 2004, and the IUGS ratified the choice on 21st March 2005. The GSSP is thus defined at the top of "Chiesense groove", located about 5 m above the base of the Buchenstein Beds at Bagolino, northern Italy; the lower surface of the overlying thick limestone bed has the lowest occurrence of the ammonoid *Eoprotrachyceras curionii*. Secondary global markers in the uppermost Anisian include the lowest occurrence of conodont *Neogondolella praehungarica* and a brief normal-polarity magnetic zone. The GSSP level is bracketed by U-Pb single zircon age data, indicating that the boundary age is within the range 240-242Ma. A description of the GSSP was published in *Episodes*. Since summer 2009 the GSSP site is accessible through a geological pathway with explanatory notes and ammonoid casts provided by the local administration of Bagolino and by the Natural History Museum of Brescia.

The final discussion on the **Ladinian-Carnian boundary** GSSP proposal started in 2004, during the Spiti Workshop, after new samplings of the three most interesting sites for the boundary: Prati di Suores (Dolomites, Italy), Spiti (Himalaya, India) and South Canyon (Nevada, USA). Crucial biostratigraphic data concerns the

distinction between prospective index ammonoids *Daxatina* and *Trachyceras*, the FAD of the prospective conodont species *polygnathiformis*, and the appearance of the bivalve *Halobia*.

Work in the Dolomites included a very heavy resampling of the Prati di Stuores section which resulted in a single incomplete specimen of *Metapolygnathus polygnathiformis noah* near the bed with the FAD of *Daxatina*. The Padova research group sought new sections in the Eastern Dolomites to better document the interval between the top of *Daxatina* beds and base of *Trachyceras aon*.

In Spiti, as in Prati di Stuores, *Daxatina* appears towards the top of the range interval of the genus *Frankites*, and *Trachyceras* overlaps with highest *Daxatina*. However, the FAD of the conodont *M. polygnathiformis* predates the oncoming of *Daxatina* by several meters. Doubtful *Halobia* still appear within the *Frankites* beds but well established occurrences are higher, within the beds with *Trachyceras*. The pros of the Spiti sections are the concurrent record of ammonoids, conodonts and bivalves, which allows the intercalibration of the bioevents. The cons are the remagnetization of the section, the cooked out content in palynomorphs, and the accessibility limited to the summer months, due to the altitude.

In the successions in New Pass, Nevada, *Frankites sutherlandi* overlaps the lower part of the range of *Trachyceras* gr. *T. desatoyense*, several meters above the FAD of *desatoyense*. *Halobia* appears in the same beds from where *sutherlandi* was recovered and possibly is even older. The richest beds in ammonoids of the South Canyon section overlies a sudden facies change, with the drowning of a carbonate platform. South Canyon does not appear to be a possible GSSP candidate mostly because of the facies change and the remagnetization due to the nearby Cenozoic volcanic rocks. The section is, however, of great significance for large scale correlations of North America with the Tethyan realm

M. Gaetani, the task group chair, distributed a questionnaire in June 2006 concerning the status of the boundary deliberations and the pros and cons of various fossil criteria. An outcome of this was that, in spite of a lack of an ancestor for *Daxatina*, ammonoids were favored for definition of the boundary. M. Balini, the principal worker on the ammonoid faunas of this boundary interval, visited the Smithsonian Museum for comparative studies and then completed his collections in South Canyon, Nevada. He reports a much more detailed view of the lithologic as well as of the faunal succession, with bed-by-bed data from 5 sites: A, B, D, E, F, three of which have yielded conodont fauna.

The Albuquerque Symposium (May 2007) was the most important moment for the discussion of the GSSP options. The third and last possible candidate section, South Canyon (Nevada), was visited by the Task Group during the pre-congress field trip. Several contributions on British Columbia, Nevada and Prati di Stuores were presented at the symposium and data were published in the New Mexico Museum Bulletin (#40 and #41: Balini et al., Balini & Jenks; Orchard; Orchard & Balini; Mietto et al.). The detailed bed-by-bed study of South Canyon, the most important site to test the correlations of the tethyan bioevents with northamerican successions, shows interesting faunal similarity with the tethyan successions. This locality, that previously was regarded to as representing the basal part of the Carnian in North America actually yields typical Upper Ladinian fossils in the lower part, such as *Frankites sutherlandi*, *Metapolygnathus intermedius* and bivalves of the group of *Daonella elegans*. The stratigraphic position of *Daxatina* is also very similar with respect to the Tethys. The upper part of the range of the overlaps with the lower part of the range of *Trachyceras*.

The significance of the new data and the selection of the marker event for the definition of the GSSP of the Carnian stage was discussed during the Business Meeting of the STS. The FO of *Metapolygnathus polygnathiformis*, previously considered as possible marker for the base of the Carnian, was no more supported by the conodont specialists while the FAD of *Daxatina canadensis* achieved the general consensus. A final dossier was published in Albertiana #36, and the proposal was voted by 72% of the Task Group members. IUGS ratified the GSSP in June 2008.

The Task Group on the **Carnian-Norian boundary** was established in 2001. Key sections in Canada, Sicily, Slovakia, Turkey, and Oman have been studied resulting in an integrated bio-, magneto- and chemostratigraphic cross-correlation of key sections in the Tethys. The Pizzo Mondello section in Sicily contributes a magnetostratigraphic profile tied to a preliminary conodont zonation for the C-N boundary interval in Tethys. Alternate views of its correlation with the cyclostratigraphically calibrated Newark non-marine successions, place the base of the Norian at about 214 Ma or 228 Ma. A preliminary new conodont zonation from a potential GSSP at Black Bear Ridge, Western Canada was presented during a formal Workshop on Upper Triassic boundaries at the IGC in Florence in 2004.

Discussions during ICOS1 centered on the suitability of key CNB conodont taxa for intercontinental correlation. It was agreed amongst those present that the FAD of *Epigondolella quadrata*, a higher level than those previously considered, might be a suitable index but this was not widely supported. New work in both Canada and Sicily was planned.

New integrated biostratigraphic investigations at Pizzo Mondello started at the end of 2006 in connections with three PhD theses of Milano and Padova Universities. Two of them focus on conodonts and halobiids. Preliminary results were presented at the Albuquerque meeting (May 2007) and a more advanced report was printed in *Albertiana* #36 (Nicora et al.). The biostratigraphic record of Pizzo Mondello is more complete than reported in literature. Besides conodonts, new ammonoids, halobiids and radiolaria were documented. Ammonoids document the last two chronozones of the Carnian and the first zone of the Norian. Halobiids also document the Upper Carnian and the Lower Norian. The radiolarian faunas although found in relatively few samples are very rich with more than 45 taxa.

In 2009 some data from the two sections have been submitted for publications. These include stratigraphic and sedimentologic description of Black Bear Ridge section and conodont data from Pizzo Mondello section. At the end of July the conodont specialists working on the two sections (M. Mazza, A. Nicora, M. Orchard and M. Rigo) met in Vancouver and discussed taxonomy and correlations. Nearly at the same time the bivalve specialists C. McRoberts and M. Levera compared faunas and discussed taxonomy in a meeting at SUNY Cortland. In September Pizzo Mondello section was visited by J.P. Zonneveld and Milano team in the framework of preparation of the field excursion for the Triassic Workshop Sicily 2010.

A Norian-Rhaetian boundary Task Group was formed in 2001. Sections in western Canada, USA, and Austria were studied and produced important ammonoid, bivalve, and conodont data. Magnetostratigraphic and chemostratigraphic studies were undertaken in Queen Charlotte Islands, Canada. Rock magnetism carried a Cretaceous overprint. A carbon isotopic anomaly was identified at a potential boundary where radiolarians show distinctive faunal change and which is the FAD of the conodont *Epigondolella mosheri*, which approximates the Amoenum Zone in North America. A field workshop in the Gabbs Valley Range of Nevada in March 2005 included sampling of both N/R and T/J boundary strata. Palynology results were disappointing, but the presence of the 'Tethyan' conodont *Misikella* was confirmed - a first for the North American autochthon.

In Austria, a section in the Hallstatt and Zlambach Formation produced good ammonoids, pelagic bivalves, conodonts, rare radiolarians, and palynomorphs, as well as a magnetostratigraphy. A distinctive dinoflagellate change occurs midway through the Zlambach section with the FO of *Rhaetogonyaulax rhaetica*, a datum that may have potential in correlation with shallow marine and/or high latitude basins.

At Steinbergkogel, Austria, a potential GSSP candidate, the FAD of the conodont *Misikella posthernsteini* was proven to be isochronous with the FO of the ammonoid *Cochloceras*. This well-constrained bioevent is closely above the FO of the conodont *Misikella hernsteini* and a magnetic polarity change from a long normal to a well developed reversed interval. The distinctive dinoflagellate change, which occurs with the FO of *Rhaetogonyaulax rhaetica* in the Zlambach section, is stratigraphically higher than the other two options and corresponds to another ammonoid change with the FO of the widely distributed genera *Cycloceltites* and *Vandaites*. A formal presentation of Steinbergkogel as candidate section was done for the Albuquerque Symposium (Krystyn et al., *New Mexico Museum Bulletin* 41) and updated with magnetostratigraphy in *Albertiana* #36. Steinbergkogel section was visited during the Bad Goserz meeting in 2008 and impressed the participants for the amount of work done by the group led by L. Krystyn. The thickness of the boundary succession is unfortunately rather thin, and the facies is not constant. However the section is of great interest because the Norian-Rhaetian boundary is commonly very poorly documented all over the world. The last problem to be solved in order to come to the final vote of the Task Group consists in the demonstration of the significance of events recorded at Steinbergkogel by their correlations with other sections. This rather complex task engaged L. Krystyn team for most of 2009. At the present a correlation chart for sections in the Tethyan Realm is almost ready and some possibilities of direct correlations with north America, based on conodonts of the group of *Epigondolella mosheri* is under evaluation.

11. OBJECTIVES AND WORK PLAN BEYOND 2010.

The slowing down of the research activities started in 2009 with the world economic crisis, has strongly influenced the previous schedule of the GSSP definition. Taking into account the reduction of the active members (see 6.s) the original schedule must be revised. Realistically the objective of the STS, i.e. the completion of the definition of the GSSP of the Triassic System (I-O, O-A, C-N and N-R) cannot be achieved by 2012. The STS is trying to focus on three GSSPs (I-O, C-N and N-R), with the hope to ratify at least one of them by 2012. The schedule, however, is still strictly depending on the end of the economic crisis.

Work plan:

2011: a vote of the N/R boundary Task Group is expected for the beginning of the year. A vote of the O/A Task Group is scheduled the end of the year. Hopefully a vote of the C/N Task Group can be also expected by the end of the year.

2012: further ballots, if necessary.

APPENDIX [Names and Full Addresses of Current Officers and Voting Members]

2004-2008 Subcommission officers (with addresses)

Chairman: M. J. Orchard, Geological Survey of Canada, 625 Robson Street, Vancouver, B.C. V6B 5J3, Canada, e-mail: morchard@nrcan.gc.ca

Vice Chairman: Yin Hongfu, China University of Geosciences, Yujiashan, Wuhan, Hubei, 430074, Peoples Republic of China. hfyin@cug.edu.cn

Vice Chairman: Marco Balini, Dipartimento di Scienze della Terra, via Mangiagalli 34, I-20133 Milano, Italy. Marco.Balini@unimi.it

Secretary/ STS web: **Christopher A. McRoberts, Department of Geology, State University of New York at Cortland, P.O. Box 2000, Cortland, New York 13045 USA.** <mailto:microberts@cortland.edu>

Albertiana Editor/ Webmaster: Wolfram M. Kuerschner, Laboratory of Palaeobotany and Palynology, Utrecht University, Budapestlaan 4, 3584 CD Utrecht, The Netherlands. W..M.Kuerschner@bio.uu.nl

2008-2012 Subcommission officers (with addresses)

Chairman: Marco Balini, Dipartimento di Scienze della Terra, via Mangiagalli 34, I-20133 Milano, Italy. Marco.Balini@unimi.it

Vice Chairman: Mark Hounslow, Centre for Environmental Magnetism and Palaeomagnetism, Geography Dept, Farrer Avenue, Lancaster University, Lancaster, UK., LA1 4YQ. m.hounslow@lancaster.ac.uk

Vice Chairman: Jinnan Tong, GPMR and BGEG laboratories at China University of Geosciences, Wuhan 430074, China. jntong@cug.edu.cn

Secretary/ STS web: **Christopher A. McRoberts, Department of Geology, State University of New York at Cortland, P.O. Box 2000, Cortland, New York 13045 USA.** <mailto:microberts@cortland.edu>

Albertiana Editor/ Webmaster: Wolfram M. Kuerschner, Laboratory of Palaeobotany and Palynology, Utrecht University, Budapestlaan 4, 3584 CD Utrecht, The Netherlands. W..M.Kuerschner@bio.uu.nl

Task Groups and their officers

Base Induan (Triassic): Yin Hongfu, China. hfyin@cug.edu.cn. Mission ended in 2001.

Base Olenekian: Y. Zakharov, Russia. yurizakh@mail.ru

Base Anisian: pending, new chairman is going to be defined

Base Ladinian: A. Baud, Switzerland. Aymon.Baud@sst.unil.ch. Mission ended in 2004.

Base Carnian: M. Gaetani, Italy. maurizio.gaetani@unimi.it Mission ended in 2008.

Base Norian: L. Krystyn, Austria. leopold.krystyn@univie.ac.at

Base Rhaetian: L. Krystyn, Austria. leopold.krystyn@univie.ac.at

Non-marine auxiliaries: S. Lucas, USA. Lucas, Spencer, DCA. spencer.lucas@state.nm.us

List of Voting Members (2008-2012)

Yoshiaki Aita, Utsunomiya, JAPAN

aida@cc.utsunomiya-u.ac.jp

Marco Balini, Milan, ITALY

marco.balini@unimi.it

Om N. Bhargava, INDIA

onbhargava@yahoo.co

Hugo Bucher, Zurich, SWITZERLAND

Hugo.Bucher@pim.unizh.ch

Hamish Campbell, Dunedin, NEW ZEALAND

H.Campbell@gns.cri.nz

Mark Hounslow, Lancaster, ENGLAND

m.hounslow@lancaster.ac.uk

Dennis Kent, Palisades, USA.

dvk@rci.rutgers.edu

Heinz W. Kozur, Budapest, HUNGARY

kozurh@helka.iif.hu

Leopold Krystyn, Vienna, AUSTRIA

leopold.krystyn@univie.ac.at

Wolfram M. Kuerschner, Utrecht, NETHERLANDS

w.m.kuerschner@bio.uu.nl

Max Langer, BRAZIL

mclanger@ffclrp.usp.br

Spencer Lucas, Albuquerque, USA.

SLucas@nmmnh.state.nm.us

Christopher R. McRoberts, Cortland, USA

microberts@cortland.edu

Manfred Menning, Potsdam, GERMANY

menne@gfz-potsdam.de

Paolo Mietto, Padova, ITALY

paolo.mietto@unipd.it

Alda Nicora, Milano, ITALY
Michael J. Orchard, Vancouver, CANADA
Bruce Rubidge, Wits, SOUTH AFRICA
Kazem Seyed-Emami, Tehran, IRAN
Michael A. Shishkin, Moscow, RUSSIA
Jinnan Tong, Hubei, CHINA
Attila Voros, Budapest, HUNGARY
Wolfgang Weitschat, Hamburg, GERMANY
Hongfu Yin, Hubei, CHINA
Yuri D. Zakharov, Vladivostok, RUSSIA

alda.nicora@unimi.it
morchard@nrcan.gc.ca
rubidgeb@geosciences.wits.ac.za
kemami@ut.ac.ir
schsz@orc.ru
jntong@cug.edu.cn
voros@zoo.zoo.nhmus.hu
wolfgang.weitschat@uni-hamburg.de
hfyin@cug.edu.cn
yurizakh@mail.ru

SUBCOMMISSION ON PERMIAN STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommittee on Permian Stratigraphy (SPS)

SUBMITTED BY:

Charles M. Henderson, Chairman SPS

Department of Geoscience, University of Calgary,

Calgary, AB Canada T2N 1N4

Phone: 403-220-6170; Fax: 403-284-0074;

Email: charles.henderson@ucalgary.ca

Website: <http://www.ucalgary.ca/conodont/>

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Subcommission Objectives: The Subcommittee's primary objective is to define the series and stages of the Permian, by means of internationally agreed GSSP's, and to provide the international forum for scientific discussion and interchange on all aspects of the Permian, but specifically on refined regional correlations.

Fit within IUGS Science Policy: The objectives of the Subcommittee involve two main aspects of IUGS policy:

1. The development of an internationally agreed chronostratigraphic scale with units defined by GSSP's where appropriate and related to a hierarchy of units to maximize relative time resolution within the Permian System; and
2. Establishment of framework and systems to encourage international collaboration in understanding the evolution of the Earth during the Permian Period.

3. ORGANIZATION

The Subcommittee has an Executive consisting of a Chairman, a Vice-Chairman, and a Secretary; all three are Voting Members of the Subcommittee. There are sixteen total Voting Members representing most regions of the world where Permian rocks are exposed. The objectives of the Subcommittee are pursued by both stratigraphic and thematic Working Groups that are retired upon completion of their directed task. For example, the Working Groups on the Carboniferous-Permian Boundary, on the Guadalupian stages (Middle Permian), on the base-Lopingian boundary (base-Wuchiapingian Stage), and on base-Changhsingian have been retired upon the successful establishment of their defining GSSP's and ratification by IUGS. The current working groups include the following: 1. Cisuralian stages, 2. Continental Permian, 3. Transitional biotas as gateways for global correlation, 4. Neotethys, Paleotethys, and S. China Correlations, and 5. International Lopingian Working Group.

3a. Officers for 2008-2012:

Chair: Professor Charles M. Henderson, University of Calgary

Vice-Chair: Dr. Vladimir Davydov, Boise State University

Secretary: Dr. Shuzhong Shen, Nanjing Institute of Geology and Palaeontology

SPS website is located at <http://www.nigpas.ac.cn/permian/web/index.asp>. This site includes all back issues of *Permophiles* in downloadable PDF format (#1 in 1978 to #54 December 2009). A link

to *Permophiles*/Permian research has also been established at <http://www.ucalgary.ca/conodont/spis>.

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

SPS interacts with many international projects on formal and informal levels. SPS has taken an active role on the development of integrated chronostratigraphic databases by participating with CHRONOS and PALEOSTRAT (now GeoStratSys), which are NSF funded initiatives. Vladimir Davydov and Walter Snyder are concentrating on developing their system to include improved taxonomic dictionaries, database sharing and manipulation with GeoStratSys. SPS is also involved in a NSFC supported study comparing the Proterozoic-Cambrian transition with the Permian-Triassic transition.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

GSSPs: Progress was made on the three remaining Lower Permian (Cisuralian) stage GSSPs including base-Sakmarian, base-Artinskian, and base-Kungurian. We have decided to change the section and point for the base-Sakmarian to the Usolka section and a proposal will be voted on in 2011. The Kondurovsky section failed to reproduce the requisite conodont results and problems about the evolution of *Sweetognathus merrilli* were discussed

during ICOS2009. Fortunately, the Usolka section had been fully worked up as a potential parastratotype and we have excellent carbon isotope, U-Pb isotopic ages and abundant conodonts to define the boundary. A penultimate proposal for the base-Artinskian is appearing in *Permophiles* 55. At both of these sections the Sr isotopes of conodonts have also been shown to be an accurate correlation tool. The SPS community will be invited to give input on the Artinskian proposal and based on that input a revised proposal will be submitted to SPS voting members in April 2011 for voting. Finally, it was decided that the Mechetlino section in Russia is not satisfactory for a GSSP – samples did not yield conodonts, zircons are all reworked, and the rocks are too deeply weathered to produce meaningful carbon isotopic values. Two sections in the United States, which have already been extensively studied are now being considered as potential GSSPs using the same point (FAD of *N. pnevi*); these include the Cassia Mts in southern Idaho and Rockland sections in northern Nevada. Detailed samples were collected in early July 2010 by Bruce Wardlaw, Charles Henderson, Vladimir Davydov and Mark Schmitz at the Rockland section. Conodonts, fusulinids and Sr isotopes for these samples will form the basis to make a GSSP preliminary proposal during the winter 2011 and a workshop is planned in early June (see budget request).

Publications: The December 2010 issue of *Permophiles* (#55) was produced online during the Fall of 2010 and will be distributed as a pdf document to a mailing list of 280. Owing to reduced submissions SPS is producing only one issue in 2010 (#55), which will go online in late December 2010. We have a complete series of *Permophiles* on our website (1978 to 2009).

Meetings: The SPS conducted a business meeting in association with the ICS business meeting in Prague, Czech Republic during late May 2010.

Membership: There were no changes to the membership in 2010. We have 17 voting members representing Argentina (1), Australia (2), Canada (1), China (3), France (1), Germany (1), Italy (1), Japan (1), Russia (3), and United States (3). We also have five honorary Members.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

There were no major problems in 2010, but progress is slow owing to the voluntary nature of most of this work and minimal financial support.

7. SUMMARY OF EXPENDITURES IN 2010:

INCOME

University of Calgary (1): \$2084.00

NIGPAS (2): \$2,000.00

ICS (3): \$ 2,700.00

TOTAL: \$6784.00 (quoted in US\$ using 0.99 as the conversion from Canadian\$. (1) University of Calgary support from NSERC grant to Charles Henderson for travel to ICS workshop and Wells Nevada for fieldwork. (2) NIGPAS (Nanjing Institute of Geology and Palaeontology) support from NSF-C grant to Shuzhong Shen for travel to ICS workshop. (3) ICS allocation to SPS \$1500 and \$1200 for travel to ICS workshop..

EXPENDITURES

Printing, Mailing, and Web support *Permophiles*: \$250.00

Travel costs to Prague \$4603.50.00 (Henderson and Shen)

Travel costs for *Permophiles* Production: \$0

Travel costs for Wells Nevada fieldwork \$1930.50

TOTAL: \$6784.00 (quoted in US\$)

BALANCE: \$0.00

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

1. Production of *Permophiles* #56 in Calgary during summer 2011.
2. Vote on base-Artinskian in April 2011.
3. Vote on base-Sakmarian in 2011.
4. Workshop for base-Kungurian in Boise Idaho and Wells Nevada.
4. SPS business meeting during ICCP meeting in Perth Australia during July 2011.
5. Production of *Permophiles* #57 in China late 2011 or early 2012.
6. Completion of new GSSP proposal for base-Kungurian by September 2011.

My major goal is to complete the GSSP process for the Permian stages prior to the IGC in Brisbane in August 2012.

9. BUDGET AND ICS COMPONENT FOR 2010

EXPENDITURES

We have sufficient leftover funds for the minor cost of website and printing. The primary budget request for 2011 is for a workshop at Boise Idaho with field excursion to the Rockland Section near Wells Nevada. This workshop is essential if we are to convince the international Permian community that the Rockland section is appropriate for the base-Kungurian GSSP. This is the biggest hurdle confronting SPS because we have rejected a long viewed potential section in Russia. This workshop is essential for SPS to complete the GSSP process before IGC in 2012. Financial support is necessary to bring at least 3 foreign researchers (at least one from Russia) to Boise Idaho by paying for airfare and subsidizing accommodation (\$5000). Other SPS members will be invited, but subsidies will be limited (\$1000). Workshop will be conducted over two days at Boise State University in early June 2011 with fieldtrip to the potential GSSP fieldsite. Fieldtrip costs will include vehicle rentals and 2 night's accommodation in Wells Nevada (\$2000) for the group. Samples can be collected by participants. Workshop at Boise State will include presentations and viewing of conodonts and fusulinids as well as the isotope labs of Mark Schmitz. SPS Executive will attend using their research funding. They will also attend the ICCP meeting in Perth in July 2011 using their own funds.

TOTAL 2011 BUDGET \$8,000.00

Income

Support for trip to Boise from University of Calgary (Henderson; NSERC) \$750.00

Support for trip to Boise from NIGPAS (Shen; NSF-C) \$2,000.00

Support from Boise State (Davydov; NSF) \$250.00

Requested ICS contribution (1) \$5,000.00

TOTAL BUDGET REQUEST (ICS) \$5,000.00

10. REVIEW CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2006-2010)

The SPS has approved the general divisions of the Permian and has now had 6 GSSP's ratified by ICS and IUGS (Asselian, Roadian, Wordian, Capitanian, Wuchiapingian, Changhsingian).

Proposals for the latter two stages were published in Episodes in 2006. Support for documentation (fieldwork and publications) of the various chronostratigraphic methods for the establishment of the GSSP's has been the most outstanding and differentiating character of this Subcommittee. Substantial work has been conducted toward producing excellent proposals for the remaining stages. *Permophiles* has become an internationally respected newsletter and bears an ISSN designation (1684-5927) and is deposited in the National Library of Canada; nine issues were published during the five-year period.

11. OBJECTIVES AND WORK PLAN FOR NEXT 2 YEARS (2010-2012)

The primary objectives are to complete the GSSP's for the last three GSSP's (Sakmarian, Artinskian, and Kungurian). We will produce one or two issues of *Permophiles* each year depending on input. We anticipate the following schedule:

1. Vote on base-Artinskian in April 2011.
2. Vote on base-Sakmarian in 2011.
3. **Workshop** to decide feasibility of base-Kungurian. Boise State University in June 2011.
4. Business meeting at International Congress on Carb and Permian July 2011; Perth Australia.
5. Production of *Permophiles* 56 and 57.
5. Election process for new executive including SPS Chair to take effect at IGC, Brisbane 2012.

Once the GSSP process is completed SPS will shift focus toward three directions beginning in 2012:

1. correlations into continental deposits,
2. correlations across provincial boundaries and within the Tethys region,
3. detailed documentation of the geologic evolution of the Earth during the Permian with respect to the established chronostratigraphic framework.

12. WEBSITE STATUS AND ACTIVITIES:

SPS website is located at <http://www.nigpas.ac.cn/permian/web/index.asp>. This site is updated regularly and includes all back issues of *Permophiles* in downloadable PDF format (#1 in 1978 to #54 December 2009) as well as other information about SPS activities including annual reports, membership.... Shuzhong Shen at Nanjing China maintains the site and Henderson and Shen both have administrator rights.

13. FOUR YEAR SUMMARY OF ACTIVITIES:

GSSP's: The base-Wuchiapingian and base-Changhsingian (Upper Permian or Lopingian Series) GSSPs were published in Episodes (volume 29, No. 3&4) in 2006. Progress was made on the three remaining Lower Permian (Cisuralian) stage GSSPs including base-Sakmarian, base-Artinskian, and base-Kungurian. An international field excursion was conducted in early July 2007 (reported in *Permophiles* #49; p. 4-6) and samples for carbon isotopes, geochronology and biostratigraphy were collected and have now been processed. The geochemical samples will provide further correlation potential for the proposed GSSPs; these materials are being analyzed at Boise State University and the Nanjing Institute of Geology and Palaeontology. The biostratigraphy samples will determine reproducibility of GSSP definitions. Decisions have been made on the basis of this new work and this is described above in section 5. The most significant decision was to reject the base-Kungurian section at Mechetlino. Detailed samples were collected at the Rockland section in Nevada and a workshop is proposed to consider the feasibility of this section.

Publications: The June 2006 issue of *Permophiles* (#47) was produced at Nanjing China during June 2006 and distributed as a pdf document to a mailing list of 280. The December 2006 issue of *Permophiles* (#48) was produced at the University of Calgary during November 2006 and distributed as a pdf on our website. We now have a complete series of Permophiles on our website (1978 to 2006). The June 2007 issue of *Permophiles* (#49) was produced at Nanjing China during June 2007 and distributed as a pdf document to a mailing list of 280. The December 2007 issue (#50) was produced in January 2008 after a field excursion to Australia. June 2008 issue (#51) was produced in Calgary in July 2008. December 2008 (#52) was produced online in January 2009 and #53 was produced in July 2009 in Calgary and #54 was produced online. We now have a complete series of Permophiles on our website (1978 to 2009).

Meetings: The SPS conducted one business meeting at the 2nd International Palaeontology Congress in Beijing, China in June 2006. The SPS conducted one business meeting at the XVI International Congress on the Carboniferous and Permian in Nanjing, China in June 2007 and is reported in *Permophiles* #49. Business meetings were held in Sydney Australia (January 2008; *Permophiles* #50) and IGC in Oslo (August 2008). In 2009 business meetings were held in Trelew Argentina and at ICOS2009 in Calgary. A business meeting was held at Prague, Czech Republic in late May 2010 during the ICS workshop.

Membership: Two changes were made to voting membership in 2006. Dr. John Utting retired as a voting member and was named by the SPS Executive as a Honorary Member given his long service to SPS (past Secretary) and distinguished research record in Late Paleozoic palynology. Dr. Lucia Angiolini was nominated by the executive to fill this vacancy. This increased the membership from Europe bringing it more in line with other major regions. Secondly, we sadly lost our distinguished colleague and friend Professor Jin Yugan who died in June 2006 (see *Permophiles* 48 for a tribute). His was a very distinguished career in Late Paleozoic paleontology and service including as a past-Secretary and past- Chairman of SPS. He has been replaced as a voting member by Professor Yue Wang. There were no changes to the membership in 2007, but as noted in the 4 year summary we have made several changes over the past four years. In addition, the current executive will continue for a second term. We currently have 16 voting members representing Australia (2), Canada (1), China (3), France (1), Germany (1), Italy (1), Japan (1), Russia (3), and United States (3). We also have five honorary Members. No changes in 2008. In 2009 we added one new voting member, Dr. Nestor R. Cuneo from Argentina to add to our complement noted above. There were no changes to the membership in 2010.

Summary (2006-2010): Two GSSP proposals for the base-Wuchiapingian (also base-Lopingian Series) and base-Changhsingian were prepared, voted, ratified and published in Episodes during the past four years. Significant progress has been made on the last three Cisuralian GSSP proposals for the base-Sakmarian, base-Artinskian, and base-Kungurian stages. An international workshop was conducted in July 2007 to determine reproducibility and accessibility as well as collect new geochemical data. During the reporting period, *Permophiles* #47 to #54 have been produced with #55 to come later this year. In addition, a website was constructed and hosted by the Nanjing Institute of Geology and Palaeontology during the reporting period. Among other items, this website has pdf versions of all issues of *Permophiles* dating back to #1 in 1978.

APPENDIX “Officers and Voting Members as of November 2010”

Dr. Lucia Angiolini
Dipartimento di Scienze Terra “A. DEsio”
Via Manggiagalli 34, 20133
Milano, Italy

Urals Branch of
Russian Academy of Science
Pochtovy per 7
Ekaterinburg 620154 Russia

Dr. Boris I. Chuvashov
Institute of Geology and Geochemistry

Dr. Nestor R. Cuneo
Director, Museo Paleontologico Egidio Feruglio

(U9100GYO) Av. Fontana 140,
Trelew, Chubut, Patagonia Argentina
Dr. Vladimir Davydov, SPS Vice-Chairman
Department of Geosciences
Boise State University
1910 University Drive
Boise ID 83725 USA

Dr. Marc Durand
Universite de Nancy-I, GES, BP239
54506 Vandoeuvre-les-Nancy cedex
France

Dr. Yoichi Ezaki
Department of Geosciences
Osaka City University
Sugimoto 3-3-138
Sumiyoshi-Ku, Osaka, 558-8585, Japan

Dr. Clinton B. Foster
Australian Geological Survey Organization
G.P.O. Box 378
Canberra 2601 Australia

Prof. Charles M. Henderson, SPS Chairman
Department of Geoscience
University of Calgary
NW Calgary, Alberta
Canada T2N1N4

Dr. Galina Kotlyar
All-Russian Geological Research Institute
Sredny pr. 74
St. Petersburg 199026 Russia

Prof. Ernst Ya. Leven
Geological Institute
Russian Academy of Sciences
Pyjevskiy 7
Moscow 109017 Russia

Dr. Tamra A. Schiappa
Department of Geography, Geology and the
Environment
Slippery Rock University
Slippery Rock, PA 16057 USA

Prof. Joerg W. Schneider
Freiberg University of Mining and Technology
Institute of Geology, Dept. of Palaeontology,
Bernhard-von-Cotta-Str.2 Freiberg, D-09596,
Germany

Dr. Shuzhong Shen, SPS Secretary
Nanjing Institute of Geology and
Paleontology, 39 East Beijing Rd.
Nanjing, Jiangsu, China 210008

Dr. Guang Shi
Deakin University, Resden Campus
School of Aquatic Science and Natural Res.
Management
662 Blackburn Rd.
Clayton, Victoria, Australia 3168

Dr. Xiangdong Wang
Nanjing Institute of Geology and
Paleontology, 39 East Beijing Rd.

Prof. Yue Wang
Nanjing Institute of Geology and
Paleontology, 39 East Beijing Rd.
Nanjing, Jiangsu, China 210008

Dr. Bruce R. Wardlaw
U.S. Geological Survey
926A National Center
Reston, VA 20192-0001 USA
Honourary Members

Prof. Giuseppe Cassinis
Earth Sciences Dept.
University of Pavia, 1 Via Ferrata,
27100 Pavia, Italy

Prof. Brian F. Glenister
Department of Geology
University of Iowa
Iowa City, IA 52242 USA

Dr. Heinz Kozur
Rezsú u 83
Budapest H-1029 Hungary

Prof. Claude Spinosa
Department of Geosciences
Boise State University
1910 University Drive
Boise ID 83725 USA

Dr. John Utting
Geological Survey of Canada
3303 - 33rd Street N.W.
Calgary Alberta T2L2A7 Canada

SUBCOMMISSION ON CARBONIFEROUS STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommittee on Triassic Stratigraphy

SUBMITTED BY (with contact information)

Barry C. Richards, Chair of SCCS

Geological Survey of Canada-Calgary

3303-33rd St. N.W.

Calgary, Alberta, Canada

Office Phone: 1 (403) 292-7153

Cell Phone: 1 (403) 650-3682

Fax: 1 (403) 292-6014

Email: Barry.Richards@NRCan-RNCan.gc.ca

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

The SCCS promotes and coordinates international cooperation among various geologic specialists for the purpose of defining standard Global chronostratigraphic boundaries within the Carboniferous System. The GSSP for the Devonian-Carboniferous boundary is at La Serre in southern France (Paproth and StreeL, 1984; Paproth *et al.*, 1991), and the Carboniferous-Permian boundary GSSP at the top has been selected in northern Kazakhstan (Davydov *et al.*, 1998). The Mid-Carboniferous boundary GSSP is preserved in Arrow Canyon, Nevada, U.S.A. (Lane *et al.*, 1999; Richards *et al.*, 2002), and it subdivides the Carboniferous into two subsystems, the Mississippian Subsystem below and the Pennsylvanian Subsystem above. As pointed out by the former chair, Philip Heckel, in the SCCS annual report for 2007, there are serious problems with the GSSP at the base of the Carboniferous (Kaiser, 2009), such that the boundary needs to be at least placed at lower stratigraphic position, and both a new event marker and stratigraphic section are probably required. The immediate SCCS goals are to redefine the Carboniferous-Devonian boundary and select the best stage boundaries within the two Carboniferous subsystems to facilitate global correlation within the system. The ultimate goal is to calibrate biostratigraphy with other methods of correlation, such as chemostratigraphy, sequence stratigraphy, magnetostratigraphy, and radiometric dating, so that the successions dominated by terrestrial and endemic cold-water marine biotas in the Gondwana and Angara regions can be correlated with the biostratigraphic framework of the pan-tropical standard succession.

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3. ORGANIZATION

3a. Officers for 2008-2012:

Chair: Barry C. Richards (Canada)

Vice-Chair: Xiangdong Wang (China)

Secretary: Markus Aretz (France)

Website

During the 2008-2009 fiscal year, the SCCS established an official website: www.nigpas.ac.cn/carboniferous. The site is basic and occasionally difficult to download files from, but the membership is striving to improve each of the main pages by including data, line figures and photographs. The site has eight main pages containing the following information: 1) Homepage - list of SCCS officers, task groups and leaders, and voting members, 2) GSSPs - shows ratified GSSPs and those in progress, 3) Working Groups - lists task groups and provides latest task-group progress reports, 4) Annual Reports - includes annual reports submitted to the ICS by the SCCS, 5) News - information about current SCCS activities and progress, 6) Forthcoming Meetings - lists conventions for professional societies and field meetings that are relevant to membership goals and activities, 7) Newsletters - the current (2010 v. 28 issue) back issues of the Newsletter on Carboniferous Stratigraphy are available in pdf format for download, and 8) Links - provides web links to important websites such as those of the ICS and IUGS.

Membership

The SCCS has a total of 21 voting members (list at end of report), and approximately 280 corresponding members (see latest issue of Newsletter on Carboniferous Stratigraphy for contact information). The main business meetings of the SCCS are held every two years, both at the quadrennial meetings of the International Congress on the Carboniferous and Permian, and at a Field Meeting convened by the SCCS midway between the congresses. The latest major Field Meeting was held in Russia from August 11th to 19th, 2009 (see Newsletter on Carboniferous Stratigraphy, v. 26, 28) but subordinate meetings and workshops are held every year as the opportunities arise.

SCCS has six current task groups and one exploratory Project Group:

Task Group to redefine the Devonian-Carboniferous Boundary [which is also the base of the Lower Mississippian Series and Tournaisian Stage], a joint task group was established in early 2008 that comprises 10 members appointed by Thomas Becker of the Devonian Subcommittee (SDS) and 10 members selected by Philip Heckel of the SCCS in 2008, who summarized the reasons for establishing the group in the 2008 issue of Newsletter on Carboniferous Stratigraphy [v. 26, p. 3]. A chairman was not appointed in 2008, and the SCCS executive that replaced the previous officers at the 33rd International Geological Congress in Oslo during August 2008 decided to wait to see what direction the task group would take and if a chairman was necessary before selecting one. During 2010, it became apparent that problems with the GSSP would not be resolved without major taxonomic and lithostratigraphic analyses requiring strong direction and leadership from a chairman. Consequently, at the International Commission of Stratigraphy workshop about the GSSP concept that was held in Prague from May 31st to June 3rd 2010, the SCCS chairman Barry Richards appointed Markus Aretz as chairman of the task group while the SDS chairman Thomas Becker designated Carlo Corradini to be vice-chairman. Richards summarized the recent work of the group through September 2010 in this year's Newsletter on Carboniferous Stratigraphy [v. 28].

Task Group to establish the Tournaisian-Viséan Boundary [which is also the base of the Middle Mississippian Series], chaired by George Sevastopulo (Ireland). Using e-mail communications from the chairman, Richards and Aretz summarized the recent activities of the group through September 2010 in the Newsletter on Carboniferous Stratigraphy for 2010 [v. 28].

Task Group to establish the Viséan-Serpukhovian Boundary [which is also the base of the Upper Mississippian Series], chaired by Barry Richards (Canada), who summarized the recent work of the group through September 2010 in this year's Newsletter on Carboniferous Stratigraphy [v. 28].

Task Group to establish the Bashkirian-Moscovian Boundary [which is also the base of the Middle Pennsylvanian Series], chaired by John Groves (USA), who summarized the recent work of the group through September 2010 in this year's Newsletter on Carboniferous Stratigraphy [v. 28].

Task Group to establish the Moscovian-Kasimovian Boundary [which is also the base of the Upper Pennsylvanian Series], and the **Kasimovian-Gzhelian Boundary**, chaired by Katsumi Ueno (Japan) who succeeded Elisa Villa (Spain) at the Oslo IGC meeting in August 2008. Ueno summarized the recent work of the group through September 2010 in this year's Newsletter on Carboniferous Stratigraphy [v. 28].

Project Group on Carboniferous magnetostratigraphy, chaired by Mark Hounslow (United Kingdom), who did not submit a progress report this year for the Newsletter on Carboniferous Stratigraphy but summarized the recent work of the group through June 2009 in last year's Newsletter on Carboniferous Stratigraphy [v. 27, p. 18-19].

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

The SCCS has worked closely with the Subcommissions and task groups on Devonian and Permian Stratigraphy to establish the common boundaries with the Carboniferous. The SCCS expects to cooperate with the NSF-sponsored Chronos initiative, which has a website at www.chronos.org, and with the NSF-sponsored PaleoStrat community digital information system for sedimentary, paleontologic, stratigraphic, geochemical, geochronologic, and related data, hosted at Boise State University, and with a website at www.paleostrat.org. It also has established a working relationship with the Permian Research Group at Boise State, which has initiated a program of obtaining precise ID-TIMS U-Pb radiometric dates from biostratigraphically constrained uppermost Devonian to Permian successions in the Ural Mountains and elsewhere.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2009-2010 fiscal year

The **Newsletter on Carboniferous Stratigraphy, Volume 28**, published in November 2010, includes commentaries by the current SCCS executive on various current issues, summaries about field meetings and workshops, reports of the task groups for July 1st 2009 to September 30th 2010 [typically containing much current detail], and articles on various topics of interest. Volume 28 also contains a revised directory for the corresponding membership. As usual, the Newsletter provides a significant outlet for timely presentation and discussion of useful information relating to boundary selection, often from areas that are not typically covered in other journal venues. During the last fiscal year, task-group and corresponding members have published a number of papers in refereed journals and in abstract volumes associated with conventions. Many of the most important of these publications are cited in the full versions of the task group reports included in Appendix B.

Summary of Task Group Reports

The full text of the reports, including references, have been shortened and updated from the 2010 Newsletter on Carboniferous Stratigraphy and are provided in Appendix B.

Task Group to redefine the Devonian-Carboniferous Boundary Since publication of the task-group report in the July 2009 issue of the Newsletter on Carboniferous Stratigraphy, considerable progress has been made toward addressing the work objectives outlined in that report and the 2009 Annual Report Richards submitted to the ICS. A chairman was appointed to lead the task group, the conodont lineage used to define the current boundary at La Serre in southern France is being intensively studied along with other conodont lineages that have potential for D-C boundary definition, and it has become clear from recent task-group studies that the La Serre section is no longer suitable for the GSSP and another section is required. The biologic-sedimentologic event used to define the boundary has not been chosen, but the search for better GSSP sections is progressing.

During late 2009, it became apparent that problems with the GSSP would not be resolved without major taxonomic and lithostratigraphic analyses requiring strong direction and leadership from a chairman. At the International Commission of Stratigraphy workshop about the GSSP concept that was held in Prague from May 31st to June 3rd 2010, the SCCS chairman Barry Richards appointed Markus Aretz as chairman of the task group while the SDS chairman Thomas Becker designated Carlo Corradini vice-chairman.

During 2008 to 2009, task-group members Carlo Corradini and Sandra Kaiser commenced work on the taxonomic and phylogenetic problems within the *S. Praesulcata* - *S. sulcata* lineage and protognathodid lineages. They presented their initial findings in a paper (Morphotypes in the early *Siphonodella* lineage: implications for the definition of the Devonian/Carboniferous boundary) at the Second International Conodont Symposium (ICOS 2009) in Calgary, Canada. Their study indicates several morphotypes occur in the *S. praesulcata* to *S. sulcata* transition and that the position of the current D-C boundary at La Serre is based on subjective interpretations.

Following the 2009 SCCS meeting held in Russia, Vladimir Pazukhin continued his work on the *S. praesulcata*-*S. sulcata* lineage and associated D-C boundary conodonts in the southern Urals and presented his results at the 2010 IPC3 convention in London England. In that study, the conodont zones were correlated with the regional foraminiferal zones to test the utility of using foraminifers to either define the boundary or provide corroborating data. Unlike Corradini and Kaiser, who think the *S. praesulcata* to *S. sulcata* lineage has little potential for boundary definition, several conodont workers including task-group members Vladimir Pazukhin and Ji Qiang think the phylogenetic problems within the lineage can be solved and that the lineage still presents the best potential for boundary definition.

Task-group members Carlo Corradini, Sandra Kaiser and Claudia Spalletta along with Maria Cristina Perri are studying the taxonomic and phylogenetic problems within the protognathodid lineages. They presented initial findings in a paper at the 2010 IPC3 convention in London, England. They concluded that a comprehensive study of *Protognathodus*, a genus appearing in the latest Devonian and extending into the Mississippian, would permit a more precise definition of the D-C boundary than is presently available using that group of conodonts. Four species of *Protognathodus* are known from the relevant time span: *Pr. meischneri*, *Pr. collinsoni*, *Pr. kockeli* and *Pr. kuehni*.

Presently favoured for boundary definition are the first occurrences of *Pr. kockeli* from *Pr. collinsoni* and *Pr. kuehni* from *Pr. kockeli*. These lineages require additional study and their relative advantages, if any, over the siphonodellids require careful evaluation.

At the D-C boundary workshop held at the ICP3 meeting in London on July 2, 2010, Carlo Corradini summarized the current stage of knowledge of the various species within the genus *Protognathodus* across the D-C boundary. He indicated there are problems with the first appearances and distribution of the protognathodid species and especially emphasized the group's rareness to absence in many sections and facies dependence. He concluded that none of the *Protognathodus* species has the potential to be the primary marker for the D-C boundary but could be used in conjunction with other taxa.

At the 2010 IPC3 workshop, Carlo Corradini also gave an important presentation outlining the problems of the *praesulcata-sulcata* lineage. Most conodont workers at the workshop did not see much potential for the continued use of the *Siphonodella* lineage for boundary definition. However, Carlo suggested that his observations and conclusions along with those of Sandra Kaiser should be independently tested by other conodont specialists before the lineage is abandoned. In the La Serre section, the *S. praesulcata* and *S. sulcata* morphotypes that Corradini and Kaiser recognized lacked any apparent relationship with the stratigraphic level (several morphotypes occurred together in the beds); but it is necessary to determine if this is the case in several sections, where the extensive reworking observed at La Serre is not an issue.

At the July ICP3 workshop in London and at other recent meetings, it was proposed that we explore the possibility of using an event such as some component of the multiphase Hangenberg extinction for boundary definition. The idea of using a phase of the Hangenberg event for boundary definition was discussed and received much support at the IPC3 workshop. The event presents potential for correlation into both shallow and relatively deep-water marine facies. A variety of techniques can be used to recognize the Hangenberg event and it is relatively well constrained by biostratigraphic markers.

At the International Commission of Stratigraphy meeting held in Prague from May 31st to June 3rd, 2010 to discuss the GSSP concept, Vladimir Davydov (Boise State University, Idaho USA) proposed that volcanic ash beds and laminae could be used to define boundaries such as the D-C boundary. The ashes represent instants in deep time and can be precisely dated using U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology. Precise Global correlation of such ashes would require supporting biostratigraphic data. The proposal was met with moderate enthusiasm at the IGC meeting but requires further evaluation.

Task Group to establish the Tournaisian-Viséan boundary

Following approval of the proposed GSSP [see Devuyst *et al.* (2003) for early version of proposal] at Pengchong in southern China, by the SCCS in late 2007 and its ratification by the ICS and IUGS, task-group member François-Xavier Devuyst has been preparing the final report about the Tournaisian-Viséan boundary GSSP. After completion of the report, the task group will be dissolved according to ICS rule (7.5).

Task-group member Hongfè Hou is trying to organize an official ceremony for the placement of the "golden spike" in the GSSP section at Pengchong. Several task-group members and SCCS officials plan to attend the historic ceremony.

Task Group to establish the Viséan-Serpukhovian boundary

During the past year, the task group made encouraging progress toward the selection of a GSSP for the stage boundary. The group continues to find that the first evolutionary appearance of the conodont *Lochriea zieglerei* Nemirovskaya, Perret & Meischner in the lineage *Lochriea nodosa-Lochriea zieglerei* presents the best potential for boundary definition. This lineage, best documented from deep-water carbonate sections, has been recently documented in numerous sections in Europe and Asia, and *L. zieglerei* has been identified in the USA. Task-group research is currently focused on using the *Lochriea* lineage to define the boundary at the two GSSP candidate sections that have the best potential - the Nashui section in southern Guizhou province of China and Verkhnyaya Kardailovka section in the southern Urals of Russia.

Until late this year, task-group members and other SCCS members felt that not enough was known about the geographic and lithofacies distributions of the *Lochriea* lineage and the degree of diachroneity of the first evolutionary appearance of *L. zieglerei* to warrant a vote to either reject or accept the first evolutionary appearance of *L. zieglerei* for boundary definition. George Sevastopulo, chairman of the Tournaisian/Viséan boundary task group, had serious concerns that the first appearance of *L. zieglerei* might be highly diachronous. During the last two years, Sevastopulo and colleague Mark Dean along with student Milo Barham at Trinity College in Dublin have tied the first appearance of *L. zieglerei* to ammonoid-bearing marine bands and the ammonoid zonation scheme used in Western Europe. The preliminary results indicate the diachroneity is minimal. Taxa in the lineage containing *L. zieglerei* display a broad range of morphological variations and studies by task-group members are underway to

access the variations and more precisely define the limits of *L. ziegléri*, its immediate ancestor *L. nodosa* (Bischoff), and *L. cruciformis* (Clarke), which appears near the first occurrence of *L. ziegléri*.

Task-group members and students from the Nanjing Institute of Geology and Paleontology completed a bed-by-bed study of the boundary interval in the Nashui section in southern China and spent several days measuring and describing the nearby Yashui and Dianzishang sections to place the Nashui section into its geological context. At Nashui conodonts within the *L. nodosa* - *L. ziegléri* lineage are well preserved and abundant. Elements transitional between *L. nodosa* and *L. ziegléri* are also plentiful, occurring in several samples, and the oldest representatives of *L. ziegléri* could be readily distinguished from the associated transitional forms of *L. nodosa*. John Groves completed his study of the foraminifers in the Nashui section but results were disappointing because of the scarcity of specimens.

The Yashui section, situated near the city of Huishui in Guizhou province, is important because it contains abundant rugose corals and foraminifers, and is dominated by shallow-marine neritic to peritidal facies. The purpose of studying the section is to determine the relationship of the coral and foraminiferal zones to the *L. nodosa* - *L. ziegléri* transition in south China. In the summer and fall of 2008 and in 2009, Wang Xiangdong sampled the Yashui section for corals and Qi Yuping sampled it for conodonts. In early 2010, the lower 103 metres of the Yashui section was measured and described by Barry Richards at a bed-by-bed level of detail and sampled by other team members for conodonts, foraminifers, and rugose corals. The conodont samples have been processed but yields were poor and the *L. nodosa* - *L. ziegléri* transition could not be located. Sedimentologic and paleogeographic data that place the Nashui section into its geologic context were obtained and the diverse coral and foraminifer faunas have biostratigraphic utility for boundary recognition. The section provides an excellent opportunity to see what the shallow-marine platform facies and faunas are like in southern Guizhou Province. John Groves largely completed his study of the foraminifers and can bracket the Viséan-Serpukhovian boundary with them.

Strata in the Dianzishang section, by Dianzishang village along the Zin Zai River about 1 km upstream from the Red Flag bridge, section are intermediate between the lower-slope to basin deposits at Nashui and the shallow-marine shelf deposits at Yashui. The Dianzishang section includes spectacular syndepositional slump deposits formed in middle- to lower-slope setting on a carbonate ramp and provides another opportunity to see conodonts and foraminifers spanning the *L. nodosa* - *L. ziegléri* transition. In early 2010, task-group members measured 72.7 m of strata extending from the uppermost Viséan into lowermost Bashkirian but not at a bed-by-bed resolution. The well-exposed section is dominated by carbonate turbidites and slump deposits.

In June Javier Sanz-López and Silvia Blanco-Ferrera introduced task group members to sections spanning the Viséan-Serpukhovian boundary in the Cantabrian Mountains of northwestern Spain. Two of the Cantabrian sections, the Vegas de Sotres and Millaró sections in the Alba Formation, are excellent, rivaling the better known Kardailovka and Nashui exposures. In the Vegas de Sotres section (by village of Sotres) and Millaró section (by village of Millaró), conodonts within the *L. nodosa* - *L. ziegléri* lineage are well preserved and abundant and the first occurrence of *L. ziegléri* has been located with moderate precision. A major biostratigraphic advantage of the two sections is the common occurrence of abundant, well-preserved ammonoids being studied by Svetlana Nikolaeva; foraminifers and algae introduced from shallow-water settings are also present at Vegas de Sotres. In both sections, deposits within the *L. nodosa* - *L. ziegléri* transition are dominated by nodular, deep-water carbonates of the Alba Formation.

During August 2010, several task-group members worked at the Verkhnyaya Kardailovka section, a deep-water, carbonate succession along the Ural River opposite the village of Verkhnyaya Kardailovka on the eastern slope of the southern Urals in Russia. Nikolaeva and her colleagues have worked on this section for several years and recently published a synthesis of their studies on the ammonoids, conodonts, foraminifers and ostracodes. The synthesis indicates that specimens transitional between *L. nodosa* and *L. ziegléri* occur in the Verkhnyaya Kardailovka section immediately below the first appearance of *L. ziegléri*. On an August 2009 trip, to Verkhnyaya Kardailovka, task-group members had a stratigraphic overview of the section and found that most of it was well exposed and lacked major structural complications, but it was not sufficiently exposed below the probable boundary level. In August 2010, the covered interval was excavated, exposing several metres of carbonates and a 12 - 13 m thick underlying succession of marine shale and volcanic ash. A major biostratigraphic advantage of the Kardailovka section is the common occurrence of abundant, well-preserved ammonoids that span the boundary level and have been thoroughly studied by Svetlana Nikolaeva.

Corresponding members Sergio Rodriguez (Universidad Complutense in Madrid, Spain) and Wayne Bamber (Geological Survey of Canada-Calgary), continue to study various carbonate-dominant sections across the Viséan-Serpukhovian boundary interval in the upper Viséan to Serpukhovian Etherington Formation in the southern Canadian Rocky Mountains. Rodriguez and Bamber are preparing a monograph on the taxonomically diverse rugose coral faunas that span the Viséan-Serpukhovian boundary within the Etherington.

The **Task Group to establish the Bashkirian-Moscovian boundary** is conducting research in Europe and Asia but a lineage and taxon suitable for boundary definition has not been selected. Investigations focus on evolutionary transitions in several conodont lineages, with fusulinid biostratigraphy providing auxiliary information. Conodont evolutionary events that have potential for defining the base of the Moscovian include: 1) derivation of *Idiognathoides postsulcatus* from *Id. sulcatus*, 2) derivation of *Declinognathodus donetzianus* from *D. marginodosus*, and 3) the appearance of *Diplognathodus ellesmerensis*. The fusulinids *Eofusulina* ex gr. *triangula* and *Profusulinella* [= *Depratina*] *prisca* recently emerged as additional taxa with considerable potential for boundary characterization. During the later part of the fiscal year, conodont specialists revealed that rapid morphologic evolution in P₁ elements of *Streptognathodus expansus* and *S. suberectus* permit the identification of a new biostratigraphic level at which the base of the Moscovian Stage might be placed.

Elena Kulagina has completed a study of *Depratina prisca* in which she documented its evolutionary origin and showed its first occurrence in the south Urals can be used to identify the base of the Moscovian. Kulagina showed that *D. prisca* was derived from *Staffellaeformes staffellaeformis* via the intermediates *Staffellaeformes eoprisca* and *Depratina praeprisca*. Occurrences of *D. prisca* have been examined at the Askyn, Basu River and Uklykaya sections.

South China. Substantial progress has been made on the intensive biostratigraphic and lithostratigraphic studies of the Bashkirian-Moscovian boundary interval in the Nashui section, in southern Guizhou province. John Groves completed his analysis of the foraminifers from the Bashkirian-Moscovian boundary interval using samples collected during a 2008 expedition. Qi Yuping, assisted by Lance Lambert and Jim Barrick, continued with a detailed analysis of the conodonts derived from several collecting expeditions to the section. They have established that conodonts are abundant and taxonomically diverse in the lower- to middle-slope carbonates of the 20 m thick Bashkirian-Moscovian boundary interval. The provisional Bashkirian-Moscovian boundary recognized by Qi *et al.* (2007, 2009) on the lowest occurrence of *Diplognathodus ellesmerensis* remains at 173 m above the base of the Nashui section, at a position containing a foraminiferal association dominated by *Profusulinella* spp. and *Pseudostaffella* spp. The lowest occurrence of a Moscovian fusulinid is at 183.45 m, where *Eofusulina* sp. was recovered. In the section, rapid morphologic evolution in P₁ elements of *Streptognathodus expansus* and *S. suberectus* permit the identification of a new biostratigraphic level at which the base of the Moscovian Stage might be placed. Older forms of these species possess short adcarinal ridges that are not clearly separated from the platforms, but starting at 169.05 m above the base of the section, new morphotypes with significantly longer, more clearly distinct adcarinal ridges appear. The level coincides with the entry of *Neognathodus kanumai* and *Neognathodus atokaensis*, traditional markers for the base of the Moscovian in North America. Several evolutionary events offer potential for boundary definition, including the appearances of *Diplognathodus ellesmerensis* and *Neognathodus atokaensis*, and chronoclines within *Declinognathodus*, *Idiognathoides*, *Idiognathodus*, *Gondolella*, *Mesogondolella* and *Streptognathodus* s.l.

Northwest Spain. Javier Sanz-López, Silvia Blanco-Ferrera and Elisa Villa are conducting integrated foraminiferal and conodont biostratigraphic analyses at the San Antolín-La Huelga section along the Bay of Biscay. On June 5th of 2010 this section, comprising the Valdeteja and overlying Picos de Europa formations, was examined by SCCS members during the June 4th - 10th field meeting in the Cantabrian Mountains. Participants found the section well exposed but difficult to accurately measure, and the boundary level lay in an interval dominated by resedimented and commonly coarse-grained slope lithofacies. The Bashkirian-Moscovian boundary is provisionally placed 180 m above the section's base in lower-slope deposits. The boundary is marked by the lowest occurrence of *Idiognathoides postsulcatus*, and this level is slightly higher than the lowest occurrences of *Declinognathodus marginodosus* and *Profusulinella* ex gr. *prisca*. The San Antolín-La Huelga section contains four conodont taxa identified as potential Bashkirian-Moscovian boundary markers: *Id. postsulcatus*, *Diplognathodus ellesmerensis*, *Neognathodus nataliae* and *Declinognathodus donetzianus*. The lowest occurrences of these conodonts are in the order listed, spanning a stratigraphic interval of over 300 m.

Donets Basin, Ukraine. Katsumi Ueno and Tamara Nemyrovska continued their work on fusulinids and conodonts from the Donets Basin. The Malonikolaevka section has yielded interesting results that were summarized by Ueno and Nemyrovska (2008). At Malonikolaevka, the proposed boundary marker *Declinognathodus donetzianus* first occurs in Limestone K1 in evolutionary continuity with its ancestor *D. marginodosus*. Limestone K1 also contains unquestioned occurrences of the Moscovian fusulinid *Eofusulina*.

Davydov (2009) summarizes fusulinid occurrences in the Bashkirian-Moscovian transition in the Donets Basin with proposed correlations to the Moscow Basin. Davydov follows Ueno and Nemyrovska (2008) in placing the base of the Moscovian Stage at the K₁ limestone on the appearance of *Declinognathodus donetzianus*. He regards limestones I₂², I₃ and I₄ as pre-Vereian in age (older than basal Moscovian Substage), although those units contain fusulinids such as *Verella? transiens* that occur elsewhere in Moscovian strata. Davydov suggests that the appearances of *Paraeofusulina* and *Eofusulina* are potential markers for the base of the Moscovian in Tethyan regions.

South Urals, Russia - The well-exposed Basu River section, visited during the August 2009 SCCS field meeting, is one of the best GSSP candidate sections in the southern Urals. It contains the first appearance of *Depratina prisca* a few metres below that of *Declinognathodus donetzius*. The discovery of the *Declinognathodus* lineage and a fusulinid fauna including the *P. prisca* group make the Basu section a good potential GSSP candidate. Kulagina *et al.* (2009) provisionally place the boundary, and that of the Solontsian Horizon (local unit in lowermost Moscovian), 0.9 m above the base of the section coincident with the appearance of *Depratina prisca*. The appearance of *Aljutovella aljutovica*, an index to the base of the Moscovian Stage in many areas, occurs 28.8 m above the section's base. The uppermost Bashkirian and basal Moscovian strata contain *Declinognathodus marginodosus*. The appearance of *D. donetzius* is 6.2 m above the base of the section, about 5.3 m above the appearance of *D. prisca*.

E.I. Kulagina, V.N. Pazukhin, N.V. Goreva, T.N. Isakova, A.S. Alekseev, V.B. Panfilova, O.P. Nikulina, and E.A. Krylova recently completed a study addressing correlation of the Bashkirian-Moscovian boundary between the Russian Platform and the South Urals. Data from the Russian Platform and South Urals sections show that the basal Vereian Substage is characterized by the appearance of *Aljutovella aljutovica*. The appearance of *Declinognathodus donetzius* in the Basu section occurs in the lower Solontsyan Horizon within the *Depratina prisca* Zone (Kulagina *et al.* 2009).

Ivanova (2008) published a beautifully illustrated monograph on fusulinids (and calcareous algae) of the Bashkirian and Moscovian stages in the Urals. The volume is the most up-to-date summary of fusulinid species-level occurrences and zonal stratigraphy for the middle Carboniferous in a belt extending from Pechora in the north to Aktyubinsk in the south. Ivanova places the base of the Moscovian throughout the Urals at the base of the *Depratina* [= *Profusulinella*] *prisca*—*Aljutovella aljutovica* Zone.

The **Task Group to establish the Moscovian-Kasimovian boundary** is focusing on the stratigraphic occurrence and distribution of the conodonts *Idiognathodus sagittalis* Kozitskaya 1978 and *Idiognathodus turbatus* Rosscoe and Barrick 2009 and their ancestors as potential biostratigraphic markers for defining the base of the Kasimovian Stage. The use of either conodont would raise the boundary level one substage from the traditional position at the base of the Krevyakinian Substage, to approximately the base of the Khamovnikian Substage but will facilitate global correlation.

Cantabrian Mountains, NW Spain. Spanish task-group members are continuing with their study of the Moscovian-Kasimovian transition in the Castillo del Grajal and Morra del Lechugales sections, in the uppermost part of the carbonate-dominant Picos de Europa Formation and Las Llacerias Formation. Fusulinid biostratigraphic data indicate the study interval ranges from the top of the *Fusulinella* Zone (upper Moscovian) to the lower *Montiparus* Zone (Khamovnikian Substage). The *Protriticites* Zone, spanning at least 245 m, is well exposed and fusulinid rich. Preliminary sampling indicates the occurrence of the conodont *Idiognathodus sagittalis* and its potential ancestor *Idiognathodus* n. sp. 1 of Goreva *et al.* (2009), allowing correlation with the Moscow Basin and the North American Midcontinent.

South China James E. Barrick and Qi Yuping have been collaborating in examining existing and new collections of conodonts from the Nashui section in southern Guizhou Province and plan to publish preliminary results in the field guide for the November 2010 SCCS field meeting in Nanjing. Study of the specimens will facilitate recognition of the Moscovian-Kasimovian Stage boundary in the Nashui section. At Nashui, latest Moscovian conodont faunas are characterized by abundant elements of *Swadelina* spp. and a few elements of *Idiognathodus* spp. The base of the Kasimovian is marked by the disappearance of *Swadelina* and appearance of *Idiognathodus* morphotypes of the *I. swadei-I. sagittalis* group, including at least one form that may be the early Missourian species *I. turbatus* Rosscoe and Barrick 2009. Overlying Kasimovian conodonts include, in ascending order, the *Streptognathodus guizhouensis*, *Idiognathodus magnificus*? and *Streptognathodus excelsus* faunas.

The recently discovered Loukun section in southern Guizhou Province, exposed along a road leading to the village of Loukun, was measured and sampled for fusulinids and conodonts to place the Nashui section into its geological context, provide another opportunity to study conodonts and fusulinids spanning the Moscovian-Kasimovian boundary, and prepare the field guide for the November 25th-30th 2010 field excursion for the SCCS field meeting organized by the Nanjing Institute of Geology and Palaeontology. The Loukun section occupies an intermediate depositional position between the shallow-marine shelf deposits in the Zhongdi section 30 km southeast of the town of Ziyun and lower- to middle-slope deposits at Nashui.

Moscow Basin, Russia The task group has been studying specimens collected during 1994 from the Stsherbatovka quarry section on the Oka-Tsna Swell of the Ryazan Region, east of the town of Kasimov, Moscow Basin. In the section, the middle part of the Neverovo Formation (Khamovnikian Substage) contains abundant macrofauna. Conodonts occur as well but are not common and most elements are juveniles of the *Idiognathodus sagittalis-I. turbatus* group. *Idiognathodus sulciferus* was also identified. Earlier, fusulines were used to correlate this interval with the Krevyakinian *Obsoletes obsoletus* Zone, but the conodonts suggest a younger age. The Stsherbatovka section, about 250 km southeast of the better-known Afanasievo section in the Moscow Basin, demonstrates a wider

distribution of the marker conodont species for identifying the base of the Kasimovian. The Afanasievo section is a potential candidate for the GSSP of the Kasimovian Stage.

Southern Urals, Russia The Dalniy Tyulkas section, several kilometres south of the Usolka section in the Urals, is a composite comprising three segments (Dalniy Tyulkas 1, 2, and 3) and ranges from upper Moscovian to the Artinskian Stage. It is a deeper-water succession containing abundant conodonts. Segment 1 spans the upper Moscovian to basal Kasimovian and Alekseev, Goreva, and others recognized the *Streptognathodus subexcelsus* and *Swadelina makhlinae* assemblages in the section's upper part. These assemblages are characteristic of the Suvorovo and Voskresensk formations, respectively, of the regional Krevyakinian Substage (traditional lower substage of Kasimovian) in the Moscow Basin. Dalniy Tyulkas 1 is the first section outside the Moscow Basin where these two lower Kasimovian conodont zones have been recognized. Dalniy Tyulkas 2 comprises upper Moscovian to lower Gzhelian strata. Alekseev, Goreva, and others are reinvestigating the conodonts in segment 2 and in the segment's middle part they found *Idiognathodus sagittalis*, one of the species chosen as a potential biostratigraphic marker for defining the base of the Kasimovian. Segment 2 is a promising candidate for the Moscovian-Kasimovian boundary stratotype.

Ukraine. Davydov *et al.* (2010) published data on high-precision U-Pb ages of volcanic ashes, with an age resolution of ~100 ka, to radiometrically calibrate the detailed lithostratigraphic, cyclostratigraphic, and biostratigraphic frameworks of the Donets Basin in the Ukraine. Based on this precision, they confirmed the long-standing hypothesis that individual high-frequency Pennsylvanian cyclothem and bundling of cyclothem into fourth-order sequences are the eustatic response to the orbital eccentricity (~100 and 400 ka) forcing within the Milankovitch Band. Their work facilitates a more precise cyclostratigraphic calibration for the Moscovian-Gzhelian interval in the basin.

The **Task Group to establish the Kasimovian-Gzhelian boundary** has selected the conodont *Idiognathodus simulator* (s.s.) as the event marker for defining the base of the Gzhelian Stage) and is directing research toward studying the Gzhelian in the vicinity of its stratotype and selecting a suitable section for the GSSP.

Russia. In August 2009, the Subcommittee on Carboniferous Stratigraphy held a field meeting in the Moscow Basin and southern Urals of Russia to examine Carboniferous stratotype sections and candidate sections for GSSPs. The visited sections that are closely related to the task group's work are the Gzhel stratotype in the Moscow region and the Usolka and Dalniy Tyulkas sections in the southern Urals.

With the help of Aleksey Reimers and Yuliya Ermakova, Alekseev and others studied an important Gzhelian-Asselian reference section at Yablonovyy Ovrage in the Samara Bend of the Volga River, about 800 km east southeast of Moscow. They found *Idiognathodus simulator* in the interval traditionally considered to contain the base of the Gzhelian. The occurrence is important because it fills a geographical gap in the distribution of *I. simulator* between the Moscow Basin and southern Urals, and reinforces the importance of the taxon for defining the base of the Gzhelian Stage.

In the southern Urals, the Usolka section was visited during the 2009 SCCS field meeting to investigate its utility as a base-Gzhelian GSSP candidate. This is the only section that has been formally proposed as a potential candidate for the GSSP defining the base of the Gzhelian Stage. Davydov *et al.* (2008) documented in detailed the fauna and correlation of the Kasimovian-Gzhelian transition at Usolka. The Kasimovian-Gzhelian boundary interval of the Usolka section is largely concealed by soil and vegetation but the task group plans to re-expose the succession and inspect the results reported by Chernykh *et al.* (2006) and Davydov *et al.* (2008).

The Dalniy Tyulkas section, located several kilometers south of the Usolka section, comprises three separate segments (Dalniy Tyulkas 1, 2, and 3) ranging from the upper Moscovian to the Permian Artinskian Stage. It represents a deeper-water succession with abundant conodonts. Dalniy Tyulkas 2 is an upper Moscovian-lower Gzhelian section, and conodonts were reported earlier by Chernykh and Reshetkova (1987). Alekseev, Goreva and others are reinvestigating the conodont succession in segment 2 and have discovered *Idiognathodus eudoraensis* Barrick, Heckel and Boardman and *I. simulator* in the section's upper part. *I. simulator* is the event marker for the base of the Gzhelian Stage, and *I. eudoraensis* is interpreted to be its probable ancestor. Segment 2 of the Dalniy Tyulkas section is a promising candidate for the Kasimovian-Gzhelian boundary stratotype.

South China. James Barrick and Qi Yuping are collaborating to examine existing and new collections of conodonts from the Nashui section in southern Guizhou Province, China and plan to publish preliminary results in the field guide for the November 2010 SCCS field meeting in south China. Study of the specimens will facilitate recognition of the approximate position of the Kasimovian-Gzhelian Stage boundary in the Nashui section. Uppermost Kasimovian strata are characterized by morphotypes of *Idiognathodus* (*I. praenuntius?* and *I. eudoraensis?*) that appear to be transitional to *I. simulator*. The base of the Gzhelian is marked by the appearance of *I. simulator*, *I. auritus* and rare specimens of *I. sinistrum*. The distinctive genus *Solkagnathus*, described from the Gzhelian in the Urals, appears with *I. simulator*. The *Idiognathodus nashuiensis* fauna occurs slightly higher in the Gzhelian, and is followed by the middle Gzhelian *Streptognathodus vitali* fauna. Because the Nashui section is a completely exposed

carbonate-slope succession containing a rich conodont record throughout, it has great potential as a GSSP candidate for the Kasimovian-Gzhelian boundary.

Ukraine. Davydov *et al.* (2010) present data on high-precision U-Pb ages of volcanic ash layers, with an age resolution of ~100 ka, to radiometrically calibrate the detailed stratigraphic framework for the Donets Basin in the Ukraine. They confirmed the long-standing hypothesis that individual high-frequency Pennsylvanian cyclothem and bundling of cyclothem into four-order sequences are the eustatic response to the orbital eccentricity (~100 and 400 ka) forcing within the Milankovitch band. Their results facilitate a more precise cyclostratigraphic calibration for the Moscovian-Gzhelian interval in the basin.

Progress by the **Project Group on Carboniferous Magnetostratigraphy** has been hampered by a shortage of members, insufficient funding, and a lack of integration with the activities of the other SCCS task groups. The group is particularly interested in collaborating with task groups working on sections and boundaries where magnetostratigraphy could be employed, to facilitate international correlations. Sections that have low thermal maturity and are dominated by siliciclastics are the most suitable for magnetostratigraphic analyses (based on the review in the SCCS Newsletter, v. 22: 35-41) but carbonates can be used. Unfortunately, most of the best GSSP candidate sections are carbonate dominant and thermally over mature but some reference sections and stratotypes for stages show potential. In general, the study of Mississippian magnetostratigraphy has languished and much remains to be done before Carboniferous magnetostratigraphy can be widely applied to facilitate global correlations.

During the last fiscal year, little progress was made on the initial palaeomagnetic assessment of the two sections in southern Scotland that were discussed in the SCCS annual report for the Nov. 1st 2008 to Oct. 31st 2009 fiscal year. The first section is at Cove in the Cockburnspath outlier on the southern flank of the Midland Valley Basin and includes the Inverclyde and Strathclyde groups of latest Devonian to (Asbian) late Viséan age (Cossey *et al.*, 2004; Hounslow 2009). The second section is at Kirkbean on the northern edge of the Northumberland Basin and is of early to late Viséan age, overlapping in age with the upper part of the Cove section. Some progress may occur on the two Scottish sections in 2011, if grant income from United Kingdom sources is forthcoming.

During the May 31st to June 3rd 2010 ICS meeting in Prague, the task group leader discussed with Barry Richards and Svetlana Nikolaeva (Russian Federation) the possibility of designing a magnetostratigraphic project that would evaluate Late Mississippian and Pennsylvanian sections in the Moscow Basin, Lard Basin in northwestern Canada and sections in the mid-continent region of the USA. So far, these initial discussions have not developed into tangible outcomes and the main problems stem from a lack of funding and suitable investigators.

John Utting (member Viséan/Serpukhovian boundary task group) and colleagues Peter Giles (Geological Survey of Canada-Atlantic) and Neil Opdyke (University of Florida) have largely completed a very useful magnetostratigraphic study of the Brigantian, Pendleian and much of the Arnsbergian substages (upper Viséan and Serpukhovian) in the Maritimes Basin of eastern Canada (Giles *et al.*, in progress). They have correlated the polarity reversal patterns in the Maritimes Basin with published data from the Brigantian to mid-Arnsbergian interval in the central part of the Appalachian Basin in the eastern United States (Di Venere and Opdyke, 1990, 1991).

CONFERENCES AND FIELD MEETINGS NOVEMBER 1ST, 2009 - OCTOBER 31ST, 2010

During the last ICS fiscal year there were several geological conferences, field meetings and workshops that SCCS members needed to attend. Some of these meetings such as the workshop at the Third International Paleontological Congress in London (June 28th to July 3rd, 2010) were mainly of interest to the D-C boundary task group and the notes taken at those meetings are incorporated into the task-group report for the D-C boundary working group herein. The most significant meetings for the full subcommission were the Prague 2010 International Commission of Stratigraphy workshop (The GSSP Concept, May 31–June 3), and the 2010 field meeting held Spain (SCCS field meeting in Cantabrian Mountains, northwestern Spain, June 4th - 10th). In this Annual Report, we summarize relevant components of the ICS Prague meeting and subsequent SCCS Cantabrian meeting. The full reports are published in volume 28 of the Newsletter on Carboniferous Stratigraphy.

Report on the International Commission on Stratigraphy Workshop - The GSSP Concept; Prague, May 31st –June 3rd, 2010.

The Prague ICS workshop, held in the Geoscience Building of Charles University, was hosted by the Institute of Geology and Palaeontology at Charles University, and the Institute of Geology, Academy of Sciences, Czech Republic. Most of the approximately 60 delegates were executive members of ICS subcommissions, with others representing national stratigraphic commissions. Our subcommission was well represented and those in attendance were: Markus Aretz, Svetlana Nikolaeva, Barry Richards, Katsumi Ueno, Wang Xiangdong, and Qi Yuping. What we consider to be the most important aspects of the presentations and discussions in terms of the mandate of the SCCS are outlined below.

From the talks and discussions, we learned about some procedures to avoid when defining a GSSP but we were also introduced to methods that should be utilized to properly locate and define them. As an outcome of the meeting, the SCCS leadership can not provide a comprehensive set of instructions for locating and defining GSSPs; however, many good methods and practices to employ were presented and many of those points are presented below. 1) Multiple stratigraphic methods including biostratigraphy should be used when establishing a GSSP. 2) Other stratigraphic techniques such as event stratigraphy and stable-isotope stratigraphy are increasingly being used to supplement biostratigraphy. For many boundaries, particularly in the Precambrian, the use of a non-biostratigraphic approach is the only method available. 3) In some proposals, the taxon used to define the boundary is not illustrated and this should be strictly avoided. Guide fossils must be illustrated and not just named. 4) It is very important that boundary stratotype sections extend well above and below the GSSP as well as across it in order that important biostratigraphic and other trends can be clearly observed and documented. 5) A proposal for a GSSP should not be published before being approved by the ICS. 6) While it is a priority to complete the task of defining GSSPs for periods, series, and stages, there is no pressure from the IUGS or ICS to do this by a specific deadline. 7) There is no formal procedure for establishing auxiliary boundary-stratotype sections (they are not formally ratified by the ICS). 8) After the IUGS geological time scale has been defined by selecting GSSPs for the higher-level boundaries, much work for the subcommissions will remain including the refinement of existing GSSPs, creation of lower rank GSSPs, and selection of auxiliary stratotypes around the world.

Report on the SCCS Field Meeting in the Cantabrian Mountains, Northwest Spain, June 4th - 10th, 2010

At the Second International Conodont Symposium, held in Calgary from July 12-17th 2009, the SCCS executive met with Spanish colleagues Javier Sanz-López and Silvia Blanco-Ferrera to discuss their recent work on conodonts from Carboniferous sections in the Cantabrian Mountains of northwest Spain. At the end of that meeting, we discussed the possibility of arranging a four- to five-day SCCS fieldtrip for early June of 2010 to see some of the Spanish sections that they have been studying and are relevant to SCCS projects. Javier and Silvia assisted by Elisa Villa, Cor Winkler Prins, Luis C. Sánchez de Posada and Roberto Wagner, organized a field trip to the Cantabrian Mountains for us. A summary of what the participating SCCS members examined and learned on that excursion is presented below.

A principal objective of the fieldtrip was to visit several of the best carbonate-dominated sections that span the Viséan-Serpukhovian boundary and have yielded conodonts within the *Lochriea nodosa-Lochriea zieglerei* lineage. Task group members wanted to compare those sections with the better known Verkhnaya Kardailovka section on the eastern slope of the southern Urals in Russia (Nikolaeva *et al.*, 2005) and the well known Nashui section (by village of Naqing) in southern Guizhou province, China (Qi and Wang 2005, Qi, 2008). Additional objectives were to obtain structural and paleogeographic overviews of the Cantabrian region and examine some of the best sections spanning the Devonian-Carboniferous, Mississippian-Pennsylvanian, and Bashkirian-Moscovian boundaries to see how they compared with other sections SCCS task groups are studying. The very interesting and somewhat controversial results of Javier's and Silvia's research on conodonts spanning the Devonian-Carboniferous and Mid-Carboniferous boundaries (Sanz-López and Blanco-Ferrera, 2009) were presented and discussed. The Cantabrian Zone probably has the longest marine record in the Carboniferous of Central and Western Europe, and thus it is of great interest for global stratigraphic correlations that the SCCS aims to achieve.

Conclusions

- 1) The Cantabrian Mountains in northern Spain present an outstanding opportunity to study Carboniferous microbial boundstone-dominated carbonate platform characterized by high-relief margins and steep depositional slopes.
- 2) The Cantabrian Mountains contain several well-exposed sections that span the Devonian-Carboniferous boundary. Most of them are probably not suitable candidates for detailed biostratigraphic analyses across boundary at the level of the *Siphonodella praesulcata-Siphonodella sulcata* lineage but could be useful for studying late Famennian to early Tournaisian event stratigraphy.
- 3) The region contains several excellent carbonate-dominated sections that span the Viséan-Serpukhovian boundary and contain abundant well-preserved conodonts within the *Lochriea nodosa-Lochriea zieglerei* lineage. Of the sections we examined that span the Viséan-Serpukhovian boundary in the Cantabrian Mountains, the Millaró section has the highest potential for high-resolution biostratigraphy, containing both conodonts and abundant ammonoids, and could be a good candidate for the Viséan-Serpukhovian boundary GSSP. The section is well exposed, accessible, and very suitable for detailed sedimentological, geochemical, and sequence-stratigraphic analyses.
- 4) The Cantabrian Mountains contain several excellent and well-studied sections that span the Mid-Carboniferous boundary and contain well-documented conodont assemblages that could lead to a better understanding of order of occurrence of conodonts within the *Declinognathodus* group of species and lead to a resolution of the apparent problem of using *Declinognathodus* s.l. to define the Mid-Carboniferous GSSP.

- 5) The region is structurally complex but metamorphic grades are relatively low and valuable regional stratigraphic and basin analysis studies can be completed through the integrated use of biostratigraphy, sedimentology and lithostratigraphy.
- 6) The Cantabrian Mountains contain suitable sections for integrated biostratigraphic, geochemical, and sedimentologic analyses related to the pursuit of GSSP candidates at the level of the Bashkirian-Moscovian boundary but we did not see enough sections at this level to enable us to make any recommendations.

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6. CHIEF PROBLEMS ENCOUNTERED IN 2010

Several problems confronted the SCCS task groups during the fiscal year and most are ongoing. Many of the most active specialists are working on two or more task groups and have over extended themselves, making it difficult to make substantial progress during any one fiscal year. They have found it difficult to find a balance between employment-related projects, SCCS projects and family obligations. Members of some task groups have found the deposits at other boundary levels to be more interesting than the ones they have been assigned to work on and have directed a substantial part of their time duplicating the efforts of other task groups. Progress by the project group on Carboniferous magnetostratigraphy has been hampered by a shortage of members, insufficient funding, and a lack of integration with the activities of the other task groups.

The most significant issue confronting the SCCS is the difficult and time-consuming task of locating suitable evolutionary lineages and first occurrences for boundary definition. Within the Carboniferous, the endemism of conodont, foraminiferal and ammonoid lineages between Eurasia and North America, which slowed down submission of the Tournaisian-Viséan boundary proposal, continues to hamper the choice of the boundary levels for the Viséan-Serpukhovian and Bashkirian-Moscovian boundaries. The problem is being overcome somewhat by correlating other fossil groups to bracket the boundary levels in major regions where the boundary-event taxa have not been found. In the case of the higher two boundary levels [Moscovian-Kasimovian, Kasimovian-Gzhelian], there are enough conodont species in common between the regions to achieve what appears to be fairly precise correlations. However, the strong cyclic control over sedimentation and consequent widespread disconformities across entire shelves, still hampers the selection of acceptable GSSPs for these younger boundaries, which will require successions of relatively continuous sedimentation. We are now focusing study on deep-water, carbonate-slope and basin sections in southern China and the southern Urals of Russia, which can be correlated with the shelf cyclothem successions, for potential GSSPs.

Essentially all lineages being chosen for GSSP definition are conodont based and have the most utility in carbonate-dominant lower-slope and basin deposits containing few other taxa than ammonoids that are suitable for global correlations. The best of the known deeper water successions in terms of abundance and diversity of conodonts and continuity of outcrop are in southern China and the southern Urals. The direction the current work of the SCCS is advancing indicates all of the remaining GSSPs will be placed in south China and Russia. Additional suitable sections, even if they just become reference sections, should be located and intensively studied in Western Europe, northern Africa/Middle East, and North America.

Some lineages used in the past for boundary definition such as the *Siphonodella praesulcata*-*Siphonodella sulcata* conodont lineage, used to define the Devonian-Carboniferous boundary, were not sufficiently known prior to being used for GSSP definition. Current specialists are finding those lineages are either no longer suitable for defining and correlating boundaries or require intensive re-evaluation.

7. SUMMARY OF EXPENDITURES IN 2009:

STATEMENT OF OPERATING ACCOUNTS FOR NOVEMBER 1st, 2009 TO OCTOBER 31st, 2010
Prepared by Barry Richards, Chairman SCCS

(Accounts maintained in Canadian currency)

INCOME (November 1, 2009 – October 31, 2010)

| | |
|---|-------------------|
| IUGS-ICS Grant; June 14, 2010 | \$1,003.30 |
| Donations from Members; November 1, 2009 - June 30 2010 | \$100.00 |
| Donations from Members; July 1- October 31, 2010 | 50.51 |
| Interest from Bank of Montreal; November 1 - October 31, 2010 | <u>0.18</u> |
| TOTAL INCOME | \$1,153.99 |

EXPENDITURES (November 1, 2009 – October 31, 2010)

| | |
|---|-------------------|
| Bank Charges: Bank of Montreal June 14, 2010 | \$1.70 |
| Richards travel to Nanjing for SCCS field work; Jan. 26 - Feb. 10, 2010 | \$250.00 |
| Richards attendance of SCCS field meeting in Spain; June 4-10, 2010 | \$250.00 |
| Support for V. Pazukhin to attend 3IPC London; June 10, 2010 | \$1,000.00 |
| Drilling equipment for SCCS use in Russia and Europe | \$503.39 |
| Generator for SCCS use in Russia | \$380.36 |
| Electrical cable for use with drill and generator | <u>\$35.48</u> |
| TOTAL EXPENDITURE | \$2,420.93 |

BALANCE SHEET (2009 – 2010)

| | |
|---|-------------------|
| Funds carried forward from October 31, 2009 | \$2,481.94 |
| Plus Income November 1, 2009 – October 31, 2010 | <u>\$1,153.99</u> |
| Total assets | <u>\$3,635.93</u> |
| Less Expenditures November 1, 2009 – October 31, 2010 | <u>\$2,420.93</u> |
| BALANCE CARRIED FORWARD (to 2010 - 2011 fiscal year) | \$1,215.00 |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

The following activities are planned for the new fiscal year (Nov. 1, 2010 to Oct 31, 2011) by the task groups, as communicated by task-group chairs and distilled from the reports in # 5 above, for which the full texts including references are in Appendix B.

Devonian-Carboniferous boundary The D-C Boundary is currently defined by the first occurrence of the conodont *Siphonodella sulcata* in the evolutionary lineage *Siphonodella praesulcata* to *S. sulcata* (Paproth and Strel, 1984). Based on numerous detailed biostratigraphic studies including those of Flajs and Feist (1988) at La Serre Hill in the Montagne Noir of southern France, the boundary section best displaying the lineage was thought to be in trench E' at La Serre. Therefore, the base of bed 89 in trench E' was selected as the D-C Boundary GSSP (Paproth *et al.*, 1991). Recent doctoral work by Sandra Kaiser followed by further sampling and analysis has shown that there are severe problems with the D-C Boundary GSSP at La Serre (Kaiser, 2009).

The primary task, and one that requires immediate attention by the task group before major progress is made on selecting a new GSSP for the D-C boundary, is to locate either a suitable event in a biotic lineage or another event marker to define the boundary. At the onset of the D-C boundary reappraisal project in 2008, the SCCS executive had hoped the current event marker, the FAD of the conodont *S. sulcata*, could be used to define the boundary. Preliminary results from the re-evaluation of the lineage by Sandra Kaiser and Carlo Corradini strongly suggest it is not useable but additional work is required by other conodont workers to test their findings. Slightly later in the project, it was thought a protognathodid conodont lineage could be used for D-C boundary definition but to date the assessment of that group has not provided favorable results. A suitable section for the GSSP also needs to be located because it is clear from recent task-group studies that the La Serre section is not suitable for the GSSP.

Since the project's first official meeting at the IGC in Oslo 2008, Sandra Kaiser and Carlo Corradini have made considerable progress on re-evaluating the lineage containing the current D-C boundary event marker, the FAD of the conodont *Siphonodella sulcata*. Additional study of the lineage is required, however, and the task group plans to complete that work as soon as possible. At La Serre, Corradini and Kaiser (2009) identified seven morphotypes in the transition from *S. praesulcata* to *S. sulcata*. Unfortunately, the conodonts within the transition are reworked and no correlation exists between the stratigraphic level and individual morphotypes. The task group plans to determine if any correlation between the morphotypes and stratigraphic level exists in other D-C boundary sections, where reworking is not an issue. The morphotype analysis is significant because of its bearing on whether or not the lineage actually comprises two species that can be readily differentiated.

At the July 2010 IPC3 workshop in London England, Carlo Corradini outlined the problems of the *praesulcata-sulcata* lineage. Most conodont workers at the workshop did not see much potential for the continued

use of the *Siphonodella* lineage for boundary definition. However, Carlo stated that his observations and conclusions along with those of Sandra Kaiser require independent testing by other conodont specialists before the lineage is abandoned.

Task-group members Carlo Corradini, Sandra Kaiser and Claudia Spalletta along with Maria Cristina Perri are studying the taxonomic and phylogenetic problems within the protognathodid conodont lineages. In a paper at the July 2010 IPC3 convention in London, they concluded that a comprehensive study of *Protognathodus*, a genus appearing in the latest Devonian and extending into the Mississippian, would permit a more precise definition of the D-C boundary than is presently available using that group of conodonts. Four species of *Protognathodus* are known from the relevant time span: *Pr. meischneri*, *Pr. collinsoni*, *Pr. kockeli* and *Pr. kuehni*. Presently favoured for boundary definition are the first occurrences of *Pr. kockeli* from *Pr. collinsoni* and *Pr. kuehni* from *Pr. kockeli*. These lineages require additional study and their relative advantages, if any, over the siphonodellids require careful evaluation. The SCCS executive has asked the conodont specialists to evaluate the utility of using the lineages for boundary definition by studying them in the best of their D-C boundary sections.

At the D-C boundary workshop held at the 2010 ICP3 meeting in London on July 2, Carlo Corradini summarized the current stage of knowledge of the species within the genus *Protognathodus* across the D-C boundary. He indicated there are problems with the first appearances and distribution of the protognathodid species and especially emphasized the group's rareness to absence in many sections and facies dependence. He concluded that none of the *Protognathodus* species could be the primary marker for the D-C boundary but can be used in conjunction with other taxa. The findings of Corradini require confirmation by other conodont specialists before the protognathodid lineages are abandoned.

If the FAD of *S. sulcata* is retained for boundary definition, a suitable section for the GSSP will need to be located because work at La Serre (Kaiser, 2009; Corradini and Kaiser, 2009) indicates the lack of the phylogenetic transition from *S. praesulcata* to *S. sulcata* in that section. In addition, the section is not suitable because the first occurrence of *S. sulcata* occurs immediately above an abrupt facies change (oid grainstone on sandy shale) that is probably erosional. Because of the potential break, some members of the task group plan to complete a sedimentologic assessment of that contact and the entire section.

At the July 2010 ICP3 workshop in London and at some other recent meetings, it was proposed that we explore the possibility of using an event such as some component of the multiphase Hangenberg extinction event for boundary definition. The event presents potential for correlation into both shallow and relatively deep-water marine facies. A variety of techniques can be used to recognize the Hangenberg event and it is relatively well constrained by biostratigraphic markers. At the end of the meeting, Markus Aretz asked those present to prepare for the next D-C boundary workshop by developing precise correlation charts for their regions of study showing the biostratigraphic, geochemical and depositional events within the Hangenberg event interval. We want to know how the phases of the Hangenberg are represented in different facies and how well they can be correlated globally.

At the International Commission of Stratigraphy meeting held in Prague from May 31st to June 3rd, 2010 to discuss the GSSP concept, Vladimir Davydov (Boise State University, Idaho USA) proposed that volcanic-ash layers could be used to define boundaries such as the D-C boundary. The ashes represent instants in deep time and can be precisely dated using U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology. Precise Global correlation of such ashes would require supporting biostratigraphic data. Study of the ash horizons is ongoing.

Several comprehensive D-C boundary projects that are planned for next four to five years are outlined below. Vladimir Pazukhin (member D-C task group) along with Yury Gatovsky and Lyudmila Kononova (Moscow State University) plan to complete a monograph on the conodont biostratigraphy of D-C boundary interval in the Ural Mountains of Russia. The focus of the study will be from the Famennian *marginifera* Zone into the Tournaisian *isosticha* Zone.

Chinese colleagues along with the SCCS executive and task-group leaders plan to initiate a re-assessment of the best D-C boundary sections in China, starting in November 2010 with the visitation of the Dapoushang section (Ji, 1987) in southern Guizhou Province with Ji Qiang as part of the November 22nd - 29th 2010 SCCS Nanjing workshop and field meeting.

Task Group member Jiri Kalvoda and colleagues from the Czech Republic have initiated a multidiscipline project to study the Devonian-Carboniferous boundary interval in Western Europe including the La Serre section. The project's principal goal is the correlation of evolutionary changes in foraminifer and conodont faunas in the Devonian-Carboniferous boundary interval with a high-resolution stratigraphic framework arising from multidiscipline stratigraphic-paleoenvironmental analysis including petrophysical logging (gamma-ray spectrometry and magnetic susceptibility) and isotope geochemistry. Because of its principal goals, the proposed project is totally relevant to the major goals (outlined in the ICS annual report for 2009 and the Newsletter on Carboniferous Stratigraphy v. 27) of the Joint Task Group for the Reappraisal of the Devonian-Carboniferous Boundary GSSP.

The methods proposed by Kalvoda and colleagues are not new, but their study is more multidiscipline in nature and includes a broader geographic region than other investigations currently being done by the task group. At

present, most task-group work is focused on conodont systematics and evolutionary trends within that group of fossils. Some members are working on the sedimentology and geochemistry of individual sections, but multidisciplinary studies embracing major regions such as Asia are not being done.

Anticipated benefits of the Western European D-C project for the ICS and SCCS are a better understanding of the *S. praesulcata*-*S. sulcata* lineage and whether or not it is suitable for definition of the D-C Boundary GSSP. Other conodont lineages relevant to the boundary (particularly protognathodids lineages) will also be evaluated. In addition, the study may lead to the discovery of events and lineages in other faunal groups than conodonts that had not been considered for boundary definition. The resulting high-resolution stratigraphy will be used to test the isochroneity of the Hangenberg event and contribute to a better correlation between basinal and shallow-water successions in the D-C boundary interval.

From the recent work completed by the D-C boundary task group, it is clear that the La Serre section is not suitable for boundary definition. The biologic-sedimentologic event used to define the boundary has not been chosen, but the search for better GSSP sections is in progress. New D-C boundary sections are being studied in regions such as Morocco (T. Becker, written com., 2010) and previously studied sections such as the Hasselbachtal and those in southern China are being re-evaluated.

Additional workshops relevant to the task group are being planned for the upcoming major meetings of the SCCS (Nanjing, China November 21st - 30th) and SDS. The SDS chairman Thomas Becker and vice-chairman El Hassani, Rabat and the SCCS secretary Markus Aretz plan to organize a field meeting for early 2013 in Morocco.

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Tournaisian-Viséan boundary The task group plans to continue with its preparation of the final manuscript for the project.

Viséan-Serpukhovian boundary Since determining that the first appearance of the conodont *Lochriea ziegleri* in the lineage *Lochriea nodosa*-*Lochriea ziegleri* is the best event to define the boundary, the task group is drafting a proposal advocating the FAD of *L. ziegleri* be used for boundary definition. The group also plans to focus its attention on selecting the best candidate section for the GSSP. At this point, they think the two best candidate sections are the Nashui section by the village of Naqing in southern Guizhou Province, China and the Verkhnyaya Kardailovka section on the Ural River in southern Russia. A third section by the village of Millaró in the Cantabrian Mountains of northern Spain appears to have potential rivaling that of the others but has received less study and, therefore, requires more work than the other two.

Activities in South China

The deep-water (lower- to middle-slope), carbonate-dominant Nashui section in southern Guizhou Province, China is one of the best candidates for the GSSP at the base of the Serpukhovian because the *L. nodosa*-*L. ziegleri* lineage is well defined in it and has been quite precisely located. This section is most intensively studied of the candidate sections but still requires additional work before the final proposal is submitted. The conodont studies for the locality are almost complete and the FAD of *L. ziegleri* is located at 60.10m (Qi *et al.*, 2010) above the base of the section. Some additional work is required including the slicing the bed (bed parallel to bedding) containing the FO and the immediately underlying bed to see if boundary can be more precisely located. John Groves plans to complete his study of the foraminifers in the section in time to present his results at the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting. Work on the sedimentology, stable-isotope geochemistry, and geophysical characteristics of the boundary interval are not as advanced as the paleontological investigations and will be the focus of the team's work in 2011. During December, 2010 Barry Richards plans to complete a bed-by-bed analysis of the strata over a 10-metre-thick interval on either side of the boundary. That work will include taking a

continuous sample through about two metres of strata on each side of boundary to determine the location of all principal sedimentary events and the characteristics and origins of the beds. Depending on the results of the bed-by-bed analysis, Richards may measure the rest of the section up to the mid-Carboniferous boundary at same level of detail.

In order to place the important Nashui section into its sedimentological and paleoenvironmental context and to determine the relationship of shallow-water coral and foraminiferal zones to the deeper-water *L. nodosa* - *L. ziegleri* transition in south China, the investigation of three reference sections - the Yashui, Dianzishang, and the Luokun sections - will continue during the new fiscal year.

The most important reference section and the one that has received the most study is the Yashui section, situated near the city of Huishui in Guizhou province. It is an important section because it contains abundant well-preserved rugose corals and foraminifers (Wu *et al.*, 2009) and is dominated by shallow-marine, neritic- to peritidal-ramp facies. In early 2010, most of the Yashui section was measured and described by Barry Richards at a bed-by-bed level of detail and sampled by other team members for conodonts, foraminifers, and rugose corals. During December 2010, the team plans extend the measurement of section into the lowermost Bashkirian. John Groves plans to complete his study of the foraminifers in the lower part of the section in time to present his results at the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting. The conodont study is partly finished but recovery has been poor and many additional samples need to be processed in the November 1st to October 31st fiscal year to locate the Viséan-Serpukhovian boundary. Investigations on the sedimentology, stable-isotope geochemistry and geophysical characteristics of the section are less advanced than the paleontological work and will be the focus of the team's work in 2011.

Strata in the Dianzishang section, situated by Dianzishang village along the Zin Zai River 1 km upstream from the Red Flag Bridge, are intermediate between the lower-slope to basin deposits at Nashui and the shallow-marine ramp deposits at Yashui. The Dianzishang section includes spectacular syndepositional slump deposits formed in a lower- to middle-slope setting and provides another opportunity to see conodonts and foraminifers spanning the *L. nodosa*- *L. ziegleri* transition in the region. In February 2010, task-group members measured 72.7 m of strata extending from the uppermost Viséan into lowermost Bashkirian but not at a bed-by-bed resolution. Conodont work at the locality has been completed to the extent that the Viséan-Serpukhovian boundary has been located using the *L. nodosa* - *L. ziegleri* transition. John Groves plans to complete his study of the foraminifers in the section in time to present his preliminary results at the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting. Work on the sedimentology, stable-isotope geochemistry and geophysical characteristics of the boundary interval and section are not as advanced as the paleontological studies and will be the focus of the teams work at the locality in 2011.

During 2010, the task group commenced measuring and sampling of the Luokun section, situated by the village of Luokun several kilometres from Naqing and the Nashui section. Like the Nashui section, the exposure at Luokun is essentially 100% complete and dominated by lower- to middle-slope carbonates of turbiditic and hemipelagic aspect. At Luokun, the deposits are of more proximal aspect than those at Nashui but not as shallow as those at Yashui. Study of the section will provide another opportunity to see conodonts and foraminifers spanning the *L. nodosa*-*L. ziegleri* transition in the region. Foraminifers are more abundant and better preserved than at Nashui, and it is anticipated that a better correlation between conodonts and foraminifers can be achieved by the study of the Luokun section. Study of all aspects of the section is at a preliminary level but sufficient biostratigraphic work has been completed to locate the approximate positions of the Viséan-Serpukhovian and Serpukhovian-Bashkirian stage boundaries. During 2011, the task group plans to complete the measurement and sampling of the section (for lithology, fossil, stable-isotope geochemistry and geophysics) at a bed-by-bed level and place aluminum marker pins at one metre intervals.

Activities in Southern Urals, Russia

With its conodonts characteristic of the *Lochriea nodosa*-*Lochriea ziegleri* transition, abundant ammonoids, and moderately common foraminifers, the Kardailovka section, a deep-water basinal succession on the west bank of the Ural River near the village of Verkhnyaya Kardailovka in the southern Urals remains the other strong candidate for the Viséan-Serpukhovian boundary GSSP. During the summer of 2010, the lower part of section was completely exposed using a tractor with back hoe and aluminum marker pins were placed at one-metre intervals. Conodonts, foraminifers and ammonoids in section have been studied in substantial detail (Nikolaeva *et al.*, 2009; Pazukhin *et al.*, 2010) but will require additional study when the section is measured at a bed-by-bed level of detail in August 2011. Sufficient conodont work been done to locate the approximate position of the FAD of the conodont *Lochriea ziegleri* in the lineage *L. nodosa*-*L. ziegleri*. Work on the sedimentology, stable-isotope geochemistry and geophysical characteristics of the section is less advanced than the paleontological work and will be a focus of the team's investigations in 2011 when the team plans to complete a detailed sampling and analysis of the conodonts over a five-metre-thick interval on either side of the Viséan-Serpukhovian boundary. That work will include taking a continuous sample (by using portable gas-powered saw) through about one metre of strata on each side of boundary

to determine the location of all principal sedimentary events and the characteristics and origins of the beds. The sections contains numerous volcanic ash layers near the boundary level and the task group will have the most important ashes dated using the U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology.

The Verkhnyaya Kardailovka section is geographically isolated from other well-exposed Viséan/Serpukhovian boundary sections in the region and the relationship of its basin deposits to slope- and shallow-shelf successions in region are, therefore, very poorly known. A couple of relatively shallow-water but poorly-exposed sections such as the Bolshoi Kizil River section (Kulagina *et al.*, 2009) occur in the region. The task group plans to start measuring the best one of them in 2011 to place the important Kardailovka section into its sedimentological and paleoenvironmental context and to determine the relationship of shallow-water coral and foraminiferal zones to the deeper-water *L. nodosa* - *L. ziegleri* transition.

Activities in Cantabrian Mountains, northern Spain

In June 2010, task-group members were introduced by task-group members Javier Sanz-López and Silvia Blanco-Ferrera to several sections that span the Viséan-Serpukhovian boundary in the Cantabrian Mountains of northwestern Spain. One of the sections, the Millaró section by the village of Millaró in the fold and Nappe province of the Cantabrian zone, is excellent rivaling the better known Kardailovka and Nashui exposures. Conodonts within the *L. nodosa* - *L. ziegleri* lineage are well preserved and abundant; in addition, the first occurrence of *L. ziegleri* has been located with moderate precision. A major biostratigraphic advantage of the section is the common occurrence of abundant, well-preserved ammonoids being studied by team-member Svetlana Nikolaeva. Deposits within the *L. nodosa* - *L. ziegleri* transition are dominated by nodular, deep-water, basin carbonates of the Alba Formation. The conodont biostratigraphy has been moderately well established (Sanz-López *et al.*, 2007) but the FAD of *L. ziegleri* may need to be more precisely located and sedimentological, geophysical and geochemical analyses are required. A problem with the section is that the interval containing the *L. nodosa* - *L. ziegleri* transition may be too condensed for a good GSSP candidate. During 2011, the team plans to systematically sample the section for ammonoids and commence sedimentological, geophysical and geochemical analyses.

Activities in Rocky Mountains, Canada

The task group chairman along with corresponding members Sergio Rodriguez and Wayne Bamber will continue to study carbonate-dominant sections across the Viséan-Serpukhovian boundary interval in the upper Viséan to Serpukhovian Etherington Formation in the southern Canadian Rocky Mountains. They are preparing a monograph on the taxonomically diverse rugose coral faunas that span the Viséan-Serpukhovian boundary within the Etherington. Although none of the Etherington sections are likely to be candidates for the GSSP, the investigation will provide valuable biostratigraphic and sedimentologic data that will assist correlations between Western North America and the low-latitude tropical-marine successions of Europe and Asia.

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Bashkirian-Moscovian boundary The task group is conducting research at locations in Europe and Asia and it is anticipated that during this fiscal year a lineage and taxon suitable for boundary definition will be selected. Investigations focus on evolutionary transitions in several conodont lineages, with fusulinid biostratigraphy providing auxiliary information. Until the fall of 2010, it was thought that the conodont evolutionary events that had the best potential for defining the base of the Moscovian include: 1) derivation of *Idiognathoides postsulcatus* from *Id. sulcatus*, 2) derivation of *Declinognathodus donetzianus* from *D. marginodosus*, and 3) the appearance of *Diplognathodus ellesmerensis*. Recent conodont studies by Qi Yuping and Lance Lambert, however, suggest there are better alternatives and that rapid morphologic evolution in P₁ elements of *Streptognathodus expansus* and *S. suberectus* permit the identification of a new biostratigraphic level that is slightly below the traditional base of the Moscovian. The fusulinids *Eofusulina* ex gr. *triangula* and *Profusulinella* [= *Depratina*] *prisca* recently emerged as additional taxa with considerable potential for boundary characterization.

One proposal for boundary definition is being crafted by Qi Yuping and Lance Lambert in which they will propose to use the appearances of advanced morphotypes of *Streptognathodus expansus* and *S. suberectus* to mark the Bashkirian-Moscovian Stage boundary. Qi and Lambert must finalize some basic taxonomic work on these two species before they can distribute a formal proposal. Their proposal would slightly lower the base of the Moscovian to a level that historically has been regarded as upper Bashkirian. Their work will focus on existing collections from the Nashui section (Qi *et al.*, 2007, 2009) in Guizhou Province in southern China. For a more complete discussion about the use of *S. expansus* and *S. suberectus* for boundary definition, see the task group report for 2010 in Appendix B.

John Groves, Katsumi Ueno and other fusulinid specialists within the task group are developing the second proposal for Bashkirian-Moscovian boundary definition. Their proposal will advocate using the FAD of the fusulinid *Eofusulina triangula* to mark the base of the Moscovian. The FAD of *Profusulinella prisca* will probably be used as an auxiliary marker. Both species of fusulinid are widespread geographically, both have been used historically as basal Moscovian indices, and both are well understood in terms of their evolutionary origins. This is the first time the task group has considered using fusulinids to mark the lower Moscovian boundary; all previous proposals have involved conodonts. As an outgrowth of using the fusulinids for boundary definition, Demir Altiner will analyze fusulinids from two localities in the Tauride Belt of southern Turkey where *E. triangula* and *P. prisca* are known to appear at the base of the Moscovian. Altiner is attempting to demonstrate that the appearances of the potential markers occur in evolutionary continuity with their ancestors.

Activities in South China

The carbonate-dominant Nashui section in Guizhou Province is one of the best candidates for the GSSP at the base of the Moscovian because the conodonts the task group is considering for boundary definition are abundant, well preserved, and their first occurrences quite precisely located. John Groves plans to complete his study of the foraminifers in the section in time to present his results at the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting. Work on the sedimentology, stable-isotope geochemistry, and geophysical characteristics of the boundary interval are not as advanced as the paleontological investigations and will be the focus of the team's work in 2011. During 2011, the task group plans to complete measuring the Moscovian component of the section into the lower Kasimovian and finish a bed-by-bed analysis of the strata over a 10-metre-thick interval on either side of the boundary. That work will include taking a continuous sample through about two metres of strata on each side of boundary to determine the location of all principal sedimentary events and the characteristics and origins of the beds.

In order to place the important Nashui section into its sedimentological and paleoenvironmental context and to determine the relationship of shallow-water coral and foraminiferal zones to the deeper-water conodont markers within the Bashkirian-Moscovian transition in south China, the investigation of two reference sections - the Zongdi, and the Luokun sections - will continue during the new fiscal year. If the fusulinid proposal gains widespread support, that likely will trigger more work in both sections, because they are known for their fusulinid successions and both would be logical sections in which to search for an eventual GSSP. In February 2011, Katsumi Ueno and Wang Yue will re-visit the well-known Zhongdi section in southern Guizhou (Ueno *et al.*, 2007) for additional sampling of a critical biostratigraphic interval. At Zhongdi *Eofusulina* and its ancestor *Verella* occur in stratigraphic succession, but with a gap between their ranges. Katsumi and Yue will focus on this gap in hopes of finding evolutionarily transitional forms.

During 2010, the task group commenced measuring and sampling of the Luokun section, situated by the village of Luokun several kilometres from Naqing and the Nashui section. Like the Nashui section, the exposure at Luokun is essentially 100% complete and dominated by lower- to middle-slope carbonates of turbiditic and hemipelagic aspect. At Luokun, the lithofacies are of more proximal aspect than those at Nashui and include submarine-debris-flow deposits. Study of the section will provide another opportunity to see conodonts and foraminifers spanning the Bashkirian-Moscovian transition in the region. Foraminifers are more abundant and better preserved than at Nashui, and it is anticipated that a better correlation between conodonts and foraminifers can be

achieved by the study of the Luokun section. Study of all aspects of the section is at a preliminary level but sufficient biostratigraphic work has been completed to locate the approximate position of the Bashkirian-Moscovian Stage boundary. During 2011, the task group plans to complete the measurement and sampling of the section (for lithology, microfossils, stable-isotope geochemistry and geophysics) at a bed-by-bed level and place aluminum marker pins at one metre intervals.

The task group will participate along with other SCCS Task Groups in a workshop in Nanjing and field excursion in southern Guizhou Province, China in November 2010, organized and hosted by Wang Xiangdong and colleagues with the Nanjing Institute of Geology and Palaeontology.

Activities in Northwest Spain.

Javier Sanz-López, Silvia Blanco-Ferrera and Elisa Villa will continue with their ongoing integrated foraminiferal and conodont biostratigraphic analyses at the San Antolín-La Huelga section along the Bay of Biscay (Bahamonde *et al.*, 2008; Villa 1995; Villa *et al.* 1997; Blanco-Ferrera, S. *et al.*, 2009) and at other key sections in the Cantabrian Mountains. If the fusulinid proposal that is being developed by Groves and Ueno gains widespread support, that likely will trigger more work in the Cantabrian sections, because they are known for their fusulinid successions and both would be logical places (along with Turkey and southern Guizhou Province in China) in which to search for an eventual GSSP.

Activities in South Urals, Russia - It is anticipated that Elena Kulagina and her team will continue their ongoing work on the well-exposed Basu River section, visited during the August 2009 SCCS field meeting (Kulagina *et al.*, 2009), and other well-exposed sections spanning the Bashkirian-Moscovian boundary in the southern Ural Mountains. In the recent past, the Basu River section was considered to be one of the best GSSP candidate sections in the southern Urals. It contains the first appearance of *Profusulinella* [= *Depratina*] *prisca* a few metres below that of *Declinognathodus donetzianus*. At the Basu River the discovery of the *Declinognathodus* lineage along with a fusulinid fauna including the *prisca* group had made it a good potential GSSP candidate section. Kulagina *et al.* (2009) provisionally place the boundary, and that of the Solontsian Horizon (local unit in lowermost Moscovian), 0.9 m above the base of the section coincident with the appearance of *P. prisca*. If the boundary is placed at this level, more strata at the base of the section will need to be excavated.

If the fusulinid proposal of Groves and Ueno using the FAD of *E. triangula* for boundary definition gains widespread support, that likely will trigger more work in the Ural Mountain sections, because many of them are known for their fusulinid successions and would be logical places to search for an eventual GSSP. Unfortunately, the fusulinid *E. triangula* has not been located in the Basu River section.

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Moscovian- Kasimovian boundary During the 2011 fiscal year, the ongoing biostratigraphic analyses reported on in section #5 above will continue in southern China, the Cantabrian Mountains of NW Spain, Moscow Basin and southern Urals in Russia, and Donets Basin in the Ukraine. In these regions, the task group plans to continue its integrated assessment of fusulinids and two species of conodonts as potential biostratigraphic markers by which the base of the Kasimovian Stage can be selected and correlated globally: 1) *Idiognathodus sagittalis* Kozitskaya 1978, based on material from the Donets Basin (Ukraine) and also identified from the Moscow region and southern Urals of Russia, and the Cantabrian Mountains in Spain; and 2) *Idiognathodus turbatus* Rosscoe and Barrick 2008, based on material from the Midcontinent region of the U.S.A., and recognized also in the Moscow region, the southern Urals, and the Donets Basin. The use of either conodont would raise the base of the Kasimovian up one substage from the traditional position at the base of the Krevyakinian Substage, to approximately the base of the Khamovnikian Substage but will facilitate global correlation.

Activities in southern China

Chinese colleagues along with Steven J. Rosscoe and James E. Barrick will continue with intensive studies to provide more detailed information on the conodont succession across the Moscovian-Kasimovian boundary in the Nashui section (Qi *et al.*, 2007, 2009) in southern Guizhou Province, China as a potential GSSP locality. Barrick and Qi Yuping have been collaborating in examining existing and new collections of conodonts from the Nashui section and plan to publish preliminary results in the field guide for the November 21st to 30th 2010 SCCS workshop and field meeting in Nanjing and Guizhou Province. Study of the specimens will facilitate recognition of the Moscovian-Kasimovian Stage boundary in the Nashui section.

Work on the sedimentology, stable-isotope geochemistry, and geophysical characteristics of the Moscovian-Kasimovian boundary interval at Nashui are not as advanced as the paleontological investigations and will be a focus of the team's field work in 2011. During 2011, the task group plans to complete the measurement and sampling of the upper Moscovian to lower Kasimovian component of the Nashui section (for lithology, stable-isotope geochemistry, and geophysics) and place aluminum marker pins at one metre intervals from the Moscovian into the Lower Permian. In conjunction with the latter work, the task group plans to complete a bed-by-bed study through 10 metres of strata on either side of the proposed Moscovian-Kasimovian boundary level. That work will include taking a continuous sample through about two metres of strata on each side of boundary to determine the location of all principal sedimentary events and the characteristics and origins of the beds.

In order to place the important Nashui section into its sedimentological and paleoenvironmental context and determine the relationship of shallow-water coral, conodont and foraminiferal zones to the deeper-water conodont markers within the Moscovian-Kasimovian transition in south China, the investigation of two reference sections - the Zhongdi (Ueno *et al.*, 2007), and the Luokun sections - will continue during the fiscal year. During 2010, the task group commenced measuring and sampling the Luokun section, situated by the village of Luokun several kilometres from Naqing and the Nashui section in Guizhou. Like the Nashui section, the exposure at Luokun is essentially 100% complete and dominated by slope carbonates of turbiditic and hemipelagic aspect but the lithofacies are of more proximal aspect than those at Nashui and include submarine-debris-flow deposits. Study of the section will provide another opportunity to see conodonts and foraminifers spanning the Moscovian-Kasimovian transition in the region. Foraminifers are more abundant and better preserved than at Nashui and it is anticipated that a better correlation between conodonts and foraminifers can be achieved by the study of the Luokun section. Study of all aspects of the section is at a preliminary level but sufficient biostratigraphic work has been completed to locate the approximate position of the Moscovian-Kasimovian Stage boundary. Task group is preparing a field guide for the November 25th to 30th 2010 field excursion for the SCCS field meeting organized by the Nanjing Institute of Geology and Palaeontology. During 2011, the task group plans to complete the measurement and sampling of the section (for lithology and microfossils) at a bed-by-bed level and place aluminum marker pins at one metre intervals.

Activities in Cantabrian Mountains, NW Spain

Spanish task-group members will continue their study of the Moscovian-Kasimovian transition in the Castillo del Grajal and Morra del Lechugales sections, in the uppermost part of the carbonate-dominant Picos de Europa Formation and Las Llacerias Formation (Villa *et al.*, 2009). Fusulinid biostratigraphic data indicate the study

interval ranges from the top of the *Fusulinella* Zone (upper Moscovian) to the lower *Montiparus* Zone (Khamovnikian Substage). The *Protriticites* Zone, spanning at least 245 m, is well exposed and fusulinid rich. Preliminary sampling indicates the occurrence of the conodont *Idiognathodus sagittalis* and its potential ancestor *Idiognathodus* n. sp. 1 of Goreva *et al.* (2009), allowing correlation with the Moscow Basin and the North American Midcontinent.

Activities in Moscow Basin, Russia

The task group will continue to study specimens collected during 1993 from the Stsherbatovka quarry section on the Oka-Tsna Swell of the Ryazan Region, east of the town of Kasimov in the Moscow Basin but they also plan to visit the quarry in the fall of 2011 to examine its current condition and determine if additional strata in the lower part of the section can be exposed. In the section, the middle part of the Neverovo Formation (Khamovnikian Substage) contains abundant macrofauna. Conodonts occur as well but are not common and most elements are juveniles of the *Idiognathodus sagittalis*-*I. turbatus* group. *Idiognathodus sulciferus* was also identified. Earlier, fusulines were used to correlate this interval with the Krevyakinian *Obsoletes obsoletus* Zone, but the conodonts suggest a younger age. The Stsherbatovka section, situated about 250 km southeast of the better-known Afanasievo section in the Moscow Basin, demonstrates a wider distribution of the marker conodont species for identifying the base of the Kasimovian. The section is better than the Afanasievo section because it was deposited in somewhat deeper water and elements of the *I. sagittalis*-*I. turbatus* group are more abundant. Tatiyana Isakova will work on the *Fusiella* fusulinid lineage as potential marker for slightly lower position of the Moscovian-Kasimovian boundary than the one defined by the *I. sagittalis*-*I. turbatus* group. The Afanasievo section is a potential candidate for the GSSP defining the base of the Kasimovian Stage but no additional information is needed from it at the present time.

Activities in Southern Urals, Russia

The Dalniy Tyulkas section, several kilometres south of the Usolka section in the Urals, is a composite comprising three segments (Dalniy Tyulkas 1, 2, and 3) and ranges from upper Moscovian to the Artinskian Stage. It is a deeper-water succession containing abundant conodonts. Segment 1 spans the upper Moscovian to basal Kasimovian and Alekseev, Goreva, and others recognized the *Streptognathodus subexcelsus* and *Swadelina makhlinae* assemblages in the section's upper part. These assemblages are characteristic of the Suvorovo and Voskresensk formations, respectively, of the regional Krevyakinian Substage (traditional lower substage of Kasimovian) in the Moscow Basin. Dalniy Tyulkas 1 is the first section outside the Moscow Basin where these two lower Kasimovian conodont zones have been recognized. Dalniy Tyulkas 2 comprises upper Moscovian to lower Gzhelian strata. Alekseev, Goreva, and others are reinvestigating the conodonts in segment 2 and in the middle part of the segment they found *Idiognathodus sagittalis*, one of the species chosen as a potential biostratigraphic marker for defining the base of the Kasimovian. Segment 2 is a promising candidate for the Moscovian-Kasimovian boundary stratotype.

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Kasimovian-Gzhelian boundary Since 2007, when the Task Group voted overwhelmingly in favor of using the first appearance of the conodont *Idiognathodus simulator* [*sensu stricto*] as the boundary-defining event, the search

for a suitable section for the GSSP became the main focus of the task group. The event level is consistent with both the working ammonoid definition of the boundary and with the first appearance of a cotype of the fusulinid *Rauserites rossicus* in the Moscow region. The recent selection of the lectotype of the fusulinid *R. rossicus* at the first appearance of *I. simulator* in Russia will expedite the recognition of this boundary in Eurasia.

For establishment of the GSSP, Russian colleagues are undertaking a detailed re-description and recollection of the Usolka section in the southern Urals and have published a comprehensive synthesis of their preliminary results (Davydov *et al.*, 2008). On August 14 2009, task-group members along with other representatives of the SCCS visited the Usolka section during the SCCS Field Meeting, which was held in the Moscow Basin region and southern Urals. The field-trip participants observed that only fragments of the section were exposed and they were in small, partly filled to overgrown trenches. In response to that observation, the task group plans to extensively excavate the site during its re-assessment.

Last September, Russian colleagues briefly visited the Kholodny Log section on the western slope of the Middle Urals. The upper part of the section is a famous shallow-water Asselian (Lower Permian) succession containing abundant fusulinids but the lower part of the section spans the Kasimovian/Gzhelian boundary interval, which contains abundant fusulinids and the conodont *Streptognathodus pawhuskaensis*. The task group plans to visit the locality in 2011 to collect more samples for conodont extraction.

Chinese colleagues and collaborator James E. Barrick are undertaking a detailed sampling across the boundary in the well-exposed, carbonate-slope succession that constitutes the upper part of the Carboniferous component of the Nashui section in Guizhou Province, south China for conodonts and fusulinids. A sedimentological and geochemical analysis of that section at the appropriate level is also in progress. During 2011, the task group plans to complete the measurement and sampling of the upper Kasimovian to Lower Permian component of the Nashui section (for lithology, stable-isotope geochemistry, and geophysics) and place aluminum marker pins at one metre intervals from the Moscovian into the Lower Permian. In conjunction with the latter work, the task group plans to complete a bed-by-bed study through 10 metres of strata on either side of the proposed Kasimovian-Gzhelian boundary level. That work will include taking a continuous sample through about two metres of strata on each side of boundary to determine the location of all principal sedimentary events and the characteristics and origins of the beds.

Much of the work that is ongoing in all task and project groups will be published in Volume 29 of the Newsletter on Carboniferous Stratigraphy in November 2011.

9. BUDGET AND ICS COMPONENT FOR 2010 - 2011 fiscal year

PROJECTED EXPENSES

| | | |
|---|--------|-----------|
| Mailing and sample shipping | | \$200 |
| Bank charges at Bank of Montreal | \$25 | |
| Travel support for SCCS chairman to attend SCCS workshop and field meeting at Nanjing of Geology and Paleontology November 21 to December 7, 2011 | \$500 | Institute |
| Travel support for SCCS chairman and secretary to XVII International Congress on the Carboniferous and Permian in Perth, Australia; July 2011 (will hold business meeting and have special session for SCCS) | | \$1000 |
| Travel support for task-group leaders and selected voting members to XVII International Congress on the Carboniferous and Permian in Perth, Australia; July 2011 (for presentations at business meeting and SCCS special session) | \$1000 | |
| Travel support for SCCS chairman to attend SCCS field meetings in south China (September 2011) and southern Urals, Russia in August 2011 | | \$500 |

| | | |
|--|--|-------------------|
| TOTAL PROJECTED EXPENSES | | \$3,225 |
| INCOME | | |
| Carryover (from credit balance in section # 7 above) | | \$1,215.00 |
| Estimated donations | | \$200.00 |
| TOTAL PROJECTED INCOME | | \$1,415.00 |
| BALANCE | | |
| Estimated (deficit) / credit from above | | -\$1810.00 |
| BUDGET REQUEST FROM ICS for 2009 | | \$1800.00 |

No direct funding sources for SCCS exist beyond the ICS allotment and voluntary donations from SCCS members, which fluctuate from year to year and cannot accurately be predicted.

10. SUMMARY OF CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2006-2010)

This summary is updated from the information provided in last year's annual report by incorporating information from the task-group reports published in the November 2010 issue of the Newsletter on Carboniferous Stratigraphy. For the full reports including references see Appendix B.

General An initial 1997 ballot on the naming of the two subdivisions of the Carboniferous System resulted in a close vote that rejected the names Lower and Upper, and approved the names Mississippian and Pennsylvanian, but just short of the required 60% majority to be declared final. After a long period of wrangling over procedure as well as nomenclatural issues, the final ballot was ultimately taken at the mandate of former ICS Chair Jurgen Remane in late 1999. As reported in the 2000 Newsletter on Carboniferous Stratigraphy [v. 18, p. 3], a vote by SCCS members resulted in approval of the names Mississippian and Pennsylvanian by a 76% majority, along with a reconfirmation of the previous decisions of the SCCS to regard their rank as subsystems, by the same 76% majority. In 2003 the SCCS voted to classify the two subsystems into Lower, Middle, and Upper Mississippian Series and Lower, Middle, and Upper Pennsylvanian Series, by a 74% majority of those 90% of the total membership who voted. This vote with its implicit acceptance of the stage names used in Russia as the global stage names for the Carboniferous now provides the Carboniferous with all its official global series and stage names, and all effort is now focused on selecting events and GSSPs for stage boundaries. Information on usage of the new official scheme of Carboniferous subdivision was recently published by Heckel and Clayton (2006a, 2006b).

Heckel, P.H., and Clayton, G., 2006a. Use of the new official names for the subsystems, series and stages of the Carboniferous System in international journals: Proceedings of the Geologists' Association, v. 117, p. 1-4.

Heckel, P.H., and Clayton, G., 2006b. The Carboniferous System. Use of the new official names for the subsystems, series, and stages: *Geologica Acta*, v. 4, p. 403-407.

Task Group to redefine the Devonian-Carboniferous Boundary Doctoral work by Sandra Kaiser (2005) and subsequent analysis demonstrated severe problems exist with the Devonian-Carboniferous Boundary GSSP (Paproth *et al.*, 1991) at La Serre Hill in the Montagne Noir of France (Kaiser and Becker, 2007; Heckel, 2008; Kaiser, 2009). Because of the serious problems with the integrity of the D-C GSSP, Thomas Becker (chairman of Subcommittee on Devonian Stratigraphy) and Philip Heckel (former chairman of SCCS) established the joint Devonian-Carboniferous Boundary GSSP reappraisal task group in early 2008, appointing 10 members from each subcommittee (Heckel, 2008). In June 2010, the new SCCS chairman Barry Richards appointed Markus Aretz to chair the task group.

At the 33rd International Geological Congress (IGC) held in Oslo during August 2008, Philip Heckel, Barry Richards and members of the D-C task group met with SDS chairman Thomas Becker and members of the Devonian Subcommittee to discuss the reappraisal of the D-C boundary GSSP. Those attending the IGC workshop agreed the issues summarized by Heckel (2008) required resolution. Following the Oslo workshop, Richards included plans for future work by the task group in the 2008 SCCS Annual Report submitted to the ICS. The work plan had three recommendations: 1) the use of the first evolutionary occurrence of the conodont *Siphonodella sulcata* in the lineage *S. praesulcata* to *S. sulcata* for boundary definition requires re-evaluation; 2) if the FAD of *S. sulcata* is retained for boundary definition, either the position of the GSSP at La Serre must be lowered from the base of bed 89 or a more suitable section must be located, and 3) because the first appearance of *S. sulcata* may not be the best marker, other conodont lineages require evaluation.

Since Richards submitted the work plan in the 2008 annual report, the *S. praesulcata* to *S. sulcata* conodont lineage used to define the boundary has been carefully re-evaluated by Kaiser and Corradini, and the protognathodids, the other conodont group that had shown potential for boundary definition has been studied by Corradini and some other conodont experts (see D-C task group report in Appendix B). So far the outcome of the conodont studies has been quite disappointing because it appears that neither the siphonodellid lineage nor the protognathodids are suitable for D-C boundary definition and other appropriate taxa have not been discovered. However, there is considerable disagreement among the conodont specialists about the utility of the siphonodellid lineage and the conclusions of Kaiser and Corradini need to be tested by other specialists before the FAD of *S. sulcata* is totally abandoned for boundary definition.

From the work completed by members of the D-C boundary task group during 2009 and 2010, it is clear that the La Serre section will not be suitable for boundary definition (see D-C task group report in Appendix B). The main problem is the base of the bed 84b, which contains the FAD of *S. sulcata* is a sharp facies change Kaiser (2009) and probably erosional; in addition, the underlying strata lack the evolutionary lineage from *S. praesulcata* to *S. sulcata*. Although an event to define the boundary has not been chosen, the search for better GSSP sections is already in progress. New D-C boundary sections are being studied in regions such as Morocco (T. Becker, written

com., 2010) and previously studied sections such as the Hasselbachtal and those in southern China (Yu, 1988) are being carefully re-evaluated. [see Appendix B for references]

Work by the **Tournaisian-Viséan boundary** Task Group into 2003 progressed to the point that a proposal for the GSSP in south China was published by Devuyst *et al.* (2003). Supplementary information requested by the SCCS chair Philip Heckel on correlating this boundary into regions where the defining taxa do not occur was published in the 2004 Carboniferous Newsletter [v. 22, p. 8-11], and further updated and summarized in the full text of this task-group report in Appendix B in the 2004 Annual Report. The task group voted unanimously to approve the Pengchong GSSP in southern China in 2004, further refined correlation with the type Mississippian in 2005, readjusted the boundary slightly in the GSSP section in 2007, and presented the formal proposal to the SCCS for ballot in late November 2007. The proposal has now been unanimously approved by the SCCS and ratified by the ICS and IUGS. The Secretary's report for 2008 (Newsletter on Carboniferous Stratigraphy, v. 26 p. 4) provides the details about the proposal and SCCS ballot. The principal work of this task group has come to completion. Task group members are preparing the final report. [see Appendix B for references]

The **Viséan-Serpukhovian Boundary** task group, established by B. Richards in 2002, initially considered several conodont and foraminiferal lineages for potential boundary-defining events, but in 2004, it began to focus attention on the FAD of *Lochriea zieglerei* in the conodont lineage, *Lochriea nodosa-Lochriea zieglerei*, for boundary definition. By the end of the 2010 fiscal year, the *L. nodosa-L. zieglerei* lineage had become widely recognized in Western Europe, Russia and Asia (Skompski *et al.*, 1995; Nikolaeva *et al.*, 2009; Qi and Wang, 2005) and although the lineage is not yet known from North America, specimens of *L. zieglerei* and other species in the genus have been discovered. By late 2010, the task group decided the FAD of *L. zieglerei* was suitable for boundary definition and a proposal is being written in preparation for a vote by the task group and the SCCS.

In 2005 identification of the *Lochriea* lineage along with recognition of the conodont, ammonoid, ostracode, and foraminiferal zones in a deep-water (basinal), carbonate section by the village of Verkhnaya Kardailovka on the eastern slope of the Russian Urals established that section as a strong candidate for a GSSP (Nikolaeva *et al.*, 2005). Since then, Nikolaeva and her colleagues have thoroughly examined the section and published a synthesis of their studies on the ammonoids, conodonts, and ostracodes (Nikolaeva *et al.*, 2009). The synthesis indicates conodonts that are transitional between *L. nodosa* and *L. zieglerei* occur in the Kardailovka section immediately below the FAD of *L. zieglerei*. Prior to 2010, extensive parts of the section were poorly exposed but during August 2010 the covered components of the section were excavated and permanent aluminum marker pins placed at one metre intervals in preparation for a bed-by-bed sedimentological analysis and systematic sampling for stable-isotope geochemistry and magnetic susceptibility studies in August of 2011.

In 2005, the *Lochriea* lineage was reported from carbonate-slope facies in the Nashui section in southern Guizhou Province, China (Qi and Wang, 2005). Since 2007, the conodonts spanning the Viséan-Serpukhovian boundary in the Nashui section have undergone intensive study by Chinese colleagues and the section has become a strong potential candidate for a GSSP at the base of the Serpukhovian. Qi Yuping has essentially finished his detailed analysis of the conodonts across the Viséan-Serpukhovian boundary at Nashui and incorporated the results in his doctoral thesis (Qi, 2008). In the Nashui section, conodonts within the *L. nodosa - L. zieglerei* lineage are well preserved and abundant. Elements transitional between *L. nodosa* and *L. zieglerei* are plentiful at Nashui, occurring through several metres of section, and the oldest representatives of *L. zieglerei* could be readily distinguished from the associated transitional forms of *L. nodosa*. A detailed stratigraphic section extending from the upper Viséan into the Bashkirian has been measured at Nashui and aluminum marker pins placed at one-metre intervals through the section but a bed-by-bed sedimentologic and geochemical study needs to be completed across the Viséan-Serpukhovian and Serpukhovian-Bashkirian boundaries. John Groves has largely completed his study of the foraminifers in the section and plans to have this work completed in time for the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting. The measurement and intensive study of several other sections (Yashui, Loukun and Dianzishang sections) in the region is enabling the task group to place the Nashui section into its paleogeographic, stratigraphic, and lithofacies contexts.

In June 2010, Spanish colleagues introduced task group members to several sections spanning the Viséan-Serpukhovian boundary in the Cantabrian Mountains of Spain. Two of the sections, the Vegas de Sotres and Millaró (Sanz-López *et al.*, 2004; 2007) sections in the Alba Formation, are excellent deep-water carbonate sections rivaling the better known Kardailovka and Nashui exposures. In the Vegas de Sotres section and Millaró section, conodonts within the *L. nodosa - L. zieglerei* lineage are well preserved and abundant; in addition, the first occurrence of *L. zieglerei* has been located with moderate precision. A major biostratigraphic advantage of the two sections is the common occurrence of abundant, well-preserved ammonoids (Blanco-Ferrera *et al.*, 2009). The conodont biostratigraphy has been relatively well established in the two sections (Sanz-López *et al.*, 2007; Blanco-Ferrera *et*

al., 2009) but the biostratigraphic and sedimentologic work at the two localities is less advanced than at the Nashui and Verkhnyaya Kardailovka sections.

In 2006 work was initiated on ammonoid-rich successions in the western U.S.A., southern Urals of Kazakhstan, and on foraminifer- and coral-rich successions in Western Europe and western Canada in order to bracket the level of the first appearance of *L. zieglerei* in North America. By the end of the 2010 fiscal year, the lineage still has not been identified in North America but *L. zieglerei* has been found in the Barnett Shale in Texas and other species of *Lochriea* have been identified at several localities (Brenckle *et al.*, 2005; Qi Yuping, pers. com., 2010).

Although the lineage along with associated faunas and strata are being studied in several areas, the task group has concluded the Nashui section in China and the Verkhnyaya Kardailovka section in Russia have the best potential as GSSP candidates. [see Appendix B for references]

The task group on the **Bashkirian-Moscovian Boundary**, established by John Groves in 2002, initially considered several conodont and foraminiferal lineages for GSSP definition; but after the chairman asked for boundary-defining events in 2004, proposals for only three conodont lineages were received. A more recent consensus suggested that only two conodont lineages are viable, and work became concentrated on them. After further investigation of the *Idiognathoides sulcatus*-*Id. postsulcatus* lineage [the most favored of the two remaining proposals for boundary-defining events] resulted in discovery that the event taxon was misidentified in cratonic North America, and also may occur in strata well below the boundary in Japan, some attention turned to reassessing the identity of the older specimens in Japan. Most attention turned to evaluating the less widespread *Declinognathodus marginodosus*—*D. donetzi* lineage for defining the event level, and the task group focused on correlating the Bashkirian-Moscovian boundary into the areas it is absent, using other groups and other conodont taxa. Members then reported the appearance of the distinctive *Profusulinella prisca* fusulinid group near this boundary level in Spain, Turkey, southern Urals, and possibly North and South America.

In 2006, Russian workers discovered an evolutionary lineage of *Declinognathodus marginodosus*—*D. donetzi* in the Basu River section in the southern Urals, which also contains rich foraminiferal faunas, and might be a candidate for a GSSP. The well exposed Basu section (Kulagina *et al.*, 2009), visited during the August 2009 SCCS field meeting, contains the first appearance of the fusulinid *Profusulinella prisca* a few metres below that of *D. donetzi*. The discovery of the *Declinognathodus* lineage at the Basu River section along with a rich fusulinid fauna including the *P. prisca* group make it a good potential candidate section for a GSSP (Kulagina *et al.*, 2009).

In northwest Spain, Javier Sanz-López, Silvia Blanco-Ferrera and Elisa Villa are conducting integrated foraminifera and conodont biostratigraphic analyses at the San Antolin-La Huelga section along the Bay of Biscay in the Cuera area (Bahamonde *et al.*, 2008; Villa 1995; Villa *et al.* 1997). The Bashkirian-Moscovian boundary is provisionally placed about 180 m above the base of the section. The boundary is marked by the lowest occurrence of *Idiognathoides postsulcatus*, and this level is slightly higher than the lowest occurrences of *Declinognathodus marginodosus* and *Profusulinella ex gr. prisca*. The San Antolin-La Huelga section contains four conodont taxa identified as potential Bashkirian-Moscovian boundary markers: *Id. postsulcatus*, *Diplognathodus ellesmerensis*, *Neognathodus nataliae* and *Declinognathodus donetzi*.

Chinese workers (Qi *et al.* 2007) reported the appearance, with *D. donetzi*, of another conodont, *Diplognathodus ellesmerensis*, which has a broader more global distribution and would help identify the level of *D. donetzi* in places where it is absent. At the Nashui section in Guizhou Province, *D. ellesmerensis* appears in evolutionary continuity from *D. coloradoensis* at the base of the Moscovian (Qi *et al.*, 2007). Several task-group members have proposed that the first appearance of *D. ellesmerensis* also be considered as the marker event for this boundary because it has a broader distribution than the other two conodont lineages being considered.

Since 2007 Chinese colleagues have selected the interval spanning the Bashkirian-Moscovian boundary at Nashui for intensive biostratigraphic and sedimentologic study as another potential candidate section for a GSSP. In May 2008, John Groves and several other SCCS members visited the Nashui section to start on a detailed biostratigraphic/sedimentologic analysis across the boundary in that carbonate-dominant section. Since that trip, Qi Yuping finished his detailed analysis of the conodonts across the Bashkirian-Moscovian boundary at Nashui and incorporated the results in his doctoral thesis (Qi, 2008). A detailed stratigraphic section extending from the upper Serpukhovian into the Moscovian has been measured at Nashui and aluminum marker pins placed at one-metre intervals through the section. John Groves has largely completed his study of the foraminifers in the section and plans to have this work completed in time for the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting. The provisional Bashkirian-Moscovian boundary recognized by Qi *et al.* (2007) on the lowest occurrence of *Diplognathodus ellesmerensis* falls 173 m above the base of the Nashui section. That level contains a foraminiferal association dominated by *Profusulinella* spp. and *Pseudostaffella* spp.

During the early fall of 2010, Qi Yuping and Lance Lambert were examining conodonts from the Nashui section that span the Bashkirian-Moscovian boundary interval and discovered that rapid morphologic evolution in P_1

elements of *Streptognathodus expansus* and *S. suberectus* permit the identification of a new and possibly better biostratigraphic level at which the base of the Moscovian Stage might be placed and plan to present this information at the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting in southern China. [see Appendix B for references]

The **Task Group to establish the Moscovian-Kasimovian and Kasimovian-Gzhelian boundaries**, chaired by Elisa Villa until the International Geological Congress in August 2008 and currently chaired by Katsumi Ueno, has continued studies on fossil lineages and potential levels of correlation within the upper Moscovian to lower Gzhelian. Much new work has been stimulated on both fusulinids and conodonts as a result of the collaboration engendered within the task group at its nearly annual meetings, which started in Ukraine in 1996. Correlation charts based on the scale of glacial-eustatic cyclothem as well as biostratigraphic events for the successions across both boundaries in the U.S.A. and Eastern Europe provide a framework for evaluating lineages being considered for boundary markers (Heckel *et al.*, 2007). All this work has engendered new progress in Russia, southwestern U.S.A., and south-central China.

Fusulinid workers have recognized that problems of provincialism across the **Moscovian-Kasimovian boundary** interval preclude the use of that group to define the boundary. Nevertheless, two fusulinid events appear to coincide with events in conodont appearances near the M-K boundary. The higher one, involving *Montiparus*, is readily identified, but the lower one, among protritricitids, is more dependent on preservation.

Despite the recognition of more provincialism than was once thought to exist between Eurasian and North American conodont lineages during the late Moscovian and Kasimovian, more widespread conodont appearances are being recognized, and one soon may be able to be chosen to define the Moscovian-Kasimovian boundary. Until recently, the conodont specialists were clearing up the serious taxonomic problems that stymied progress within that group. Taxonomic and zonal updating of the conodont faunas in eastern Europe (Goreva and Alekseev, 2006; Alekseev and Goreva, 2007; Goreva *et al.*, 2007), and in the Midcontinent region of the U.S.A. (Rosscoe and Barrick, 2008) formed the basis for welcome progress at the June 2008 task-group workshop and general meeting at the University of Oviedo, Spain. The task-group members who attended the 2008 Oviedo meeting, unanimously agreed (Villa and Task Group, 2008) to focus future work on two conodont species as the potential biostratigraphic marker for the base of the Kasimovian Stage: 1) *Idiognathodus sagittalis* Kozitskaya 1978, based on material from the Donets Basin (Ukraine) and also identified from the Moscow region and southern Urals of Russia, and the Cantabrian Mountains (Spain), and 2) *Idiognathodus turbatus* Rosscoe and Barrick 2008 (*I. n. sp. A* of Barrick *et al.*, 2004), based on material from the Midcontinent region of the U.S.A., and recognized also in the Moscow region, the southern Urals and the Donets Basin. A potential ancestor-descendent lineage from *I. aff. sagittalis* n. sp. to *I. sagittalis* may be present in the Moscow region and a lineage from *Idiognathodus swadei* Rosscoe and Barrick 2008 to *I. turbatus* has been described from the Midcontinent region of the U.S.A. The use of either conodont would raise the boundary level one substage from the traditional position at the base of the Krevyakinian Substage, to approximately the base of the Khamovnikian but the move will facilitate global correlation. Using the new research direction, the group has made substantial recent progress in northwest Spain, the Moscow Basin (Russia), Donets Basin (Ukraine), Midcontinent Basin in the U.S.A. and at the Nashui section in southern China (see section #5 of the Annual Report for the November 1st 2009 to October 31st 2010 fiscal year).

Members of the task group have long favored use of the conodont lineage *Idiognathodus* aff. *Simulator-I. simulator* [*sensu stricto*] to define the **Kasimovian-Gzhelian boundary** at the first appearance of *I. simulator* [*sensu stricto*]. This event marker was unanimously approved by a vote taken by the task group in April 2007, and has been unanimously approved by the SCCS in a vote that passed the 60% required quorum. Preliminary description of a potential GSSP at Usolka in the southern Urals was published by Chernykh *et al.* in the 2006 Newsletter on Carboniferous Stratigraphy [v. 24, p. 23-29] and in a 2006 issue of *Geologija* [v. 49, p. 205-217]. Davydov *et al.* (2008) published a more detailed description of the potential GSSP at Usolka. The appropriate interval in the Nashui section in south China is undergoing a thorough biostratigraphic, sedimentologic and geochemical study as a potential GSSP. In Eurasia, the use of the FAD of *I. simulator* [*sensu stricto*] for boundary definition is reinforced by the appearance of the fusuline *Rauserites rossicus* at a level very close to first appearance of *I. simulator*. [see Appendix B for references]

The SCCS **Project Group on Carboniferous Magnetostratigraphy**, formed in 2004 and chaired by Mark Hounslow to research the potential for identifying correlatable magnetostratigraphic events in the Carboniferous, reported on some aspects of this approach in both the 2004 and 2005 issues of the Carboniferous Newsletter. Progress by the magnetostratigraphy project group has been hampered by a shortage of members and lack of integration with the activities of the other SCCS task groups.

Hounslow (2005) indicated his group was working on the important transition across the Pennsylvanian-Permian boundary in New Mexico, U.S.A. Unfortunately, the magnetostratigraphic work on the Carboniferous-Permian

boundary section at New Well Peak, S.W. New Mexico indicates that section was remagnetised during the Late Cretaceous to early Tertiary (Hounslow, 2009) and does not warrant further study.

During the 2008-2009 fiscal year, the search for Mississippian sedimentary rocks that are likely to carry a primary magnetisation, to construct a magneto-stratigraphic timescale, focused on two sections in southern Scotland but no analytical results are available yet. Both sections have good potential for recovery of primary magnetisation because they are dominated by siliciclastics and their thermal maturity is low (Hounslow, 2009).

During the May 31st to June 3rd 2010 ICS meeting in Prague, the task group leader discussed with Barry Richards and Svetlana Nikolaeva (Russian Federation) the possibility of designing a magnetostratigraphic project that would evaluate Late Mississippian and Pennsylvanian sections in the Moscow Basin, Lard Basin in northwestern Canada and sections in the mid-continent region of the USA. So far, these initial discussions have not developed into tangible outcomes and the main problems stem from a lack of funding and suitable investigators.

John Utting (member Viséan/Serpukhovian boundary task group) and colleagues Peter Giles (Geological Survey of Canada-Atlantic) and Neil Opdyke (University of Florida) have largely completed a very useful magnetostratigraphic study of the Brigantian, Pendleian and much of the Arnsbergian substages (upper Viséan and Serpukhovian) in the Maritimes Basin of eastern Canada (Giles *et al.*, in progress). They have correlated the polarity reversal patterns in the Maritimes Basin with published data from the Brigantian to mid-Arnsbergian interval in the central part of the Appalachian Basin in the eastern United States (Di Venere and Opdyke, 1990, 1991). [see Appendix B for references]

Radiometric dating Precise radiometric U-Pb zircon dating now being undertaken by the Permian Research Group at Boise State University on ash beds from conodont-bearing intervals in the Pennsylvanian-Permian succession in the south Urals has recently provided new dates on the Carboniferous-Permian boundary and the late Moscovian with error bars of ± 0.2 Ma, which Heckel used to more accurately calibrate the late Pennsylvanian time scale by means of cyclothems in the 2006 Newsletter on Carboniferous Stratigraphy [v. 24, p. 35-39] and in a chapter in the article on cyclostratigraphy published by Strasser, Hilgen, and Heckel in a 2007 issue of *Newsletters in Stratigraphy* [v. 42, p. 75-114].

Since ratification of the Tournaisian-Viséan boundary proposal in 2007, task-group chair George Sevastopulo and his students have been attempting to bracket the absolute age of the Tournaisian-Viséan boundary in Europe by using the ID-TIMS U-Pb method of dating zircons from ash bands. They plan to continue with that work.

11. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2011-2014)

The SCCS executive is encouraging its task groups to maintain progress on researching and selecting defining events for as many stage boundaries as possible in the next four years, keeping in mind the emphasis on selecting readily correlatable boundaries as expressed by Remane *et al.* (1996). Within the next year, we think it will be possible to select the boundary defining events for all of the stage boundaries with the exception of the base of the Tournaisian and then progress toward selecting sections for the GSSPs. Most task groups have either selected an event to define their respective boundary and held a successful vote on it (Kasimovian-Gzhelian task group) or have located an event and are preparing proposals in preparation for taking the proposal to ballot (Viséan-Serpukhovian and Bashkirian-Moscovian task groups).

Once the principal mandate of a task group has been fulfilled, the SCCS executive will encourage that group to remain together and embark on basin-analysis and Global projects that are appropriate to their time slices and employ integrated paleoclimatic, geochronologic, biostratigraphic, and geochemical studies. An anticipated outcome of the latter work is the establishment of a more precise correlation between successions dominated by terrestrial and endemic cold-water marine biotas in the Gondwana and Angara regions and those of the pan-tropical standard succession. In addition, we will encourage some task groups to consider division of their respective time slices (all of these are stages). Some stages such as the Viséan are inordinately long and require division to facilitate more precise Global correlation. Should a stage such as the Viséan be divided, the name of that stage would be applied to the corresponding series such as the Middle Mississippian in the case of the Viséan, thereby retaining the classic names in current use.

Devonian-Carboniferous boundary

The main focus of the task group over the next four years will be to locate an event for defining the D-C boundary because the current definition, the FAD of *Siphonodella sulcata*, is apparently deficient. Following the selection of the event, a suitable section for the GSSP will need to be located.

Since Richards submitted the work plan for the next four years in the 2008 annual report for the ICS, Corradini and Kaiser (2009) carefully re-evaluated the *Siphonodella praesulcata* - *Siphonodella sulcata* conodont lineage used to define that boundary and Corradini *et al.* (2010) along with some other conodont experts have studied the protognathodids, the other conodont group that had substantial potential for boundary definition. So far the results of the conodont investigations have been disappointing because it appears that neither the siphonodellid

lineage nor the protognathodids are suitable for D-C boundary definition and other appropriate taxa are unknown to task-group members. There is, however, some hope the siphonodellid lineage can be used because considerable disagreement exists among conodont specialists about its utility and the conclusions of Kaiser and Corradini still require testing before the FAD of *S. sulcata* is totally abandoned for boundary definition.

In the Devonian-Carboniferous Boundary GSSP section at La Serre, Corradini and Kaiser identified seven morphotypes in the transition from *S. praesulcata* to *S. sulcata* (Corradini and Kaiser, 2009; Kaiser, 2009). Unfortunately, the conodonts within the transition at La Serre are reworked and no apparent correlation exists between the stratigraphic level and individual morphotypes. The task group plans to determine if a correlation exists between the morphotypes and stratigraphic level in other D-C boundary sections, where reworking is not an issue. The morphotype analysis is significant because of its bearing on whether or not the lineage actually comprises two species that can be readily differentiated.

Three taxonomic problems identified by the task group at the 2008 IGC meeting in Oslo require resolution: 1) the holotype of *S. sulcata* has been lost; 2) the locations of the paratypes are uncertain; and 3) the holotype of *S. sulcata* was collected from the *Siphonodella duplicata* Zone and may have been *S. duplicata*.

Even if the FAD of *S. sulcata* is retained for boundary definition, a suitable section for the GSSP must be located because recent studies at La Serre (current location of GSSP) indicate the lack of the phylogenetic transition from *S. praesulcata* to *S. sulcata* and the base of bed 84b, which contains the FAD of *S. sulcata*, is immediately above a probable erosion surface and major lithofacies facies change (Corradini and Kaiser, 2009; Kaiser, 2009). Several sections, particularly those in south-central China, which had been proposed as GSSP candidates prior to selection of the La Serre section, will be carefully re-examined. Intensive biostratigraphic, geochronologic, sedimentologic and geochemical studies will be initiated at all potential GSSP sections.

At the D-C boundary workshop held at the 2010 ICP3 meeting in London on July 2, Carlo Corradini summarized the current stage of knowledge of the species within the genus *Protognathodus* across the D-C boundary. He indicated there are problems with the first appearances and distribution of the protognathodid species and especially emphasized the group's rareness to absence in many sections and facies dependence (shallow water preference). He concluded that none of the *Protognathodus* species could be the primary marker for the D-C boundary but can be used in conjunction with other taxa. The findings of Corradini require confirmation by other conodont specialists before the protognathodid lineages are totally abandoned. Although the siphonodellids and protognathodids may not be as useful for boundary definition as previously thought, there may be other significant latest Famennian to earliest Tournaisian biostratigraphic events that have potential for boundary definition and an intensive search needs to be undertaken to locate them.

At the July 2010 ICP3 workshop in London and at some other recent meetings, it was proposed that the task group start exploring the possibility of using either a sedimentological or geochemical event such as some component of the multiphase Hangenberg extinction event (Kaiser, 2005, 2010; Cramer *et al.*, 2008) for boundary definition. The event presents potential for correlation into both shallow and relatively deep-water marine facies. A variety of techniques can be used to recognize the Hangenberg event and it is relatively well constrained by biostratigraphic markers. At the end of the meeting, Markus Aretz asked those present to prepare for the next D-C boundary workshop by developing precise correlation charts for their regions of study showing the biostratigraphic, geochemical and depositional events within the Hangenberg event interval. The executive wants to know how the phases of the Hangenberg are represented in different facies and how well they can be correlated globally.

At the International Commission of Stratigraphy meeting held in Prague from May 31st to June 3rd, 2010 to discuss the GSSP concept, Vladimir Davydov (Boise State University, Idaho USA) proposed that volcanic-ash layers could be used to define boundaries such as the D-C boundary. The ashes represent instants in deep time and can be precisely dated using U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology. Study of the ash horizons is ongoing. [see Appendix B for references]

The **Viséan-Serpukhovian Boundary Task Group** will continue to focus on the use of the FAD of *Lochriea ziegleri* in the conodont lineage *Lochriea nodosa-Lochriea ziegleri* for boundary definition. Richards is preparing a proposal for submission to the task group and SSCS membership for a vote on either accepting or rejecting the FAD of *L. ziegleri* for GSSP definition. Given the ballot is successful, two sections present substantial potential for the GSSP, and the ongoing integrated biostratigraphic, sedimentological and geochemical studies of those sections will continue. Identification of the *L. nodosa-L. ziegleri* lineage and recognition of associated conodont, ammonoid, ostracode, and foraminiferal zones in the richly fossiliferous section near Verkhnyaya Kardailovka in the southern Urals establishes that section as a strong candidate for a GSSP. The other main candidate is the Nashui section near Naqing in southern Guizhou Province, China. In the Nashui section, the *Lochriea* lineage has been recognized and intensively studied across the boundary interval by Chinese colleagues, and intensive sedimentological and geochemical studies initiated.

The *Lochriea* lineage has not yet been found North America but specimens of *Lochriea ziegleri* and other species within the genus have been discovered. In order to identify correlatable faunal zones that can closely bracket the boundary interval on that continent, a Global study of conodonts, ammonoids, foraminifers, and corals across the boundary interval in Europe and Asia will continue. All this suggests selection of the GSSP is possible in the next 2 years.

The long-term plans for the **Bashkirian-Moscovian Boundary Task Group** are to find a suitable event marker for the Bashkirian-Moscovian boundary and then look for GSSP candidate sections. Until the fall of 2010, much of the task group's time was directed toward the evaluation of two conodont lineages that had moderate potential for defining the base of the Moscovian: 1) derivation of *Idiognathoides postsulcatus* from *Id. Sulcatus*, and 2) derivation of *Declinognathodus donetzianus* from *D. marginodosus*. Both lineages have short comings and if either *D. donetzianus* or *I. postsulcatus* are chosen as the marker, the group's challenge will be to demonstrate how the base of the Moscovian Stage might be identified in areas where these taxa do not occur because both have limited geographic distributions. Nevertheless, the *D. arginodosus*-*D. donetzianus* lineage remains a candidate for the event level, and further work on it and a distinctive fusulinid group that accompanies it is being carried out by Russian workers at the Basu River section in the southern Urals, a well-exposed potential GSSP candidate comprising carbonate-slope lithofacies (Kulagina *et al.*, 2009).

A third potential boundary marker the task group has been evaluating is the appearance of the conodont *Diplognathodus ellesmerensis*, which appears in evolutionary continuity from *D. coloradoensis* at the base of the Moscovian in the Nashui section by Naqing in Guizhou Province, China (Qi *et al.*, 2007, 2009) and has been widely recognized globally. Chinese colleagues have selected the interval spanning the Bashkirian-Moscovian boundary at Nashui for intensive biostratigraphic and sedimentologic study as a potential GSSP for the B-M boundary and are currently working at the locality. In late November 2010, the task group intends to hold a joint workshop with the other SCCS task groups in Nanjing to study specimens from the locality.

During the fall of 2010, collaborative conodont studies by Qi Yuping and Lance Lambert revealed there could be better alternatives for boundary definition than the three conodont lineages discussed above and the focus of the task group is being redirected to those alternatives. Rapid morphologic evolution in P₁ elements of *Streptognathodus expansus* and *S. suberectus* permit the identification of a new biostratigraphic level that is slightly below the traditional base of the Moscovian. Through the work of John Groves and Katsumi Ueno, the fusulinids *Eofusulina* ex gr. *triangula* and *Profusulinella* [= *Depratina*] *prisca* recently emerged as additional taxa with considerable potential for boundary characterization. Because of the discovery of the two new alternatives for boundary definition, the task group has decided to start preparing two proposals for boundary definition.

One proposal is being crafted by Qi Yuping and Lance Lambert in which they will propose to use the appearances of advanced morphotypes of *Streptognathodus expansus* and *S. suberectus* to mark the Bashkirian-Moscovian Stage boundary. Qi and Lambert must finalize some basic taxonomic work on these two species before they can distribute a formal proposal. Their proposal would slightly lower the base of the Moscovian to a level that historically has been regarded as upper Bashkirian. Their work will focus on existing collections from the Nashui section (Qi *et al.*, 2007, 2009) in Guizhou Province in southern China. For a more complete discussion about the use of *S. expansus* and *S. suberectus* for boundary definition, see the task group report for 2010 in Appendix B.

John Groves, Katsumi Ueno and other fusulinid specialists within the task group are developing the second proposal for Bashkirian-Moscovian boundary definition. Their proposal will advocate using the FAD of the fusulinid *Eofusulina triangula* to mark the base of the Moscovian. If the SCCS favors this proposal over the first one, the FAD of *Profusulinella prisca* will probably be used as an auxiliary marker. As an outgrowth of using the fusulinids for boundary definition, Demir Altiner will analyze fusulinids from two localities in the Tauride Belt of southern Turkey where *E. triangula* and *P. prisca* are known to appear at the base of the Moscovian. Altiner is attempting to demonstrate that the appearances of the potential markers occur in evolutionary continuity with their ancestors.

The carbonate-dominant Nashui section in Guizhou Province is one of the best candidates for the GSSP at the base of the Moscovian because the conodonts the task group is considering for boundary definition are abundant, well preserved, and their first occurrences quite precisely located. Foraminifers are also present and John Groves plans to complete his study of the foraminifers in time to present his results at the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting. Work on the sedimentology, stable-isotope geochemistry, and geophysical characteristics of the boundary interval at Nashui are not as advanced as the paleontological investigations and will be the focus of the team's work in 2011 and 2012.

In order to place the important Nashui section into its sedimentological and paleoenvironmental context and to determine the relationship of shallow-water coral and foraminiferal zones to the deeper-water conodont markers within the Bashkirian-Moscovian transition in south China, the investigation of two reference sections - the Zhongdi, and the Luokun sections - will continue. If the fusulinid proposal gains widespread support, that will trigger more work in both sections, because they are known for their fusulinid successions and both would be logical sections in

which to search for an eventual GSSP. In late February 2011, Katsumi Ueno and Wang Yue will re-visit the well-known Zhongdi section in southern Guizhou (Ueno *et al.*, 2007) for additional sampling of a critical biostratigraphic interval.

If the fusulinid proposal gains widespread support that will also stimulate additional work on sections the task group has been working on in the Cantabrian Mountains of northwestern Spain. The region is known for its fusulinid successions and is a logical region in which to search for an eventual GSSP.

Because substantial work still is still required before a GSSP can be selected, 2013 is the earliest likely completion date.

The **Moscovian-Kasimovian Boundary and Kasimovian-Gzhelian Boundary Task Groups** are moving ahead as the previously muddled conodont taxonomic problems have been largely resolved. Publication of the cyclothem correlation chart (Heckel *et al.*, 2007) across both boundaries in North America [Midcontinent of U.S.A.] and Eastern Europe where the disconformity-bounded cyclothem are identified [Moscow Basin, Russia, and Donets Basin in Ukraine], has increased the potential for recognizing the conodont events that can be identified in the essentially complete lower-slope to basin successions in the southern Urals and south China.

The members of the task group on the **Moscovian-Kasimovian Stage Boundary**, who attended the 2008 Oviedo meeting, reached unanimous agreement to focus future work on two species of conodonts as the potential biostratigraphic marker by which the base of the Kasimovian Stage can be selected and correlated globally. The first is *Idiognathodus sagittalis* Kozitskaya 1978, based on material from the Donets Basin (Ukraine) and also identified from the Moscow region and southern Urals of Russia, and the Cantabrian Mountains (Spain). A potential ancestor-descendent lineage from *I. aff. sagittalis* n. sp. to *I. sagittalis* may be present in the Moscow region. The second potential marker is *Idiognathodus turbatus* Rosscoe and Barrick 2008 (*I. n. sp. A* of Barrick *et al.*, 2004), based on material from the Midcontinent region of the U.S.A., and also recognized in the Moscow Basin, the southern Urals, and the Donets Basin. A lineage from *Idiognathodus swadei* Rosscoe and Barrick 2008 to *I. turbatus* has been described from the Midcontinent of the U.S.A. While the event marker for the Moscovian-Kasimovian boundary still needs to achieve consensus, continued assessment of the two lineages and clarification of the taxonomy of species involved will hasten the process.

The task group will continue to evaluate the utility of the two lineages in the slope-deposits of the Nashui section; and in late November of 2010, they will hold a joint workshop with other SCCS task groups at Nanjing, China to study specimens from the locality.

Members of the **Kasimovian-Gzhelian boundary Task Group** have long favored use of the conodont lineage *Idiognathodus aff. simulator-I. simulator [sensu stricto]* to define the boundary at the first appearance of *I. simulator [sensu stricto]*. *I. aff. simulator* is now named *I. eudoraensis* by Barrick *et al.* (2008). This event marker was unanimously approved by a vote taken by the task group in April 2007, and has been unanimously approved by the SCCS. Now that the event marker has been selected, task-group members will focus on the selection of a suitable section for the GSSP. Further taxonomic work is in progress on the morphotypes of the fusulinid *Rauserites*, which accompanies *I. simulator* in Eurasia.

The existence of widespread disconformities within the Kasimovian-Gzhelian transition across nearly all of the well-known shelf regions presents a substantial problem for selecting a section for the GSSP, but work on the essentially complete carbonate-slope sections in the southern Urals (Usolka River section) and on the slope deposits in the Nashui section, are providing more appropriate sections for a potential GSSP. Conodont studies are well advanced at the two localities, but sedimentologic, geochemical and geophysical studies at the sections are at an early stage. Therefore, 2013 - 2014 is probably the earliest a GSSP for the boundary will be selected.

Chemostratigraphy, magnetostratigraphy and radiometric dating

The SCCS executive is hopeful that ongoing work in chemostratigraphy and magnetostratigraphy will identify events that can be used to supplement the boundaries that will be defined by means of faunal events, and eventually will provide the basis for correlating these boundaries into the northern-hemisphere Angara region and the southern-hemisphere Gondwana region, where the pan-tropical biotas are replaced by provincial cold-climate communities.

We are also hopeful that new, more coordinated precise radiometric dating on biostratigraphically well-constrained marine successions, such as are being reported from the Pennsylvanian of the southern Urals by the Boise State group, and from the Mississippian of Belgium by the Tournaisian-Viséan task group, will both narrow the age disparities that currently exist within much of the Carboniferous and also provide better correlation with more precise modern radiometric dates that will hopefully be obtained from the Angara and Gondwana regions.

Meeting-field workshop schedule with themes and anticipated results.

During the 2011 fiscal year, there will be many meetings of substantial interest to SCCS members but two of them are considered to be the most important in terms of the goals of the subcommission and are discussed below.
November 21st to 30th 2010: **GSSPs of the Carboniferous System - a SCCS Workshop and Field Excursion - Nanjing and southern Guizhou Province, China**

From November 21st to 30th 2010, all of the SCCS task groups will participate in a workshop in Nanjing and attend a subsequent field excursion in southern Guizhou Province organized and hosted by Wang Xiangdong and colleagues with the Nanjing Institute of Geology and Palaeontology.

At the meeting and workshop in Nanjing (November 21st to 24th), the task groups will discuss the present status of their boundary studies and present plans leading toward the final designation and ratification of the GSSP that their group is responsible for. The workshop and field meeting will provide Carboniferous specialists an outstanding opportunity to compare and discuss specimens and data from relevant areas of the World. The SCCS executive has encouraged participants to bring conodonts, foraminifers, ammonoids, and other fossils from the successions they are studying for comparison with specimens brought by other participants. Principal objectives of the comparative analysis are to reach a consensus on the taxonomic assignment of specimens and agreement about the limits of morphologic variation permitted within taxa. In particular, participants will be able to examine conodonts and foraminifers from the outstanding Naqing (Nashui) section of South China, one of the world's most complete (extending from the Viséan into the Permian), relatively thick, and continuously exposed Carboniferous carbonate-slope sections.

Following the Nanjing workshop, there will be a field excursion (November 25th to 30th) to southern Guizhou Province in southern China to examine and sample Carboniferous successions deposited on the Yangtze carbonate platform and in the adjacent basin. Some of these successions contain sections such as the Nashui section by the village of Naqing that have substantial potential as GSSP candidates.

July 3-8, 2011: **The XVII International Congress on the Carboniferous and Permian** - Perth Australia:

From July 3-8, members of the SCCS task Groups will attend the XVII ICCP in Perth, hosted by the University of Western Australia. Details about the congress are available on the website- <http://www.iccp2011.org/>. The congress on the Carboniferous and Permian is held every four years and is our most important meeting, providing an excellent opportunity to present results from research on faunas and sections leading to the selection of GSSPs for stage boundaries. The ICCP offers an opportunity to place our research into a global context and to renew links with colleagues. The conference organizers have given the SCCS a full-day special session - "Carboniferous Stage Boundaries: the Present State and Future", at which our task group members will present progress reports relevant to their specific boundaries. Other sessions dealing with a broad spectrum of topics will also be open to SCCS members. During the congress, the SCCS will hold a business meeting for task group leaders and SCCS voting members. A proceedings volume will be published and task-group members are encouraged to publish the results of their work in that volume.

Perth lies in the Perth Basin, part of the East Gondwana rift system which extended far into the interior of Gondwana. The Western Australian Basins of the rift system have excellent Carboniferous and/or Permian successions, some of which will be examined by SCCS members on the ICCP field trips.

**APPENDIX A. [Names and Full Addresses of Current Officers and list of Voting Members]
Subcommission officers (with addresses)**

Chairman: Barry C. Richards
Geological Survey of Canada-Calgary
3303-33rd St. N.W. Calgary
Alberta, Canada T2L 3A7
Email: Barry.Richards@NRCan-RNCan.gc.ca
FAX: 1 (403) 292-4961
Office phone: 1 (403) 292-7153

Vice-Chairman: Xiangdong Wang
Nanjing Institute of Geology and Paleontology
Chinese Academy of Science
39 East Beijing Road
Nanjing 210008, China
Email: xddwang@yahoo.com.cn

Secretary/Editor: Markus Aretz
Université Paul-Sabatier

Observatoire Midi-Pyrénées
14, avenue Edouard Belin
31400 Toulouse, France
Email: aretz@lmtg.obs-mip.fr

List of Task Groups and their officers

Base Carboniferous (base Lower Mississippian): Chairman to be appointed

Base Viséan (base Middle Mississippian): George Sevastopulo, Republic of Ireland. gsvstpul@tcd.ie

Base Serpukhovian (base Upper Mississippian): Barry C. Richards, Canada. Barry.Richards@NRCan-RNCan.gc.ca

Base Moscovian (base Middle Pennsylvanian): John Groves, USA. john.groves@uni.edu

Base Kasimovian (base Upper Pennsylvanian) and base Gzhelian: Katsumi Ueno, Japan. katsumi@fukuoka-u.ac.jp

List of Voting Members [2008-20012]

Demir Altiner, Ankara, Turkey
Email: demir@metu.edu.tr

Markus Aretz, Toulouse, France
Email: aretz@lmtg.obs-mip.fr

James E. Barrick, Lubbock, U.S.A.
Email: jim.barrick@ttu.edu

Darwin R. Boardman, Stillwater, U.S.A.
Email: darwin.boardman@okstate.edu

Holger C. Forke, Berlin, Germany
Email: holger.forke@gmx.de

Natalya V. Goreva, Moscow, Russia
Email: goreva@ginras.ru

John R. Groves, Cedar Falls, U.S.A.
Email: john.groves@uni.edu

Luc Hance, Belgium
Email: luc.hance@skynet.be

Jin Xiao-chi, Beijing, China
Email: jinxchi@cags.net.cn

Jiri Kalvoda, Brno, Czech Republic
Email: dino@sci.muni.cz

Dieter Korn, Berlin, Germany
Email: dieter.korn@museum.hu-berlin.de

Olga L. Kossovaya, St. Petersburg, Russia
Email: koss@mail.wplus.net

Elena I. Kulagina, Ufa, Russia
Email: kulagina@anrb.ru

Tamara I. Nemirowska, Ukraine
Email: tnemyrov@i.com.ua

Svetlana Nikolaeva, London, United Kingdom
Email: s.nikolaeva@nhm.ac.uk

Edouard Poty, Liège, Belgium
Email: e.poty@ulg.ac.be

Yuping Qi, Nanjing, China
Email: ypqi@nigpas.ac.cn

Barry C. Richards, Canada
Email: Barry.Richards@NRCan-RNCan.gc.ca

Katsumi Ueno, Japan
Email: katsumi@fukuoka-u.ac.jp

Wang Xiang-dong, Nanjing, China
Email: xddwang@yahoo.com.cn

David M. Work, Augusta, U.S.A.
Email: david.work@maine.gov

APPENDIX B. [Full text of Task Group Reports]

Task Group to redefine the Devonian-Carboniferous Boundary Barry C. Richards and task group

Since the last task-group report was published in the Newsletter on Carboniferous Stratigraphy (Richards and Task Group, 2009), considerable progress has been made toward addressing the work objectives outlined in that report and in the 2009 Annual Report that Richards submitted to the ICS in November 2009 for the SCCS. A chairman, Markus Aretz, has been appointed to lead the task group, the conodont lineage used to define the current boundary at the La Serre section in southern France is being intensively studied along with other conodont lineages that have potential for D-C boundary definition, and it has become clear from the recent studies of the task group members that the La Serre section is no longer suitable for the GSSP and another section needs to be selected. The biologic-sedimentologic event used to define the boundary has not been chosen, but the search for better GSSP sections is already in progress.

The D-C Boundary is currently defined by the first occurrence of the conodont *Siphonodella sulcata* in the evolutionary lineage *Siphonodella praesulcata* to *S. sulcata* (Paproth and Streel, 1984). Based on numerous detailed biostratigraphic studies including those of Flajs and Feist (1988) at La Serre Hill in the Montagne Noir of southern France, the boundary section best displaying the lineage was thought to be in trench E' at La Serre. Therefore, the base of bed 89 in trench E' was selected as the D-C Boundary GSSP by Paproth *et al.*, (1991). Recent doctoral work by Sandra Kaiser (currently at Bonn University) supervised by Thomas Becker (university of Muenster) and followed by further sampling and analysis has shown that there are severe problems with the D-C Boundary GSSP at La Serre (Kaiser and Becker, 2007; Heckel, 2008; Kaiser, 2009).

The Joint Devonian-Carboniferous Boundary GSSP reappraisal Task Group was established in 2008 by Philip Heckel (former chairman of the SCCS) and Thomas Becker (chairman of the SDS) to study and resolve the serious problems with the integrity of the D-C GSSP. At the time the task group was established, 10 members were appointed from each subcommission to form the task group (Heckel, 2008). During 2009, it became apparent that problems with the GSSP would not be resolved without major taxonomic and lithostratigraphic analyses requiring strong direction and leadership from a chairman. Consequently, at the International Commission of Stratigraphy workshop about the GSSP concept that was held in Prague from May 31st to June 3rd 2010, the SCCS chairman Barry Richards appointed Markus Aretz as chairman of the task group while the SDS chairman Thomas Becker designated Carlo Corradini to be vice-chairman.

Following the 2009 SCCS meeting held in Russia, Pazukhin continued his work on the *S. praesulcata*-*S. sulcata* lineage (Pazukhin and Kulagina, 2010) and associated D-C boundary conodonts in the southern Urals and presented his results at the IPC3 convention in London England, 2010. In that study, the conodont zones were correlated with the regional foraminiferal zones to test the utility of using foraminifers to either define the boundary or provide corroborating data.

Task-group members Carlo Corradini, Sandra Kaiser and Claudia Spalletta along with Maria Cristina Perri are studying the taxonomic and phylogenetic problems within the protognathodid lineages. They presented some of their initial findings in a paper (Corradini *et al.*, 2010) at the IPC3 convention in London, England. They concluded that a comprehensive study of *Protognathodus*, a genus appearing in the latest Devonian and extending into the

Mississippian, would permit a more precise definition of the D-C boundary than is presently available using that group of conodonts. Four species of *Protognathodus* are known from the relevant time span: *Pr. meischneri*, *Pr. collinsoni*, *Pr. kockeli* and *Pr. kuehni*. Presently favoured for boundary definition are the first occurrences of *Pr. kockeli* from *Pr. collinsoni* and *Pr. kuehni* from *Pr. kockeli*. These lineages require additional study and their relative advantages, if any, over the siphonodellids require careful evaluation.

At the D-C boundary workshop held at the ICP3 meeting in London on July 2, 2010 after the SDS business meeting, Carlo Corradini summarized the current stage of knowledge of the various species within the genus *Protognathodus* across the D-C boundary level. He indicated there are problems with the first appearances and distribution of the protognathodid species and especially emphasized the group's rareness to absence in many sections (see Pazukhin and Kulagina, 2010) and facies dependence (shallow water). He concluded that none of the *Protognathodus* species has the potential to be the primary marker for the D-C boundary but could be used in conjunction with other taxa. After Carlo's presentation, the utility of using the protognathodids was further discussed at the workshop. During those discussions, it was apparent that no general agreement existed on the usefulness of the protognathodid lineages for boundary definition. It is clear that the group requires substantial additional study in the coming years.

At the IPC3 workshop, Carlo Corradini also gave an important presentation outlining the problems of the *praesulcata-sulcata* lineage. The majority of the conodont workers present at the workshop did not see much potential for the continued use of the *Siphonodella* lineage for boundary definition. However, Carlo suggested that his observations and conclusions along with those of Sandra Kaiser (Corradini and Kaiser, 2009; Kaiser, 2009) should be independently tested by other conodont specialists before the lineage is abandoned. In the La Serre section, the *S. praesulcata* and *S. sulcata* morphotypes that Corradini and Kaiser recognized lacked any apparent relationship with the stratigraphic level (several morphotypes occurred together in the beds); but it is necessary to determine if this is the case in several sections, where extensive reworking is not an issue.

At the July ICP3 workshop in London and at some other recent meetings, it was proposed that we explore the possibility of using an event such as some component of the multiphase Hangenberg extinction event (Kaiser, 2005, 2010; Cramer *et al.*, 2008) to define the boundary. The idea of using a phase of the Hangenberg event for boundary definition was discussed and received much support at the IPC3 workshop. It was pointed out that the event presents potential for correlation into both shallow and relatively deep-water marine facies. In addition, a variety of techniques can be used to recognize the Hangenberg event and it is relatively well constrained by biostratigraphic markers. Those present felt the transgressive surface marking the onset of the Hangenberg was not as useful as the maximum flooding surface or surfaces resulting from the subsequent sea-level drop. At the meeting's end, Markus Aretz asked those present to prepare for the next D-C boundary workshop by developing precise correlation charts for their regions of study showing the biostratigraphic, geochemical and depositional events within the Hangenberg extinction event interval. We would like to know how the phases of the Hangenberg are represented in different facies and how well they can be correlated globally.

At the International Commission of Stratigraphy meeting held in Prague from May 31st to June 3rd, 2010 to discuss the GSSP concept, Vladimir Davydov (Boise State University, Idaho USA) proposed that volcanic ash beds and laminae could be used to define boundaries such as the D-C boundary. The ashes represent instants in deep time and can be precisely dated using U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology. Precise Global correlation of such ashes would require supporting biostratigraphic data. A principal merit of the proposal is that volcanic ash beds are present to common at many locations in the D-C boundary interval including the auxiliary global stratotype at Hasselbachtal in the Rhenish Massif near the town of Hagen, Germany (Trapp *et al.*, 2004; Richards *et al.*, 2009). The proposal was met with moderate enthusiasm at the IGC meeting but requires further evaluation.

From the recent work completed by members of the D-C boundary task group, it is clear that the La Serre section will not be suitable for boundary definition. The biologic-sedimentologic event used to define the boundary has not been chosen, but the search for better GSSP sections is already in progress. New D-C boundary sections are being studied in regions such as Morocco (T. Becker, written com., 2010) and previously studied sections such as the Hasselbachtal and those in southern China (Yu, 1988) are being carefully re-evaluated.

Additional workshops relevant to the task group are being planned for the upcoming major meetings of the SCCS (Nanjing, China November 21st - 30th) and SDS. The SDS chairman Thomas Becker and vice-chairman El Hassani, Rabat and the SCCS secretary Markus Aretz plan to organize a field meeting (including 2 days for presentations) for early 2013 in southern and central Morocco.

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Members of the Joint D-C Boundary GSSP Reappraisal Task Group

Chairman: Markus Aretz

Vice-chairman: Carlo Corradini

SCCS members

Markus Aretz, France: corals Aretz@lmtg-mip.fr

Jim Barrick, USA: conodonts <jim.barrick@ttu.edu>

Paul Brenckle, USA: foraminifers <saltwaterfarm1@cs.com>

Geoff Clayton, Ireland: palynomorphs <gclayton@tcd.ie>

Jiri Kalvoda, Czech Republic: foraminifers <dino@sci.muni.cz>

Rich Lane, USA: conodonts <hlane@nsf.gov>

Svetlana Nikolaeva, Russia: ammonoids <44svnikol@mtu-net.ru>

Vladimir Pazukhin, Russia: conodonts <pazukhin@mail.ru>

Edouard Poty, Belgium: corals <e.poty@ulg.ac.be>

Barry Richards, Canada, Chair of SCCS: stratigraphy, sedimentology <Barry.Richards@NRCan-RNCan.gc.ca>

Yuan Jin-Liang, China: trilobites <yuanjl403@sohu.com>

Experts selected by Thomas Becker, Chair of the Devonian Subcommittee:

Thomas Becker, Germany, Chair of SDS: ammonoids <rbecker@uni-muenster.de>

Denise Brice, France: brachiopods <d.brice@isa-lille.fr>

Carlo Corradini, Italy: conodonts <corradin@unica.it>

Brooks Elwood, USA: magnetostratigraphy <ellwood@lsu.edu>

Ji Qiang, China: conodonts <Jiroad@cags.net.cn>
Sandra Kaiser, Germany: conodonts, isotope stratigraphy <sakaiser@uni.de>
J. E. Marshall, UK: miospores <jeam@noc.soton.ac.uk>
Hanna Matyja, Poland: conodonts <hanna.matyja@pgi.gov.pl>
Claudia Spalletta, Italy: conodonts <claudia.spalletta@unibo.it>
Wang Cheng-Yuan, China <cywang@nigpas.ac.cn>

Task Group to establish the Tournaisian-Viséan boundary Following approval of the proposed GSSP [see Devuyst *et al.* (2003) for early version of proposal] at Pengchong in southern China, by the SCCS in late 2007 and its ratification by the ICS and IUGS, task-group member François-Xavier Devuyst and his colleagues have been preparing the final report about the Tournaisian-Viséan boundary GSSP. After completion of the report, the task group will be dissolved according to ICS rule (7.5).

Task-group member Hongfé Hou is trying to organize an official ceremony for the placement of the "golden spike" in the GSSP section at Pengchong. Several task-group members and SCCS officials plan to attend the historic ceremony.

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The **Task Group to establish the Viséan-Serpukhovian boundary**, chaired by Barry C. Richards, considers the first evolutionary appearance of the conodont *Lochriea zieglerei* in the lineage *Lochriea nodosa-Lochriea zieglerei* to be the best event for boundary definition. The lineage along with associated faunas and strata are being studied in several areas but the Nashui section in south China and the Verkhnyaya Kardailovka section in Russia have the best potential as GSSP candidates and are receiving the most intensive study.

During the past year, the task group to establish the Viséan-Serpukhovian boundary made encouraging progress toward the selection of a GSSP for the Viséan/Serpukhovian stage boundary. Most importantly, the group continues to find that the first evolutionary appearance of the conodont *Lochriea zieglerei* Nemirovskaya, Perret & Meischner in the lineage *L. nodosa-L. zieglerei* presents the best potential for boundary definition. *L. zieglerei* appears in the upper part of the Brigantian Substage slightly below the current base of the Serpukhovian as defined by its lectostratotype in the Zaborie quarry near the city of Serpukhov in the Moscow Basin, Russia (Kabanov, 2003, 2004; Kabanov *et al.*, 2009). This lineage, best documented from deep-water carbonate sections, has been recently documented in numerous sections in Europe and Asia including the well known Verkhnyaya Kardailovka section in the southern Urals of Russia (Nikolaeva *et al.*, 2009b), the Nashui section (by village of Naqing) in southern China (Qi and Wang 2005, Qi, 2008), Cantabrian Mountains of northern Spain (Nemyrovskaya, 2005; Sanz-López *et al.*, 2007), and the Dombay Hills in western Kazakhstan (Nikolaeva *et al.*, 2009a). The lineage has not been identified in North America but *L. zieglerei* has been found in the Barnett Shale in Texas and other species of *Lochriea* have been identified at several localities (Brenckle *et al.*, 2005; Qi Yuping, pers. com., 2010).

Until this year, many task group members and other SCCS members felt that not enough was known about the geographic and lithofacies distributions of the lineage and the degree of diachroneity of the first evolutionary appearance of *L. zieglerei* to warrant a vote. In particular, George Sevastopulo, chairman of the Tournaisian-Viséan boundary task group, had serious concerns that the first appearance of *L. zieglerei* might be highly diachronous. During the last two years, George and task-group member Mark Dean along with student Milo Barham at Trinity College in Dublin have tied the first appearance of *L. zieglerei* to ammonoid-bearing marine bands and the ammonoid zonation scheme used in Western Europe (see Nikolaeva and Kullmann, 2003). Fortunately, the preliminary results of this work, presented by George Sevastopulo at the June 2010 SCCS field meeting in northern Spain, indicate the degree of diachroneity is minimal. Taxa in the lineage containing *L. zieglerei* display a broad range of morphological variations and studies by several task-group members are underway to determine the variations and more precisely define the limits of *L. zieglerei*, its immediate ancestor *L. nodosa* (Bischoff), and *L. cruciformis* (Clarke), which appears near the first occurrence of *L. zieglerei*.

Field activities

During the early part of the 2009-2010 project year, field work was concentrated in southern Guizhou province, People's Republic of China. Later in the project year, during the June 2010 SCCS field trip held in Cantabrian Mountains of northwestern Spain (see itinerary in executive's column of this newsletter), conodont specialists Javier Sanz-López and Silvia Blanco-Ferrera introduced several task-group members to a number of excellent stratigraphic sections in which the lineage was particularly well developed and documented. In August

2010, field work was concentrated on the Verkhnyaya Kardailovka section in the southern Urals of the Russian Federation.

Southern Guizhou province During February 2010, several task-group members and students from the Nanjing Institute of Geology and Paleontology briefly visited the Nashui section (by village of Naqing) near the city of Luodian in southern Guizhou province and spent several days measuring two other sections (Yashui section and Dianzishang section) in the region to place the Nashui section into its paleogeographic, stratigraphic, and lithofacies contexts. In the Nashui section, conodonts within the *L. nodosa* - *L. ziegleri* lineage are well preserved and abundant (Qi, 2008). In addition, elements transitional between *L. nodosa* and *L. ziegleri* are plentiful, occurring in several samples, and the oldest representatives of *L. ziegleri* could be readily distinguished from the associated transitional forms of *L. nodosa*. A detailed stratigraphic section extending from the upper Viséan into the Bashkirian has been measured at Nashui but a bed-by-bed study needs to be completed across the Viséan-Serpukhovian and Serpukhovian-Bashkirian boundaries. John Groves has largely completed his study of the foraminifers in this section and plans to have this work completed in time for the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting.

The Yashui section, situated near the city of Huishui in Guizhou province, is important because it contains abundant rugose corals and foraminifers (Wu *et al.*, 2009) and is dominated by shallow-marine neritic- to peritidal-ramp facies. The purpose of studying the section is to determine the relationship of the coral and foraminiferal zones to the *L. nodosa* - *L. ziegleri* transition in south China. In the summer and fall of 2008 and in 2009, Wang Xiangdong sampled the Yashui section for corals and Qi Yuping sampled it for conodonts. From January 29th to February 2nd 2010, the lower 103 metres of the Yashui section from the upper Viséan into the upper part of the Serpukhovian were measured, described, and sampled at a (bed-by-bed) level of detail by Barry Richards and a supporting team of several task-group members and farmers. Conodont samples collected in 2008-2009 have been processed but yields were poor and the *L. nodosa* - *L. ziegleri* transition could not be located. However, valuable sedimentologic and paleogeographic data were obtained and the diverse coral and foraminifer faunas are worthy of study. The section provides an excellent opportunity to see what the shallow-marine carbonate-ramp facies are like in southern Guizhou Province. John Groves has largely completed his study of the exceedingly abundant and taxonomically diverse foraminifers from the lower part of the section. He is attempting to bracket the level of the Viséan-Serpukhovian boundary with them and plans to complete the study and present his results at the November 21st - 30th 2010 SCCS Nanjing workshop and field meeting.

Strata in the Dianzishang section, situated by Dianzishang village along the Zin Zai River 1 km upstream from the Red Flag Bridge, are intermediate between the lower-slope to basin deposits at Nashui and the shallow-marine ramp deposits at Yashui. The Dianzishang section includes spectacular syndepositional slump deposits formed in a lower- to middle-slope setting and provides another opportunity to see conodonts and foraminifers spanning the *L. nodosa*- *L. ziegleri* transition. In early February 2010, Barry Richards assisted by a team of task-group members and farmers measured and described 72.7 m of strata extending from the uppermost Viséan into lowermost Bashkirian but not at a bed-by-bed resolution.

Cantabrian Mountains, northern Spain In June 2010, task group members were introduced by Javier Sanz-López and Silvia Blanco-Ferrera to several sections spanning the Viséan-Serpukhovian boundary in the Cantabrian Mountains of northwestern Spain. Two of the Cantabrian sections, the Vegas de Sotres and Millaró (Sanz-López *et al.*, 2004; 2007) sections in the Alba Formation, are excellent, rivaling the better known Kardailovka and Nashui exposures. In the Vegas de Sotres section (by village of Sotres in the Picos de Europa unit, northeastern Cantabrian zone) and Millaró section (by village of Millaró, in fold and Nappe province of the Cantabrian zone), conodonts within the *L. nodosa* - *L. ziegleri* lineage are well preserved and abundant; in addition, the first occurrence of *L. ziegleri* has been located with moderate precision. A major biostratigraphic advantage of the two sections is the common occurrence of abundant, well-preserved ammonoids being studied by Svetlana Nikolaeva; in addition, foraminifers and algae introduced from shallow-water settings are present at Vegas de Sotres (Blanco-Ferrera *et al.*, 2009). In both sections, deposits within the *L. nodosa* - *L. ziegleri* transition are dominated by nodular, deep-water carbonates of the Alba Formation. The conodont biostratigraphy has been well established in the two sections (Sanz-López *et al.*, 2007; Blanco-Ferrera *et al.*, 2009) but sedimentological and geochemical analyses are required.

Urals, Russia During August 2010, members of the task group worked at the condensed, deep-water, carbonate section along the Ural River opposite the village of Verkhnyaya Kardailovka on the eastern slope of the southern Urals, southern Russia (Nikolaeva *et al.*, 2005). Nikolaeva and her colleagues have worked on this section over several years and published syntheses of their studies on the ammonoids, conodonts, foraminifers and ostracodes (Nikolaeva *et al.*, 2009b; Pazukhin *et al.*, 2010). The syntheses indicate that specimens transitional between *L. nodosa* and *L. ziegleri* occur in the Verkhnyaya Kardailovka section immediately below the first appearance of *L. ziegleri*. On the August 2009 trip, to Verkhnyaya Kardailovka, task-group members had a stratigraphic overview of the section and collected samples for foraminifers, ammonoids, and conodont extraction across the probable location of the Viséan-Serpukhovian boundary. They found that most of the section was well exposed and lacked major

structural complications, but it was not sufficiently exposed below the probable boundary level (only about 1.5 to 2.0 m of section well exposed). In August 2010, the covered interval was completely excavated, exposing several metres of carbonates and a 12 - 13 m thick underlying succession of marine shale and volcanic ash.

Svetlana Nikolaeva and her colleagues expanded their study of carbonate-dominant Viséan/Serpukhovian successions from the Verkhnyaya Kardailovka section to the Dombar Limestone in the nearby Dombar and Kyzl-Shin region of northern Kazakhstan. In the Dombar Limestone, the *Lochriea* lineage occurs with a taxonomically diverse association of extremely abundant ammonoids (Kulagina *et al.* 2006; Konovalova and Nikolaeva, 2007). The relationship between the regional ammonoid zones and conodont zones has been well established through their work (Nikolaeva *et al.*, 2009a).

In the Ladeiny section (Gubakha area, western slope of the Middle Urals) G. Ponomareva from Perm State University studied the distribution of foraminifers across the Viséan-Serpukhovian boundary interval. Vladimir Pazukhin processed the conodont samples and found all contained conodonts and some had *L. cf. zieglerei*. The section, which also contains brachiopods and algae, may provide another good example of the *L. nodosa* and *L. zieglerei* transition in the Urals.

United Kingdom and Republic of Ireland The *L. nodosa*-*L. zieglerei* lineage has been reported from England (Skompski *et al.*, 1995) but its geographic distribution and stratigraphic position in the United Kingdom and Republic of Ireland are poorly known. In order to better understand its distribution and biostratigraphy in that important region, Mark Dean and George Sevastopulo are continuing their investigation of the lineage in the Lower and Upper Limestone formations in the Yordale facies of central Scotland and in the Bowland Shale Formation, Craven Basin, England. Much of their work is focused on the study of conodont collections used by Varker (1964) and Higgins (1975). An important goal of their work is to tie the first appearance of *L. zieglerei* to the ammonoid-bearing beds of Western Europe.

Rocky Mountains, southwestern Canada Members Sergio Rodriguez (Universidad Complutense in Madrid, Spain) and Wayne Bamber (Geological Survey of Canada-Calgary), continue to study various carbonate-dominant sections across the Viséan-Serpukhovian boundary interval in the upper Viséan to Serpukhovian Etherington Formation in the southern Canadian Rocky Mountains. Rodriguez and Bamber are preparing a monograph on the taxonomically diverse rugose coral faunas that span the Viséan-Serpukhovian boundary within the Etherington. The coral faunas are particularly interesting in that they include a number of European species not previously reported from southwestern Canada. In conjunction with that work, task-group member Bernard Mamet has completed a preliminary analysis of the associated Etherington foraminifers in order to obtain a precise correlation with Eurasian sections containing the *Lochriea* lineage.

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Members of the Viséan-Serpukhovian Boundary GSSP Task Group

- Markus Aretz**, France: corals, biostratigraphy and sedimentology, aretz@lmtg.obs-mip.fr
- Andrew Barnett**, United Kingdom: stratigraphy and sedimentology, Andrew.Barnett@bg-group.com
- Igor Barskov**, Russian Federation: conodonts and biostratigraphy, ibarskov@hotmail.com
- Silvia Blanco-Ferrera**, Spain: conodonts and biostratigraphy, silvia.blanco@geol.uniovi.es
- Paul Brenckle**, USA: foraminifers and biostratigraphy, saltwaterfarm1@cs.com
- Geoff Clayton**, Republic of Ireland: palynology and biostratigraphy, gclayton@tcd.ie
- Mark Dean**, United Kingdom: Conodonts and biostratigraphy, mtd@bgs.ac.uk
- Ellwood, Brooks**, USA: Magnetostratigraphy & magnetosusceptibility, ellwood@lsu.edu
- Nilyufer Gibshman**, Russian Federation: Foraminifers and biostratigraphy, nilyufer@bk.ru
- Maria Hecker**, Russian Federation: Corals and biostratigraphy, Maria.Hecker@skynet.be
- Vera Konovalova**, Russian Federation: Ammonoids and biostratigraphy, konovalovavera@mail.ru
- Dieter Korn**, Germany: Ammonoids and biostratigraphy, dieter.korn@museum.huberlin.de
- Elena Kulagina**, Russian Federation: Foraminifers and biostratigraphy, kulagina@anrb.ru
- Richard Lane**, USA: Conodonts and biostratigraphy, hlane@nsf.gov
- Bernard Mamet**, Belgium & France: Foraminifers and biostratigraphy, Université de Bruxelles
- Tamara Nemyrovskaya**, Ukraine: Conodonts and biostratigraphy, tnemyrov@i.com.ua
- Svetlana Nikolaeva**, Russian Federation and United Kingdom: Ammonoids and biostratigraphy 44svnikol@mtu-net.ru; s.nikolaeva@nhm.ac.uk
- Vladimir Pazukhin**, Russian Federation: Conodonts and biostratigraphy, pazukhin@mail.ru
- Yu-ping Qi**, Peoples Republic of China: Conodonts and biostratigraphy, ypqi@nigpas.ac.cn
- Barry Richards**, Canada: Stratigraphy and sedimentology, Barry.Richards@NRCan-RNCan.gc.ca

Javier Sanz-López, Spain: Conodonts and biostratigraphy, jasanz@udc.es
Matt Saltzman, USA: Chemostratigraphy Saltzman.11@osu.edu
Alan Titus, USA: Ammonoids, biostratigraphy, Alan.Titus@ut.blm.gov
John Utting, Canada: Palynology and biostratigraphy, John.Utting@rncan.gc.ca
Xiangdong Wang, Peoples Republic of China: Corals and biostratigraphy, xdwang@nigpas.ac.cn

The **Task Group to establish the Bashkirian-Moscovian boundary**, chaired by John Groves, is conducting research at locations in Europe and Asia but a lineage and taxon suitable for boundary definition has not been selected. Investigations focus on evolutionary transitions in several conodont lineages, with fusulinid biostratigraphy providing auxiliary information. Conodont evolutionary events that have potential for defining the base of the Moscovian include: 1) derivation of *Idiognathoides postsulcatus* from *Id. sulcatus*, 2) derivation of *Declinognathodus donetzianus* from *D. marginodosus*, and 3) the appearance of *Diplognathodus ellesmerensis*. The fusulinids *Eofusulina* ex gr. *triangula* and *Profusulinella* [= *Depratina*] *prisca* recently emerged as additional taxa with considerable potential for boundary characterization. During the early fall of 2010, conodont specialists discovered that rapid morphologic evolution in P₁ elements of *Streptognathodus expansus* and *S. suberectus* permit the identification of a new biostratigraphic level at which the base of the Moscovian Stage might be placed and plan to present this information at the November 21st - 30th 2010 SCCS Nanjing workshop and subsequent field meeting in southern Guizhou Province, China.

Elena Kulagina has completed a study of *Depratina prisca* in which she documented its evolutionary origin and showed its first occurrence in the south Urals can be used to identify the base of the Moscovian (Kulagina 2009). [Many western specialists regard *Depratina* as a junior synonym of *Profusulinella*.] Kulagina showed that *D. prisca* was derived from *Staffellaeformes staffellaeformis* via the intermediates *Staffellaeformes eoprisca* and *Depratina praeprisca*. Occurrences of *D. prisca* have been examined at the Askyn, Basu River and Uklykaya sections.

South China. During 2010, substantial progress has been made on the intensive biostratigraphic and lithostratigraphic studies of the Bashkirian-Moscovian boundary interval in the Nashui section, in southern Guizhou province. John Groves completed his comprehensive analysis of the foraminifers from the Bashkirian-Moscovian boundary interval using samples collected during a 2008 expedition organized by the Nanjing Institute of Geology and Palaeontology. Qi Yuping, with the assistance of Lance Lambert and Jim Barrick, continued with a detailed analysis of the conodonts derived from several collecting expeditions to the section. They have established that conodonts are abundant and taxonomically diverse in the lower- to middle-slope carbonates of the 20 m thick Bashkirian-Moscovian boundary interval. The provisional Bashkirian-Moscovian boundary recognized by Qi *et al.* (2007, 2009) on the lowest occurrence of *Diplognathodus ellesmerensis* remains at 173 m above the base of the Nashui section, at a position containing a foraminiferal association dominated by *Profusulinella* spp. and *Pseudostaffella* spp. The lowest occurrence of a demonstrably Moscovian fusulinid is at 183.45 m, where a specimen of *Eofusulina* sp. was recovered. In the section, rapid morphologic evolution in P₁ elements of *Streptognathodus expansus* and *S. suberectus* permit the identification of a new biostratigraphic level at which the base of the Moscovian Stage might be placed (Qi *et al.*, 2010). Older forms of these species possess short adcarinal ridges that are not clearly separated from the platforms, but starting at 169.05 m above the base of the section, new morphotypes with significantly longer, more clearly distinct adcarinal ridges appear. The level coincides with the entry of *Neognathodus kanumai* and *Neognathodus atokaensis*, traditional markers for the base of the Moscovian in North America. In the section, several evolutionary events offer potential for boundary definition, including the appearances of *Diplognathodus ellesmerensis* and *Neognathodus atokaensis*, and chronoclines within *Declinognathodus*, *Idiognathoides*, *Idiognathodus*, *Gondolella*, *Mesogondolella* and *Streptognathodus* s.l.

Northwest Spain. Javier Sanz-López, Silvia Blanco-Ferrera and Elisa Villa are conducting integrated foraminiferal and conodont biostratigraphic analyses at the San Antolín-La Huelga section along the Bay of Biscay (Bahamonde *et al.*, 2008; Villa 1995; Villa *et al.* 1997). On June 5th of 2010 this section, comprising the Valdeteja and overlying Picos de Europa formations, was examined by SCCS members during the June 4th - 10th field meeting in the Cantabrian Mountains. Participants found the section well exposed but difficult to accurately measure, and the boundary level lay in an interval dominated by resedimented and commonly coarse-grained slope lithofacies. The Bashkirian-Moscovian boundary is provisionally placed 180 m above the section's base in lower-slope deposits. The boundary is marked by the lowest occurrence of *Idiognathoides postsulcatus*, and this level is slightly higher than the lowest occurrences of *Declinognathodus marginodosus* and *Profusulinella* ex gr. *prisca* (Blanco-Ferrera *et al.*, 2009). The San Antolín-La Huelga section contains four conodont taxa identified as potential Bashkirian-Moscovian boundary markers: *Id. postsulcatus*, *Diplognathodus ellesmerensis*, *Neognathodus nataliae* and *Declinognathodus donetzianus*. The lowest occurrences of these conodonts are in the order listed, spanning a stratigraphic interval of over 300 m.

Donets Basin, Ukraine. Katsumi Ueno and Tamara Nemyrovska continue their work on fusulinids and conodonts from the Donets Basin. The Malonikolaevka section has yielded interesting results that were summarized by Ueno

and Nemyrovska (2008). At Malonikolaevka, the proposed boundary marker *Declinognathodus donetzianus* first occurs in Limestone K1 in evolutionary continuity with its ancestor *D. marginodosus*. Limestone K1 also contains unquestioned occurrences of the Moscovian fusulinid *Eofusulina*.

Davydov (2009) summarizes fusulinid occurrences in the Bashkirian-Moscovian transition in the Donets Basin with proposed correlations to the Moscow Basin. Davydov follows Ueno and Nemyrovska (2008) in placing the base of the Moscovian Stage at the K₁ limestone on the appearance of *Declinognathodus donetzianus*. He regards limestones I₂², I₃ and I₄ as pre-Vereian in age (older than basal Moscovian Substage), although those units contain fusulinids such as *Verella? transiens* that occur elsewhere in Moscovian strata. Davydov suggests that the appearances of *Paraeofusulina* and *Eofusulina* are potential markers for the base of the Moscovian in Tethyan regions.

South Urals, Russia - The well-exposed Basu River section, visited during the August 2009 SCCS field meeting (Kulagina *et al.*, 2009), is one of the best GSSP candidate sections in the southern Urals. It contains the first appearance of *Depratina prisca* a few metres below that of *Declinognathodus donetzianus*. The discovery of the *Declinognathodus* lineage at the Basu River along with a fusulinid fauna including the *P. prisca* group make it a good potential GSSP candidate section. Kulagina *et al.* (2009) address the biostratigraphy of the Basu section with emphasis on the Bashkirian-Moscovian boundary. The authors provisionally place the boundary, and that of the Solontsian Horizon (local unit in lowermost Moscovian), 0.9 m above the base of the section coincident with the appearance of *Depratina prisca*. The appearance of *Aljutovella aljutovica*, an index to the base of the Moscovian Stage in many areas (Ivanova, 2008), occurs 28.8 m above the section's base. The uppermost Bashkirian and basal Moscovian strata contain *Declinognathodus marginodosus*. The appearance of *D. donetzianus* is 6.2 m above the base of the section, about 5.3 m above the appearance of *D. prisca*.

E.I. Kulagina, V.N. Pazukhin, N.V. Goreva, T.N. Isakova, A.S. Alekseev, V.B. Panfilova, O.P. Nikulina, and E.A. Krylova recently completed a study addressing correlation of the Bashkirian-Moscovian boundary between the Russian Platform and the South Urals. The Bashkirian-Moscovian boundary beds have been examined in the South Urals (Askyn and Basu River sections), boreholes in the Bashkirian Cis-Uralia and the Orenburg Region, type sections in the Moscow Basin (Aljutovo, Yambirno Quarry) (Makhlina *et al.* 2001), and also boreholes in the Samara Bend and Zavolzhye in the eastern Russian Platform (boreholes 401 Syzran, 402 Syzran, 1 Krasnaya Polyana) (Rauser-Chernousova, 1938; Reitlinger, 1961). Data from Russian Platform and South Urals sections show that the basal Vereian Substage is characterized by the appearance of *Aljutovella aljutovica*. This datum occurs at a depth of 551 m in Syzran (Rauser-Chernousova, 1938) and the Vereian Substage extends upward to 489 m. The holotype of *Aljutovella aljutovica* was obtained from borehole 402 Syzran at 508–511 m, 40 m above the traditional Vereian boundary. Abundant *A. aljutovica* occur in the 401- and 402 Syzran boreholes at 40-50 m above the Bashkirian-Moscovian boundary. The level with abundant *Aljutovella* in the Aljutovo section (2.75 m above boundary) corresponds to a similar level in the Samara Bend section and in the upper Solontsyan Horizon in the South Urals (beds 35-37 of the Askyn section). The appearance of *Declinognathodus donetzianus* in the Basu section occurs in the lower Solontsyan Horizon within the *Depratina prisca* Zone (Kulagina *et al.* 2009).

Ivanova (2008) published a beautifully illustrated monograph on fusulinids (and calcareous algae) of the Bashkirian and Moscovian stages in the Urals. The volume is the most up-to-date summary of fusulinid species-level occurrences and zonal stratigraphy for the middle Carboniferous in a belt extending from Pechora in the north to Aktyubinsk in the south. The author places the base of the Moscovian Stage throughout the Urals at the base of the *Depratina* [= *Profusulinella*] *prisca*—*Aljutovella aljutovica* Zone, although occurrences of *D. prisca* are reported from the upper part of the uppermost Bashkirian Asataussky Horizon.

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The **Task Group to establish the Moscovian-Kasimovian boundary**, chaired by Katsumi Ueno, is conducting intensive biostratigraphic research in Europe and Asia but a lineage and taxon suitable for boundary definition have not been selected. The task group is focusing on the stratigraphic occurrence and distribution of the conodonts *Idiognathodus sagittalis* Kozitskaya 1978 and *Idiognathodus turbatus* Roscoe and Barrick 2009 and their ancestors as potential biostratigraphic markers for defining the base of the Kasimovian Stage. The use of either conodont would raise the boundary level one substage from the traditional position at the base of the Krevyakinian Substage, to approximately the base of the Khamovnikian Substage but the move will facilitate global correlation. Other biostratigraphic and lithostratigraphic events near the FAD levels of the species will be examined because of their potential as auxiliary events for identifying the base of the Kasimovian Stage. Using the research direction, the group made the progress summarized below.

Cantabrian Mountains, NW Spain. Spanish task-group members are continuing with their study of the Moscovian-Kasimovian transition in the Castillo del Grajal and Morra del Lechugales sections, (Andara Massif in Picos de Europa structural unit of Cantabrian Mountains), which embrace the uppermost part of the carbonate-dominant Picos de Europa Formation and the Las Llacerias Formation (Villa *et al.*, 2009). Fusulinid biostratigraphic data indicate the study interval ranges from the top of the *Fusulinella* Zone (upper Moscovian) to the lower *Montiparus* Zone (Khamovnikian Substage). The *Protriticites* Zone, spanning at least 245 m, is well exposed and fusulinid rich. Preliminary sampling indicates the occurrence of the conodont *Idiognathodus sagittalis* and its potential ancestor *Idiognathodus* n. sp. 1 of Goreva *et al.* (2009), allowing correlation with the Moscow Basin and the North American Midcontinent.

South China. Task group members are studying the boundary interval in several sections in southern Guizhou Province, south China. James E. Barrick and Qi Yuping have been collaborating in examining existing and new collections of conodonts from the Nashui section in southern Guizhou Province, China (Wang and Qi, 2003) and plan to publish preliminary results in the field guide for the November 2010 SCCS field meeting in Nanjing. Study of the specimens will facilitate recognition of the approximate position of the Moscovian-Kasimovian Stage

boundary in the Nashui section. At Nashui, latest Moscovian conodont faunas are characterized by abundant elements of *Swadelina* spp. and a few elements of *Idiognathodus* spp. The base of the Kasimovian is marked by the disappearance of *Swadelina* and appearance of *Idiognathodus* morphotypes of the *I. swadei-I. sagittalis* group, including at least one form (Wang and Qi, 2003, pl. 4, fig. 21) that may be the early Missourian species *I. turbatus* Rosscoe and Barrick 2009. Overlying Kasimovian conodonts include, in ascending order, the *Streptognathodus guizhouensis*, *Idiognathodus magnificus?* and *Streptognathodus excelsus* faunas.

This summer, the recently discovered Loukun section in southern Guizhou Province, exposed along a road leading to the village of Loukun, was measured and sampled for fusulinids and conodonts to place the Nashui section into its geological context, provide another opportunity to study conodonts and fusulinids spanning the Moscovian-Kasimovian boundary in south China, and prepare the field guide for the November 25th-30th 2010 field excursion for the SCCS field meeting organized by the Nanjing Institute of Geology and Palaeontology. The Loukun section occupies an intermediate depositional position between the shallow-marine shelf deposits in the Zhongdi section 30 km southeast of the town of Ziyun (Ueno *et al.*, 2007) and lower- to middle-slope deposits at Nashui.

Moscow Basin, Russia Alexander Alekseev, Natalia Goreva, Tatiana Isakova and Olga Kossovaya have been studying specimens collected during 1994 from the poorly-exposed Stsherbatovka section (in an abandoned quarry) on the Oka-Tsna Swell of the Ryazan Region, east of the town of Kasimov on the left bank of the Oka River, Moscow Basin (see Alekseev *et al.*, 2009). In the section, the middle part of the Neverovo Formation (Khamovnikian Substage), consisting of marls and shales with limestone intercalations, contains abundant macrofauna. Conodonts occur as well but are not common and most elements are juveniles belonging to the *Idiognathodus sagittalis-I. turbatus* group. *Idiognathodus sulciferus* was also identified. Earlier, fusulines were used to correlate this interval with the Krevyakinian *Obsoletes obsoletus* Zone, but the conodonts suggest a younger age. The Stsherbatovka section, about 250 km southeast of the better-known Afanasievo section in the Moscow Basin (Alekseev *et al.*, 2009a), is important because it demonstrates a wider distribution of the marker conodont species for identifying the base of the Kasimovian. The Afanasievo section can be considered as a potential candidate for the GSSP of the Kasimovian Stage.

Southern Urals, Russia The Dalniy Tyulkas section, located several kilometres south of the Usolka section in the southern Urals (Chernykh *et al.*, 2006; Davydov *et al.*, 2008), is a composite section comprising three discrete segments (Dalniy Tyulkas 1, 2, and 3) and ranges from the upper Moscovian to the Permian Artinskian Stage. It is a deeper-water succession containing abundant conodonts. Segment 1 spans the upper Moscovian to basal Kasimovian and Alekseev, Goreva, and others are studying the conodont succession within it. They recognized the *Streptognathodus subexcelsus* and *Swadelina makhlinae* assemblages in the upper part of this section. These assemblages are characteristic of the Suvorovo and Voskresensk formations, respectively, of the regional Krevyakinian Substage (traditional lower substage of Kasimovian) in the Moscow Basin (Goreva *et al.*, 2009). Dalniy Tyulkas 1 is the first section outside the Moscow Basin where these two lower Kasimovian conodont zones have been recognized. Dalniy Tyulkas 2 comprises upper Moscovian-lower Gzhelian strata. Chernykh and Reshetkova (1987) reported on the conodonts in it but Alekseev, Goreva, and others are reinvestigating them. In the middle part of segment 2, they found *Idiognathodus sagittalis*, one of the species the task group has chosen as a potential biostratigraphic marker for defining the base of the Kasimovian (Villa and Task Group, 2008; Ueno and Task Group, 2009). Overall, segment 2 of the Dalniy Tyulkas section is a promising candidate for the Moscovian-Kasimovian boundary stratotype.

Ukraine. Davydov *et al.* (2010) published data on high-precision U-Pb ages of tuffs and tonsteins, with an age resolution of ~100 ka, to radiometrically calibrate the detailed lithostratigraphic, cyclostratigraphic, and biostratigraphic frameworks of the Donets Basin in the Ukraine. Based on this precision, they confirmed the long-standing hypothesis that individual high-frequency Pennsylvanian cyclothems and bundling of cyclothems into fourth-order sequences are the eustatic response to the orbital eccentricity (~100 and 400 ka) forcing within the Milankovitch Band. Their work facilitates a more precise cyclostratigraphic calibration for the Moscovian-Gzhelian interval in the Donets Basin.

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The **Task Group to establish the Kasimovian-Gzhelian boundary**, chaired by Katsumi Ueno has selected the conodont *Idiognathodus simulator* (s.s.) as the event marker for defining the base of the Gzhelian Stage (Heckel *et al.*, 2008) and is directing research toward studying the Gzhelian in the vicinity of its stratotype and selecting a suitable section for the GSSP.

Russia. In August 2009, the I.U.G.S. Subcommittee on Carboniferous Stratigraphy held an international field meeting in the Moscow Basin and southern Urals of Russia to examine historical type sections and proposed and potential GSSPs of the Carboniferous (Alekseev and Goreva, 2009; Puchkov *et al.*, 2009). The visited sections that are closely related to the task group's work are the Gzhel stratotype situated in a quarry by the Gzhel railway station in the Moscow region (Alekseev *et al.*, 2009) and the Usolka (Chernykh *et al.*, 2006; Davydov *et al.*, 2008) and Dalniy Tyulkas sections in the southern Urals.

With the help of Aleksey Reimers and Yuliya Ermakova, Alekseev and others studied an important Gzhelian-Asselian reference section at Yablonovyy Ovrage in the Samara Bend of the Volga River, about 800 km east southeast of Moscow. In that section, they found *Idiognathodus simulator* in the interval traditionally considered to contain the base of the Gzhelian on the basis of fusulines. The occurrence is important because it fills a geographical gap in the distribution of *I. simulator* between the Moscow Basin and southern Urals, and reinforces the importance of the taxon for defining the base of the Gzhelian Stage.

In the southern Urals, the Usolka section was visited during the 2009 SCCS field meeting to investigate its utility as a base-Gzhelian GSSP candidate. To date, this is the only section that has been formally proposed as a potential candidate for the GSSP defining the base of the Gzhelian Stage (Chernykh *et al.*, 2006). Later, Davydov *et al.* (2008) documented in detailed the faunal and correlation of the Kasimovian-Gzhelian transition at Usolka. Unfortunately, the Kasimovian-Gzhelian boundary interval of the Usolka section is now largely concealed by soil and vegetation. Plans are being made to re-expose the succession and inspect the results reported by Chernykh *et al.* (2006) and Davydov *et al.* (2008).

The Dalniy Tyulkas section, located several kilometers south of the Usolka section, is a composite consisting of three discrete segments (Dalniy Tyulkas 1, 2, and 3) ranging from the upper Moscovian to the Permian Artinskian Stage. It represents a deeper-water succession with abundant conodonts. Dalniy Tyulkas 2 is an upper Moscovian-lower Gzhelian section, and conodonts were reported earlier by Chernykh and Reshetkova (1987). Alekseev, Goreva and others are reinvestigating the conodont succession in segment 2 and have discovered *Idiognathodus eudoraensis* Barrick, Heckel and Boardman (2008) and *I. simulator* in the section's upper part. *I. simulator* is the event marker for the base of the Gzhelian Stage, and *I. eudoraensis* is interpreted to be its probable

ancestor (Heckel *et al.*, 2008). Segment 2 of the Dalniy Tyulkas section is a promising candidate for the Kasimovian-Gzhelian boundary stratotype.

South China. James Barrick and Qi Yuping are collaborating to examine existing and new collections of conodonts from the Nashui section (Wang and Qi, 2003) in southern Guizhou Province, China and plan to publish preliminary results in the field guide for the November 2010 SCCS field meeting in south China. Study of the specimens will facilitate recognition of the approximate position of the Kasimovian-Gzhelian Stage boundary in the Nashui section. Uppermost Kasimovian strata are characterized by morphotypes of *Idiognathodus* (*I. praenuntius?* and *I. eudoraensis?*) that appear to be transitional to *I. simulator*. The base of the Gzhelian is marked by the appearance of *I. simulator*, *I. auritus* and rare specimens of *I. sinistrum*. The distinctive genus *Solkagnathus*, described from the Gzhelian in the Urals (Chernykh, 2005), appears with *I. simulator*. The *Idiognathodus nashuiensis* fauna occurs slightly higher in the Gzhelian, and is followed by the middle Gzhelian *Streptognathodus vitali* fauna. Because the Nashui section is a completely exposed carbonate-slope succession containing a rich conodont record throughout, it has great potential as a GSSP candidate for the Kasimovian-Gzhelian boundary.

Ukraine. Davydov *et al.* (2010) present data on high-precision U-Pb ages of volcanic ash layers, with an age resolution of ~100 ka, to radiometrically calibrate the detailed stratigraphic framework for the Donets Basin in the Ukraine. They confirmed the long-standing hypothesis that individual high-frequency Pennsylvanian cyclothems and bundling of cyclothems into four-order sequences are the eustatic response to the orbital eccentricity (~100 and 400 ka) forcing within the Milankovitch band. Their results facilitate a more precise cyclostratigraphic calibration for the Moscovian-Gzhelian interval in the basin.

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Progress by the **Project Group on Carboniferous Magnetostratigraphy** has been hampered by a shortage of members, insufficient funding, and a lack of integration with the activities of the other SCCS task groups. The group is particularly interested in collaborating with task groups working on sections and boundaries where magnetostratigraphy could be employed, to facilitate international correlations. Sections that have low thermal maturity and are dominated by siliciclastics are the most suitable for magnetostratigraphic analyses (based on the review in the SCCS Newsletter, v. 22: 35-41) but carbonates can be used. Unfortunately, most of the best GSSP candidate sections are carbonate-dominant and thermally over mature but some reference sections and stratotypes for stages show potential. In general, the study of Mississippian magnetostratigraphy has languished and much remains to be done before Carboniferous magnetostratigraphy can be widely applied to facilitate global correlations.

During the last fiscal year, little progress was made on the initial palaeomagnetic assessment of the two sections in southern Scotland that were discussed in the SCCS annual report for the Nov. 1st 2008 to Oct. 31st 2009 fiscal year. The first section is at Cove in the Cockburnspath outlier on the southern flank of the Midland Valley Basin and includes the Inverclyde and Strathclyde groups of latest Devonian to (Asbian) late Viséan age (Cossey *et al.*, 2004; Hounslow 2009). The second section is at Kirkbean on the northern edge of the Northumberland Basin and is of early to late Viséan age, overlapping in age with the upper part of the Cove section. Some progress may occur on the two Scottish sections in 2011, if grant income from United Kingdom sources is forthcoming.

During the May 31st to June 3rd 2010 ICS meeting in Prague, the task group leader discussed with Barry Richards and Svetlana Nikolaeva (Russian Federation) the possibility of designing a magnetostratigraphic project that would evaluate Late Mississippian and Pennsylvanian sections in the Moscow Basin, Lard Basin in northwestern Canada and sections in the mid-continent region of the USA. So far, these initial discussions have not developed into tangible outcomes and the main problems stem from a lack of funding and suitable investigators.

John Utting (member Viséan-Serpukhovian boundary task group) and colleagues Peter Giles (Geological Survey of Canada-Atlantic) and Neil Opdyke (University of Florida) have largely completed a very useful magnetostratigraphic study of the Brigantian, Pendleian and much of the Arnsbergian substages (upper Viséan and Serpukhovian) in the Maritimes Basin of eastern Canada (Giles *et al.*, in progress). They have correlated the polarity reversal patterns in the Maritimes Basin with published data from the Brigantian to mid-Arnsbergian interval in the central part of the Appalachian Basin in the eastern United States (Di Venere and Opdyke, 1990, 1991).

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SUBCOMMISSION ON DEVONIAN STRATIGRAPHY

ANNUAL REPORT 2010s

1. TITLE OF CONSTITUENT BODY

Subcommission on Devonian Stratigraphy

Submitted by:

R. Thomas BECKER, *Chair of SDS*

Westfälische Wilhelms-Universität, Institut für Geologie und Paläontologie, Corrensstr. 24, D-48149 Münster, Tel. +49-251-83 339 51, fax +49-251-83 339 68; rbecker@uni-muenster.de

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

SDS has continued in 2010 its work on the revision of existing but problematical GSSPs (Emsian, Devonian-Carboniferous boundary) and on the formal definition of substages. Reports on both were presented at the Prague ICS Workshop. Other activities cover the improvement of multidisciplinary international correlation, the Devonian chapter to the next GTS volume, the organisation of Devonian stratigraphic symposia, and the publication of its SDS Newsletter and of monographic books/journal volumes. SDS objectives for 2010 can be summarized as:

- Work on formal definitions of Pragian, Givetian, Frasnian, and Famennian substages
- Revision of the basal Emsian GSSP in Uzbekistan
- Revision of the D/C boundary in the frame of the new D/C Boundary Working Group and in close collaboration with the Carboniferous Subcommission
- Preparation for a new Devonian IGCP, as follow-up to the out-phased IGCP 499 (in co-operation with P. KÖNIGSHOF, Th. SUTTNER and others)
- Publication of volumes on Devonian stratigraphy, partly in co-operation with IGCP 499
- Compilation and distribution of SDS Newsletter 25
- Official Business meeting in conjunction with the 3rd International Palaeontological Congress (IPC3), London, June/July 2010
- Full-day Devonian symposium and one week field trip to the Old Red Devonian in conjunction with IPC3
- Support for additional international Devonian symposia ("STRATI 2010", Paris)
- Revision of Devonian chapter for the GTS 2010 volume
- Intensive cooperation with ICS (e.g., Prague ICS Workshop)
- Juvenation of SDS Membership and enlarging its scientific capacity by the hiring of new active members

All listed objectives fit the directions of IUGS and ICS:

- development of an internationally approved chronostratigraphical timescale for the Devonian with maximum time resolution;
- promotion of new and modern stratigraphical techniques and their integration into Devonian multidisciplinary schemes;
- application of GSSP decisions internationally and as a base for a better understanding of patterns and processes in Earth History, including Devonian major global environmental changes.

3. ORGANIZATION

Officers for 2008-2012

Chair: Prof. Dr. R. Thomas BECKER, WWU Münster, Germany

Vice-Chair: Prof. Dr. Ahmed EL HASSANI, Institute Scientifique, Rabat, Morocco

Secretary: Dr. John E. MARSHALL, University of Southampton, U. K.

The Subcommission has currently further 18 Voting Members that cover many major Devonian outcrop areas and many stratigraphical disciplines (see Appendix).

The SDS Membership covers currently the following 29 countries (in alphabetical order): Australia, Austria, Belarus, Belgium, Bolivia, Bulgaria, Canada, China, Czechia, Estonia, France, Germany, Great Britain, Iran, Italy, Latvia, Lithuania, Morocco, Myanmar, New Zealand, Pakistan, Poland, South Africa, Spain, USA, Uzbekistan,

Tadzhikistan, Turkey, Vietnam. At national level several Devonian Subcommissions exist in various countries, partly under different organisational names (e.g., Germany, Russia, “Friends of the Devonian” at GSA meetings).

Website: <http://www.unica.it/sds/>

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

SDS is traditionally strongly tied with IGCP projects that have a Devonian focus. Until 2010 this was IGCP 499 on “Devonian land-sea interaction: evolution of ecosystems and climate” (DEVEC), led by P. KÖNIGSHOF and colleagues from the Senckenberg Institute, Frankfurt a. M., Germany. Plans for a successor project on “Climate change and biodiversity patterns in the Mid-Paleozoic” by P. KÖNIGSHOF, Th. SUTTNER, and others, have advanced far. Formal support was also awarded to a new IGCP proposal on “The Early to Middle Paleozoic Revolution: Bridging the Gap between the Great Ordovician Biodiversification Event and the Devonian Terrestrial Revolution”, brought forward by B.D. CRAMER, T.R.A. VANDENBROUKE, and others.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

Chronostratigraphic definitions:

The main arguments for formally defined substages were summarized in a presentation at the Prague ICS Workshop:

- Some Devonian stages are much longer than usual Phanerozoic stages (Famennian: ca. 15Ma, Emsian: up to 17 Ma)
- There are significant global events and extinctions within stages that give natural subdivisions
- Substages are widely in use but without any agreement
- Devonian biostratigraphy is so detailed that good tools for global correlation within stages are available
- There are classical regional stages in various regions that can serve for international subdivision (e.g., equivalents of Belgian Strunian and Czech Dalejan)

PRAGIAN SUBSTAGES

The 2008 decision to utilize the current basal Emsian GSSP as future GSSP of a formal Upper Pragian substage (“Zinzilbanian substage”) has been substantiated during the discussion at the London Business Meeting. However, any formal decision has to await the Emsian revision and the clarification of the process of formal substage recognition by ICS.

REVISION OF BASAL EMSIAN GSSP

Four research lines concerning the Kitab Emsian GSSP have been followed intensively and led to publications/abstracts. These are:

- A revision of Emsian ammonoids of the Kitab Reserve (Becker et al. 2010, SDS Newsletter 25)
- A revision and new description of all Pragian to Eifelian trilobites from Uzbekistan, including the new material from around the anticipated future Emsian GSSP level (“*excavatus* boundary”; Owens et al. 2010, Memoirs of the Association of Australasian Palaeontologists 39)
- Magnetostratigraphy of the Zinzilban GSSP and “dynamic time warp” correlation with the Barrandian (Hladil et al. 2010 submitted)
- Work on Zinzilban and correlative Pragian/Emsian conodonts (e.g., Valenzuela-Ríos & Martínez-Pérez 2010, London Abstract; Martínez-Pérez et al. 2010 submitted to Rivista Italiana di Paleontologia e Stratigrafia)

The resampling of the interval around the expected entry of *Polygnathus excavates* by several independent workers, above the current GSSP, especially of its “Morphotype 114” (as the currently discussed best future GSSP candidate level), unfortunately, resulted in a very poor recovery of polygnathid conodonts. Based on the previous publications, this was not expected and the consequences are not yet clear and have to await the final results. Possibly it will be necessary to move to one of the adjacent sections within the Kitab Reserve of eastern Uzbekistan. A revision of the dacryoconarid stratigraphy has not yet been completed. The promise for a review of the Zinzilban graptolites (given at the Prague Meeting) was severed by the unexpected death of T. KOREN.

EMSIAN SUBSTAGES

The decision on an intra-Emsian substage GSSP also will have to await the Emsian GSSP revision. Due to medical problems of Czech investigators, the announced revision of relevant Barrandian dacryoconarids from the Emsian has not yet been finalized or published. Especially important is the revision of the *Nowakia elegans-cancellata* transition.

New Moroccan data (Becker et al. 2010, London Abstract) showed the necessity to distinguish between the successive, transgressive Upper Zlichov (ca. *nothoperbonus* Zone) and true Daleje Events (within *laticostatus* Zone) around the future substage boundary. Tafalalt sections contain just below thick Daleje Shale equivalents polygnathid conodonts that, based on previously studied other areas (e.g., La Grange Limestone, France), may serve as an alternative to nowakiids but research has only just started.

GIVETIAN/FRASNIAN SUBSTAGES

The continuing uncertainty concerning the formal recognition of substages by ICS has further delayed the submission of proposals concerning Givetian and Frasnian substages, which already have been subject to formal vote by SDS. Important new Givetian data have just been published online in "Palaeogeography, Palaeoclimatology, Palaeoecology" (ABOUSSALAM & BECKER 2010, BRETT et al. 2010, ELLWOOD et al. 2010, MARSHALL et al. 2010). New Frasnian data were presented in several talks at the London Meeting. There is an important clarification of the relationships of the global Middlesex or *punctata* Event, and of the timing of the Alamo Impact (MORROW et al. 2009).

At the SDS Business Meeting it was decided to submit summaries of formal substage proposals at the same time to ICS and, as official SDS recommendations, to Episodes. This will allow their preliminary use whilst the procedure of substage ratification is further clarified. The decided definitions are as follows:

| | |
|-------------------------|--|
| base of Middle Givetian | base of <i>Polygnathus rhenanus-varcus</i> Zone |
| base of Upper Givetian | base of <i>Schmidtognathus hermanni</i> Zone |
| base of Middle Frasnian | base of <i>Palmatolepis punctate</i> or MN 5 Zone, isotope spike |
| base of Upper Frasnian | entry of <i>Palmatolepis semichatovae</i> (ca. base of MN 11 Zone) |

FAMENNIAN SUBSTAGES

Since most relevant data have now been published, the formal vote on an Uppermost Famennian substage will take place at the end of 2010 (results to be expected in SDS Newsletter 26). A voluminous Ph.D. by S. HARTENFELS (defended in summer 2010 - to be published early in 2011) on Famennian conodonts from Germany, Poland, and Morocco will provide a huge new data base for the unsettled discussion concerning the Middle/Upper Famennian stage boundary. Data from a similarly voluminous, still unpublished study on the Famennian of Franconia (conodonts by H. TRAGELEHN) should also become available in 2011. Equally important are new results concerning the Polish Kowala section (RACKA et al. 2010, Palaeogeography, Palaeoclimatology, Palaeoecology 297 (3/4)). But decisions on the bases of the Middle and Upper Famennian may have to wait until 2012.

REVISION OF THE D/C BOUNDARY

The new D/C Boundary Task Group met right after the London SDS Business Meeting and a special conodont workshop took place in the afternoon of the same day (1st July), in conjunction with the Pander Society Workshop organized by Stephen A. Leslie. Following the joint proposal by the SDS and SCS Chairmen, Markus ARETZ, the SCS Secretary, was elected as new Task Group Chairman, with Carlo CORRADINI, the SDS Homepage Webmaster, as Vice-Chairman. Presentations, partly repeating the contributions to the SDS Event Symposium of the previous day, gave summaries of the new critical data concerning the current La Serre GSSP (S.I. KAISER), the taxonomy of siphonodellids and protognathodids (C. CORRADINI & S.I. KAISER), and new data on the new Kule (Uzbekistan, S.I. KAISER, R. T. BECKER & H. MATYJA) and Lalla Mimouna sections (Maider, Morocco, R.T. BECKER, Z.S. ABOUSSALAM & H. HARTENFELS). The partly heated discussion showed that much more work is needed in order to reach a consensus of conodont specialists concerning the taxonomy, origin, and evolution of the two critical conodont lineages, especially of the siphonodellids. In this context it was very disadvantageous that H. TRAGELEHN could not attend after an unfortunate traffic accident just before the meeting. His new insights, briefly outlined in SDS Newsletter 25, that are based on new Franconia collections, currently cannot be followed by other specialists. His manuscript has been completed in the meantime and will be submitted for publication in January. Russian siphonodellid collections examined jointly during the workshop added further questionmarks.

In summary it is clear that a breakthrough of conodont revisions has not yet been reached but it is a positive sign that many new data come in. Workers on neritic faunal groups are monitoring the current conodont discussions closely and eventually will have to contribute new data, too. The proposal to lower the boundary to the level of the main Hangenberg Event (base of Hangenberg Black Shale) and mass extinction has become a serious alternative.

Publications:

- BECKER, R. T. (Ed.) 2010. SDS Newsletter 25. - 100 pp., Westfälische Wilhelms-Universität Münster. [a formal publication, with ISSN No. 2074-7268]

- BRETT, C.E., SCHINDLER, E. & KÖNIGSHOF, P. (Eds., online 2010). Sea-level cyclicality, climate change, and bioevents in Middle Devonian marine and terrestrial environments. – A thematic issue of Palaeogeography, Palaeoclimatology, Palaeoecology, 10 contributions).

SDS Members also contributed significantly to a new Devonian volume (No. 39) of the Memoirs of the Association of Australasian Palaeontologists, published in November 2010.

Meetings:

- SDS Annual Business Meeting at the 3rd International Palaeontological Congress, associated with a full-day (total of 38 contributions) symposium on “Devonian Bioevents: Timing, Palaeoecological and Evolutionary Patterns” (organized by the Chairman), followed by a joint SDS/SCS meeting of the International Task Group on the Devonian/Carboniferous Boundary.
- Palaeozoic sessions co-organized by French SDS Members at the 4th “French” Congress on Stratigraphy (STRATI 2010), August/Septembre 2010 (with official SDS support): Session 21 on “Refining the Palaeozoic time scale” and Session 22 on “Interactions between Palaeozoic stratigraphy, geography and climates”. These were augmented by a Palaeozoic excursion to Brittany.

Membership:

Six new members elected in 2010 come from Austria, Czechia, Russia, and Canada. Unfortunately, two very active and experienced members (J.E. MORROW from the U.S. and T. KOREN from Russia) died this year.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

The open/unsolved procedure for the formal ratification of formal substages delayed the submission of formal proposals to ICS that have already been voted on by SDS. The unexpectedly poor recovery of critical conodonts from higher parts of the Zinzilban GSSP section slowed the Emsian revision process. The inaccessibility of important new conodont data from the Saxothuringian zone of Germany at the London Workshop prevented progress towards a revision of siphonodellid taxonomy and biostratigraphy. Currently, there are largely different opinions concerning the origin of its critical lineages.

SDS is still lacking formal members from a range of countries with extensive and important Devonian outcrops, such as Algeria, Libya, Brazil, Bolivia, Argentine, Turkey, Thailand, Kirgisia, and Caucasian countries. New contacts with Devonian stratigraphers from Algeria, Argentine, and Thailand partly bridge this gap.

7. SUMMARY OF EXPENDITURES IN 2010

INCOME

| | |
|------------------------|---------|
| carried over from 2009 | 356 \$ |
| IUGS subvention 2010 | 2000 \$ |
| Sum | 2356 \$ |

EXPENSES

| | |
|---|---------|
| SDS Newsletter 26, printing/ mailing | 500 \$ |
| Support for three members to attend IPC3 (SDS Business Meeting, Devonian Symposium and D/C Boundary Meeting) | 1400 \$ |
| balance early 2011 | 456 \$ |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011)

- International Conference: “Middle-Upper Devonian and Lower Carboniferous Biostratigraphy of South Urals and Kuznetsk Basin”, in memory of Evgeny A. Yolkin (**SDS Field Meeting**), Ufa, Novosibirsk, Russia, July 20 - August 10, 2011 (for 1st Circular see SDS Newsletter 25: p. 56 – 2nd Circular available on SDDS Homepage or on <http://www.ipgg.nsc.ru>)
- Finalize and submit proposals for the formal definition of Givetian and Frasnian substages to ICS and Episodes.

- Editorial work for of a Proceedings Volume of the London SDS Devonian Event Symposium in “Palaeogeography, Palaeoclimatology, Palaeoecology” (C.E. BRETT, R.T. BECKER & E. SCHINDLER, Eds. – 20 possible manuscripts offered at London)
- Publication of SDS Newsletter 26 in early 2011
- Compilation of conodont results from the various specialists groups that re-sampled the interval for a revised basal Emsian GSSP in the Zinzilban Gorge
- Update/finalization of the Devonian chapter (BECKER, HOUSE & GRADSTEIN) for GTS 2012 (GRADSTEIN et al.)
- Update of SDS homepage
- Active participation in joint Devonian/Carboniferous Boundary Task Group with a focus on conodont revisions and pelagic-neritic correlations
- Progress on Famennian substage definitions
- Preparation for the votes on new SDS officers (due in 2012)

9. BUDGET AND ICS COMPONENT FOR 2011

INCOME

balance from 2010 456 \$

EXPENSES

SDS Newsletter 27 500 \$

support for SDS members to attend the 2011 International SDS
Field Meeting, Russia 1500 \$

request for support/subvention from IUGS/ICS 2000 \$

APPENDIX A

Subcommission officers

CHAIRMAN + SDS NEWSLETTER EDITOR

R. Thomas BECKER

Westfälische Wilhelms-Universität, Geologisch-Paläontologisches Institut, Corrensstr. 24, D-48149
Münster, Tel. +49-251-83 339 51, fax +49-251-83 339 68; rbecker@uni-muenster.de

VICE-CHAIRMAN

Ahmed EL HASSANI, Département de Géologie, Institut Scientifique, B.P. 703-Rabat-Agdal, Marokko;
elhassani@israbat.ac.ma

SECRETARY

John E. MARSHALL, School of Ocean and Earth Science, University Southampton, Southampton
Oceanography Centre, European Way, Southampton SO14 3 ZH, U. K., jeam@soc.soton.ac.uk

WEBMASTER

Carlo CORRADINI, Dipartimento di Scienze della Terra, Università di Cagliari, Via Trentino 51, I-09127
Cagliari, Italy; corradin@unica.it

List of voting members, country, special fields, email:

1. A. BLIECK: France, micro- and macro-vertebrates; alain.blieck@univ-lille1.fr
2. C.E. BRETT: Eastern U.S., sequence and cyclostratigraphy; carlton.brett@uc.edu
3. J.-G. CASIER: Belgium, ostracods; casier@naturalsciences.be
4. CHEN Xiuqin: Nanjing, brachiopods; xqchen@nigpas.ac.cn
5. J. HLADIL: Czechia, stromatoporoids, tabulate corals, various modern stratigraphic methods; hladil@gli.cas.cz
6. N. IZOKH: Siberia, Asian Russia, conodonts; izokhn@uiggm.nsc.ru
7. MA Xueping: Beijing, brachiopods; maxp@pku.edu.cn
8. R. MAWSON: Australia, conodonts; rmawson@laurel.ocs.mq.edu.au
9. J. OVER: U.S., conodonts; over@geneseo.edu

10. M.C. PERRI: Italy, conodonts; perri@geomin.unibo.it
11. G. RACKI: Poland, brachiopods, event and sequence stratigraphy; racki@uranos.cto.us.edu.pl
12. J. DAY, USA/Canada, brachiopods, sequence stratigraphy; jeday@ilstu.edu
13. E. SCHINDLER: Germany, tentaculites, event stratigraphy; eberhard.schindler@senckenberg.de
14. V. TSYGANKO: European Russia, corals; tsyganko@geo.komisc.ru
15. J.I. VALENZUELA-RIOS, Spain, conodonts; jose.i.valenzuela@uv.es.
16. U. JANSEN, Germany, brachiopods; ulrich.jansen@senckenberg.de
17. G. YOUNG: Australia, micro- and macrovertebrates, general stratigraphy; gyoung@geology.anu.edu.au
18. ZHU Min: Beijing, vertebrates; zhumin@ht.rol.cn.net

SUBCOMMISSION ON SILURIAN STRATIGRAPHY

ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY

International Subcommittee on Silurian Stratigraphy ISSS

Submitted by:

Michael J. Melchin, *Chairman, ISSS*
Department of Earth Sciences
St. Francis Xavier University
Antigonish, Nova Scotia B2G 2W5, Canada
Phone: 902-867-5177; Fax: 902-867-2414
E-mail: mmelchin@stfx.ca

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Mission statement

The objectives of the Subcommittee relate to three main aspects of IUGS policy:

4. The development of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs at Series and Stage levels and related to a hierarchy of units (Substages, Standard Zones, Subzones etc.) to maximize relative time resolution within the Silurian Period;
5. Establishment of frameworks and mechanisms to encourage international collaboration in understanding the evolution of the Earth during the Silurian Period;
6. Working towards an international policy concerning conservation of geologically important sites (such as GSSPs, global and regional stratotype sections, etc.).

Goals

5. Rationalization of global chronostratigraphical classification.
6. Intercalibration of fossil biostratigraphies, integrated zonations, and recognition of global datums.
7. Establishment of magneto- and chemo-stratigraphic scales.
8. Definition of Stage boundaries and restudy of global stratotype sections.
9. Correlation of Silurian rock successions and events, including marine to non-marine.

3. ORGANIZATION

The ISSS is a Subcommittee of the Commission on Stratigraphy. The Subcommittee is organized by an Executive consisting of Chairman, Vice-Chairman and Secretary, who are all Voting Members of the Subcommittee. In the new Subcommittee elected for 2008-2012 there are twelve other Voting Members. The network of Corresponding Members have, first of all, a responsibility for communication in both directions between the Subcommittee and researchers on Silurian topics in their region. Secondly they represent a broad spectrum of specialized stratigraphical disciplines from those countries or regions where Silurian rocks are extensively studied in relation to fundamental and/or applied geological research.

Officers for 2008-2012:

| | |
|-------------|--------------------------------------|
| Chair: | Michael Melchin, Antigonish, Canada. |
| Vice-Chair: | Peep Mannik, Tallinn, Estonia |
| Secretary: | J. Verniers, Ghent, Belgium |

Current research activities and future plans are communicated through publication of an annual ISSS newsletter, *Silurian Times*, distributed by both email attachment and as a web release.

Websites: <http://www.silurian.cn/home.asp> contains newsletters, meeting announcements, discussion posting-boards, bibliography of Silurian articles, links to related sites, and other information.

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

Collaboration on an IGCP Project N° 503 entitled “*Ordovician Palaeogeography and Palaeoclimate*”. This project ended in 2009 and two special volumes of the journal *Palaeogeography, Palaeoclimatology, Palaeoecology* were published in 2010 containing the contributions of ISSS and ISOS members to this project. Members of the ISSS

have spearheaded a collaboration with ISOS and ISDS members in the proposal of a follow-up project proposal for IGCP, IGCP Project 591, “The Early to Middle Paleozoic Revolution”.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

Silurian Times No 17 was edited by the secretary in June 2010, posted on the web site for the ISSS, and circulated as an email attachment to all titular, corresponding and interested members of the Subcommittee. It contained the reports on previous meetings, announcement of upcoming meetings and publications, and the latest news and recent publications on Silurian research.

A special issue of *Bollettino della Società Paleontologica Italiana* was published containing some of the papers presented at the last Silurian Field Meeting, which took place in Sardinia, Italy, June 4-11, 2009. As reflected in the diversity of papers in this volume, the meeting was particularly successful in advancing one of the stated goals of the ISSS, integration of data from different biostratigraphic, chemostratigraphic and lithostratigraphic perspectives, all focused toward a better resolution of Silurian time and understanding of the processes and events that operated in this interval.

Plans are well under way for the next International Symposium on the Silurian System. The meeting location will be in Ludlow, England, July 9-15, 2011. In addition to two days of oral and poster presentations, the meeting will have two field trips (pre- and post-conference) that will visit all the Silurian GSSPs that are in Wales and Welsh border areas.

The SSS Chair continued his interaction with scientists at the British Geological Survey to in the development of collaborative research between BGS scientists and members of the Silurian Subcommittee, particularly focusing on the restudy of the type areas for the GSSPs for the Silurian, all of which occur in the UK except for the base of the Pridoli. Such work will form the basis of future refinement of the definition and correlation of the GSSP, particularly those in Wales and the Welsh borders, including the bases of Aeronian, Telychian, Wenlock (Sheinwoodian), Homerian, Ludlow (Gorstian), and Ludfordian. Each of these GSSPs can be shown to be in need of refinement. New research by the BGS has resulted in considerable refinement of the stratigraphic and structural framework for this region and this will form an important basis for future deliberations regarding the merits of these GSSPs and their possible need for reconsideration.

As noted elsewhere in this report, the current GSSP for the base of the Wenlock Series has been shown not to correlate with the biostratigraphic level that was stated in its original definition. This has led many ISSS members to suggest that a new GSSP is required for this level. As part of the ongoing efforts to resolve this problem the ISSS Chair (M. Melchin) visited a previously known Llandovery-Wenlock boundary section in the Prague area in June 2010, under the guidance of ISSS Titular Member, Dr. P. Storch. In July, Dr. Melchin met with several Chinese colleagues in Nanjing and studied graptolites from possible GSSP section in Ziyang, China. The results of these investigations will be reported at the ISSS business meeting in Ludlow.

Five of the ISSS Titular Members, including the Chair and Vice-Chair, were co-authors on a paper published in *Lethaia*, outlining a proposed, informal subdivision of the Silurian time scale into stage slices. This proposal will be a subject of discussion at the ISSS business meeting in Ludlow. The paper also presented a generalized carbon isotope curve for the Silurian as well as a updated proposed correlation of the North American regional stages with the global standard scale.

The ISSS Chair, with several colleagues, is currently preparing the chapter on the Silurian System for the 2012 edition of *The Geologic Time Scale*. This chapter is near completion.

All three of the ISSS executive participated in the ICS Workshop “The GSSP Concept”, in Prague, May 30-June 3, 2010. The ISSS chair made a brief presentation on the current state of understanding and some of the revisions and remaining problems associated with several of the Silurian GSSPs.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

The most significant problem encountered in 2010 related to the venue for the 2011 Silurian Field Meeting. The plan agreed upon in 2008 and presented to the members in 2009 was to hold the conference in St. Petersburg, Russia, with a field trip to the Subpolar Urals. However, early in 2010 it became clear to the organizers that the significant financial support that would be necessary to run the meeting, particularly the field trip, would not be available. As result, the plans for this meeting had to be cancelled. Fortunately, David Loydell, Brad Cramer, David Ray, and Jan Zalasiewicz put together an excellent plan to run the ISSS meeting in the summer of 2011 centred in the Ludlow area of UK. The field trips will focus on the British Silurian GSSPs and their stratigraphic context.

No other major problems except for the old problem related to difficulties in obtaining grants for research on stratigraphical topics and travel to meetings of Subcommittee. Applications are often given low priority by national grant-awarding agencies. It would be helpful if IUGS emphasized to its member countries the importance it attaches to the GSSP programme and encouraged the relevant research funding bodies to give priority to funding relevant basic research.

7. SUMMARY OF EXPENDITURES IN 2010

| | | |
|----------------|--------------------------------------|--------------|
| Income | | |
| | Carried forward from 2009 | nil |
| | ICS Allocation | US\$1000 |
| Total | | US\$1000 |
| Expenditure | | |
| | ICS GSSP workshop expenses Secretary | US\$1000 |
| <u>Balance</u> | | <u>US\$0</u> |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

Regular updating the website for Silurian Subcommittee. We gratefully acknowledge the support of the Nanjing Institute of Geology and Palaeontology Academia Sinica for this work.

Publication of Silurian Times Newsletter 18

International Symposium on the Silurian System in Ludlow, England, July 2011. The meeting location will be in Ludlow, England, July 9-15, 2011. In addition to two days of oral and poster presentations, the meeting will have two field trips (pre- and post-conference) that will visit all the Silurian GSSPs that are in Wales and Welsh border areas. These will provide an opportunity for a new generation of Silurian scientists to see the GSSP and for those working in this region to synthesize the results of recent research on these sections.

Publication of Bulletin of Geosciences on current research on the Silurian System/Period. Although this volume will follow shortly after the Ludlow meeting, contributions to the volume will not be restricted to papers presented at that meeting.

Publication of a special volume of Proceedings of the Yorkshire Geological Society honouring the lifetime contributions of Dr. Barrie Rickards, a well known and respected Ordovician-Silurian graptolite paleontologist and stratigrapher. Invited papers will focus on current research in graptolites, including contributions from Silurian graptolite researchers.

Publication of a special volume of papers entitled "Siluro-Devonian Studies", to be published as a Memoir of the Association of Australasian Palaeontologists.

Continued progress on the refinement of our understanding of Silurian GSSPs, particularly in collaboration with the ongoing regional mapping programme of the British Geological Survey in Wales and the Welsh Borders. In particular, collaborative studies of the chemostratigraphy and palynology of the Llandovery sections are under way and planned for 2011.

Initiation of the activities of IGCP 591, if successfully funded. The planned milestones for 2011 are: A research focus on improving global biostratigraphic and chronostratigraphic correlation; project participation in the 2011 Silurian Field Meeting in Ludlow; participation in the 2011 International Symposium on the Ordovician System in Madrid, Spain, May 9-13, 2011; participation in other regional conferences. In the event that this project is not successfully funded, ISSS members will continue to pursue these research objectives and will likely reapply to IGCP in 2011.

Focus of ISSS members on continued collaboration on the process of full integration of the various regional and global biostratigraphic, lithostratigraphic, sequence stratigraphic, and chemostratigraphic scales. This integration is essential for refinement of the Silurian time scale and high-resolution correlation of Silurian events. In addition, some ISSS members are focusing on generation of new, high-resolution radiometric dates that are well constrained within the Silurian time scale. This is essential to achieve better calibration of this scale, which is has been a serious weakness for the Silurian System.

9. BUDGET AND ICS COMPONENT FOR 2011

Contribution toward transportation, accommodation & registration of the

Chair, Vice-Chair and Secretary to participate in the in the ISSS Field Meeting in Ludlow – \$4000.00
Financial support for field trips to Silurian GSSPs to enable other ISSS members to participate – \$6000.00

The ISSS has done pioneering work in the area of restudy of previously ratified GSSPs (see below). Recent work has shown that many of the Silurian GSSPs, all of which were ratified in the mid-1980s, have serious deficiencies in terms of their potential use as benchmarks for high-resolution global correlation. It is essential, if the ISSS is to make informed decisions regarding possible revision or replacement of some of the GSSPs, that members of the ISSS executive and as many corresponding members as possible attend these trips, see the sections, and review our current state understanding of them.

Total requested from ICS: \$10,000.00

Potential funding sources outside IUGS

Most of the costs of Working Group newsletter, meetings and other activities will be met by local support from host institutions and participation by individuals by national research and travel grants from their own authorities.

10. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2006-2010)

Over the period of 2006-2010 the Subcommittee on Silurian Stratigraphy was active in several respects. The most recent of these activities are summarized above under the heading of “CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010”. In addition to those, the following are the most significant accomplishments of the past five years.

1) The restudy of the base of the Silurian System. A restudy of the GSSP for the Base of Silurian was prepared in 2002 by a working group under the leadership of Michael Melchin. After three years work, the working group has unanimously agreed that the current GSSP, at 1.6 m above the base of the Birkhill Shale, at Dob’s Linn, Scotland, should be maintained as the GSSP, but the biostratigraphical definition of the boundary needs to be revised. The GSSP should be regarded as coinciding with the first appearance of *Akidograptus ascensus*, defining the base of the *A. ascensus* Biozone at that GSSP section. By the middle of March 2006 all titular members have voted in favour of the proposal of Mike Melchin for the base of the Silurian at Dob's Linn. It has now been ratified by ICS and IUGS and a final report has been published in the September 2008 issue of *Episodes*.

2) Regarding the restudy of the base of the Wenlock Series. The working group to restudy the Base of the Wenlock Series (base of Sheinwoodian Stage) was led by David Loydell, looked at potential GSSP sections in the Czech Republic and Wales, as possible alternatives to the current GSSP in England. The primary marker for the base-Wenlock was a graptolite, but the GSSP in England is notably poor in allowing exact determination of their ranges. Recent evidence has shown that the current GSSP does not coincide with the base of the *Cyrtograptus centrifugus* Biozone, as was supposed when the GSSP was defined. It has been suggested to retain the GSSP location in England but revise the level of the GSSP to coincide with a conodont event -- the Ireviken conodont datum 2. The correlation between this level and the graptolite biozonation is a matter of some controversy. It is either approximately correlative with the base of the lower *murchisoni* graptolite Biozone (instead of the current *centrifugus* graptolite zone), or else a level high within the *murchisoni* graptolite Biozone. Alternatively, another GSSP locality with a precise base of the *Cyrtograptus centrifugus* Biozone could be chosen (e.g., potential sections in Great Britain or the Czech Republic), but this process would be quite lengthy. The report of this work at the Silurian Field Meeting in Gotland, in August, 2005, was discussed over the winter and spring, 2006. Most voting members appreciated very much the amount of work by the working group and especially the leader of the group. But most felt that for the moment that no good alternative for the previous GSSP can be proposed. It was decided not to propose a new GSSP and stick for the time being to the old GSSP, although it had many shortcomings, until new studies can propose a better alternative. This time consuming study could however not be completed before the deadline of the ISC, ending at the International Geological Congress in Oslo summer 2008.

At the 2009 Silurian Field Meeting in Sardinia many of the ISSS members expressed their desire to continue to search for a new GSSP for the Base of Wenlock to replace the current one. Those members felt that it would be in the best interest of stability to find a new GSSP whose level coincides with the base of the *Cyrtograptus centrifugus* Biozone. Other members expressed the view that, with additional study, it may be that the current GSSP can be shown to provide a high level of biostratigraphic resolution based on its conodont faunas and that it would be in the best interest of stability to keep the current location and level. This is a matter of ongoing research and discussion for the Subcommittee.

3) An International Conference on the Silurian System was held in Nanjing, China, in June-July 2007, hosted by the Nanjing Institute of Geology and Palaeontology. 22 talks and posters were presented on the Silurian and three excursions to the extensive Silurian outcrop areas of South China with more than 70 participants impressed the participants by the good exposures and the extensive work that was done in these sections. Conference proceedings were published in a special issue of *Acta Palaeontologica Sinica*.

4) ISSS members participated in 19 conferences in which IGCP 503 held sessions or symposia and undertook collaboration on planning of a followup IGCP project proposal, IGCP 591.

5) The Silurian Field Meeting, called “*Time and life in the Silurian: a multidisciplinary approach*” was held between 4-11 June 2009 in Sardinia, Italy. The meeting (organized by Petr Storch, Enrico Serpagli and Annalisa Ferretti) consisted of three days of scientific communications followed by a four days field trip in southern Sardinia. More than fifty scientists from fifteen countries attended the meeting. The scientific sessions were filled with talks dealing on any aspect of Silurian stratigraphy and palaeontology; the poster session included 18 posters.

In connection with the meeting, three special volumes were published in the series of the *Rendiconti della Società Paleontologica Italiana*: A. The Silurian of Sardinia - Corradini C., Ferretti A. & Storch P. (Eds.), 170 pp. The volume is dedicated to Prof. Enrico Serpagli, to celebrate his more than 40 years of activity in the Lower Palaeozoic of Sardinia. The volume comprises contributions that include an historical overview of the studies already carried out on the Silurian faunas of Sardinia, a global overview of the palaeoenvironment and palaeogeography, and seven research papers that illustrate current knowledge of major fossil groups encountered in the Silurian limestones and shales of southern Sardinia. B. Time and Life in the Silurian: a multidisciplinary approach - Field Trip Guidebook - Corradini C., Ferretti A. & Storch P. (Eds.), 96 pp.

A brief geological and stratigraphical overview of the Silurian of Sardinia introduces to the excursion itinerary with locality descriptions. C. Time and Life in the Silurian: a multidisciplinary approach - Abstracts - Corriga M.G. & Piras S. The volume includes the forty-seven abstract of the talk or posters presented at the meeting. The pdf of the volume is available in the meeting web page (www.unica.it/silurian2009).

As noted above proceedings volume was published in a special issue of *Bollettino of the Società Paleontologica Italiana* in 2010.

OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2011-2014)

In addition to the points listed above as “WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR”, many of which will extend into future years, the priorities (not in order of merit) proposed for the Silurian Subcommittee for the next four years include:

Silurian Field Meeting in 2013, location to be announced.

The research objectives for the proposed IGCP Project 591 are to investigate the biological, chemical and physical evolution of the ocean-atmosphere-biosphere system during this dynamic interval of Earth history by addressing in detail the relationships between climate, sea level, tectonics, biology, oceanography, volcanism, and the stratigraphic record of Early to Middle Paleozoic global planetary change. This project will be conducted in collaboration with the International Subcommissions on Ordovician, Silurian, and Devonian Stratigraphy (SOS, SSS, SDS), and will be accomplished in successive steps over the five-year duration of the project (2011-2015).

- 2011 – Improving global biostratigraphic and chronostratigraphic correlation
- 2012 – Reconstructing global sea levels, sequence stratigraphy and paleogeography
- 2013 – Identifying biological, chemical and physical indicators of global planetary change
- 2014 – Addressing evolutionary paleoecology, paleobiodiversity and paleobiogeography
- 2015 – Oceanographic and climate modeling of Early to Middle Paleozoic events

International and regional conferences are planned for the five-year duration of the proposed projects, as well as special publications each year. As noted above, in the event that this project is not funding, we will likely reapply in 2011. In addition, these are many of the research objectives that ISSS members will pursue regardless of the success of this project.

As also noted above, ISSS members are collaborating with the British Geological Survey in the remapping and stratigraphic reinvestigation of the GSSPs and surrounding type regions for the bases of the Aeronian, Telychian,

Wenlock (Sheinwoodian), Homerian, Ludlow (Gorstian), and Ludfordian. It is our objective to complete integrated biostratigraphic, chemostratigraphic, and sequence stratigraphic of each of the GSSPs. At the present time, each of these GSSPs has a significant level of imprecision in its definition for the purposes of high resolution stratigraphic correlation. It is our hope that these restudies will increase the precision with which the GSSPs can be defined and correlated, as has been the case with the restudy of the Base of the Silurian. If not, this work may provide a compelling rationale for seeking a replacement section and point for one or more of the current GSSPs.

We will investigate the establishment of databases which would bring together and make available information from all sources associated with the Silurian researchers. One such database has been created at the Nanjing Institute of Geology and Palaeontology by Dr. Fan Junxuan, who is also Webmaster for ISSS. This database, called Geobiodiversity Database (GBDB) is currently in the advanced development stage. Associated with this will be the development and expansion of the Thematic Working Groups: for example, searching for and interpreting data from all sources relevant to reconstructing the palaeobiogeography or the climate of one or more specific time-intervals.

Other related activities include participation in the production of a new volume synthesizing our current understanding of Palaeozoic Palaeobiography. This volume is being edited by D.A.T. Harper and T. Servais.

APPENDIX [Names and Addresses of Current Officers and Voting Members, 2008-2012]
SUBCOMMISSION ON SILURIAN STRATIGRAPHY

Subcommission officers

Chairman: Michael J. Melchin, Department of Earth Sciences, St. Francis Xavier University, Antigonish, NS, Canada, B2G 2W5; mmelchin@stfx.ca.

Vice Chairman: Peep Mannik, Institute of Geology at Tallinn University of Technology Ehitajate tee 5, 19086 Tallinn, Estonia; mannik@gi.ee.

Secretary: Jacques Verniers, Research Unit Palaeontology, Department of Geology and Soil Science, Ghent University, Krijgslaan 281 building S8, B-9000, Gent, Belgium,; Jacques.Verniers@ugent.be.

List of Voting Members

C.E. Brett, Cincinnati, USA, brettce@email.uc.edu

D. Holloway, Melbourne, Australia, dhollow@museum.vic.gov.au

Jin Jisuo, London, Canada, jjin@uwo.ca

M.E. Johnson, Williamstown, USA, Markes.E.Johnson@williams.edu

T.N. Koren', St. Petersburg, Russia, koren@vsegei.sp.ru

J. Krí_, Prague, Czech Republic, kriz@cgu.cz

A. Le Hérisse, Brest, France, alain.le.herisse@univ-brest.fr

D.K. Loydell, Portsmouth, UK, david.loydell@port.ac.uk

P. Mannik, Tallinn, Estonia, mannik@gi.ee

M.J. Melchin, Antigonish, Canada, mmelchin@stfx.ca

A. Munnecke, Erlangen, Germany, axel.munnecke@gzn.uni-erlangen.de

S. Peralta, San Juan, Argentina, speralta@unsj.edu.ar

P. _torch, Prague, Czech Republic, storch@gli.cas.cz

J. Verniers, Ghent, Belgium, Jacques.Verniers@ugent.be

Zhan Renbin, Nanjing, China, rbzhan@nigpas.ac.cn

SUBCOMMISSION ON ORDOVICIAN STRATIGRAPHY
ANNUAL REPORT 2010

1. Name of constituent body:

Subcommission on Ordovician Stratigraphy (SOS)

Submitted by:

David A.T. Harper
Chairman, ISOS
Natural History Museum of Denmark (Geological Museum)
University of Copenhagen
Øster Voldgade 5-7
DK-1350 Copenhagen K
Denmark

Work +45 35322371
Fax +45 35322325
Mobile +45 40598867
E-mail: DHarper@snm.ku.dk

J. C. Gutiérrez-Marco
Vice-Chairman, SOS
Instituto de Geología Económica (CSIC-UCM)
Facultad de Ciencias Geológicas
28040 Madrid
Spain
Tel.: +34 915 44 54 59
Fax: +34 913 94 48 74
E-mail: jcgrapto@geo.ucm.es
URL: <http://www.ucm.es/info/paleo/personal/gutierrez.htm>

I.G. Percival
Secretary, SOS
Geological Survey of NSW
NSW Department of Primary Industries
W.B. Clarke Geoscience Centre
47-953 Londonderry Road
Londonderry
New South Wales 2753
Australia
E-mail: ian.percival@industry.nsw.gov.au

2. Overall objectives, and Fit within IUGS science policy:

The Subcommission promotes international cooperation on all aspects of Ordovician Stratigraphy. Specific objectives are:

- a. To delimit and subdivide the Ordovician System (and Period) as a part of the overall ICS mission to elaborate the standard global stratigraphic scale. This work aims to establish the boundaries (GSSPs), the correlation of the subdivisions (Stages and Series), the nomenclature of the subdivisions and periodically review the effectiveness and utility of these decisions.
- b. To promote regular international meetings on all aspects of Ordovician geology, especially those devoted to clarifying stratigraphic procedures, nomenclature and methods for use in establishing a unified global time scale and to prepare correlation charts with explanatory notes (the main phase of this latter task is now completed).
- c. To encourage, promote, and support research on all aspects of Ordovician geology worldwide and to provide outlets, *Ordovician News*, international meetings, and a web page, for promoting discussions and reporting results of this research.
- d. To encourage, promote, and support interdisciplinary research on the Ordovician global Earth system, addressing topics that require high-resolution, global correlation.

d. The ultimate goal of the Subcommittee is to provide a high-resolution geological time scale that will be a critical foundation for interdisciplinary research on the global Earth system during the Ordovician Period. The work is broad based and must include specialists in palaeontology, all subdisciplines of stratigraphy (bio-, litho-, chemo-, and magneto-), sedimentology, geochemistry, and tectonics. With a large network including active participants from more than 25 countries, the Subcommittee thus involves much of the global geological community.

3. Summary table of Ordovician subdivisions

| SYSTEM | GLOBAL SERIES | GLOBAL STAGES | KEY GRAPTOLITE/ CONODONT(C) BIOHORIZONS |
|------------|---------------|---------------|--|
| ORDOVICIAN | UPPER | HIRNANTIAN | ← <i>A. ascensus</i> (GSSP-Dob's Linn) |
| | | KATIAN | ← <i>N. extraordinarius</i> (GSSP-Wangjiawan North) |
| | | SANDBIAN | ← <i>D. caudatus</i> (GSSP-Black Knob Ridge) |
| | MIDDLE | DARRIWILIAN | ← <i>N. gracilis</i> (GSSP-Fågelång) |
| | | DAPINGIAN | ← <i>U. austrodentatus</i> (GSSP-Huangnitang) |
| | LOWER | FLOIAN | ← <i>B. triangularis</i> (C), (GSSP-Huanghuachang) |
| | | TREMADOCIAN | ← <i>T. approximatus</i> (GSSP-Diabasbrottet) |
| | | | ← <i>I. fluctivagus</i> (C) (GSSP-Green Point) |

4. Organization

- a. Subcommittee Executive (from August 2008)
 - Chairman, David A.T. Harper (Denmark)
 - Vice Chairman Juan Carlos Gutiérrez-Marco (Spain)
 - Secretary, Ian G. Percival (Australia)
 - 16 other Voting Members
 - Over 100 Corresponding Members

Subcommittee website: www.ordovician.cn. Alternative website: <http://seis.natsci.csulb.edu/ISOS> (remains active for facilitating discussion of GSSP proposals, if and when relevant).

The Subcommittee officers and voting members have been agreed for the next term from 2008-2011. Following the Subcommittee's business meeting during the Nanjing conference (2007) a postal ballot confirmed the election of the new Subcommittee officers, and elected a new group of voting members. Details of the procedure and results were included in the report for 2007. The new Subcommittee not only includes a broad national representation and coverage of key fossil groups but also specialists in interdisciplinary fields such as geochemistry and sedimentology.

F.G. Aceñolaza (Argentina)
G.L. Albanesi (Argentina)
A.V. Dronov (Russia)
O. Fatka (Czech Republic)
J.C. Gutiérrez-Marco (Spain)
D.A.T. Harper (Denmark)
O. Hints (Estonia)
Li Jun (China)
S. Leslie (USA)
C.E. Mitchell (USA)
A.T. Nielsen (Denmark)
G. Nowlan (Canada)
A.W. Owen (UK)
I.G. Percival (Australia)
L.E. Popov (UK)
M.R. Saltzman (USA)
T. Servais (France)
T. Vandenbroucke (Belgium)
Zhang Yuandong (China).

5. Interfaces with other international projects

IGCP Project 503: Arguably the most sustained rise in marine biodiversity took place during the Ordovician, and the second largest mass extinction event took place close to the end of that Period, coincident with an episode of major climate fluctuation. The results of the very successful IGCP project n° 410 "The Great Ordovician Biodiversification Event" not only included the development of an improved globally-integrated biozonation for graptolites, conodonts and chitinozoans, but also generated biodiversity curves that have been constructed for all Ordovician fossil groups.

Following the work of the numerous regional teams and of the clade teams, that were established for each fossil group in IGCP project n° 410, a new successor project (IGCP project n° 503) was approved in order to develop a better understanding of the environmental changes that influenced the biodiversity trends in the Ordovician and Early Silurian. In this project, the major objectives are thus to attempt to find the possible physical and/or chemical causes (e.g., related to changes in climate, sea level, volcanism, plate movements, extraterrestrial influences, etc.) for the Ordovician biodiversification, the end-Ordovician extinction, and the subsequent Silurian radiation.

6. Chief accomplishments and products in 2010 cycle

a. The next International Symposium on the Ordovician System will take place in Spain during May, 2011. The conference itself and associated business meetings and workshops will be held in the environs of Madrid with field excursions to various parts of the Iberian Peninsula including the Iberian Chains and northern Portugal.

Although IGCP 503 formally concluded its 5-year program with an International Congress on Palaeozoic Climates in Lille, France during August, 2008, an extension of this successful project was agreed and a further

meeting on 'Early Palaeozoic Palaeogeography' was held in Copenhagen during late August and early September 2009. The proceedings of this conference (Early Palaeozoic biogeography and geography) to be published as a Memoir of the Geological Society are currently being edited by Harper and Servais. Publication will be in late 2011.

b. The Subcommittee completed its GSSP research programme in 2008 and all 7 Stage GSSPs were established and approved by the IUGS before the Ordovician Yangtze Conference (June 2007). Bergström, Chen Xu, Gutiérrez-Marco, and Dronov have compiled a new chronostratigraphic classification of the Ordovician System and its relations to the main regional series and stages. The English version has been published in *Lethaia* and the Chinese version was published in the *Journal of Stratigraphy* in China prior to the 33rd IGC in Oslo during August 2008. Discussion, however, at the business meeting in Copenhagen included the wish to routinely evaluate the efficacy of the current stages. A colour reprint of the Global Ordovician Chronostratigraphy (The Ordovician Time Table) chart is still being planned dependent on funding and will be distributed to colleagues in different countries if funding permits.

c. *Ordovician News No. 27* was produced and posted on the Subcommittee website and is available for download.

7. Chief problems encountered in 2010

The Subcommittee is planning to publish an Ordovician 'Time Table' following the approval and ratification of all the GSSPs. This was discussed and agreed at the Yangtze conference during June 2007 in Nanjing. The Subcommittee, however, lacks financial support to publish this table although some support has been offered from Chen Xu's research project.

A lack of travel support limited the participation of Voting Members in the 33rd IGC in Oslo during August 2008. In fact only two members were present (Harper and Gutiérrez-Marco) at the ISOS business meeting. This problem was partly rectified during 2009, when the ISOS business meeting associated with IGCP 503 in Copenhagen was well attended by titular and corresponding members together with other interested parties.

8. Summary of expenditure for 2010

TOTAL INCOME (from ICS): DKK 5,630

Support for attendance of subcommittee officer at ICS meeting in Prague DKK 3,730

Support for attendance at IPC3 meeting in London DKK 1,600

Miscellaneous expenditure DKK 300

TOTAL EXPENDITURE DKK 5,630

9. Work plan, critical milestones, anticipated results and communications to be achieved next year

The new Subcommittee came into force during the 33rd IGC in Oslo. Plans for the Subcommittee's future work were initially stated as follows.

a. Will open debate on the formal definition of chronozones within the Ordovician System. This possibility arises from the time-slice concept of Webby (2004) and the finer subdivision of the system presented by Bergström et al. (2008). **This will be addressed in a session at the Madrid Meeting.**

b. Will establish a forum to assess the efficacy and utility of the newly-established international stages. **This too will be addressed at the Madrid meeting.**

c. Will stimulate where relevant the production of revised regional correlation charts on the basis of new regional stratigraphic data and their relationship to the newly-established international stages. **During the Prague meeting in May those present agreed to begin discussions in their own regions regarding the possibilities of providing simple correlation charts, linking regional chronostratigraphies to the global stages.**

d. Will open debate on the applicability of non-biologic methods of correlation of Ordovician strata.

d. Production and internet distribution of *Ordovician News No. 27* in 2010.

e. Management of Subcommittee website will remain based in Nanjing. Following discussions with the webmaster, Fan Junxuan, the site will be remodelled following the general format of the attractive and effective main ICS site. A number of redundant features will be removed and a number of more relevant additions will appear during the next few months. **Little progress has been made on this front.**

During the business meeting at the final meeting of IGCP 503 and at the ICS meeting in Prague plans were formalized with the agreement to form a number of working groups in the following areas:

1. There may be a requirement to evaluate the efficacy and utility of our stages and stage boundaries. Where appropriate and/or necessary we will have to move to establish some small advisory groups. One major boundary problem may need urgent attention and will be raised at the forthcoming congress in Madrid.
2. Clearly the Subcommittee can now move with some confidence towards confirming and establishing finer divisions of Ordovician time. In this respect Bergström et al. (2009: *Lethaia*) have divided our international stages into stage slices based mainly on existing biozones. Finer time slices were also proposed by Webby (2004: *The Great Ordovician Biodiversification Event*, Columbia University Press) and used effectively in developing data for the GOBE. As these time divisions are more widely adopted, it would be useful to confirm their definition and status. These time slices have been used in the recent *Palaeogeography, Palaeoclimatology, Palaeoecology* special issue on the palaeoecology of the GOBE edited by Servais and Owen (2010). This will be addressed at the Madrid meeting.
3. Over the last few years we have neglected somewhat the role of the regional groups and the many important regional and diverse stratigraphies that make our system so exciting. A number of the key regional successions were included in the correlation charts provided by Bergström et al. (2009), but there more that require calibration with our new stages. Moreover a few regions such as Baltoscandia and SE Asia were never formally published. This is a priority for our system and work that can involve all our colleagues. In progress.
4. Work is now far advanced on a Carbon stable isotope curve for the Ordovician. Consistent results have been already achieved for parts of the column. There are of course other stable isotopes and it will be appropriate and useful to evaluate if we can help develop these curves not least as one of our nonbiologic means of correlation. There are other nonbiologic techniques that we could also consider. These issues were addressed in a recent issue of *Palaeogeography, Palaeoclimatology, Palaeoecology* edited by Munnecke, Calnar and Harper (2010).
5. A more difficult area is sea-level or water-depth curves for the period. There have been a number of curves for the Ordovician and many more for particular parts of the period. It would be useful to examine these curves more carefully and the criteria upon which they are based with a move towards developing more standardised curves for the Ordovician. Some of these issues were addressed in the recent issue of *Palaeogeography, Palaeoclimatology, Palaeoecology* edited by Munnecke, Calnar and Harper (2010).
6. We now have a number of accurate palaeogeographic maps for our period. Not everyone agrees with all the reconstructions and perhaps they never will. But it is possible to engage in cooperation with some of the groups to develop a more standard set of base maps for the period. This is now an active area research with the wide availability of Trond Torsvik's BugPlates program that is forming the basis for many chapters in the forthcoming GSL Memoir on Early Palaeozoic biogeography and geography edited by Harper and Servais.
7. We already have a number of robust absolute dates for parts of the system but it would useful to develop more, not least to be able to calibrate the true rates of biological and geological process occurring during the period. Discussions are now ongoing with a number of geochronology laboratories, for example the StarPlan group in Copenhagen, whose terrestrial dating facility is headed up by Jim Connelly.
8. We have tended as a group to ignore the economic potential of our system. But, for example in New South Wales, nearly all the gold and copper mines are hosted in Ordovician volcanics of the Macquarie Arc and in China considerable funding is being made available through SINOPEC (the Chinese petroleum company) to support research into Ordovician biostratigraphy.

10. Budget and ICS component for 2011

- a. Support for publication of Geological Society Memoir on Early Palaeozoic Biogeography and Geography, arising out of the Copenhagen Conference, edited by Harper and Servais (more than half the manuscripts have now been received). This will be a substantial volume with chapters on the main fossil groups, new interactive palaeogeographic base maps provided by Trond Torsvik (BugPlates), and introductory chapters on nomenclature and terminology. The ICS will be credited as a main sponsor. **5000 USD**
- b. Preparation of an Ordovician Time Table, carried over from last year: **1000USD**
- c. Support for attendance at ISOS congress, May 2010 in Madrid: **5000USD**
- d. Support for production of revised regional correlation charts: **2500 USD**
- e. Startup funding for potential review of GSSPs, in particular that at the base of the system: **3000 USD**

TOTAL 2011 BUDGET: 16,500USD
REQUESTED FROM ICS: 8000USD

Potential funding sources outside IUGS

The IGCP Project 503, “Ordovician Palaeogeography and Palaeoclimate”, co-funded four meetings (with related field trips) in 2007, including the 10th Ordovician conference China and further relevant meetings in 2008: The project has continued for a final year in 2009 but without funding and was marked by two volumes of *Palaeogeography, Palaeoclimatology, Palaeoecology* in 2010. This project has in the past provided travel support to a significant number of Ordovician specialists, including voting members of the Subcommittee, allowing for regular meetings at the annual workshops scheduled for the project. A new successor project is planned to be led by Brad Cramer and colleagues; and if successful will continue to support Ordovician together with Silurian geology.

The State Key Laboratory of Stratigraphy and Palaeobiology, Nanjing Institute of Geology and Palaeontology, Chinese of Academy of Sciences, provides a server for the Subcommittee website.

The Subcommittee officers are also supported by their research projects for most of their activities.

11. Review chief accomplishments over last nine years (2001-2010)

- a. Approval, ratification, and dedication of the Green Point GSSP for the base of the Ordovician System.
- b. Approval, ratification, and dedication of the Diabasbrottet and Fågelsång GSSPs for the bases of the upper stage of the Lower Ordovician Series and the Upper Ordovician Series, respectively.
- c. Approval, ratification, and dedication of the Black Knob Ridge section, Oklahoma, USA and the Wangjiawan North, Yichang, China GSSPs for the bases of the Katian and Hirnantian stages, respectively.
- d. Approval, ratification, and dedication of the Huanghuachang section, Yichang, China for the base of the Dapingian Stage, which coincides with the base of the Middle Ordovician.
- e. With publication in 2000 of *A Revised Correlation of Ordovician Rocks in the British Isles*, correlation charts have been completed for Ordovician rocks on virtually all continents.
- f. The 9th International Symposium on the Ordovician System held in San Juan, Argentina, in August 2003, in conjunction with the 7th International Graptolite Conference and a Field Meeting of the Subcommittee on Silurian Stratigraphy and publication of 556 page proceedings, 130 participants represented 18 countries, 124 papers were presented in technical sessions.
- g. Publication of *Ordovician News* nos. 17-27 and their posting on the Subcommittee’s web site.
- h. Development of the web site “Ordovician Stratigraphy Discussion Group” to facilitate discussions on selection of the GSSPs. This site has evolved into the Subcommittee's web site and also includes postings of *Ordovician News*.
- i. Sponsorship of a technical session and field excursion on the GSSP for the base of the Middle Ordovician Series at the Annual Meeting of the Geological Society of America in November 2000.
- j. Sponsorship at the 31st International Geological Congress, Rio de Janeiro, Brazil, 2000, of the symposium “Paleontological, stratigraphical, and paleogeographical relations among South America, Laurentia, Avalonia, and Baltica during the Ordovician.”
- k. Sponsorship at the 32nd International Geological Congress, Florence, Italy, 2004, of the symposium “The global Ordovician Earth system”.
- l. Launched GOES (Global Ordovician Earth System) Program to stimulate integrated multi-disciplinary studies of global events (mass extinction, sea-level changes, greenhouse conditions, tectonics) during the Ordovician Period.
- m. Sponsorship of a special symposium on the Ordovician System at the Geological Society of America Annual Meeting in 2000, of WOGOGO 2001 in Copenhagen, and the meeting and field excursion “The Gondwanan Platform in Ordovician times: Climatic, eustatic and geodynamic evolution”, in Morocco in February 2001.
- o. Selection of names for 2nd, 3rd, 5th, 6th and 7th stages of the Ordovician System.

- p. Sponsorship of the 2006 IGCP 503 Glasgow meeting on “Changing palaeogeographical and palaeobiogeographical patterns in the Ordovician and Silurian”.
- q. Sponsorship of the 2007 Yangtze Conference (the 10th Ordovician Conference) that was combined with the 3rd Silurian Conference and the IGCP 503 annual meeting in Nanjing. The combined conference was attended by 140 scientists from 24 countries; 66 papers and 22 posters were presented, with publication of these in a Proceedings volume of 566 pages. Two field guides were also printed.
- r. Publication of ‘The new chronostratigraphic classification of the Ordovician System and its relations to major series and stages and to ¹³C chemostratigraphy’ *Lethaia* 2008.
- s. Support and participation in the following major conferences during 2008: 7th Baltic Stratigraphic Conference, Tallinn, and associated field excursions, May 2008 and ‘Development of Early Paleozoic Biodiversity: The role of biotic and abiotic factors, and event correlation’ Moscow, June 2008 and the subsequent field excursion to the Altai Mountains; 33rd IGC in Oslo during August 2008 and the IGCP 503 ‘International Congress on Palaeozoic Climates’ in Lille, France during August, 2008.
- t. Support, participation and sponsorship of the following major conferences during 2009. NACP Cincinnati 21-26 June and IGCP 503 Copenhagen 31 August – 4 September.
- u. Agreement in principle to establish a new range of working groups tackling a wide spectrum of areas of Ordovician with a view to developing new products for the community.
- v. Support, participation and sponsorship of Ordovician session at IPC3 in London, June 2010.
- w. Publication of a *Special Paper, Geological Society of America* (2010) on Ordovician research (edited by Finney and Berry).
- x. Publication of two volumes of *Palaeogeography, Palaeoclimatology, Palaeoecology* (2010) on Ordovician research (edited by Servais and Owen together with Munnecke, Calnar and Harper).

SUBCOMMISSION ON CAMBRIAN STRATIGRAPHY
ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY

International Subcommission on Cambrian Stratigraphy

Submitted by:

Prof. Loren E. BABCOCK, Secretary
School of Earth Sciences
125 South Oval Mall
The Ohio State University
Columbus, OH 43210
USA
Tel. 01 614-292-2721
Email babcock.5@osu.edu

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Mission Statement

The Subcommission is the primary body for facilitation of international communication and scientific cooperation in Cambrian stratigraphy.

Goals

The goals of the Subcommission fall into two main areas:

- (1) To develop a global stage-level and series-level chronostratigraphic classification of the Cambrian System.
- (2) To complete and publish regional and global correlation charts for the Cambrian System.

Fit within IUGS Science Policy

The objectives of the Subcommission fall within three main areas of IUGS policy:

- (1) The development of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs where appropriate (stages and series), and related to a hierarchy of units (zones) to maximize relative time resolution within the Cambrian Period.
- (2) Establishment of frameworks and systems to encourage international collaboration in understanding the evolution of the Earth during the Cambrian Period.
- (3) Working towards an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs.

3. ORGANIZATION

The Subcommission is organized by an Executive consisting of Chairman, two Vice-Chairs, and Secretary, who are all Voting Members of the Subcommission. There are currently 17 other Voting Members. The Voting Members are elected for their expertise and experience, but also represent a diversity of countries and regions.

The objectives of the Subcommission are pursued by Working Groups, both stratigraphic and thematic. Each Working Group is organized by a Chair who is a Voting or Corresponding Member.

The Subcommission sponsors an International Symposium on the Cambrian System at irregular intervals, and sponsors Field Conferences of the Cambrian Stage Subdivision Working Group generally at one-year intervals. The Chair of the Organizing Committee of each of the meetings is normally a Voting Member, Honorary Member, or Corresponding Member of the Subcommission.

Officers for 2004-2008:

| | |
|--------------------|---|
| Chairman: | Prof. Shanchi Peng, China |
| First Vice-Chair: | Prof. Malgorzata Moczydlowska-Vidal, Sweden |
| Second Vice-Chair: | Prof. Gerd Geyer, Germany |
| Secretary: | Prof. Loren E. Babcock, USA |

Website: The Subcommittee website has been transferred to an Uppsala University server and is in a state of complete reorganization. It is now visible at http://www.palaeontology.geo.uu.se/ISCS/ISCS_home.html and will be further updated in the coming months.

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

Members of the Cambrian Subcommittee are involved in a number of international projects, normally in an individual capacity but sometimes facilitated by contacts through activities related to the Subcommittee. In 2010, VMs of the Cambrian Subcommittee participated in a variety of international and regional meetings.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010.

5a. 15th International Field Conference on Cambrian Stage Subdivision, Czech Republic and Germany, June 2010.

The 15th International Field Conference on Cambrian Stage Subdivision was held in June 2010 in Prague, Czech Republic, and southeastern Germany. The meeting was organized principally by Oldrich Fatka, Gerd Geyer, Olaf Elicki, and Petr Budil. A field guide/abstract volume was published in association with the meeting.

5b. Progress with selection of GSSPs for Cambrian Stages.

Three proposals for a GSSP of provisional Cambrian Stage 9 were submitted to Duck K. Choi, Chair of the Working Group on the *Agnostotes orientalis* level, and the Working Group provided opinions on them. After recommending a single GSSP stratotype and a name for the stage, a ballot was put before the Voting Members of the Cambrian Subcommittee. The name Jiangshanian Stage, with a stratotype in the Duibian B section, Zhejiang, China, was approved by an 85% majority of votes. A proposal for the Jiangshanian Stage has been forwarded to ICS and IUGS.

Work toward definition of a GSSP for the base of provisional Cambrian Stage 5 (and Series 3) continues. After much discussion by email, organized by Fred Sundberg, Co-chair of the Stage 5 Working Group, and after discussions at the ISCS Field Meeting in the Czech Republic and Germany, there is still some disagreement about the best choice of primary boundary marker. Two levels have been identified, and it is expected that in the coming year attention will narrow to one horizon. At that point, it can be expected that GSSP proposals will be solicited by the Working Group.

The Subcommittee is working toward establishing GSSPs of the remaining undefined series and stages. Working Groups have been formed to investigate potential GSSP horizons for stages 2, 3, and 4. These Working Groups replace the Working Group on the Lower Half of the Cambrian, which was successful in determining the best choices of horizons for intercontinental correlation within the first two series of the Cambrian.

A Working Group investigating the Stage 10 base is in early stages of progress. Multiple potential horizons have been suggested for the base of the terminal Cambrian stage, and it is expected that within two years the Working Group will narrow the field to a single horizon.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

The principal difficulties encountered in 2010 were: 1, obtaining funding to support basic research on key stratigraphic intervals (potential GSSP horizons and sections); and 2, obtaining funding to support travel. A modest increase in funding for the coming year would be of great benefit to members of some of the Working Groups on key horizons who have limited access to funding through nationally competitive research grants.

7. SUMMARY OF EXPENDITURES IN 2009:

INCOME

| | |
|---------------------------|------------|
| Carried forward from 2009 | \$ 53.12 |
| ICS Allocation | \$ 3000.00 |
| SUBTOTAL 2010 income | \$ 3053.12 |

EXPENDITURE FROM 2010 BUDGET

| | |
|--|---|
| Contribution to officer's travel expenses | \$ 3008.01 |
| Publishing cost of field guide (and ISCS proceedings as an issue of Bulletin of Geosciences) | \$1000.00 (owing to Czech Geological Survey, see below) |
| SUBTOTAL 2010 expenditures | \$ 3500.00 |

To be carried forward to 2011

(\$ - 945.11)

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR

8a. GSSP proposals and plans for meetings.

Planning is underway for a meeting of the Cambrian Stage Subdivision Working Group in 2011. Planning is also underway for a special session devoted to the Cambrian at the IGC meeting in Australia in 2012.

In late 2010 it is expected that ICS and IUGS will approve and ratify the proposal for the Jiangshanian Stage (replacing provisional Stage 9). It is also possible that proposals will be submitted to the Subcommittee for the GSSP of provisional Stage 5.

8b. Newsletter

An annual newsletter, highlighting activities of the Subcommittee, is expected to be issued by email in 2011.

9. BUDGET REQUESTS AND ICS COMPONENT FOR 2011

9a. In order to accelerate the pace of work in establishing GSSPs within the Cambrian, we request a modest increase in funds from ICS as compared to previous years (also because the over-expense of the 2010 allocation). The proposed increased funding is targeted at field research on key sections by Working Group members and young scientists, and travel by Voting Members to international meetings where much of the decision-making takes place.

9b. The Cambrian Subcommittee plans to sponsor a symposium on the Cambrian System at the upcoming IGC meeting in Australia. To help facilitate this, we request a special increase in funds in 2012, which will help officers and other Voting Members to meet in advance of the meeting to work out plans.

INCOME

| | |
|----------------------|---------|
| Carry-over from 2010 | \$45.11 |
|----------------------|---------|

PLANNED EXPENDITURES FOR 2011

| | |
|---|-------------------|
| Publishing cost of 2010 ISCS Field Guide and Proceedings as a special issue of Bulletin of Geosciences (The ISCS still owes the Czech Geological Survey for publishing the field guide and an issue of Bulletin of Geosciences for the 2010 field conference because the 2010 allocation was insufficient) | \$1000 |
| Preparation for the XVI Cambrian Stage Subdivision Working Group Conference in western U.S. Executive and VMs travel costs, Cambrian Subcommission field meeting | \$ 2000.00 |
| Support for 3 young scientists to attend the field meeting | \$ 3000.00 |
| General office expenses | \$100.00 |
| TOTAL 2010 PLANNED EXPENSES | \$ 9100.00 |

ICS 2009 BUDGET REQUEST

| | |
|--------------------------------------|-------------------|
| Total ICS 2009 budget request | \$ 9100.00 |
|--------------------------------------|-------------------|

11. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2006-2010)

In 1998, the Cambrian Subcommittee began work to define chronostratigraphic subdivisions (stages and series) within the system. Previously, the base and top of the Cambrian were defined by Working Groups on the Precambrian-Cambrian boundary (voted on and ratified in 1992) and Cambrian-Ordovician boundary (voted on in 1999 and ratified in 2000). Most of the Subcommittee members share the opinion that the process of defining and ratifying globally appropriate divisions must begin with an evaluation of potential correlation horizons. Following this work, evaluation of candidate sections can begin. The Cambrian Stage Subdivision Working Group has made reconnaissance visits to sections in association with international field conferences. Areas visited include Morocco (1995), Spain (1996), eastern Canada (1997), Sweden (1998), the Great Basin, USA (1999), Argentina (2000), South

China (2001), France (2002), South Korea (2004), North and South China (2005), South Australia (2006), East Laurentia (2007), Siberia (2008), Kazakhstan (2009), and the Czech Republic and Germany (2010).

In a seminal paper, John Shergold and Gerd Geyer (Episodes, 2000) reviewed widely recognizable biohorizons having intercontinental correlation value (ones that could potentially serve as stage-level or series-level boundaries for chronostratigraphic units). This work led to a focusing of subsequent effort on the issue of better characterizing potential chronostratigraphic boundary horizons using available stratigraphic tools. A protocol for identifying GSSPs within the Cambrian has been established: 1, selection of a horizon suitable for intercontinental correlation (followed by balloting by the Voting Members); then 2, search for the best sections from which to select a GSSP (followed by balloting by the Voting Members).

A plan has been devised for subdivision of the Cambrian System into four series, each representing roughly equal time intervals. The lowermost two series, which approximately correspond to the traditional lower Cambrian, are each expected to be divided into two nearly equal stages. The uppermost two stages are each expected to be divided into three nearly equal stages. The plan received overwhelming support from ISCS Voting Members.

With the objectives now better focused, and a procedure in place for selecting the best horizons and locations for GSSPs, work has proceeded toward the establishment of stage-level or series-level GSSPs. Successful GSSP proposals arising from the Cambrian Subcommittee were for the bases of the Paibian Stage and Furongian Series (2004), the Drumian Stage (2006), and the Guzhangian Stage (2007). In addition, names have been ratified for the Terreneuvian Series (2007) and Fortunian Stage (2007). A proposal for the Jiangshanian Stage (replacing provisional Stage 9) has been overwhelmingly supported by the Voting Members of the ISCS, and has been forwarded to ICS for approval and ratification by IUGS.

12. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2011-2015)

The primary objective for the immediate future for the Cambrian Subcommittee remains the completion of definition of the stages by GSSPs. It is hoped that all stages of the upper half of the Cambrian will be defined by GSSPs by 2012. There is one stage remaining to be defined in the upper half of the system. Stages of the lower half of the Cambrian are expected to be defined by GSSPs by around 2014.

APPENDIX [Names and Addresses of Current Officers and Voting Members, 2008-2012] INTERNATIONAL SUBCOMMISSION ON CAMBRIAN STRATIGRAPHY

Subcommission officers

Chairman: Shanchi Peng, Nanjing Institute of Geology and Palaeontology, The Chinese Academy of Sciences, 39 East Beijing Street, Nanjing 210008, China, Email: scpeng@nigpas.ac.cn

First Vice Chair: Malgorzata Moczydlowska-Vidal, Department of Earth Sciences, Palaeobiology, Uppsala University, Villavägen 16, 752 36 Uppsala, Sweden, Email: malgo.vidal@pal.uu.se

Second Vice-Chair: Gerd Geyer, Bayerisches Landesamt für Umwelt, Hans-Högn-Straße 12 95030 Hof, and Department of Earth Sciences, Palaeobiology, Uppsala University, Villavägen 16, 752 36 Uppsala, Sweden, Email: gerd.geyer@geo.uu.se.

Secretary: Loren E. Babcock, School of Earth Sciences, 125 South Oval Mall, The Ohio State University, Columbus, OH 43210, USA, babcock.5@osu.edu

List of Working (Task) Groups and their officers

Stage 2: Michael Steiner Michael.Steiner@FU-Berlin.de

Stage 3: Xingliang Zhang xizhang69@126.com

Stage 4: James B. Jago jim.jago@unisa.edu.au

Stage 5: Linda McCollum lmccollum@ewu.edu

Series 9: Duck K. Choi dkchoi@snu.ac.kr

Stage 10: Per Ahlberg per.ahlberg@geol.lu.se

Geochemistry: Matt Saltzman saltzman.11@osu.edu

List of Voting Members (other than officer) for 2009-2012

Per Ahlberg, Lund, Sweden per.ahlberg@geol.lu.se
José-Javier Álvaro, Villeneuve d'Ascq, France Jose-Javier.Alvaro@uni-lille1.fr
Duck K. Choi, Seoul, Korea dkchoi@snu.ac.kr
Gappur Kh. Ergaliev, Almaty, Kazakhstan ergaliev@nursat.kz
Rodolfo Gozalo, Valencia, Spain rodolfo.gozalo@uv.es
James B. Jago, Mawson Lakes, Australia jim.jago@unisa.edu.au
Pierre D. Kruse, Adelaide, Australia archaeo.kruse@gmail.com
Ed Landing, Albany, New York, USA elanding@mail.nysed.gov
Elena Naimark, Moscow, Russia naimark@paleo.ru
Tatyana V. Pegel, Novosibirsk, Russia pegel@mail.ru
Brian Pratt, Saskatoon, Saskatchewan, Canada brian.pratt@usask.ca
Matthew R. Saltzman, Columbus, Ohio, USA saltzman.11@osu.edu
Michael Steiner, Berlin, Germany Michael.Steiner@FU-Berlin.de
Stephen R. Westrop, Norman, Oklahoma, USA swest@hoth.gcn.ou.edu
Xingliang Zhang, Xi'an, China xizhang69@126.com
Maoyan Zhu, Nanjing, China myzhu@nigpas.ac.cn
Andrey Yu. Zhuravlev, Zaragoza, Spain ayzhur@mail.ru

Total number of Voting Members for term 2008-2012: 21.

Preparer information:

Prof. Shanchi Peng
Nanjing Institute of Geology and Palaeontology
39 East Beijing Street
The Chinese Academy of Sciences
Nanjing 210008, China
Email: scpeng@nigpas.ac.cn

Prof. Loren E. Babcock
School of Earth Sciences
125 South Oval Mall
The Ohio State University
Columbus, OH 43210, USA
Email: babcock.5@osu.edu

Date: 25 November 2010

SUBCOMMISSION ON NEOPROTEROZOIC (EDIACARAN AND CRYOGENIAN) STRATIGRAPHY
ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY

Subcommission on Neoproterozoic (Ediacaran and Cryogenian) Stratigraphy

Submitted by:

Dr James GEHLING, Chairman
South Australian Museum, North Terrace, Adelaide, 5000, Australia
Tel. +61-8-8207-7441, Fax. +61-8-8207-7222
Email: jim.gehling@samuseum.sa.gov.au

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Mission statement

The Subcommission is the primary body for facilitation of international communication and scientific cooperation in Neoproterozoic stratigraphy, defined in the broad sense of multidisciplinary activities directed towards better understanding of the evolution of the Earth and life during the Ediacaran Period and more generally during the late Neoproterozoic (circa 800 – 542 Ma). Its first priority is the unambiguous definition, by means of agreed GSSPs, of a hierarchy of chronostratigraphic units that provide the framework for global correlation.

Goals

These fall into three main areas:

- (a) The definition of basal boundary stratotypes (GSSPs) and the refinement of standard chronostratigraphic scales, through the establishment of multidisciplinary Working Groups;
- (b) International coordination of and collaboration in research on late Neoproterozoic environments, through the establishment of thematic Working Groups, for example on Neoproterozoic glaciations.
- (c) International coordination of efforts to establish consensus global stratigraphic calibration schemes for the late Neoproterozoic using alternative methods of stratigraphy, such as chemostratigraphy.

In addition, the Subcommission exists to further communication with a wider public through grassroots initiatives to conserve important Ediacaran geological sites, to support International Geoscience Programme (IGCP) projects, and to encourage the wider dissemination of research findings on the World Wide Web or in popular science publications.

Fit within IUGS Science Policy

The objectives of the Subcommission relate to four main aspects of IUGS policy:

- (1) The development of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs where appropriate (Series and Stages), and related to a hierarchy of units (Standard Zones, Subzones etc.) to maximize relative time resolution within the Ediacaran period;
- (2) Proceed with a program of workshops and symposia to select criteria, boundary stratotype section, and GSSP for a “Cryogenian” period and system, immediately below the Ediacaran;
- (3) Establishment of frameworks and systems to encourage international collaboration in understanding the evolution of the Earth during the late Neoproterozoic interval, in particular, cooperating with the **Precambrian Subcommission (M. Van Kranendonk, chair)** to subdivide the late Precambrian. The Neoproterozoic (Ediacaran and Cryogenian) Subcommission will concentrate on the Neoproterozoic, while the Precambrian Subcommission will work on Archean and older eras of the Proterozoic. Both subcommissions seek to established “natural” or rock-based boundaries that will enable global correlation.
- (4) Working towards an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs. This relates to, *inter alia*, the IUGS Geosites Programme.

3. ORGANIZATION

Officers for 2004-2012:

| | |
|-------------|------------------------------|
| Chair: | Dr. James Gehling, Australia |
| Vice-Chair: | Dr. Shuhai Xiao, USA |
| Secretary: | Dr. Graham Shields, UK |

The Subcommittee is organized by an Executive consisting of Chairman, Vice-Chairman and Secretary, who are all Voting Members of the Subcommittee. These officers were nominated and elected by voting members of the now terminated Terminal Proterozoic Subcommittee during late 2003. There are currently 33 other Voting Members, making a total of 36 voting members. There are currently over 30 additional corresponding members, about half of whom participate actively in online discussions. The Voting Members have been specifically selected for their international reputations, recognized expertise in an area of geoscience relevant to the subcommittee, and their willingness to take an active role in the subcommittee's activities. Four voting members are required to be officers of the Cambrian and Precambrian Subcommittees.

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

Members of the Neoproterozoic (Ediacaran and Cryogenian) Subcommittee are lead investigators and officers in a number of related international projects:

IGCP 587 (*Of Identity, Facies and Time, the Ediacaran Puzzle: Factors Controlling the Observed Diversity and reality of the Relationships of the Earliest Metazoans*) led by Mikhail Fedonkin (Paleontological Institute, Russian Academy of Sciences, Moscow, Russia), Patricia Vickers-Rich (School of Geosciences, Monash University, Melbourne, Victoria), Jim Gehling (South Australian Museum, South Australia) and Guy Narbonne (Dept of Geology, Queens University, Kingston, Ontario, Canada).

IGCP 478 (*Neoproterozoic-early Paleozoic events in SW Gondwana*) led by voting members **Claudio Gaucher, Hartwig Frimmel and Paulo Boggiani**; IGCP 493 (*The Rise and Fall of the Vendian biota*) led by **Mikhail Fedonkin** (Paleontological Institute, Moscow), Patricia Vickers-Rich (Monash Uni.) and **James Gehling**; IGCP 497 (*The Rheic Ocean: its origin, evolution and correlatives*) led by **Ulf Linnemann**; IGCP 512 (*Neoproterozoic Ice ages*) led by **Graham Shields** and Emmanuelle Arnaud.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

1. An international conference, with workshop and field meeting, was held in India from February 2-9, 2010 on Precambrian Life, Time and Environments: "Evolving Concepts and Modern Analogues" together with a workshop on acritarchs. This followed an international field workshop on the Proterozoic Vindhyan Supergroup (Jan. 20-31, 2010) organized by Mukund Sharma.
2. For *The New Geologic Time Scale*, two chapters on periods of the Neoproterozoic were completed during 2010. The *Ediacaran Period* was written by Narbonne, Shields, Xiao and Gehling; while *The Cryogenian Period* by Shields, Hill and MacGabhann.
3. IGCP 512's book *Neoproterozoic Ice Ages* (Arnaud, Halverson and Shields), which summarises present knowledge on Cryogenian Period glacial units around the world and their correlation was also completed in 2010.
4. Task groups were assembled during 2010 to direct research to test criteria for correlating and defining a Cryogenian GSSP, and subdivision of the Ediacaran Period.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

- Continuing inadequacy of geochronological control in key sections. This is being addressed continually using new U-Pb and Lu-Hf ages and chemostratigraphy.
- An international conference, workshop and field excursion to be based in Novosibirsk (Siberia), originally planned for 2010, had to be moved to 30 July – 14 August, 2011. The 2nd Circular was issued in November 2010 (see Appendix).
- Research teams working on Neoproterozoic projects in Australia are being asked to take greater care with obtaining access to private property, parks and reserves, following complaints in 2010 about unauthorized destructive sampling and misrepresentation of affiliations.

7. SUMMARY OF EXPENDITURES IN 2010:

INCOME

| | | |
|------------------------------|-------|-----------|
|carried forward to 2010 | | US\$ 3000 |
| | ICS | US\$ 4500 |
| | TOTAL | US\$ 7500 |

EXPENDITURE FROM 2010 BUDGET

| | |
|---|-----------|
| IGC Travel expenses and support for Indian conference and field trip (Feb) | US\$ 3465 |
|---|-----------|

| | |
|--|-----------|
| Travel to ICS meeting in Prague (May-June) | US\$ 1835 |
| TOTAL | US\$ 5300 |
| To be carried forward to 2011 | US\$ 2200 |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

(a) End of year Newsletter (December 2010)

(b) Preparation of GSSP proposals: The consensus criteria for defining the Cryogenian GSSP (2009) allow the first call to be made for submission of informal and then full proposals for a Cryogenian Period basal GSSP during 2011/12. Progress towards subdivision of the Ediacaran Period is expected following workshops in India, Novosibirsk and Nanjing.

(c) International Conference “Neoproterozoic sedimentary basins: stratigraphy, geodynamics and petroleum potential”, Russian Workshop on Ediacaran Acritarch Taxonomy, and IGCP 512 Field Trip to the East Sayan Mountain Ranges will be held in Novosibirsk in August 2-20, 2010. It aims to foster international exchange of ideas in the fields of Neoproterozoic stratigraphy, sedimentology and sedimentary basins to facilitate progress in establishing intercontinental correlation of Neoproterozoic strata. Discussions will include problems in biostratigraphic definition and subdivision of Cryogenian and Ediacaran. They will primarily focus on Neoproterozoic sedimentary basins of Siberian Platform in relation of subsidence regime, climate glacial depositional systems, timing of magmatism and tectonic deformations.

(d) Subcommittee workshop in Svalbard 2012: A meeting in Svalbard to discuss the base of the Cryogenian GSSP is being organized for 2012 with exploratory field excursions in Summer 2010 and also Summer 2011 (chief organizer: Ian Fairchild).

(e) New Geological Time Scale book: The new Geological Time Scale book which is due out in 2011 will be the first to contain full chapters on the Ediacaran and Cryogenian periods. IGCP 512 will publish its compendium of Neoproterozoic regional geology during the course of 2011.

(f) Voting:

- Request for informal proposals for Cryogenian basal GSSP (2011).
- Voting on criteria for the subdivision of Ediacaran Period (2011).
- Request for informal proposals for Ediacaran Period subdivision (2012).

10. BUDGET AND ICS COMPONENT FOR 2011

We anticipate that more than US \$5,000 will be required during 2011 to ensure maximum participation at the Novosibirsk workshop/excursion, especially considering that several members of the subcommittee are from developing countries.

Projected Budget for 2011:

| | |
|--|------------------|
| Carried over from 2010 | US \$2200 |
| General office expenses | US \$250 |
| Preparation and production of Newsletter/web support | US \$250 |
| Advance to Novosibirsk workshop JG SX GS, etc. | US \$5000 |
| TOTAL BUDGET PROJECTED | US \$3300 |
| | ----- |

Potential funding sources outside IUGS

National IGCP committees and project groups for IGCP projects 478, 587 and 512.

The Neoproterozoic (Ediacaran and Cryogenian) Subcommittee does not receive financial support from outside IUGS-ICS, except for office support (computer, access to internet services, telephone, etc.) from the host institutions of the Executive. Most members are supported by national research grants, normally won competitively. Specific activities, such as meetings and some Working Groups, sometimes receive small grants to Conveners and Organizers from various sources, such as host institutions and national and regional authorities of the country where the meeting is being held.

Additional financial support will be sought from petroleum companies and consortia, which are currently turning their attention to successively older successions in their global search for hydrocarbons.

11. REVIEW CHIEF ACCOMPLISHMENTS OF PAST SIX YEARS (2004-2010)

2004: On February 16th, 2004, the ICS voted 14:1 in favor (with one abstention) on the GSSP and name for the “Ediacaran System”. The results were submitted to IUGS, which ratified the GSSP and name for the Ediacaran System and Period on March 19th (IUGS E-Bulletin, March 2004).

2005: Interpretive signs and a marker or “golden spike” were dedicated by the South Australian Premier at the Ediacaran GSSP on April 16 at the Ediacaran GSSP site in the Flinders ranges National Park.

2006: 2nd International Palaeontological Congress held in China from June 17-24, 2006, Chinese voting members Zhu Maoyan, Yin Chongyu and Shuhai Xiao and a team of colleagues and their students organized a *Neoproterozoic field workshop* from June 6-16, to study the Cryogenian and Ediacaran successions of South China of the Neoproterozoic Subcommittee. “*Snowball Earth 2006 appraisal conference*” was held at the Centro Stefano Franscini, Ascona, Switzerland, July 16-21, 2006. The conference brought together many of the world’s experts in Neoproterozoic Earth System Science.

2007: Kimberley field meeting (Neoproterozoic glaciogenic successions of NW Australia) organised by Maree Corkeron (Australia) attended by 14 participants from 7 countries (Canada, USA, China, Brazil, Germany, Spain and Australia). At this meeting, evidence for post-Elatina glaciation in Australia was presented, indicating that the c. 582 Ma ‘Gaskiers’ glaciation may be of widespread significance.

Two discussion documents on acritarch biostratigraphy of the Ediacaran and Cryogenian Periods, respectively, were compiled by Kath Grey (Australia), circulated widely and discussed using the IGCP 512 discussion forum. This led to informal workshops in Perth, Australia (Aug. 1 and 14, 2007) and calls to hold a meeting in 2008 to discuss global taxonomic standards (Uppsala, Sweden, Aug. 18-21, 2008).

Six special volumes and books on Neoproterozoic stratigraphy and earth system evolution were published during 2007.

2008: IGCP 512-sponsored field meeting: Neoproterozoic glacial and associated facies in the Varanger (ex-type) area Excursion 42 at IGC 2008 (July 29 – Aug. 5, 2008).

Subcommittee business meeting at IGC 2008, Oslo, Norway following the IGCP 512-sponsored symposium Stratigraphic correlation of Neoproterozoic strata and IGCP493 sponsored symposium Rise and fall of the Ediacaran (Vendian) biota (Aug. 6-14, 2008). Approximately two thirds of the voting membership attended the IGC.

Swedish Workshop for Ediacaran Acritarch Taxonomy (SWEATshop), Uppsala, Sweden (Aug. 18-21, 2008) attended by 12 scientists from six countries represented the first of a series of attempts to unravel taphonomic hindrances to biostratigraphic subdivision of the Ediacaran period (see App. 2).

2009: The Neoproterozoic Subcommittee officers received 87% overall response following the request to vote on a working definition for the Cryogenian Period. 79% of replies were positive, which gives us a mandate to move forward on this issue. The vote and the lengthy discussion preceding that vote establish a clear priority order with regard to the criteria likely to be used in the future definition and correlation of the Cryogenian Period. Final definition: “*The base of the Cryogenian should be placed within an outcrop section at a precisely defined stratigraphic level (GSSP) beneath the oldest clearly glaciogenic deposits in a Neoproterozoic succession. The chosen section should demonstrate proven potential for global C- and Sr-isotope stratigraphic correlation and preferably be amenable to microfossil biostratigraphy, isotope geochronology and other forms of global correlation such as magnetostratigraphy*” (17.08.2009).

A good response (31/36) was also received with regard to the Ediacaran Period Questionnaire resulting in a clear consensus that stable carbon isotopes, acritarchs, and Ediacara fossils are the most practical correlation tools. Ediacaran glaciations and oxidation events may be useful. There is very little support for stromatolites or the Acraman impact events as interregional correlation tools. Consequently, most people believe that we should focus on successions with mixed lithologies, geochronological constraints, and chemostratigraphic and biostratigraphic potential; and proceed from Series to Stages, rather than from Stages to Series (as practiced in Phanerozoic stratigraphy). The Ediacaran System can be divided into two or more Series.

Although the Series boundary should be unambiguously defined (e.g., using fossil FAD or LAD, or isotopic features), at the present it is perhaps unrealistic to use the FAD or LAD of an Ediacaran species (with possible exception of *Cloudina hartmannae*) for global correlation. Thus, we should aim at characterizing the Series using a

combination of bio- and chemostratigraphic features (e.g., one or two Series in the lower Ediacaran System characterized by Ediacaran acanthomorphs; one or two Series in the upper Ediacaran System characterized by macroscopic Ediacara fossils; alternatively, three Series each characterized with a carbon isotope cycle).

The broad congruency between evolutionary and physical events in the Ediacaran Period is encouraging, but the uncertainties about each individual criterion demand that we should adopt a holistic approach (i.e., using multiple criteria in order to maximize the usefulness of the GSSP) (06.04.2009).

12. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2011-2014)

The Neoproterozoic (Ediacaran and Cryogenian) Subcommittee aims to encourage research that will facilitate ratification of late Neoproterozoic subdivision (circa 800 – 542 Ma) by end 2014.

2011

- Lucknow, India, February 2011; Workshop on Neoproterozoic acritarch biostratigraphy (organized by Mukund Sharma)
- Completion of chapters of the *New Geological Timescale* (eds. Gradstein, Ogg and Van Kranendonk) book on *Ediacaran Period* (Narbonne, Xiao, Shields, Gehling) and *Cryogenian Period* (Shields, Hill and MacGabhann).
- Novosibirsk, Russia, August 2011 for Symposium, Workshop on acritarch biostratigraphy, and Excursion to Cryogenian and Ediacaran successions in East Sayan Mountains.
- Progress towards formal proposals for a Cryogenian GSSP and Ediacaran Period GSSP.

2012

- Neoproterozoic Symposium at 34th International Geological Congress, Brisbane, Australia: 5-10 August, 2012. Excursion: *Ediacaran and Cambrian of South Australia*. Discussion of formal proposals.
- Field excursion to Cryogenian succession of Svalbard (September) followed by Geological Society of London, Fermor Meeting: “The Neoproterozoic Era: evolution, glaciation and oxygenation” (Fairchild, Lenton, Condon and Shields).

2013

- Voting on formal proposals for a Cryogenian GSSP and Ediacaran Period GSSP; final field excursions to this aim.

2014

- Ratification of formal proposals for a Cryogenian GSSP and Ediacaran Period GSSP.

APPENDIX 1: NEOPROTEROZOIC (EDIACARAN AND CRYOGENIAN) SUBCOMMISSION Voting Members 2008-2010

Subcommission officers

Chairman: **James Gehling**, South Australian Museum, North Terrace, Adelaide, 5000 Australia; Tel. +61-8-8207-7441, email: jgehling@ozemail.com

Vice-Chairman: **Shuhai Xiao**, Department of Geological Sciences, Virginia Polytechnical Institute and University, 4044 Derring Hall, Blacksburg, VA 24061-0420, USA; Tel. +1-540-231-1336, email: xiao@vt.edu

Secretary: **Graham A. Shields**, [Department](#) of Earth Sciences, University College London, Gower Street, WC1E 6BT, London, UK; Tel. +44 207-679 7821; email: g.shields@ucl.ac.uk

Voting Members

Jose-Javier Alvaro, Lille, France; Jose-Javier.Alvaro@univ-lille1.fr

Paulo César Boggiani, São Paulo, Brazil; boggiani@usp.br

Martin D. Brasier, Oxford, UK; martin.brasier@earth.ox.ac.uk

Nicholas Butterfield, Cambridge, UK; njb1005@esc.cam.ac.uk

Nicholas Christie-Blick, New York, USA; ncb@ldeo.columbia.edu

Nikolay Chumakov, Moscow, Russia; chumakov@ginras.ru

David A.D. Evans, New Haven, USA; dai.evans@yale.edu
Mikhail Fedonkin, Moscow, Russia; mfedon@paleo.ru
Hartwig Frimmel, Wuerzburg, Germany; hartwig.frimmel@mail.uni-wuerzburg.de
Claudio Gaucher, Montevideo, Uruguay; gaucher@chasque.apc.org
Dmitri V. Grazhdankin, Novosibirsk, Russia; dima.grazhdankin@gmail.com
Kathleen Grey, Perth, Australia; kath.grey@doir.wa.gov.au
Karl-Heinz Hoffmann, Windhoek, Namibia; khhoffmann@mme.gov.na
Hans Hofmann, Montreal, Canada; hofmann@eps.mcgill.ca
Richard Jenkins, Adelaide, Australia; jenkins.richard@saugov.sa.gov.au
Sören Jensen, Spain; soren@guadiana.unex.e
Alan Jay Kaufman, Maryland, USA; kaufman@geol.umd.edu
Vsevolod Khomentovsky, Novosibirsk, Russia; vkhom@uiggm.nsc.ru
Andrew H. Knoll, Cambridge, USA; aknoll@oeb.harvard.edu
Ulf Linnemann, Dresden, Germany; ulf.linnemann@snsd.smwk.sachsen.de
Victor Melezhik, Norway; Victor.Melezhik@ngu.no
Malgorzata Moczydlowska-Vidal, Uppsala, Sweden; malgo.vidal@pal.uu.se
Guy M. Narbonne, Kingston, Canada; narbonne@geol.queensu.ca
Peng Shanchi, Beijing, China; scpeng@nigpas.ac.cn, speng@pub.jlonline.com
Vibhuti Rai, Lucknow, India; vibhutorai@rediffmail.com
Robert Rainbird, Ottawa, Canada; rrainbir@nrcan.gc.ca
Mikhail A. Semikhatov, Moscow Russia; semikhatov@ginras.ru
Martin Van Kranendonk, Geological Survey of Western Australia; martin.vankranendonk@doir.wa.gov.au
Sun Weiguo, Nanjing, China; weiguo@jlonline.com
Malcolm Walter, Sydney, Australia; mwalter@els.mq.edu.au
Yin Chongyu, Beijing, China; chongyuyin@cags.net.cn
Yuan Xunlai, Nanjing, China; xlyuan@nigpas.ac.cn
Zhu Maoyan, Nanjing China; myzhu@nigpas.ac.cn; zhumaoyan@gmail.com

APPENDIX 2

Report On International Conference and Field Meeting on

“PRECAMBRIAN LIFE, TIME AND ENVIRONMENT: EVOLVING CONCEPTS AND MODERN ANALOGUES”

(February 2 - 9, 2010) by **Vibhuti Rai** Organizing Secretary **Centre of Advanced Study in Geology, University of Lucknow, Lucknow, U.P., PIN 226007 INDIA**

The Centre of Advanced Study in Geology organised a three day International Conference (February 2- 4, 2010) on one of the thrust areas (Precambrian Stratigraphy) on the theme **PRECAMBRIAN LIFE, TIME AND ENVIRONMENT: EVOLVING CONCEPTS AND MODERN ANALOGUES**, which was attended by 15 International participants belonging to Seven Countries. In addition to that about 40 Indian participants were also there. 8 Technical Sessions were held during the deliberations, which were exceptionally well taken by the participants in a calm and sober ambiance. Significant discussions took place on some very crucial aspects of early life on the planet earth. Both Oral and Poster Presentations were held during the deliberations. More than 20 Indian and Foreign organizations participated in the Conference.

An **EXHIBITION** of Precambrian Biota was also arranged for the benefit of the participants to evaluate the Indian fossil material. These encompassed both megascopic and microscopic fossil material.

In addition to that, a **SYMPOSIUM-CUM-WORKSHOP ON ACROTARCHS** of late Neoproterozoic to early Palaeozoic was also held in which both Indian and Foreign participants actively participated.

An **Abstract Volume** (consisting of 71 pages) comprising 40 Abstracts of participants were also prepared and distributed to participants.

These two events were followed by an **INTERNATIONAL FIELD MEETING** (February 5 – 9, 2010) in the Lesser Himalayan Krol Belt. The participants assembled in Dehradun, a city situated in the ambiance of rolling topography of Himalayan Foreland from where main three sections of the Lesser Himalaya were covered. The group later moved to Chandigarh in western part of northern India and from there covered the extreme west portion of the type area of the Krol Belt in the vicinity of Solan, Shimla areas. A few additional participants from Wadia Institute of Himalayan Geology, Jodhpur University and Panjab University joined the Field Meeting. Late evening presentations, and Discussion Meetings were part of the activities conducted during the Field Work.

A **Field Guide Book** (consisting of 80 pages) comprising details of sections, geological spots and interesting fossil bearing horizons was distributed to the participants of the Field Meeting.

International participants: 1. Dawn Hayes, USA; 2. Bindra Thusu, UK; 3. Shuhai Xiao, USA; 4. Francisco Pinho, BRAZIL; 5. Patricia V. Rich, AUSTRALIA; 6. Nick J. Butterfield, UK; 7. N. M. Chumakov, RUSSIA; 8. Jake V. Bailey, USA; 9. Mandy Hofmann, GERMANY; 10. Malgorzata M. Vidal, SWEDEN; 11. Ulf Linneman, GERMANY; 12. Sebastian Willman, SWEDEN; 13. Therese Huldgren, SWEDEN; 14. Ryan McKenzie, USA; 15. Thomas Rich, AUSTRALIA; Indian Participants: About 40 in number

DETAILS OF TECHNICAL PRESENTATIONS

DAY 1 (February 2, 2010)

Technical Session I

Convenors: Prof. Ravi Shanker and Prof. A. R. Bhattaharya

1. **Dawn Hayes:** Stratigraphic microfossils and geochemical analysis of the Neoproterozoic Uinta Mountain Group: Evidences for a Eutrophication Event.
2. **Bindra Thusu:** Advances in Neoproterozoic Acritarchs based Biostratigraphy and correlation in Pericratonic basin of North Africa and India.
3. **Naveen Hakhoo:** Biostratigraphic implications of the Neoproterozoic microflora recovered from the Back Thrusted rock slice in the Riasi Inlier Jammu.
4. **Shuhai Xiao:** SIMS Sulfur isotope analysis of pyrites in Chert nodules of the Edicaran Doushantuo Formation : Constraints on exceptional fossils preservation.

Technical Session I

Convenors: Prof. S. Gupta and Prof. A. K. Jauhri

5. **S. B. Misra:** Origin, Habitat and Life style of Edicaran Mistaken Point Fauna: A reinterpretation.
6. **S. K. Shah:** Ichnofossil Bioevents in the late Neoproterozoic sequence of Himalaya.

Technical Session III

Convenors: Prof. N. M. Chumakov and Prof. N. L. Chhabra

7. **Francisco Pinho:** Stratigraphy and resources of the Paraguay Belt, Brazil.
8. **Patricia V. Rich:** New discoveries in the Late Neoproterozoic of Namibia Southwest Africa.
9. **Prabha Kalita:** Record of sponge spicules, calcareous algae and small shelly faunal elements from Krol Formation, Mussoorie Syncline.

DAY 2 (February 3, 2010)

Technical Session IV

Convenors: Prof. Ulf Linneman and Prof. S. K. Shah

1. **Ravi Shanker:** Sequence stratigraphic and Paleogeographic evolution of India
2. **Nick J. Butterfield:** Palynology of Huqf supergroup, Oman

Technical Session V

Convenors: Prof. Patricia V. Rich and Prof. S.B. Misra

3. **N. M. Chumakov:** Late Edicaran glaciation in central Asia
4. **Jake V. Bailey:** Sulfur bacteria and phosphorites: An ancient geobiological relationship
5. **V. C. Tewari:** Neoproterozoic glaciations in the Lesser Himalaya, India and its global paleoclimatic implications
6. **Mandy Hofmann:** LA- SF- ICP- MS- U- PB – Zircon ages of Neoproterozoic to Cambrian sediments of the Lesser Himalaya, India- First Results
7. **Prabha Kalita:** Acritarch evidence for the age and correlation of the Birmania group, Rajasthan
8. **Malgorzata M. Vidal:** Diversification of Proterozoic phytoplankton and its impact on oxygenation of marine environment

Technical Session VI

Convenors: Prof. Shuhai Xiao and Prof. Francisco Pinho

9. **Ulf Linneman**: New Data from the c. 570-580 ma old glaciations during Edicaran.
10. **Naresh Kochhar**: The Malani Supercontinent

Technical Session VII

Convenors: Prof. Nick J. Butterfield and Prof. Naresh Kochhar

11. **Sebastian Willman**: Acritarch data from Australian Neoproterozoic Succession. Local or Global relevant
12. **P. K. Maithy**: Reappraisal of Acritarch from the Vindhyan system and their implication in biostratigraphy
13. **Ryan Mckenzie**: Zircon, trilobites and the Cambrian Paleogeography of eastern Gondwana land.

Day 3 (February 4, 2010)

Technical Session VIII

Convenors: Prof. Bindra Thusu and Sri Gopendra Kumar

1. **Shuhai Xiao**: Potential of Acanthomorphic Acritarchs in the subdivision and correlation of Edicaran rocks
2. **Prabha Kalia**: Records of new acanthomorphic Acritarchs from the Upper Blaini diamictite below the cap carbonate in the Krol belt.
3. **H. N. Sinha**: Acritarch morphology as a tool to demarcate PC-C boundary

APPENDIX 3

Country report from 2010, Russia

Institute of Petroleum Geology, Geological Institute, Siberian Research Institute of Geology and Geophysics, Siberian Branch Russian Academy of Sciences Geology, Geophysics and Mineral Russian Academy of Sciences Resources (SNIIGGiMS)

International Conference Neoproterozoic Sedimentary Basins: stratigraphy, geodynamics and petroleum potential
Neoproterozoic Subcommittee (ICS) Workshop
Ediacaran Paleobiology
IGCP 512 Excursion to the East Sayan Mountain Ranges
30 July – 14 August 2011 Novosibirsk (Russia)

2nd Circular

The Organizing Committee continues a call for abstracts. We propose the following topics:

1. Neoproterozoic stratigraphy and sedimentary basins in the Siberian Platform and surrounding folded belts.
2. Paleontological, sedimentological and chemostratigraphic criteria for definition and subdivision of Neoproterozoic Systems and Series.
3. Reconstruction of Neoproterozoic paleogeography and paleogeodynamics based on sedimentological, geochronological and paleomagnetic data.
4. Petroleum potential of Neoproterozoic basins.

The conference will be preceded by a workshop, with participation of leading experts on Proterozoic microfossils from Moscow, Saint-Petersburg, Irkutsk, and Novosibirsk who will bring their collections for examination by Subcommittee members. Collections of Ediacaran and Early Cambrian macrofossils, small skeletal fossils, and trace fossils from Siberia that are important for subdivision and correlation will also be demonstrated. During the conference the participants will be provided with an opportunity to examine a core of boreholes with important Vendian sections from territories of Angara-Lena Block, Nepa-Botuoba Anticline, and eastern part of West Siberian Plate, including the borehole Vostok-3, the Siberian locality of Namacalathus and the world's fourth locality of Cloudina–Namacalathus assemblage.

After the conference there will be a geological excursion to the Uda River, the East Sayan Mountain Ranges to examine possibly the most accessible sections of the Siberian Vendian, representing deposits of the Laplandian glacial stratohorizon, the Redkino transgression, the Kotlin event (with abundant macrofossils of Late Ediacaran arumberiamorphs), and the Rovno transgression (with treptichnid trace fossils).

We look forward to seeing you in Novosibirsk next summer!

Sincerely, Organizing Committee

Sponsors:

Presidium of the Siberian Branch, Russian Academy of Sciences
Russian Foundation for Basic Researches
Trofimuk Institute of Petroleum Geology and Geophysics of Siberian Branch, Russian Academy of Sciences
Subcommission on Neoproterozoic Stratigraphy, International Commission on Stratigraphy

Academic and Organizing Committee:

| | |
|-------------------|---|
| Co-Chairman | Alexey E. Kontorovich, RAS Academician |
| Co-Chairman | Mikhail A. Fedonkin, RAS Academician |
| Honorary Chairman | Boris S. Sokolov, RAS Academician |
| Honorary Chairman | Prof. Vsevolod V. Khomentovsky |
| Vice-Chairman | Vladimir A. Kashirtsev RAS Corresponding Member |
| Vice-Chairman | Valeriy A. Vernikovsky RAS Corresponding Member |
| Vice-Chairman | Prof. Nikolay V. Sennikov |
| Members | Alexander V. Kanygin RAS Corresponding Member |
| Members | Andrey V. Maslov RAS Corresponding Member |
| Members | Prof. Nikolay V. Mel'nikov |
| Members | Prof. Valeriy S. Starosel'tsev |
| Members | Prof. Vladimir N. Sergeev |
| Members | Prof. Nikolay M. Chumakov |
| Members | Dr. Alexei I. Varlamov |
| Members | Dr. Anatoliy Postnikov |
| Members | Dr. Evgeniy M. Khabarov |
| Members | Dr. Julius K. Sovetov |
| Members | Dr. Larisa N. Konstantinova |
| Members | Dr. Dmitriy V. Grazhdankin |

The official languages of the conference will be **English and Russian.**

Citizens of many countries require a valid visa issued by Russian Consulates and Embassies for entering Russia. On the receipt of Conference Registration Form, the Organizing Committee shall issue necessary documents as required for obtaining Visa from Russian Consulate/Embassy from the country of the applicant. According to the regulations, a minimum of 4 weeks may be required for the process of invitation letters and hence please register early and not later than end February 2011.

IMPORTANT DEADLINES

February 28, 2011 Registration by oversea participants

May 01, 2011 Abstract submission deadline

CALL FOR ABSTRACTS

All participants are requested to submit abstracts in line with the Conference agenda. The length of abstracts should not exceed two A4 pages, including all figures and references. The text should be typed using 12p Times New Roman font (office address and references – 10p Times New Roman font), and single-spaced. The top, bottom, left and right margins should be 2 cm. All abstracts should be submitted as attachments: text in RTF format, illustrations in TIFF, JPG, AI (Adobe Illustrator) or CDR (CorelDraw ver. 12) formats.

Please, address your abstracts to: Dmitry Grazhdankin (dima.grazhdankin@gmail.com) and copy to Julius Sovetov (SovetovYK@ipgg.nsc.ru) and Larisa Konstantinova (knsln@mail.ru).

Conference Registration fee 4,500 Russian rubles (student – 3,000 Russian rubles) paid in Novosibirsk on July 30 will cover attendance at all scientific sessions, Conference proceedings, coffee/tea breaks, and the Conference dinner. Accompanying person registration fee – 3,000 Russian rubles.

The International Conference will be held in the **Trofimuk Institute of Petroleum Geology and Geophysics SB RAS**, Novosibirsk, Akademgorodok, Russia.

Accommodation in the “Zolotaya Dolina” Hotel, located within a walking distance (about 1 km) from the Institute of Petroleum Geology and Geophysics. Reservations will be made with the “Zolotaya Dolina” Hotel for the Conference participants.

IGCP 512 Working Group Field Trip to Nizhneudinsk area (Irkutsk region) in the foothills of the East Sayan Ranges will take place on August 3–14, 2011. The logistics includes transportation by train from Novosibirsk to Nizhneudinsk and then by off-road vehicles from Nizhneudinsk to the field-trip venue. Excursions will be held on the banks of the Uda River in places, accessible by motor vehicles, motor boats and by foot. During our excursion to the Uda River participants will be camping out and should bring appropriate hiking outfit, waterproof clothes, a light sleeping bag, a tent (optional), midge/mosquito repellent, and individual drugs.

During the excursion the participants will examine the Neoproterozoic Karagassy and Oselok Groups, specifically Late Gryogenian glaciogenic facies of the Marnya Formation and the overlying succession of marine and continental deposits of the Marnya, Uda and Aisa formations of Ediacaran age. More information on geology will be provided in the guidebook or upon request.

The weather in the Sayan region is, normally, warm in August, but at times it may be rainy. The Sayany area in the Biryusa River valley represents by itself a typical foothill landscape of East Siberia. It is a wilderness reserve area with taiga vegetation and is covered with a moderate growth of pine forest, principally, cedar and larch, and there's a great variety of berries. Uda River connects the most remote village of Nizhneudinsk district, Alygzher village inhabited by indigenous people, the Tofalars with the city of Nizhneudinsk. In summer the Uda river affords traditional routes for water tourism. During the field trip to Nizhneudinsk area there is a risk of exposure to tick-borne encephalitis. We recommend the participants to take prophylaxis against the disease. Estimated cost of the field trip is 15,000 Russian rubles (equivalent to € 360) per person and includes travel expenses, accommodation costs and meals, transportation, and printed guidebook. The field trip fees are expected to be paid in Novosibirsk.

SUBCOMMISSION ON PRECAMBRIAN STRATIGRAPHY
ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY

Subcommission on Precambrian Stratigraphy

Submitted by:

Martin Van Kranendonk, *Chair*
Geological Survey of Western Australia, Mineral House, 100 Plain Street, East Perth, Western Australia
6004, Australia, e-mail: martin.vankranendonk@dmp.wa.gov.au

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

An international subcommission under ICS that has set as its main goal to construct a 'natural' stratigraphy-based time scale for much of the Precambrian, and pin key stratigraphic boundaries with GSSPs as with the Phanerozoic (not GSSAs).

3. ORGANIZATION

Officers for 2004-2008:

Chair: Dr. Martin Van Kranendonk, Geological Survey of Western Australia
Vice-Chair: Dr. Wouter Bleeker, Geological Survey of Canada
Secretary: Dr. Robert Rainbird, Geological Survey of Canada

Website: www.stratigraphy.org/precambrian -- lists all relevant information, including downloadable pdf files of key papers and reports. The page was constructed by Wouter Bleeker and Martin Van Kranendonk and is maintained and Dr. Sorin Filipescu (Dept. of Geology, Babes-Bolyai University, in Cluj-Napoca, Romania), the ICS webmaster.

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

Work of the Precambrian Subcommission interfaces closely with:

- The subcommission on the Neoproterozoic, currently chaired by Dr. Jim Gehling.
- The main body of ICS (International Commission on Stratigraphy)
- IGCP Project 509, led by Drs. Steven Reddy (Curtin University, Western Australia), David Evans (Yale University, USA), and R. Mazumder (India): Paleoproterozoic Supercontinents and Global Evolution.
- IGCP Project 512, led by Dr. Graham Shields and Emmanuelle Arnaud: Neoproterozoic Ice Ages.
- FARDEEP drilling project, through Victor Melezhik and Aivo Lepland

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

- Further analysis of samples collected from the Australian transition section across the proposed Archean-Proterozoic boundary have been undertaken, including new S isotope analyses. Results are consistent with changes recorded in other sections and have been submitted for publication.
- The chair attended the meeting of the International commission of Stratigraphy in Prague during 2010, where he gave a presentation outlining the rationale and goals of the Precambrian Subcommission in their attempt to revise the Precambrian timescale. This was well received and new connections were made with other subcommission chairs.
- A fieldtrip was led by the subcommission chair and attended by the vice-chair and a group of 20 international geoscientists to the proposed Archean-Proterozoic boundary section and other important Precambrian sections in Western Australia, as part of the 5th International Archean Symposium.
- Geochronology results from detrital zircon dating of samples from the Turee Creek Group in Australia, and Makganyene diamictite in South Africa have been obtained. Results indicate a local provenance for the glacial rocks in both cases, perhaps casting some doubt on the proposed global nature of the glaciations over the Paleoproterozoic interval.

- C and o isotopes were collected from stromatolitic carbonate rocks immediately above the glacial section in Western Australia, in order to constrain the duration of Paleoproterozoic glaciations.
- The chair has completed writing of the chapter on the Precambrian time scale for the new ICS time scale book “GTS2012”. This includes a review of the geotectonic and geobiological evolution of the whole of the Precambrian, and which provides recommendations for a fully revised Precambrian timescale (Eons, Eras and Periods, possible names and possible type sections for GSSPs) to be debated and refined by subcommission members over the coming years (see Fig. 1).
- The chair and colleagues from France and Norway were filmed on location at the proposed Archean-Proterozoic boundary in Western Australia, as part of a major French-Canadian co-production for television, “Waltz of the Continents”.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010

The busy regular job of Chair, Martin Van Kranendonk, and his writing of the comprehensive book chapter for the Geological timescale 2010 book has meant that the establishment of working groups for the Hadean and Archean-Proterozoic boundary have been delayed.

7. SUMMARY OF EXPENDITURES IN 2010:

\$3000 was granted to Van Kranendonk to help him to travel to the Prague meeting and to undertake analyses on the proposed Archean-Proterozoic transition.

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

- Establish a working group to formalize the Hadean Eon and write a formal proposal for voting by the Precambrian Subcommission and whole of the ICS.
- Publication of the results of research into the proposed Archean-Proterozoic boundary in Western Australia and South Africa.
- Establish a working group on the Archean-Proterozoic boundary and write a formal proposal for voting by the Precambrian Subcommission and whole of the ICS.
- Prepare a special session on the Precambrian timescale and associated fieldtrip to potential GSP sites within Western Australia for the 34th ICG in Brisbane in 2012.

9. BUDGET AND ICS COMPONENT FOR 2011

- Support is requested for the publication of colour figures in papers dealing with the proposed Archean-Proterozoic boundary in Western Australia - **\$1200**.
- Support is requested for the Chair to visit the Geological Survey of Norway to view the FARDEEP drillcores as they apply to Proterozoic timescale issues - **\$2,200** for airfares (accommodation covered by colleagues there).
- Support is requested for costs of Pb-Pb dating of carbonate samples from the Western Australian and South African Paleoproterozoic glacial sections - **\$1500**.

10. REVIEW CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2005-2010)

- The new Subcommission on Precambrian Stratigraphy is now fully activated.
- Chapters contributed to GTS2004, the highly successful new comprehensive book on the time scale, edited by Gradstein et al.
- Proposal for new approach published in *Lethaia* Bleeker, 2004) and in the new Geological Timescale 2012 book (Gradstein and Ogg).
- New website up and running (<http://stratigraphy.org/precambrian/>).
- Operational links with allied subcommissions (e.g., on the Cryogenian Period) firmly established.
- First ‘concept’ workshop held in Perth, Australia, in 2005.
- Follow-up workshops held in conjunction with IGCP 509, in 2007 and the Australian Earth Sciences Convention, Perth, 2008.
- Active participation at the 33rd International Geological Congress in 2008, where a proposal for revision of the Precambrian timescale was unveiled.
- Detailed scientific research on the Archean-Proterozoic transition in Western Australia and South Africa

- Active participation in the overall body of ICS.

11. OBJECTIVES AND WORK PLAN FOR NEXT 5 YEARS (2011-2015)

- A complete Precambrian time scale in place, based on the rock record and adhering to stratigraphic principles, with formalized Hadean and Archean eons.
- Formal GSSP for the Archean-Proterozoic boundary.
- Advance the idea of a formalized Hadean Eon and derivative eras, defined by chronometric boundaries.
- Natural subdivisions of the Archean Eon into Paleo-, Meso-, and Neoproterozoic eras and derivative periods, defined by chronometric (Paleoarchean) and GSSP boundaries (Mesoarchean and Neoproterozoic).
- In cooperation with the Neoproterozoic Subcommittee, an advanced plan on how to naturalize the time scale for the Neoproterozoic.
- Full incorporation of latest insights from planetary science in the earliest part of the terrestrial Precambrian time scale.
- Submit an ICDP project proposal to investigate the Archean-Proterozoic boundary in Western Australia, through drilling.

December, 2010,
Perth, Western Australia

Figure 1: Proposed Precambrian timescale, based on a naturalistic division of events. Lower boundaries are chronometric (clock symbol), whereas younger boundaries can all potentially be defined by GSSPs (open spike symbol) in well-exposed sections. Closed spike symbol for Ediacaran Period is formally defined. Single quotation marks are suggested, but not formalized, names.

APPENDIX

Subcommission officers:

Chair: Dr. Martin Van Kranendonk, Geological Survey of Western Australia, Mineral House, 100 Plain Street, East Perth, Western Australia 6004, Australia, e-mail: martin.vankranendonk@doir.wa.gov.au

Vice-Chair: Dr. Wouter Bleeker, Geological Survey of Canada, 601 Booth Street, Ottawa, Canada, K1A0E8, e-mail: wbleeker@nrcan.gc.ca

Secretary: Dr. Robert Rainbird, Geological Survey of Canada, 601 Booth Street, Ottawa, Canada, K1A0E8, e-mail: rrainbir@nrcan.gc.ca

List of voting members (see website):

Australia:

David Nelson, Curtin University, D.Nelson@curtin.edu.au

Ian Tyler, Geological Survey of Western Australia, ian.tyler@doir.wa.gov.au

Brasil:

Reinhardt Fuck, Universidade de Brasília, rfuck@unb.br

Benjamim Bley Brito Neves, Institute of Geosciences, University of Sao Paulo, bbleyn@usp.br

Cameroon:

Sadrack Félix Toteu, Centre for Geological and Mining Research, sftoteu@yahoo.fr

Canada:

Andrey Bekker, University of Manitoba, bekker@cc.umanitoba.ca

Donald W. Davis, University of Toronto, dond@geology.utoronto.ca

Mike Hamilton (c), University of Toronto, mahamilton@geology.utoronto.ca

Sandra Kamo (c), University of Toronto, skamo@geology.utoronto.ca

Guy Narbonne, Queen's University, narbonne@geol.queensu.ca

China:

Huaikun Li, Chinese Geological Survey, tjlhuaikun@cgs.gov.cn
Songnian Lu, Chinese Geological Survey, tjlsongnian@cgs.gov.cn
Yusheng Wan, Chinese Academy of Geological Sciences, wanyusheng@bjshrimp.cn
Huichu Wang, Chinese Geological Survey, tjwhuichu@cgs.gov.cn
Allen Nutman, Beijing SHRIMP centre, nutman@bjshrimp.cn

Finland:

Petri Peltonen, Geological Survey of Finland, petri.peltonen@gtk.fi

Germany:

Alfred Kröner, University of Mainz, kroener@mail.uni-mainz.de

Russia:

Andrei Khudoley, St. Petersburg State University, khudoley@ah3549.spb.edu

Sweden:

Martin Whitehouse, Swedish Museum of Natural History, martin.whitehouse@nrm.se

United Kingdom:

Stephen Moorbath, Oxford University, United Kingdom, stephenm@earth.ox.ac.uk
Euan Nisbet, Royal Holloway University of London, nisbet@gl.rhul.ac.uk
Graham Shields, University College London, g.shields@ucl.ac.uk

United States of America:

David Evans, Yale University, dai.evans@yale.edu
Don Lowe (c), Stanford University, lowe@pangea.stanford.edu
Stephen J. Mojzsis, University of Colorado, mojzsis@colorado.edu

SUBCOMMISSION ON STRATIGRAPHIC CLASSIFICATION
ANNUAL REPORT 2010

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Stratigraphic Classification (ISSC)

submitted by:

Prof. Brian R. Pratt¹

Chair, ISSC

Dr. Maria Rose Petrizzo²

Secretary, ISSC

¹Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan S7N 5E2, Canada; Tel.: +1-306-966-5725; Fax: +1-306-966-8593; E-mail: brian.pratt@usask.ca

²Department of Earth Sciences “Ardito Desio”, University of Milano, via Mangiagalli 34, 20133 Milano, Italy; Tel.: +39-02-503 15529; Fax: +39-02-503 15494; E-mail: mrose.petrizzo@unimi.it

1st December 2010

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

The Subcommission represents a core business for the International Commission on Stratigraphy, the primary body for creating, discussing, publishing and disseminating an internationally agreed-upon guide to stratigraphic terminology and classification, in other words, standardization of the nomenclature of stratigraphic units. Its immediate priorities are to advertise new developments in stratigraphic methods, check that the procedures are carefully followed, monitor the application of the accepted rules, and encourage the teaching of basic stratigraphic principles and concepts to new generations of students and professionals.

These priorities fall into two categories: (1) the worldwide acceptance of the basic rules of stratigraphy, without which no time-scale is meaningful; and (2) coordination of international application of stratigraphic principles and concepts, with special reference to the “users” of stratigraphy, that is, stratigraphers and mappers in geological surveys, graduate and undergraduate students and their professors, geologists and geophysicists in oil companies, Quaternary geologists and geomorphologists, engineering geologists, archeologists, as well as other professionals who deal with the Earth Sciences plus those interested in the information locked in Earth’s historical record in general.

The objectives of the Subcommission are relevant to IUGS policy because standardization of stratigraphic terminology is essential to any and all attempts for global correlation, and requires a large and active international cooperation.

3. ORGANIZATION

Officers for 2008–2012:

| | |
|--------------|---|
| Chair: | Prof. Brian R. Pratt, Canada; brian.pratt@usask.ca |
| Vice-Chairs: | Dr. Jan Zalasiewicz, United Kingdom; Jaz1@leicester.ac.uk Prof. Helmut Weissert, Switzerland; helmut.weissert@erdw.ethz.ch |
| Secretary: | Dr. Maria Rose Petrizzo, Italy; mrose.petrizzo@unimi.it |

4. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

ISSC has always been directly or indirectly linked to big international projects such as ODP–IODP and IGCP. It has close ties to national stratigraphic commissions which increasingly look beyond the borders of the parent countries. This is especially true with the North American Commission on Stratigraphic Nomenclature which embraces the USA, Canada and Mexico, and tacitly much of the Caribbean area. ISSC encourages other national bodies to harmonize their codes with each other and the International Stratigraphic Guide.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2010

5.1 ICS WORKSHOP IN PRAGUE

ISSC contributed to the ICS workshop held in Prague during early June, 2010. Discussion included the concepts involved in selecting 'golden spikes', i.e. chronostratigraphic markers for major intervals of geological time, and the unambiguous use of abbreviations for geological time duration and dates. Voting members discussed informally various aspects of Biostratigraphy, Sequence Stratigraphy and Chronostratigraphy with respect to the forthcoming papers on these subjects.

5.2 ISSC NEWSLETTERS

Owing to the pace of developments of the subcommission and various personal commitments, newsletters are being issued once a year for the time being. ISSC Newsletter no. 16 is being distributed in December 2010. It will advertise the status of review papers on the subdisciplines of Stratigraphy. It will be giving a personal perspective on the ICS Workshop held in Prague. It will be giving some recent, continuing discussion on abbreviations for units of geological time, be they measured dates or spans of time. Newsletters and other documents are available on the ISSC website: <http://users.unimi.it/issc>

5.3 NEW DEVELOPMENTS IN STRATIGRAPHIC CLASSIFICATION

5.3.1 THE PROJECT

The final goal of ISSC is to update, upgrade and implement the International Stratigraphic Guide (Hedberg, 1976 [1st edition]; Salvador, 1994 [2nd edition]; Murphy and Salvador, 1999 [abridged edition]). The ISG is a most important official document with a large distribution, which requires revisiting because of the fundamental advances of stratigraphy in the last 30 years. A project was developed by ISSC following a workshop organized during the 32nd IGC in Florence, entitled "Post-Hedberg Developments in Stratigraphic Classification". A 'bottom-up' or 'grass-roots' approach was initiated with the distinction of seven stratigraphic subdisciplines to be developed by different groups of scientists mostly but not necessarily existing ISSC members. The project is not funded, and is uniquely based on voluntary participation of dedicated scientists with a teamwork approach.

The target audience includes undergraduate and graduate students, and professionals of all stripes, including field geologists, petroleum geologists and so forth.

Each chapter starts with a summary of the historical development of that peculiar branch of stratigraphy. Basic concepts are clearly presented, followed by precise definitions. Then real examples (case studies) are presented and discussed. Finally recommendations and the terminology to be adopted and problems in the application of the methods are suggested.

Background and motivation of this ambitious project are clearly expressed in the introductory article (Cita, 2007) printed in *Newletters on Stratigraphy* where the various review articles are being published. This series of review articles falls under the umbrella of "New Developments on Stratigraphic Classification". A workshop with the same title took place during the 33rd IGC in Oslo in 2008.

After the Oslo workshop and the publication of the various review articles in the coordinated series, the reprinting of the various articles in a textbook is foreseen, after passing the prescribed check points for approval in order to obtain the permission to use the ICS and IUGS logos. A planned publication date of 2011 will coincide with the 50th anniversary of IUGS, and this would be a fitting tribute to the fine achievements made by IUGS in so many stratigraphic matters.

5.3.2 THE ORGANIZATION

Task Group leaders have been appointed for the following categories of stratigraphic units not included in previous ISG:

- *Chemostratigraphy*
- *Cyclostratigraphy*
- *Sequence stratigraphy*

Working Group leaders have been appointed for categories that were already considered in the ISG:

- *Biostratigraphy*
- *Chronostratigraphy*.
- *Lithostratigraphy*
- *Magnetostratigraphy*

Each Task Group or Working Group consists of a limited number of scientists with broad international experience. Overall, more than two dozen scientists are presently involved in this project. The products of their efforts are

circulated through ISSC newsletters, first among members, then within the larger community through corresponding members of ICS and the national liaisons.

Participation of our large and variegated membership to the project proceeds in two steps:

Step 1 - is the distribution of a detailed outline of each chapter (review paper). ISSC members have a one month on-line review time to send comments or additions to the ISSC Chair. Comments are then sent to the group leader, who modifies the text accordingly, while at the same time archived by the Secretary.

Step 2 –When the text and illustrations are ready, they are circulated to ISSC members for another one month on-line review. Additional comments received by the ISSC Chair are assembled and sent to the group leader for revision of the text prior to its finalization.

Step 3 – Once the papers are published in *Newsletters on Stratigraphy*, there will be reactions from the stratigraphic community at large as well as reconsiderations by the authors and other members of ISSC. Revised versions will serve as chapters of the planned textbook, and as the foundation for a revised International Stratigraphic Guide.

5.3.3 STATE OF THE ART (as of December 2010)

Papers published:

Cita, M. B. , 2007. New developments in stratigraphic classification. A project of the International Subcommittee on Stratigraphic Classification ISSC: *Newsletters on Stratigraphy*, v. 42(2), p. 69–74.

Strasser, A., Hilgen, F. and Heckel, P., 2007. Cyclostratigraphy – concepts, definitions, and applications: *Newsletters on Stratigraphy*, v. 42(2), p. 75–114.

Weissert, H., Joachimski, M. and Sarthein, M., 2008. Chemostratigraphy: *Newsletters on Stratigraphy*, v. 42(3), p. 145–179.

Langereis, C., Krijgsman, W., Muttoni, G., and Menning, M., 2010. Magnetostratigraphy – concepts, definitions, and applications: *Newsletters on Stratigraphy*, v. 43(2), p. 207–233.

5.3.3.1 Task Groups

CYCLOSTRATIGRAPHY

Leader: **Andreas Strasser**, Switzerland, andreas.strasser@unifr.ch

Fritz Hilgen, Netherlands, [fphilgen@geo.uu.nl](mailto:fhilgen@geo.uu.nl)

Philip Heckel, USA, philip-heckel@uiowa.edu

Outline distributed in ISSC Newsletter 7 (June 2005).

Comments forwarded to the leader; available in the ISSC archive

Full text distributed in January 2006, comments received.

Paper published: Strasser A., Hilgen F. and Heckel P., 2007.

CHEMOSTRATIGRAPHY

Leader: **Helmut Weissert**, Switzerland, helmut.weissert@erdw.ethz.ch

M. Joachimski, Germany, joachimski@geol.uni-erlangen.de

M. Sarthein, Germany, ms@gpi.uni-kiel.de

Outline distributed in ISSC Newsletter 9 (June 2006).

Comments received and distributed in ISSC Newsletter 10 (November 2006)

Full text distributed in appendix to ISSC Newsletter 11 (June 2007), comments received

Paper published: Weissert, H., Joachimski, M. and Sarthein, M., 2008.

SEQUENCE STRATIGRAPHY

Leader: **Octavian Catuneanu**, Canada, octavian@ualberta.ca

Andreas Strasser, Switzerland, andreas.strasser@unifr.ch

Andrew Miall, Canada, miall@geology.utoronto.ca

William Galloway, USA, galloway@mail.utexas.edu

Maurice Tucker, UK, m.e.tucker@durham.ac.uk

Christopher Kendall, kendall@geol.sc.edu

Henry Posamentier, USA, henry.posamentier@chevron.com

Outline has not been distributed by the current group but one was distributed by previous group.

Comments from the first outline were forwarded to the leader, and made available in the ISSC archive.

Full text will be distributed in early 2011, and comments will be incorporated.

5.3.3.2 Working Groups

BIOSTRATIGRAPHY

Leader: **Jacques Thierry**, France, jthierry@mail.u-bourgogne.fr; jacques-thierry2@wanadoo.fr

Stan Finney, USA, scfinney@csulb.edu

Yuri Gladenkov, Russia, gladenkov@ginras.ru

Outline distributed in ISSC Newsletter 9 (June 2006).

Comments received and distributed in ISSC Newsletter 10 (November 2006).

Full text in progress; a fourth member of the group is being contemplated

CHRONOSTRATIGRAPHY

Leader: **Maria Bianca Cita**, Italy, maria.bianca@unimi.it

Fritz Hilgen, The Netherlands, fhilgen@geo.uu.nl

Jacques Thierry, France, jthierry@mail.u-bourgogne.fr

Jan Zalasiewicz, U.K., jaz1@le.ac.uk

Stan Finney, USA, scfinney@csulb.edu

Brian Pratt, Canada, brian.pratt@usask.ca

Outline distributed in January 2007.

Comments received and distributed in ISSC Newsletter 11 (June 2007).

Full text in progress, half done, five case studies well selected.

LITHOSTRATIGRAPHY

Leader: **Brian Pratt**, Canada, brian.pratt@usask.ca

Stan Finney, USA, scfinney@csulb.edu

Werner Piller, Austria, werner.piller@uni-graz.at

Mike Easton, Canada, mike.easton@ndm.gov.on.ca

Outline distributed in ISSC Newsletter 11 (June 2007).

Comments received and forwarded to the leader; available in the ISSC archive.

Full text in progress, half done.

MAGNETOSTRATIGRAPHY

Leader: **Cor Langereis**, The Netherlands, langereis@geo.uu.nl

Wout Krijgsman, The Netherlands, krijgsma@geo.uu.nl

Giovanni Muttoni, Italy, giovanni.muttoni1@unimi.it

Manfred Menning, Germany, menne@gfz-potsdam.de

Outline distributed in ISSC Newsletter 12 (December 2007).

Comments received and forwarded to the leader; available in the ISSC archive.

Full text distributed in January 2009, comments received

Paper published: Langereis, C., Krijgsman, W., Muttoni, G. and Menning, M., 2010.

6. CHIEF PROBLEMS ENCOUNTERED IN 2010.

The ICS subvention allocated to ISSC was rather low and disproportionate to the overall importance and significance attributed to this subcommission at the IUGS Ad-hoc Review Committee (ARC) meeting in Paris (November 7–8 2005). The entire allocation for 2010 (\$1500) was devoted to maintaining the website and assembling the newsletter, and supporting the chair's attendance at the ICS workshop in Prague. Attendance by the Vice-Chairs and Secretary could not be supported.

In the meantime, progress slow but sure is being made in the preparation of the four remaining chapters on facets of Stratigraphy.

7. SUMMARY OF EXPENDITURES IN 2010:

I. INCOME

| | |
|--|--------|
| 2010 ICS travel support for Pratt to attend ICS workshop in Prague | \$1000 |
| 2010 ICS subvention | \$500 |

II. EXPENDITURES

| | |
|---|--------|
| Newsletter preparation and website maintenance | €340 |
| Travel support for Chair to attend ICS workshop in Prague | \$1000 |

8. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2011):

- Final draft form:
 - *Biostratigraphy*
 - *Chronostratigraphy*
 - *Lithostratigraphy*
 - *Sequence Stratigraphy*

- Newsletter:
 - December 2011

9. BUDGET AND ICS COMPONENT FOR 2011

| | |
|--|---------------|
| ISSC Newsletter no. 17 and website maintenance | \$ 500 |
| Subsidies to help attendance at conferences to work over manuscript drafts | <u>\$4500</u> |
| Total request | \$5000 |

Rationale—The remaining manuscripts should be prepared in 2011. It would be desirable that as many authors as possible of individual working and task groups should have a face-to-face meeting along with other ISSC members who can contribute with their special expertise. The most obvious venues for this are the AAPG–SEPM, EGU and GSA annual meetings. We will also support a meeting and field trip for the new Biostratigraphy Working Group (Rick Fluegeman, Peter Harries, Maria Rose Petrizzo, Jan Zalasiewicz, Adrian Rushton and Brian Pratt) in Bournemouth, in order to finalize content of Newsletters in Stratigraphy manuscript (and future textbook chapter) and test biostratigraphic concepts on classic Jurassic stata and stages of the southern coast of England.

Potential funding sources outside IUGS—The Subcommittee does not envisage being able, as an organization, to obtain significant funding from outside IUGS/ICS sources. As in previous years, some financial support is obtained by individual members from their host institutions and/or their personal research funds. In-kind support is provided to the Secretary by the Department of Earth Sciences, University of Milan for equipment including computer, e-mail access and telephone.

10. SUMMARY OF CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2005-2010)

See Accomplishments in ISSC Annual Reports 2005–2010 as well as relevant newsletters.

11. OBJECTIVES AND WORK PLAN FOR NEXT 2 YEARS (2011–2013)

- (1) All the various review papers on the various branches of Stratigraphy will have been submitted and printed over this period.
- (2) The series of papers will form the core of a textbook. Publication details, including arrangements with Nägeli & Obermiller, Stuttgart (the publishers of *Newsletters on Stratigraphy*) remain to be worked out, and will be done so under the general auspices of IUGS and ICS and timed to coincide with the 50th anniversary of IUGS.
- (3) ISSC will take the initiative to encourage special sessions and symposia at conferences that advance stratigraphic principles, in collaboration with other ICS subcommissions.
- (4) ISSC will make a recommendation on time-rock versus rock nomenclature (e.g. Early versus Lower).
- (5) ISSC will take the initiative to contact journal editors and scholarly book publishers to remind them of the basic tenets in the existing International Stratigraphic Guide as well as relevant national codes, as well as the background in the review papers.
- (6) The **ULTIMATE GOAL** of ISSC is the publication of a new, multi-authored, really multinational International Stratigraphic Guide—a guide not a code, simple, clear, concise, user-friendly, for world wide distribution and acceptance.
- (7) A new executive will be chosen after canvassing stratigraphically disposed colleagues and holding a forum amongst voting members.

APPENDIX [Names and Addresses of Current Officers and Voting Members]

Subcommission officers:

Chair:

Prof. Brian R. Pratt Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan S7N 5E2, Canada; Tel.: +1-306-966-5725; Fax: +1-306-966-8593; E-mail: brian.pratt@usask.ca

Vice-Chairs:

Dr. Jan Zalasiewicz, Department of Geology, University of Leicester, University Road, Leicester, LE1 7RH, UK; Tel.: +44 (0)116 252 3928; Fax: +44 (0)116 252 3918; E-mail: jaz1@leicester.ac.uk

Prof. Helmut Weissert, Geologisches Institut, Eidgenössische Technische Hochschule Zürich, Universitätsstrasse, 16_8092 Zürich, Switzerland; Tel.: +41 44 632 37 15_; Fax: +41 44 632 10 30; E-mail: helmut.weissert@erdw.ethz.ch

Secretary:

Dr. Maria Rose Petrizzo, University of Milan, Department of Earth Sciences “Ardito Desio”, via Mangiagalli 34, 20133, Milano, Italy; Tel. +39-02-503 15531; Fax: +39-02-503 15494; e-mail: mrose.petrizzo@unimi.it

List of Members:

VOTING (includes all members of working and task groups):

Berggren William A., Woods Hole, USA wberggren@whoi.edu

Brown Cathy, Canberra, AUSTRALIA cathy.brown@ga.gov.au

Carter R.M., Townsville, AUSTRALIA bob.carter@jcu.edu.au

Catuneanu Octavian, CANADA, octavian@ualberta.ca

Chang Ki-Hong, Daegu, KOREA khchang@knu.ac.kr

Choi Duck K., Seoul, KOREA dkchoi@snu.ac.kr

Csaszar Geza, Budapest, HUNGARY csaszar@mafi.hu

Dermitzakis Michael D., Athens, GREECE mdermi@geol.uoa.gr

Easton Mike, Sudbury, CANADA, mike.easton@ndm.gov.on.ca

Edwards Lucy E., Reston, USA leedward@usgs.gov

Etayo Serna Fernando, Santafé de Bogotá, COLOMBIA hduque@elsitio.net.co

Finney Stanley, Long Beach, USA scfinney@csulb.edu (Chair – ICS)

Galloway William, USA galloway@mail.utexas.edu

Gianolla Piero, Ferrara, ITALY piero.gianolla@unife.it

Gladenkov Yuri B., Moscow, RUSSIA gladenkov@ginras.ru

Grigelis Algimantas, Vilnius, LITHUANIA grigelis@geo.lt

Hasegawa Shiro, Kumamoto, JAPAN shiro@sci.kumamoto-u.ac.jp

Heckel Philip H., Iowa City, USA philip-heckel@uiowa.edu, Chair – Carboniferous Subcommission

Hilgen Frederik J., Utrecht, NETHERLANDS, fhilgen@geo.uu.nl (Chair – Neogene Subcommission)

Hoedemaeker J., Leiden, NETHERLANDS Hoedemaeker@naturalis.nnm.nl

Hongzhen Wang, Beijing, CHINA wangcugh@public.bta.net.cn

Ivanov Marin, Sofia, BULGARIA mivanov@gea.uni-sofia.bg

Joachimski Michael, Erlangen, GERMANY, joachimski@geol.uni-erlangen.de

Hutton Chris Pretoria, SOUTH AFRICA chatton@geoscience.org.za

Karogodin Yuri N., Novosibirsk, RUSSIA karogod@uiggm.nsc.ru

Kazuo Amano, Ibaraki, JAPAN kam@mx.ibaraki.ac.jp

Kendall Christopher, South Carolina, USA, kendall@sc.edu

Krijgsman Wout, Utrecht, NETHERLANDS, krijgsma@geo.uu.nl

Lane H. Richard, Arlington, USA hlane@nsf.gov

Langereis Cor, Utrecht, NETHERLANDS, langer@geo.uu.nl

Lasca Norman P., Milwaukee, WI, USA nplasca@csd.uwm.edu

Menning Manfred, Potsdam, GERMANY menne@gfz-potsdam.de

Miall Andrew D., Canada, miall@geology.utoronto.ca

Muttoni Giovanni, Milano, ITALY, giovanni.muttoni1@unimi.it

Odin G.S., Paris, FRANCE gilodin@ccr.jussieu.fr

Owen Donald E., Beaumont, USA owende@hal.lamar.edu

Palmer Julie, Palmerston North, NEW ZEALAND J.A.Palmer@massey.ac.nz

Petri Setembrino, Sao Paulo, BRAZIL spetri@usp.br

Petrizzo Maria Rose, Milano, ITALY mrose.petrizzo@unimi.it
Piller Werner E., Graz, AUSTRIA werner.piller@uni-graz.at
Pratt Brian R., Saskatoon, CANADA brian.pratt@usask.ca
Reguant Salvador, Barcelona, SPAIN reguant@geo.ub.es
Riccardi Alberto C., La Plata, ARGENTINA riccardi@museo.fcnym.unlp.edu.ar (Chair – IUGS)
Sarnthein M., Kiel, GERMANY, ms@gpi.uni-kiel.de
Shouxin Zhang, Beijing, CHINA shouxinzh@yahoo.com.cn
Steininger Fritz F., Frankfurt-am-Main, GERMANY fritz.steininger@senckenberg.de
Strasser André, Fribourg, SWITZERLAND andreas.strasser@unifr.ch
Takayanagi Yokichi, Sendai, JAPAN ytaka@cat-v.ne.jp
Thierry Jacques, Dijon, FRANCE jthierry@mail.u-bourgogne.fr
Tucker Maurice E., Durham, UK m.e.tucker@durham.ac.uk
Waterhouse J. Bruce, Oamaru, NEW ZEALAND Loris@xtra.co.nz
Weissert Helmut, Zürich, SWITZERLAND helmut.weissert@erdw.ethz.ch (Vice-Chair – ISSC)
Winter Henk de la R., Johannesburg, SOUTH AFRICA winterh@xconnect.co.za
Zalaszewicz Jan, Leicester, UK jaz1@leicester.ac.uk (Vice-Chair – ISSC)

CORRESPONDING (includes present and past chairs of subcommissions):

Beauchamp Benoit, Calgary, CANADA bbeauch@ucalgary.ca
Becker Thomas, Münster, GERMANY rbecker@uni-muenster.de, Chair – Devonian Subcommission
Bleeker Wouter, Ottawa, CANADA Wbleeker@NRCan.gc.ca, Chair – Precambrian Subcommission
Chen Xu, Nanjing, CHINA xu1936@yahoo.com, Chair – Ordovician Subcommission
Cita M. B., Milano, ITALY maria.cita@unimi.it (Past-Chair – ISSC)
Embry A., Calgary, CANADA AEmbry@NRCan.gc.ca (Past-Vice Chair – ISSC)
Gehling James, Adelaide, AUSTRALIA, jgehling@ozemail.com, Chair – Ediacaran Subcommission
Gibbard Phil, Cambridge, UK plg1@cus.cam.ac.uk, Chair – Quaternary Subcommission
Gradstein Felix, Oslo, NORWAY felix.gradstein@nhm.uio.no, Past-Chair – ICS
Henderson Charles, Calgary, CANADA charles.henderson@ucalgary.ca, Chair – Permian Subcommission
Johannessen Erik, Stavanger, NORWAY, EPJ@statoil.com
Luterbacher H.P., Barcelona, SPAIN, HPLUTER@telefonica.net
Molina Eustoquio, Zaragoza, SPAIN emolina@posta.unizar.es, Chair – Paleogene Subcommission
Morton Nicol, FRANCE NICOL.MORTON@wanadoo.fr, Chair – Jurassic Subcommission
Ogg James G., West Lafayette, USA jogg@purdue.edu, Past-Secretary – ICS
Orchard Mike J., Vancouver, CANADA morchard@nrca.gc.ca, Chair – Triassic Subcommission
Peng Shanchi, CHINA scpeng@nigpas.ac.cn, Chair – Cambrian Subcommission
Premoli Silva Isabella, Milano, ITALY isabella.premoli@unimi.it, Chair – Cretaceous Subcommission
Rawson P., London, GREAT BRITAIN p.rawson@ucl.ac.uk
Robb Laurence, Witwatersrand, SOUTH AFRICA 065LJR@cosmos.wits.ac.za
Rong Jiayu, Nanjing, CHINA jyong@nigpas.ac.cn, Chair – Silurian Subcommission
Zachariasse W.J., Utrecht, NETHERLANDS, jwzach@geo.uu.nl
Zhamoida A.I., St. Petersburg, RUSSIA MSK@vsegei.ru

SUBCOMMISSION ON STRATIGRAPHIC INFORMATION
ANNUAL REPORT 2010

TITLE OF CONSTITUENT BODY

STRATIGRAPHIC INFORMATION group
(former, and potential future, ICS Subcommission for Stratigraphic Information)

Submitted by James Ogg, chair

1. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Mission Statement

The Stratigraphic Information *group* (SSI) promotes and coordinates the gathering of selected stratigraphic information worldwide and organizes logically its presentation through the ICS website. The SSI's first priority is to enable the world geoscience community to have quick and free access to a vast amount of stratigraphic information, thus helping to spread the knowledge and foster the advancement of the science globally.

Goals

The former Subcommission for Stratigraphic Information was established in 2000, and assigned an extensive set of goals (Appendix 1). A streamlined version was adopted in 2003, with a simplified task set (diagrammed in Appendix 1).

SSI's assigned main goals are to gather selected stratigraphic information (*such as databases, compilation of biozonal schemes, regional time scales, stratigraphic standards, and geohistory teaching modules*) and develop a method of classification to organize, logically, the databases and related links, and make easy search and use of the contents through its website to the world scientific community. The SSI primarily aims to promote scientific cooperation and the advancement of the science worldwide, and to maintain the leading role of ICS in the stratigraphic information network. The four-fold set of tasks, as assigned in 2002, are:

- (1) Geologic time scale information (*from posters and cards to multi-author compilations*)
- (2) Stratigraphic database center and links (*with visualizations; links to lexicons, etc.*)
- (3) Stratigraphic standards (*GSSP information, stratigraphic code in different languages*)
- (4) Geohistory education and links

2. Organization

During 2009 and 2010, the SSI group strove to attain an extended international and thematic membership; and there are currently 14 official members (listed in section 10). Beginning in June, 2010, the chairs of other ICS subcommissions serve as ex-official members to provide guidance and expertise for vetting posted information and aiding in new compilations. It must be emphasized that this group is task-oriented, and it is expected that the membership will be active in undertaking those tasks or coordinating activities of SSI with other international programs in geoinformatics, regional geological syntheses and public outreach.

Officers

| Name | Office or Expertise | Country (Institution) |
|---------------------------|---|--------------------------------------|
| Ogg, James G. | <i>Chair</i> ; TS-Creator database and visualization | USA (Purdue University) |
| Ogg, Gabi M. | <i>Secretary/Webmaster</i> ; graphics, GSSP tables | USA (Purdue University) |
| Crampton, James S. | <i>Vice-Chair</i> , Global Change Through Time Programme of GNS | NEW ZEALAND (Inst. Geol. Nucl. Sci.) |

The SSI group is currently soliciting voting members other regions (e.g., Africa, Mideast) and additional international programs, which can contribute to the SSI mission.

3. Interfaces with other international projects

(1) **UNESCO Commission for the Geologic Map of the World (CGMW)**. In addition to collaboration in outreach materials, we are coordinating with CGMW on inter-linking our *TimeScale Creator* databases and different regional lexicons to their geological maps. Bruno Vrielynck is jointly serving on CGMW and SSI.

(2) **One-Geology, GeoSciML** and geoinformatics. During the IGC of 2008, a project was initiated with Simon Cox (*coordinator of One-Geology geoinformatics*) to provide an RSS-feed of the main ICS standards, especially GSSP definitions and approximate ages, to the One-Geology program. This was completed in April 2009, but awaits additional standards from GeoSciML. The SSI plans to eventually place its entire database of earth history (datums, zones, magnetochrons, geochem, etc.) with interpolated numerical age assignments onto a similar RSS-feed when GeoSciML standards are established.

(3) **National Geological Surveys and Strat Commissions**. As of Nov, 2010, the SSI has joint projects (mainly *TimeScale Creator* datapacks) with official bodies in 9 nations: Geoscience Australia, New Zealand geologic survey, British Geologic Survey, Geological Survey of Canada (Calgary branch), Norwegian offshore lexicon, Austria Stratigraphy Commission, German Stratigraphy Commission and German Geological Survey (BGS), Russia (All Russian Geological Institute) and China (Geodiversity Database and regional stratigraphy data center, Nanjing, China). Details of these projects are given below.

4. Chief accomplishments and products in 2010

a. Websites and RSS-feeds

Two websites were designed and populated with a wide array of information. These sites are hosted at Purdue University:

(1) The main SSI site, <http://stratigraphy.science.purdue.edu/>, has been active since Nov 2008:

The SSI website contains:

- (a) **GSSPs** – The divisions of geologic time, such as Jurassic or Danian, are defined at a Global Boundary Stratotype Section and Point (GSSP) that marks the international reference for their base. We have compiled summary tables and graphics for all ratified GSSPs and pending candidates. The main tables and display of graphics are dynamically generated; therefore any other web-service can access and display this information (RSS-feed).
- (b) **RSS-Feed** - The ICS was requested by the IUGS and One-Geology Geoinformatics groups to provide a web-based authoritative digital dataport for basic GSSP parameters (stage, ratification status, location, definition, main correlation methods, approximate age, color of stage, etc.). Therefore, a dynamic feed was successfully created by the Purdue University “VIP” undergraduate engineering project under a “contract” to SSI. This RSS-feed (or ATOM output, partly following GeoSciML standards) could be automatically queried by other applications; rather than individuals having to search through the ICS sites to see if a GSSP had been defined, revised, etc. In addition, this project provided a dynamic-generation for all GSSP tables and individual stage-level pages on the SSI website, including Google-Earth display of each location.
- (c) **CHARTS & BOOKS** – From the popular page-sized geologic time scale (*divisions of geologic time*) to poster-sized Earth’s history, all in official CGMW colors.
- (d) **STRATIGRAPHIC GUIDE** – a concise version of the official manual.
- (e) **RESOURCES** – links to lexicons (national rock formations), diagrams of inter-regional correlations, “GeoWhen” database of historic and regional stage names (*contributed in 2005 by R. Rohde; Univ. Calif. Berkeley*), and selected links to other Earth history sites.
- (f) Link to our TS-CREATOR public site.

(2) **TS-CREATOR website** – The *TimeScale Creator* site, <http://www.tscreator.org/>, is affiliated with ICS which guides the majority of the scientific content. The SSI members and other groups have provided the majority of the datasets on Earth’s global and regional history (described later). These are viewed through the *Time Scale Creator* visualization package, a free JAVA program for all platforms to explore Earth history:

TimeScale Creator

TimeScale Creator, a free JAVA package, enables you to explore and create charts of any portion of the geologic time scale from an extensive suite of global and regional events in Earth History. The internal database suite encompasses over 20,000 biologic, geomagnetic, sea-level, stable isotope, and other events – details are given on the [BUILT-IN DATA](#) page. All ages are currently standardized to *Geologic Time Scale 2004*, and to the *Concise Geologic Time Scale* compilation of the [International Commission on Stratigraphy](#) and its [Subcommission on Stratigraphic Information](#).

[How to use the program](#) (briefly; details are on the [MANUAL](#) pages):

TimeScale Creator PRO 1.4.3
 Database coordinators: Jim Ogg, Felix Gradstein
 Software development: Adam Lagowski

TS Creator Pro is for you to create on-screen and downloadable charts of any portion of the geologic time scale with your choice of bio-, magne-, chemo- and other events in Earth History. TSC Pro can load and modify data and has expanded graphic routines. See [HELP](#) for Features.

Licensed to James Ogg
 website: <http://www.stratigraphy.org>
 username and password can be found in Help->Website.

From Data to finished Chart in 3 simple steps

Step 1: Pick Time interval
 Step 2: Select stratigraphy
 Step 3: GENERATE

[click to enlarge](#)

[DOWNLOAD](#) the free TimeScale Creator.
 See [FAQs](#) for common questions.

TimeScale Creator provides a wealth of information for making charts and posters, such as these [CHARTS](#) produced by the ICS Subcommission on Stratigraphic Information.

Try some of our additional [DATAPACKS](#) of selected regional (e.g., British Isles facies successions, New Zealand range charts) or specialty stratigraphy (e.g., global reconstruction images, Ice cores and archeological culture intervals) from the *TimeScale Creator* library.

In addition to providing the free software and manuals in on-line/PDF formats, the site provides an array of datapacks ranging from British Isles geology to Russian biostratigraphic zones to New Zealand fossil ranges. These have been mainly developed in coordination with SSI members (described below).

b. Printed Material on Earth's History

We have concentrated on global distribution of free or “at cost” teaching resources for Earth History. Production, printing and distribution of these products have been sponsored by EAS/Purdue, Australian National University, Geoscience Australia, and a consortium of petroleum companies (ExxonMobil, ChevronTexaco, BP, Statoil, Shell, ENI, Conoco, Neflex). Some are joint products to be distributed by UNESCO (Commission for Geologic Map of the World).

Chart “*International Divisions of Geologic Time*” is freely available through the International Commission of Stratigraphy website (www.stratigraphy.org) and the SSI website.

Plastic card “*International Geologic Time Scale*”. Versions were sponsored by Neflex, Chevron, ExxonMobil, ConocoPhilips and ENI.

Mousepad “*International Divisions of Geologic Time*”. This was a joint production with the UNESCO Commission for the Geologic Map of the World. The first printing was sold out at the International Geological Congress (Oslo, August, 2008). The second printing is available through the CGMW website. A separate printing was done by Geoscience Australia (but including ICS icon) for distribution throughout that country.

Detailed **Charts for each geologic period**. These poster-sized summaries of major biostratigraphic, sea-level and geochemical trends can be downloaded from the SSI website.

Book, *Concise Geologic Time Scale 2008*, (full-color, 160-page, hardback via Cambridge Univ. Press; \$30) is a comprehensive review of all geological time divisions and the associated absolute (millions of years) time scale. This compilation involved a large global network of geoscientists (mainly ICS chairs) contributing their expertise. IUGS reviewed the contents, A plastic timescale card is included in each book. Approximately 2500 copies were sold between Aug, 2008 and Sept, 2010.

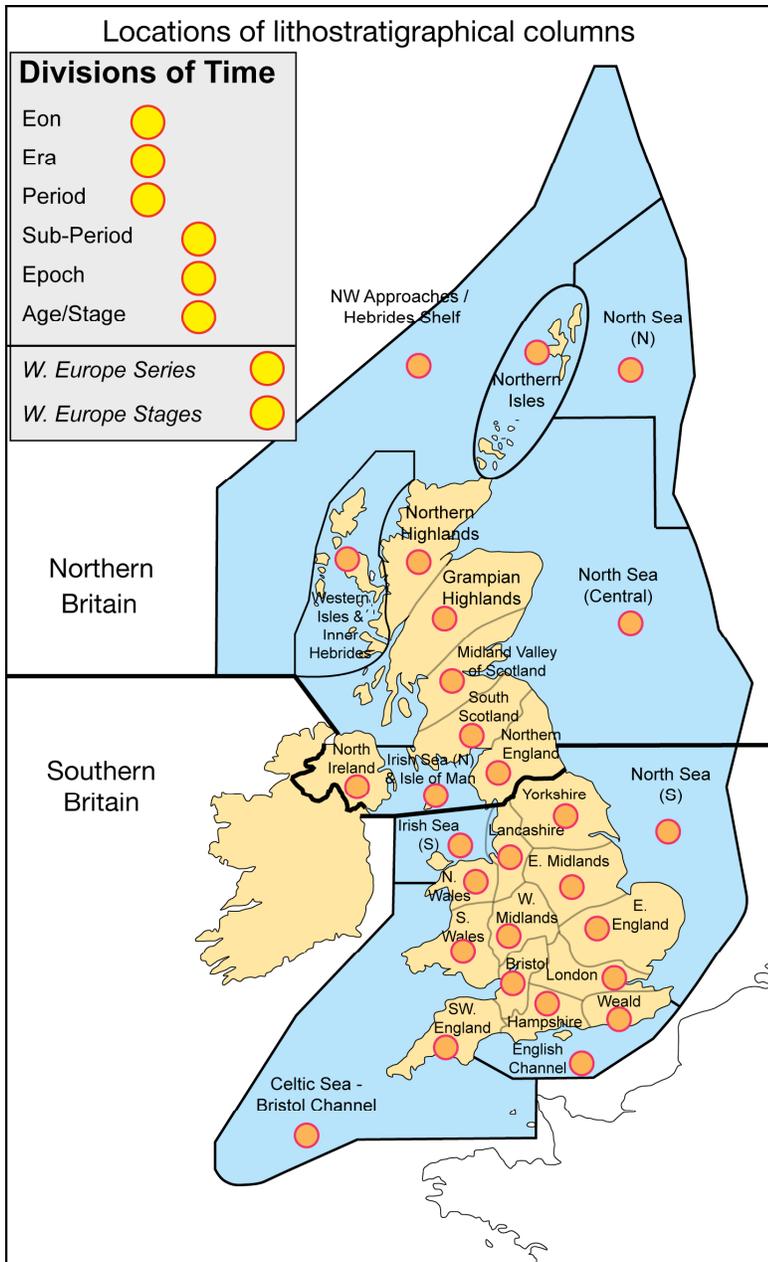
Poster “*History of the Earth*” (geologic time scale, life-through-time, and global reconstructions). This was one of our contributions for the United Nations 2008-09 “*International Year of Planet Earth*”. The target audiences are secondary schools. The IYPE reviewed and approved the product.

2500 copies were printed/distributed during 2007-09 in Australia.
3000 copies were printed/distributed in 2007-10 through Purdue University; mainly to K-12 teachers.
Poster “*A Geologic Time Scale 2008*” (3x2 feet; prepared and printed in coordination with UNESCO Commission for the Geologic Map of the World). This is available through the SSI or CGMW websites.
Chart “*Geologic Time Scale 2004*” (A3-sized).

c. Global databases and Visualization

“*TimeScale Creator*”: Version 4.2.5 of this free JAVA suite was released in Nov, 2010; and Version 4.3 with geographic interfaces will be released in Jan, 2011. This is a continuously expanding database-visualization system with hyperlinks to our stratigraphic-information and other websites. The internal database contains approximately 25,000 biologic, magnetic and other major events in Earth’s history (*status in Nov’10*), plus an extensive set of geochemical and sea-level curves. This and other datasets are collaborations among the SSI group, ICS chairs who are participating in the GTS04 or GTS2010 projects, Purdue University and many data providers. Database updates/enhancements are mounted approximately every three months. The user selects the interval of time, chooses the type of data to be displayed, and this windows into Earth’s history appears on the screen, or can be downloaded as an SVG or PDF file for use in popular graphics programs. On-line “quick-start”, tutorials, exercises and a manual (*courtesy of ExxonMobil*) provide independent training in usage and developing one’s own datasets for insertion.

Version 4.2 (August 2009) had added capabilities for lithologic columns, images of paleogeographic maps, range charts, URL-hotlinks, and other valuable features. The entire software suite was migrated to an SVN system in 2010 to enable multiple programming teams to access and modify the basic routines. The new **Version 4.3** (Nov 2010; with additional update Jan 2011) has added a geographic interface (see example below), basin transect capability with floating labels and pop-ups (*with a colorful user manual for self-entry of transects*), option to display “meter-scaled” information (e.g., outcrop or downhole wells), dual depth-vs-time cross-plot capabilities (*and manual*), outcrop-to-time conversion routine (*which also converts geochem curves or other logs*), superimposed geochemistry curve system, enhanced “focus-in” capabilities, ability to display images within range-charts or within pop-up windows, and many other features. We also worked with PaleoStrat and with the GeoBiodiversity database teams to install systems to display their outcrop information for on-line users.



Example of Geographic Interface for TimeScale Creator version 4.3: After selecting a time interval and vertical scale (a separate window), the user clicks on intervals and locations to generate a summary chart of the geologic history of those regions. All formations are hot-linked to the British lexicon. This is a collaboration with the British Geological Survey.

Stratigraphic datasets added in 2009-10 include onlap curves for Phanerozoic, large igneous provinces (*from International Association of Volcanology and Chemistry of the Earth's Interior*), ice core data, major impacts (*data from PASSC*), orbital-climate curves back to 250 Ma (*courtesy of Linda Hinnov and coworkers*), detailed oxygen-isotope records (*e.g., 15,000 Cenozoic values provided by I. Raffi et al.*) humanoid evolution and time scales for other planets (Mars, Moon, etc.). There is a separate datapack concentrating on the past 10,000 years (*Greenland ice core and preliminary "human culture" compilation*); currently being enhanced further by anthropology workers at Purdue Univ.

In 2010, we presented workshops to educational and research audiences in Houston (paleontological conference), China (International Symposium on Quantitative Stratigraphy and Palaeobiology and GBDB Summer Course), Norway (workshop on regional stratigraphy) and Vienna (EGU presentation) on how to utilize the educational exercises, create one's own datasets, and apply the datapacks for geoscience research.

e. Regional Lexicon-linked databases and Other datapacks (2009, 2010 and ongoing 2011)

NOTE: All regional visualization suites produced directly with geological surveys are freely available as datapacks through the SSI/TSC websites and as special pre-packaged TS-Creator versions through the websites of the individual geological surveys. All of the following projects were put on-line during 2009-2010 or are nearly completed for mounting in 2011:

Australian Geo-History – this was greatly enhanced in 2009-10 with Geoscience Australia (the Australian geological survey). In addition to all types of Australian biostratigraphy with full references of calibrations, the datapack has a comprehensive array of lithologic columns (about 200) of all Australian Proterozoic and Phanerozoic basins and subbasins (and even finer detail in some regions), with each formation hot-linked into the GA Oracle database. Images of paleogeographic maps, tectonic maps and facies maps (about 50 of each) provide visual columns on Australian history, and are also hot-linked to additional on-line summaries. The suite also includes reference wells for all major oil-gas reservoirs (hot-linked to appropriate databases). There are over 9000 events/datums/formations. This extensive system is intended to be a model to put the geology of other continents “on-line”.

New Zealand Geo-History – In collaboration with the NZ Geological and Nuclear Sciences (their geological survey), an extensive (ca. 3000 entries) array now includes the main and all secondary biostratigraphic events and ranges for this region. Palynology events are linked to the NZ-hosted pollen-spore database. Lithostratigraphy and transects was added in 2010 for half of the New Zealand basins, and the entire region will be completed in 2011.

British Isles Lithostratigraphy. An extensive (ca. 2000 entries) array includes the Phanerozoic of all British basins, and has been vetted by the British Geological Survey. All formations are tied to the Lexicon of BGS.

Russian Biostratigraphy. An extensive (7000 entries) array includes most biostratigraphic zones and major bioevents for all regions of Russia through the entire Phanerozoic. The suite was provided by T. Koren' (All-Russian Geological Research Institute), and is based on her institutes book and extensive charts.

Russian Lithostratigraphy (NE Russia). Dr. T. Koren' and her institute has provided an detailed compilation of Phanerozoic stratigraphy for NE Russia (ca. 80 columns for each system). The SSI has translated most of these charts, and the dataset will be mounted in early 2011. It is planned that this program with the All-Russian Geological Research Institute will eventually include syntheses for all of the Russian basins.

Russian Hydrocarbon Basins Lithostratigraphy. This set was mainly compiled from Siberian, Caspian and other regional reports of the U.S. Geological Survey.

Canada Geo-History. A collaboration with the Geological Survey of Canada (G. Nowlan, coordinator) has completed approximately 200 stratigraphic columns spanning the Phanerozoic of interior Canada and its Arctic islands, plus an extensive Arctic transect. This project will be distributed in early 2010 for vetting before mounting for public use.

China Geo-History. An initial set of major biostratigraphic zonation (all major fossil groups) and of the lithostratigraphy for most major Chinese basins was completed during the summer of 2010 in collaboration with Nanjing's Institute for Stratigraphy and Paleontology. The GeoBiodiversity group in Nanjing is proceeding with a much more detailed version in late 2010 through 2011.

Gulf of Mexico Geo-History – An extensive (ca. 2000 entries) suite integrates biostratigraphy/sequence stratigraphy charts of Shell (*provided by Mike Styzen*), of Dick Fillon (*formerly at Chevron*), of PaleoData, of the USA MMS, and lithostratigraphy columns from the Gulf of Mexico DNAG volume (*in turn, linked to the USGS Lexicon*).

Svalbard and Norwegian Sea Lithostratigraphy. All formations are tied to entries in Norlex.

Alaskan and other Arctic Hydrocarbon Basin Lithostratigraphy. This includes conversions of many regional reports of the U.S. Geological Survey.

Marine Genera ranges. This is based on the Sepkoski (2002) compilation, as revised and updated by Leif Tapanila. A user selects from 30,000 genera according to phylum and orders.

Austria Lithostratigraphy. This is based on charts produced by the Austrian stratigraphic commission and includes the Phanerozoic of basins and mountain belts. The initial data entry was completed in Summer 2008; and will be put on-line in conjunction with the publication of the Geology of Austria (W. Piller et al.) by the Austria Stratigraphic Commission in early 2011. Simultaneously, they will complete the on-line Lexicon for inter-linking.

Germany Lithostratigraphy . This includes the Phanerozoic of basins and mountain belts, and is based on charts produced by the German stratigraphic commission. The initial data entry was completed in Summer 2008; but review/deployment awaits input from the BGR and German Commission on Stratigraphy. All formations are linked to the German stratigraphic on-line Lexicon.

India and Adjacent Regions Lithostratigraphy. This datapack has already been completed; but requires vetting by stratigraphic experts. It includes the Phanerozoic of all onshore and offshore basins and mountain belts of the Indian subcontinent, and is based on charts produced by Rao et al (2007). Details on formations (and links) are from publications and the Indian directorate for hydrocarbons.

Middle East Lithostratigraphy – This is based on charts produced by GeoArabia and includes the Phanerozoic of basins and mountain belts. The initial data entry was completed in Summer 2009; but requires a thorough review before deployment in 2011. ExxonMobil and Qatar Petroleum have offered to aid in reviewing this public database.

5. Chief problems encountered in 2010

During 2010, the achievements “of the SSI group” were mainly accomplished by a core group of about a dozen dedicated researchers and students (USA, Australia, China, New Zealand, etc.), who devoted their academic and summer time to accomplishing these products. Only six of the major geological surveys or national groups (*Australia, New Zealand, Britain, Russia, China, Canada*) are currently providing extensive in-house datasets for distribution by the SSI as TS-Creator datapacks. In order to maintain this level of activity, it is essential that more international researchers and students become actively involved to contribute their expertise and datasets in a coordinated suite of tasks. We think that the benefits of providing a central and organized source of authoritative information and visualization on Earth history and its regional manifestations will provide such volunteers a sense of fulfillment, albeit with low monetary compensation for their devoted time. To this end and dependent upon external funding, in 2011, we will investigate the possibility of “wiki” systems for public contributions of datasets. As the SSI products and TS-Creator visualization datapacks become more widely used and promoted, it is anticipated that volunteer contributions from this larger audience will directly provide packages and enhancements. Our goal is for the SSI system to be both an exchange of authoritative stratigraphic compilations as well as a “top-down” suite of guided syntheses.

In Spring 2010, the voting membership was slightly dismayed to be converted from a subcommission status to a “group” status in ICS. We hope that our combined activities in 2010-2011 will enable the ICS-IUGS leadership to recognize that the SSI progressive accomplishments, the efforts to have international programs and the long-term goals are best maintained and attained under a regular subcommission officer/voting-member system.

6. Summary of expenditures in 2010

TOTAL: **\$1000** [*from IUGS via ICS Executive*]

\$1000 – To Purdue’s school of engineering for partial support of the geographic interface (see example above), developing dynamic GSSP tables for the SSI website, and an easy on-line system for updating GSSP databases and imagery. This also included a RSS-feed for One-Geology and other geoinformatics applications, and a Google-display of GSSP locations.

Another \$2000 in matching funds was provided by research funds of James Ogg for this engineering-computing project suite). The ICS Executive also provided reimbursement for J.Ogg to attend the ICS workshop in Prague in June 2010.

NOTE: Nearly all of the *TimeScale Creator* software development and datapack preparations and SSI website maintenance and mailings (charts, time-scale cards, etc.) during 2010 were funded through contributions of time and personal funds by SSI members, donations by and to Purdue University (especially by Geoscience Australia and BP), and US National Science Foundation grants. These funds supported 5 part-time students (*geoscience, computing*) during Spring of academic year 2010, 3 full-time students during summer 2010, and 6 part-time students during Fall 2010; plus travel to work on-site with the Chinese Geobiodiversity database group. We anticipate similar external donations or contributions during 2011 as we work with the different geological surveys and authoritative teams.

7. Work plan, anticipated results and communications to be achieved in 2011

a. **BOOK – Geological TimeScale 2010**

Several ICS chairs and officers are currently working on period-level syntheses for this extensive update and enhancement to the previous ICS-associated *Geologic TimeScale 2004* compilation. In addition to the new GSSPs, it is important to summarize the major advances in bio-mag-sealevel-geochem stratigraphy of the past

decade. There are about 30 authors, including the officers of several ICS subcommissions. The actual book will not be a direct product of ICS, but should be considered as a scientific product of ICS expertise. As part of this project, the SSI will:

10. Distribute preliminary drafts of period-level chapters to relevant ICS-associated officers for scientific review and enhancement.
11. Request the ICS Executive to review the usage of stratigraphic terminology (as was done quite well for the 2008 *Concise Geologic TimeScale* book).
12. Post updated numerical age models for divisions of geologic time as soon as the book is officially published.
13. Post updated period-level charts for zonations and events, and for inter-regional correlations; including revised numerical age models.
14. Update all the TimeScale Creator datasets (internal, and all external regional datapacks) to reflect revised inter-zonal correlations and numerical age models.
15. Prepare posters and cards for distribution at the Brisbane IGC in 2012.

b. Printed and Digital Material on Earth's History

16. School-level educational posters and cards in both printed and Internet form – continued distribution, as in 2009-2010. We have placed a free PDF version on-line for people to locally print their own copies, and indicate that the pre-printed quality-paper versions are available for mailing-cost-only. We will continue to provide updated reference cards for the geologic time scale for all audiences.
17. Coordinate a comprehensive summary of all GSSPs. The SSI will continue to provide standardized descriptions and graphics when new/revised GSSPs are formally published. NOTE: Some approved GSSPs have yet to be published by some subcommission groups.
18. Website: We will continue to enhance the SSI website for easy usage and add more content. Links to additional regional stratigraphic lexicons will be provided, where such on-line sources have been made available. We will also link to translated versions of the stratigraphic guide. [*Essentially, strive to accomplish the goals assigned to the original Subcommission in this area.*]
19. Prepare for an on-line “booklet” for the geological time scale. The publication of time-scale books is fine for quick browsing; but can't be easily updated. We would like to place the main contents of our “*Concise*” book onto the website, but enable updating of the critical graphics. At this point, we have only mounted versions of the period-level graphics for this timescale compilation.
20. Update and enhance the summaries of the correlation of “regional stages” to the international scale. The current “*Geowhen*” (*provided by R. Rohde, at Univ. Calif. Berkeley*) is now out-of-date, and we would either revise it or remove it.
21. RSS feed to additional numerical time-scale and stratigraphic information. Having accomplished the basic GSSP-feed, we are considering providing the entire “global” database of TimeScale Creator (about 25,000 datums) with commentary for each item. This project is part of our submission to NSF for outreach; and having supporting letters from ICS-IUGS officers may enhance the funding possibilities.
22. Promote *TimeScale Creator* visualization package for exploring Earth history. Currently, this is very poorly displayed and advertised.

c. Enhance the TimeScale Creator, plus a public browser-version

23. An **on-line Web-based “TimeScale Creator Lite”** with user-friendly interfaces. Rather than download a .jar or .exe program, a user will be able to use a browser to directly design and download charts for all types of stratigraphic information. A prototype is already finished that integrates the geographic-type interfaces with PDF generation/download from servers at Purdue University. [*NOTE: This project is part of our submission to NSF for outreach; and having supporting letters from ICS-IUGS officers may enhance the funding possibilities.*]
24. Work with geoscience educators on creating modules for exploring Earth history, and link to existing ones.
25. Place additional databases on-line to support “hot-link” version of TimeScale Creator, and create an academic “Pro” version with research applications.
26. Add more datapacks to TimeScale Creator for public usage. Several of these have been compiled, but need to be reviewed by specialists in the different regions. In 2011, the SSI members will strive to add initial versions for: Circum-Arctic, North Atlantic and offshore Canada, preliminary South America, additional China basins, OneGeologyEurope sets.
27. **Evolutionary tree visualization software.** In order to dynamically display “evolutionary trees” for public and research usage that include images, we must develop an intelligent display method with appropriate user-menus. For this purpose, in summer 2010, we developed a capability to add images of fossils/organisms to range charts, and this will be essential for user-friendly evolutionary trees. The first goal is an overview of

evolution of all major organisms at the family level; plus selected ones at the genera level (e.g., humanoids). This “family tree” project will involve collaborations with the Paleobiology database and other geobiodiversity groups.

28. Create an “educational” version of *TimeScale Creator* with more graphics, plus material that is mainly aimed at a high-school or early undergraduate level. [We will apply for an NSF grant to accomplish this important prototype, testing-feedback and deployment; but ICS/IUGS support and matching funds would be essential.]

NOTE: Some of the above projects will undoubtedly require continuation into 2012.

8. Budget and ICS component for 2011

As in 2010, the Subcommittee is planning a very active program of publications, regional and thematic databases for research and public usage, education outreach and public awareness, web enhancements, and extensive international linking. Accomplishing this involves supporting students for the database preparation, web-related expenses, paying a programmer for visualization software enhancements, etc.

We anticipate partial support from Purdue University, Geoscience Australia, New Zealand GNS, and the Geological Survey of Canada. As indicated above, J.Ogg is applying for possible NSF assistance for the international outreach activities of SSI. Therefore, we are submitting a budget that optimistically presumes that the majority of our costs will be covered by external donations/grants and internal support:

PROJECTED “ICS-SUPPORTED” EXPENSES (a fraction of the actual total)

| | |
|--|---------------|
| Web-based visualization system (<i>partial support</i>) | \$ 500 |
| Geographic interfaces for TS-Creator (<i>partial support</i>) | \$ 500 |
| Printing posters/cards/etc; shipping to conferences; and mailing tubes | \$ 500 |
| Partial student support for datapacks and modules | \$ 500 |
| TOTAL PROJECTED EXPENSES (ICS portion only) | \$2000 |

9. Objectives and Work Plan for the Next 3 Years (2011-2013)

Much of this topic was originally laid out in the original SSI mission, as summarized in the Appendix.

The main aspects that we are adding are:

- (1) Comprehensive book (*GTS2012*) and website that summarizes all aspects of global stratigraphy, inter-regional correlations, and estimated numerical ages.
- (2) Our major *TimeScale Creator* database and visualization system to place all Earth history onto a convenient framework that is accessible to both the general public and to specialty researchers. At this point, everyone is delighted to contribute, and we give adequate credit to all those who provide the data and correlations. It is intended that this program will morph to fit different audiences; and become an important tool for both geoscience research and for public exploration. The databases and visualization package are envisioned as a convenient reference tool, chart-production assistant, and a window into our planet’s fascinating history.

10. Voting members (2009-2012)

ICS Subcommittee for Stratigraphic Information

2009-Sept, 2012 – Voting Members

| NAME | COUNTRY/Organization | Specialty | Mail address |
|-------------------------------|--|--|---|
| Asch, Kristine | GERMANY (OneGeology Europe; BGR; Chair IUGS Comm. Geoscience Information) | Compiled "interactive Geological web map of Europe and adjacent areas" | Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Geozentrum Hannover, Stilleweg 2; D-30655 Hannover, GERMANY |
| Crampton, James S. | NEW ZEALAND (Inst. Geol. Nucl. Sci.) | Leader, Global Change Through Time Programme of GNS | GNS Science: Postal address: P.O. Box 30-368, 5040, Lower Hutt; Physical address: 1 Fairway Drive, Avalon, 5010, Lower Hutt, NEW ZEALAND |

| | | | |
|---|---|---|--|
| Fan, Junxuan | CHINA (Nanjing Inst.) | Coordinator of Geobiodiversity database (web) | Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing 210008, P.R. China |
| Filipescu, Sorin | ROMANIA (Babes-Bolyai Univ.) | Webmaster; microfossils (Ceno-Mesoz.) | Department of Geology, Babes-Bolyai University, Str. Kogalniceanu 1, 3400, Cluj-Napoca, ROMANIA |
| Galeotti, Simone | ITALY (Univ. Urbino) | Microfossils (Ceno-Mesoz.) ; co-founder of 2002 subcommission | Istituto di Geologia, Università degli Studi di Urbino, Campus Scientifico, Località Crocicchia, 61029 Urbino, ITALY |
| Howe, Richard | USA (Chevron) | Global stratigraphy | CHEVRON Energy Technology Co., Biostratigraphy Team , 1500 Louisiana St., Houston, TX 77002 |
| IODP (Jamus Collier) | JAPAN (IODP) | Information and Data Manager of IODP | Hokkaido University, CRIS Bldg. 05-104 & 105; N21 W10, Kita-ku, Sapporo, 001-0021, Japan |
| Koren', Tat'yana N. <i>(died autumn 2010; replacement yet to be named).</i> | RUSSIA (All-Russian Geological Research, Institute) | Head of Russian stratigraphy (bio, litho, etc.) database group; also Paleozoic graptolites | Head of Paleontology and Stratigraphy Dept., All-Russian Geological Research, Institute (VSEGEI), Srednij Prospect 74, St. Petersburg 199026, RUSSIA |
| Nowlan, Geoffrey S. | CANADA (Canad. Geol. Surv.) | Paleozoic stratigraphy; past President of the Geological Association of Canada; | Geological Survey of Canada / CGC-Calgary 3303-33rd Street N.W., Room 238 / 3303, 33 rue nord-ouest, pièce 238 Calgary, Alberta, T2L 2A7 CANADA |
| Leanza, Héctor A. | ARGENTINA (Univ. Nat.) | Argentinean Geological Survey (and Argentinean Committee on Stratigraphy) | SERVICIO GEOLÓGICO MINERO ARGENTINO (SEGEMAR), Universidad Nacional de La Plata; Avda. J.A. Roca 651, Piso 10, Buenos Aires, ARGENTINA |
| Ogg, Gabi M. | USA (Purdue University) | Secretary/Webmaster; graphics, GSSP tables | Dept. Earth & Atmos. Sci, Purdue University, 550 State Street, West Lafayette, Indiana, 47907 USA |
| Ogg, James G. | USA (Purdue University) | Chair; TS-Creator database and visualization; also Mesozoic stratigraphy | Dept. Earth & Atmos. Sci, Purdue University, 550 State Street, West Lafayette, Indiana, 47907 USA |
| Piller, Werner | AUSTRIA (Univ. Graz) | Chair of the Austrian National Committee of Geology; Chair of Commission of the Strat. and Paleont. Research of Austria (Austrian Acad. Sci.) | Institute of Earth Sciences (Geology and Palaeontology) University of Graz Heinrichstrasse 26, A-8010 Graz, Austria |
| Vrielynck, Bruno | FRANCE (Comm. Geol. Map World) | UNESCO Commission for the Geological Map of the World; and Darius database (Eurasia history) | CCGM/CGMW; 77, rue Claude-Bernard, 75005 Paris, FRANCE; Dr. Bruno Vrielynck, Institut des Sciences de la Terre Paris (UMR 7193 UPMC-CNRS) UPMC Paris Universitas Case courrier 129 4 place Jussieu 75252 Paris cedex 0 |

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| Waters, Colin N. | ENGLAND (Brit. Geol. Survey) | Manager of Geoscience Standards & Nomenclature project | British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG GREAT BRITAIN |
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2010-Sept, 2012 – invited; not yet formally accepted

| NAME | COUNTRY/Organization | Specialty | Mail address |
|--|----------------------------|---|---|
| Cox, Simon | AUSTRALIA (CSIRO) | OneGeology; Geologic mark-up language (GeoSciML) | WAS: CSIRO Exploration & Mining, 26 Dick Perry Avenue, Kensington WA 6151 [PO Box 1130, Bentley WA 6102] AUSTRALIA |
| Menning, Manfred | GERMANY (GFZ) | Chair of German Strat. Comm.; Devon-Tri paleo database | GeoForschungsZentrum Potsdam; Section 5.2: Climatic Dynamics and Landscape Evolution; Telegrafenberg, C 128; D-14473 Potsdam, GERMANY |
| Richard, Stephen | USA (Arizona Geol. Survey) | Geologic mark-up language (GeoSciML); N. Amer. geologic map data model; GSA Geoinformatics) | Arizona Geological Survey, 416 W. Congress St., #100; Tucson, Arizona, 85701 USA |
| Soller, Dave (and Nancy Stamm) -- joint | USA (USGS) | Coordinator, USGS National Geologic Map Database [Nancy Stamm is database developer for Geologic names and paleontologic databases) | U.S. Geological Survey, MS 926-A National Center, Reston, VA 20192 USA |

Ex-Official Members

All Chairs of ICS subcommissions; and ICS Executive.

Appendix:

Original task suite (2001) established for the Stratigraphic Information

In 2001, the suite of proposed objectives established for the Subcommittee on Stratigraphic Information included brief indications of their importance to the global geoscience community. It was originally planned that most of these components would have been accessible through the ICS/SSI Web site at www.stratigraphy.org.

(1) ICS/SIS Website

29. Develop a method of classification to organize, logically, the data-bases, related links and make easy search and use of the contents.
30. Open forum: Electronic discussion group (SIS-Net ?). In addition to the Web site, a link to a thematic discussion group (electronic mailing list) could be set up for SIS. Its purpose would be to make it possible to exchange useful information quickly and efficiently. Scientific comments, debates, and discussions of problems within the areas of interest, announcements and specifically addressed questions, would be all encouraged, as long as they are of relevance to SIS. Maps and stratigraphic charts are of obvious interest and photographs of taxonomically significant and/or problematic fossils could be launched for discussion among specialists.

(2) Biostratigraphy Zonations and Stratigraphic Lexicons

31. Regional biozonal schemes: with definitions of zones and type-sections (link to the iconographic atlases of index fossil species).

32. Regional lithostratigraphic frameworks and time scales, with definitions of individual lithostratigraphic units, photos of type-sections, chronostratigraphic correlations, and references.
33. This would have the enormous advantage of making easily accessible the regional lithostratigraphy and time scales of basins worldwide, with links to related data-bases.

(3) Geohistory Data-bases.

34. Facies Stratigraphy: Data base of outcrop and core sections. Iconographic atlases showing types of siliciclastic and carbonate macro- and micro-facies, diagnostic sedimentary structures, ichnofossils/ichnofabrics and ichnofacies, etc., including, wherever possible, interpretations, paleogeographic facies models, and references.
35. Paleogeographic and Paleoclimatic Maps. The database for the paleogeographic maps, sourced from the published literature, ongoing research, and from still unpublished M.Sc./Doctorate research results, could be collected and plotted on base paleogeographic maps (e.g., <http://www.scotese.com>).
36. Continental Ecosystems. Stratigraphic correlations, distribution of paleoclimatic indicators, and the relationship (depositional and time-equivalence of events) of continental ecosystems with adjacent marginal marine basins.
37. Marine Ecosystems. Paleoclimatic belts, approximate paleobathymetric contour curves, areas of paleo-upwelling, phosphate deposits, black shales, carbonate platforms, turbidites, major trends of surface and bottom currents.

(4) Iconographic Atlases.

38. Index fossil species: systematics, biostratigraphy and paleoecology. Iconographic atlases of stratigraphically significant fossil groups (ammonites, inoceramids, foraminifers, ostracodes, radiolarians, calcareous nannofossils, palynomorphs), to be accompanied by biostratigraphic frameworks for the various basins worldwide.
39. Biostratigraphy in thin-sections. Atlas of index fossil species (e.g., foraminifers, radiolarians, pithonellid calcispheres, calpionellids, roveacrinids) examined in thin sections, illustrating the diagnostic features. Biostratigraphic and paleoecological data are indispensable to establish an integrated stratigraphy for interbasinal correlation. While an enormous amount of data exist based mainly on outcrop sections and on thousands of oil exploration boreholes, surprisingly few recent synthetic biostratigraphic and paleogeographic studies have actually been published. In addition, many of the published data are in need to be brought up to date.

To be able to acquire these, it would be necessary to determine and illustrate (with good SEM photographs), if not all, at least the index species and these illustrations along with the stratigraphic distribution of these species. Simply giving stratigraphic charts without illustrations is not sufficient, as diverse forms are often used as index species under the same name.

The final aim would be, among others, the publishing of iconographic atlases of index fossils for the various sedimentary basins around the globe.

In some offshore basins, with well established stratigraphic scales, the solution would be simple, if oil companies active in the area allow the release of existing data and make possible to present these in published format through the ICS/SIS website. The first step could be to approach individually prospective authors, who could accept to collaborate and, if necessary, contact officially their company.

To maximize application, the biostratigraphic frameworks, to be included as part of the Taxonomic, Iconographic and Biostratigraphic Atlases of Index Fossil Species, have to be presented per study basin, thus reflecting differences in regional tectono-sedimentary characteristics and biogeographic differentiation.

(5) Quantitative Biostratigraphy Programs

- Interest in quantitative biostratigraphy is flourishing, and there is demand for teaching modules of key techniques and its computer programs. Compact demonstration modules will be prepared of the three methods Unitary Association (UA), Ranking and Scaling (RASC) and Constrained Optimization (CONOP) that can be downloaded via the ICS master website.

(6) Teaching & Research.

40. Easy-to-follow teaching guides: quantitative techniques of stratigraphic interpretation, chemostratigraphy, cyclostratigraphy, and Sr-stratigraphy, applied techniques to sequence stratigraphy: state-of-the-art, among others.
41. Virtual field-trips to key type-sections: stratotypes, GSSPs, stage boundaries' sections: with location map; photos and zoom showing details of beds down to thin sections; stratigraphic charts with litho-, magneto-, isotope-,

chemo-, and biostratigraphy; distribution charts of fossils, composite graphic correlation of key markers, etc.; published references and non-published theses on the area.

Original (2000) objectives and tasks for the Subcommittee on Stratigraphic Information

Stratigraphic Information Services

Geologic Time Scale Information
Geologic time scale subdivisions and GSSPs
Age dates, Orbital cycles, and Absolute time scale
Stable isotope and Geochemical curves
Magnetic and Sequence chronology

Stratigraphic Database Center & Links
Stratigraphic tools (statistics, temporal-spatial GIS-type displays, links to paleogeography)
Integrated Stratigraphic Network and links
Biostratigraphic and evolutionary databases

Stratigraphic Standards
Stratigraphic Code (on-line) -- with short-term working groups for revisions, as required
Geochronology and other standards

Geohistory Education Site & Links
New discoveries and concepts
What is the geological time scale
Adventures in geo-time (with links)
Stratigraphic applications and methods