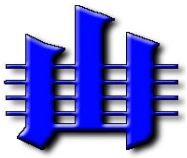

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES
INTERNATIONAL COMMISSION ON STRATIGRAPHY

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December 2015

Compiled ICS Subcommission Annual Reports for 2015

SUBCOMMISSION ON QUATERNARY STRATIGRAPHY
ANNUAL REPORT 2015

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1. TITLE OF CONSTITUENT BODY

Subcommission on Quaternary Stratigraphy (SQS)

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

1. Chronostratigraphic subdivision of the Quaternary System/Period facilitated by the intercalibration of biostratigraphies, construction of integrated zonations, and recognition of global datum points, allowing correlation worldwide and between terrestrial and marine sequences.

2. Definition of Series/Subseries/Stage and, where appropriate Substage, boundaries through the selection of recommended GSSPs.

3. Promoting SQS's activities within the wider Quaternary geoscience community through publications, symposia, and the SQS website, and creating opportunities to study and compare stratigraphic sections by means of field meetings.

4. 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 those related programs being undertaken.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

1. 19th INQUA Congress, Nagoya, Japan, July 27 – August 2, 2015. Four notable activities.

a. "The Early–Middle Pleistocene transition: local records, global correlations", a full-day symposium convened by Head, M.J., Gibbard, P.L., Kumai, H., and Pillans, B., focusing on the Lower–Middle Pleistocene Subseries boundary. This symposium showcased the latest research on the three competing candidate GSSPs: the Chiba section (Japan, see field excursion below) and the Montalbano Jonico and Valle di Manche sections (Italy), and featured presentations by the main proponents of each section. Sponsored by SQS and INQUA, including ICS-NSF funding that allowed Profs. Maria Marino (Montalbano Jonico) and Luca Capraro (Valle di Manche) to attend both this symposium and the Chiba field excursion, below.

b. Business meeting of the SQS in which attendees were appraised of developments, and invited to comment on future proposed activities and priorities.

c. Invited plenary address by M. J. Head, the Chair of SQS, entitled: "The Quaternary System and its official subdivision: past, present, and future."

d. Post-Congress field excursion to the Lower–Middle Pleistocene Chiba section, Japan, August 3–4, 2015. This two-day field excursion was arranged in conjunction with the INQUA symposium described above, allowing Profs. Maria Marino and Luca Capraro, as principal proponents of the two competing candidate GSSPs, to examine the section (with funding support from ICS-NSF) along with many other members of the Lower–Middle Pleistocene Boundary Working Group. This field trip featured on Japanese TV and national newspaper media, with the Chair of SQS (M.J. Head) being interviewed on both.

2. An SQS / INTIMATE Working Group has submitted to the SQS Executive a proposal for the subdivision of the Holocene into Lower, Middle, and Upper Holocene subseries and their corresponding stages. This proposal is currently under discussion by SQS and voting is expected to commence in a few weeks. This proposal follows a discussion paper in 2012 (Walker et al., 2012, *Journal of Quaternary Science*, 27, 649–659) in which the basic elements of this proposal were published.

3. The Anthropocene Working Group presented evidence for epoch status of the Anthropocene at the STRATI 2015 Congress at Graz on 20th July 2015; and at the 19th INQUA Congress, Nagoya, Japan, July 27 – August 2, 2015. Analysis of the overall stratigraphic character of the Anthropocene is proceeding well, and considerable, if not unanimous, agreement has been reached within the Working Group on its stratigraphic reality as both a geochronological and chronostratigraphic unit. The Working Group is currently examining the two options for defining the boundary, i.e. via GSSA or GSSP, and considering possible GSSPs.

3B LIST OF MAJOR PUBLICATIONS OF SUBCOMMISSION WORK (BOOKS, SPECIAL VOLUMES, KEY SCIENTIFIC PAPERS)

Head, M.J., Gibbard, P.L. and van Kolfschoten, T. (eds.), 2015. The Quaternary System and its formal subdivision. *Quaternary International*, 383: 1–208. This is the outcome of an SQS-sponsored full-day symposium on the formal subdivision of the Quaternary held at the STRATI 2013 Congress in Lisbon. It includes many articles by members of SQS and its constituent working groups.

Head, M.J., and Gibbard, P.L., 2015. Formal subdivision of the Quaternary System/Period: Past, present, and future. *Quaternary International*, 383: 4–35.

Waters, C.N., Syvitski, J.P.M., Gałuszka, A., Hancock, G.J., Zalasiewicz, J., Cearreta, A., Grinevald, J., McNeill, J.R., Summerhayes, C. and Barnosky, A. 2015. Can nuclear weapons fallout mark the beginning of the Anthropocene Epoch? *Bulletin of the Atomic Scientists*, 71(3), 46-57.

Waters, C.N., Zalasiewicz, J. et al., in press. The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science*.

3C. PROBLEMS ENCOUNTERED, IF APPROPRIATE

The Working Group on the Upper Pleistocene Subseries Boundary, after five years of inactivity, began making progress last year with the suggestion of a new candidate GSSP, the Fronte section, in Taranto, Italy, with Dr Alessandra Negri, a key proponent of this section, joining the Working Group. Excellent science is being conducted on the Fronte section, but finding a ~130 ka record in marine deposits on land that does not display facies changes at or near the boundary presents special challenges. An additional candidate GSSP is therefore sought, and a recently suggested possibility is in an Antarctic ice core (Head and Gibbard, 2015). Such a potential GSSP is currently being explored.

It was hoped that by the end of 2015, proposals for the three candidate GSSPs for the Middle Pleistocene Subseries Boundary would be submitted. The INQUA Congress this summer revealed, however, that while important progress is being made on all three sections (Chiba section in Japan, and the Montalbano Jonico and Valle di Manche sections in Italy), more time is needed to complete this work. Proposal submission has therefore been delayed by one year, with proposals tentatively due for submission by the end of 2016.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2016)

1. Encourage the proponents of the three Middle Pleistocene candidate GSSPs to submit their proposals, hopefully before the end of 2016.

2. Develop a case for using an Antarctic ice core as a GSSP for the Late Pleistocene. The cores are already analyzed, but theoretical aspects including global correlation and interhemispheric phasing will need to be considered.

3. An SQS-sponsored special symposium "The Quaternary System: precision and reliability in global correlation" to be convened by M. J. Head has been submitted to the 35th International Geological Congress, Cape Town, in 2016. This should provide a forum for the latest research on the three Middle Pleistocene candidate GSSPs, and progress by working groups on the Late Pleistocene and Anthropocene.

4. Submit the Holocene subdivision proposal to ICS, assuming it receives approval from SQS.

5. SUMMARY OF EXPENDITURES IN 2015 (Can $)

	Payment	Deposit	Balance
Carried forward (November 7, 2014)			1868.73*
John Wiley & Sons sponsorship for 2014		443.00	2311.73
M.J. Head (STRATI 2015 registr. & hotel*)	1071.52		1240.21
Balance at November 26, 2015			1240.21

* = corrected from CAN$1845.97 due to discrepancies in exchange rate.

ICS–NSF Special Funding (2015) – for reimbursement as follows:
Dr. Redzhep (Roger) Kurbanov (attendance at STRATI 2015, Graz) allowance of US$800.00
Prof. Luca Capraro (attendance at INQUA*) allowance up to US$2000.00
Prof. Maria Marino (attendance at INQUA*)allowance up to US$2000.00
Prof. Martin Head (one-way travel to Graz for STRATI 2015) US$1114.44

*= INQUA full-day symposium "The Early–Middle Pleistocene transition: local records, global correlations" and two-day post-Congress field excursion to the Middle Pleistocene GSSP candidate Chiba section, Japan, August 3–4, 2015.

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2015

Funds are requested to enable the Chair of SQS, Martin J. Head, to attend the 35th International Geological Congress, Cape Town, in 2016. He is convening an SQS-sponsored special symposium "The Quaternary System: precision and reliability in global correlation" at the IGC which will be invaluable for the development of future Quaternary GSSP proposals, particularly those for the Middle and Late Pleistocene. The Toronto–Cape Town return airfare alone exceeds US$4500, with Congress registration and accommodation adding to the cost. A total of US$5000 is therefore requested.

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011–2015)

1. Calabrian Stage/Age ratified in December 2011. Reference: Cita, M.B., Gibbard, P.L., Head, M.J., and The Subcommission on Quaternary Stratigraphy, 2012. Formal ratification of the base Calabrian Stage GSSP (Pleistocene Series, Quaternary System). Episodes 35(3): 388–397.

2. Submission to SQS of proposal to subdivide the Holocene into three subseries and their corresponding stages, in October 2015.

3. Strong progress on all three candidate GSSPs for the Middle Pleistocene; some progress on the Late Pleistocene GSSP; strong activity by the Anthropocene Working Group.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016–2019) – ranked according to priority.

1. Nominate two GSSPs to subdivide the Holocene Series into three named stages.
2. Nominate GSSP for the Middle Pleistocene Subseries/Stage boundary.
3. Explore further chronostratigraphic subdivision of the Quaternary System/Period, including the duration and status of the "Anthropocene".
4. Nominate GSSP for the Upper Pleistocene Subseries/Stage boundary.

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

9a Names and Addresses of Current Officers and Voting Members

Officers of SQS

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9B LIST OF WORKING (TASK) GROUPS AND THEIR OFFICERS

Working Group on the "Anthropocene"

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Secretary: Dr. Colin Waters
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Full membership of the Working Group: Tony Barnosky (USA), Alejandro Cearreta (Spain), Paul Crutzen (Germany), Matt Edgeworth (UK), Erle Ellis (USA), Mike Ellis (UK), Ian Fairchild (UK), Agnieszka Gałuszka (Poland), Philip Gibbard (UK), Jacques Grinevald (Switzerland), Peter Haff (USA), Irka Hajdas (Switzerland), Alan Haywood (UK), Juliana Assunção Ivar do Sul (Brazil)*, Catherine Jeandel (France), Reinhold Leinfelder (Berlin), John McNeill (USA), Cath Neal (UK), Eric Odada (Kenya), Naomi Oreskes (USA), Clement Poirier (France), Simon Price (UK), Andrew Revkin (USA), Dan Richter (USA), Mary Scholes (South Africa), Victoria C. Smith (Oxford), Will Steffen (Australia), Colin Summerhayes (UK), James Syvitski (USA), Davor Vidas (Norway), Michael Wagreich (Austria), Colin Waters (Secretary, UK), Mark Williams (UK), Scott Wing (USA), Alex Wolfe (Canada), Jan Zalasiewicz (Chair, UK), An Zhisheng (Xi'an) (China). * = new member in 2015. Bruce Smith (USA) dropped from the membership in 2015.

Working Group on the subdivision of the Holocene Series

Convener: Professor M.J.C. Walker
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Full membership of the Working Group: M. Berkelhammer (USA), S. Björck (Sweden), L.C. Cwynar (Canada), D.A. Fisher (Canada), A.J. Long (UK), J.J. Lowe (UK), R.M. Newnham (New Zealand), S.O. Rasmussen (Denmark), M.J.C. Walker (Convener, UK), and H. Weiss (USA). No change in membership from 2014.

Working Group on the Middle/Upper Pleistocene Subseries Boundary

Co-convener: Professor Thomas Litt
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Co-convener: TBA

Full membership of the Working Group: Art Bettis (USA), Aleid Bosch (Netherlands), Philip Gibbard (UK), Liu Jiaqi (China), Peter Kershaw (Australia), Wighart von Koenigswald (Germany), Thomas Litt (Co-convener, Germany), Jerry McManus (USA), Alessandra Negri (Italy), Charles Turner (UK), Martin J. Head (Canada), and Jan A. Zalasiewicz (Co-convener, UK). No change in membership from 2014, although Jan A. Zalasiewicz stepped down as co-convener in 2015.

Working Group on the Lower/Middle Pleistocene Subseries Boundary

Co-convener: Professor Martin J. Head
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Full membership of the Working Group: Luca Capraro (Italy), Maria Marino (Italy)*, Craig Feibel (USA), Martin J. Head (Co-convener, Canada), Hisao Kumai (Japan), Luc Lourens (Netherlands), Jiaqi Lui (China), Anastasia Markova (Russia), Tom Meijer (Netherlands), Brad Pillans (Co-convener, Australia), Yoshiki Saito (Japan), Charles Turner (UK), Cesare Ravazzi (Italy), Thijs Van Kolfshoten (Netherlands). * = new member in 2015. Neri Ciaranfi (Italy) sadly retired from this Working Group for health reasons.

9C INTERFACES WITH OTHER INTERNATIONAL PROJECTS

The Subcommission on Quaternary Stratigraphy (SQS) maintains close ties with The International Union for Quaternary Science (INQUA) through its Commission on Stratigraphy and Chronology (SACCOM). SACCOM supports research on candidate GSSPs through its grants program, so directly assists the work of SQS.

Of equal importance, INQUA established, during its congress this summer, a permanent committee with the express task of liaising with SQS. This will allow the INQUA Executive to respond rapidly to any issues of stratigraphy raised by SQS and vice versa. Prof. Thijs van Kolfschoten, a Vice-President of INQUA, chairs this committee, and also serves as a voting member of SQS.

Respectfully submitted:
Martin J. Head, Chair SQS
St. Catharines, 26th November, 2015

SUBCOMMISSION ON NEOGENE STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Neogene Stratigraphy (SNS)

Isabella Raffi, Chairman SNS (from August 1, 2012) Università "G. d'Annunzio" di Chieti-Pescara, Dipartimento di Ingegneria e Geologia (InGeo), Via dei Vestini 31, 66013 Chieti Scalo, Italy. E-mail: raffi@unich.it

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.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS in 2015

Meeting of the Subcommission on Neogene Stratigraphy

A meeting of the Subcommission on Neogene Stratigraphy was held during the STRATI 2015 Congress in Graz (July 22, 2015). It was open to anyone interested and included a workshop of the "Burdigalian-Langhian" Working group, entitled: **"The unsettled GSSPs in the Miocene: toward completion?".** Besides focusing on the topic related to Budigalian and Langhian GSSPs (details are reported below), discussion took account of the ongoing debate about "formal and informal stratigraphic units, sub-epoch/sub-series" (arisen during the ICS open assembly held in the conference) and about the proposed use of "Tertiary" as Period/System in place of Paleogene and Neogene.

The Budigalian and Langhian GSSPs

A working group for the definition of the remaining Miocene GSSPs base-Langhian and base-Budigalian (BurLan WG) was set up during 2014-2015, with Frits Hilgen acting as chair and the following designated members: W. Beggren, J. Channell, A. Di Stefano, L. Foresi, A. Holbourn, S. Iaccarino, F. Lirer, K. Miller, P. Pearson, I. Raffi, E. Turco.

During the meeting of the WG (held during the STRATI 2015, with participation of some of the voting and corresponding members of SNS, besides members of the WG itself) there was a series of introductory talks and updated reports on the "state of the art", including: Introduction to the Langhian GSSP (by F. Hilgen, chair of "BurLan" WG); the *Praeorbulina* datum (by E. Turco); Presntation of the two Mediterranean candidate sections, La Vedova (by E. Turco) and St. Peter's Pool (by L. Foresi and F. Lirer); Introduction to the Burdigalian GSSP (by A. Di Stefano); the Langhian and Burdigalian GSSPs from (I)ODP perspective (by F. Hilgen). Detailed report on the results of discussion during the WG meeting will be published on the SNS website.

Election of new board

In October-November 2015 the SNS voting members were asked to vote for a new board of SNS, active for the 2016-2020. Prof. Isabella Raffi (as chair) and Prof. Kenneth Miller (as vice-chair) have been willing to run for it once again. Results of the election will be available at the end of November 2015.

3b. List of major publications of subcommission work (books, special volumes, key scientific paper)

No major publications available.

3c. CHIEF PROBLEMS ENCOUNTERED IN 2015

During the meeting of the "BurLan"WG, a clear problem arose regarding the guiding criteria for the definition of Langhian GSSP, although two good candidate stratigraphic sections are available. A more reliable (correlatable) criterium for recognizing the Langhian GSSP (e.g. top of magnetic polarity Chron C5Cn) should be preferred to the "historical" one, the *Praeorbulina* datum, because of substantial rarity and the controversial taxonomic concepts of this bioevent. However, it has been underlined that emphasis on the biostratigraphic value of the *Praeorbulina* lineage, in the Langhian interval, and its importance for chronology and correlation has to be placed.

As regards the Burdigalian GSSP, a recurrent problem is the possible lack of suitable sections in the Mediterranean for its definition. 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 his issue will probably be made the coming year.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2016)

The constructive discussion within the WG for Burdigalian and Langhian GSSPs lead to delineate a program to reach an agreement for a Langhian GSSP proposal, either for proposing a reliable/reproducible guiding criterium,

complemented by additional criteria useful for correlation, and for deciding on the GSSP section. The research groups involved in the proposals will be asked to complete their studies and submit proposals within the 2016. Priority will be given to organization of a meeting of the WG to visit the candidate section(s).
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 would be seriously considered.

4b. Specific GSSP focus for 2016
(See sub-chapter above)

5. SUMMARY OF EXPENDITURES IN 2015:

Credit on Nov 2014	**Euro**	**5494,74**
Expense for registration at STRATI 2015 for Chair I.Raffi and Secretary E.Turco	**Euro**	**600,00**
Expense for participation at STRATI 2015 for vice-chair K. Miller	**Euro**	**1000,00**
Credit on Nov 2015	**Euro**	**3894,74**

6. BUDGET REQUESTS and ICS COMPONENT for 2016

Field trip to suitable section for the definition of base-Burdigalian Euro 1500

APPENDIX

7. SUMMARY of CHIEF ACCOMPLISHMENTS over PAST FIVE YEARS (2011-2015)

2011
Publication of papers about potential Langhian GSSP sections in a special volume of Stratigraphy. Preparation of the Neogene chapter (ATNTS2012) of the GTS2012 (Hilgen et al., 2012, in press).

2012
Publication of the Neogene chapter ATNTS2012 in GTS2012 (Hilgen et al., 2012).

2013
Presentation of ongoing work on Biozonation and biochronology of Cenozoic calcareous nannofossils from low and middle latitudes at the conference: " Geologic Problem Solving with Microfossils 2013" (NAMS-SEPM organiz., Houston March 2013) (by Raffi et al.).
Presentation of a new Paleogene calcareous nannofossil zonation at the STRATI 2013 Congress in Lisbon (by I. Raffi et al.).

2014
Talk at the Congress of Italian Geological Society (SGI-SIMP) in Milan (September 2014) about: "The Italian contribution to the definition of the ICS timescale: ongoing research" (by I. Raffi and coauthors M. Balini and S. Monechi).

2015
Abstracts and talks during STATI 2015 Congress:
Principles and protocols of biostratigraphy as applied to marine calcareous microfossils. In: STRATI 2015, 2nd International Congress on Stratigraphy, Graz, 19-22 July 2015. Session S26 - Testing the time scale: quantitative and high-resolution calibration of Cenozoic biostratigraphic events (P.N. Pearson, B. Wade, I. Raffi, J. Backman, and members of the *EU-Earthtime* consortium)

The role of calcareous nannofossils during the last ~ 220 million years of Earth history. . In: STRATI 2015, 2nd International Congress on Stratigraphy, Graz, 19-22 July 2015. Session S01 - The contribution of fossils to Chronostratigraphy, 150 years after Albert Oppel

(C. Agnini, E. Erba, S. Monechi, I. Raffi*)

Success and Failure in Paleogene-Neogene global correlations using golden spikes. . In: STRATI 2015, 2nd International Congress on Stratigraphy, Graz, 19-22 July 2015. Session 25 – Neogene Stratigraphy – Integrating global and regional Chronostratigraphy. (K. Miller, M-P Aubry, W.A. Berggren, I. Raffi, D.V. Kent)

Astronomical tuning of the La Vedova section (Ancona, Italy) between 15 and 16.2 Ma. Implications for the origin of the megabeds and the Langhian GSSP. In: STRATI 2015, 2nd International Congress on Stratigraphy, Graz, 19-22 July 2015. Session 25 – Neogene Stratigraphy – Integrating global and regional Chronostratigraphy. (E. Turco*, C, S. Husing, F. Hilgen, A. Cascella, R. Gennari, S.M. Iaccarino, L. Sagnotti)

Mediterranean Neogene planktonic foraminifer biozonation and biochronology. In: STRATI 2015, 2nd International Congress on Stratigraphy, Graz, 19-22 July 2015. Session S26 – Testing the time scale:quantitative and high-resolution calibration of Cenozoic biostratigraphic events. (F. Lirer, L-M- Foresi, S.M. Iaccarino, G. Salvatorini, E. Turco, A. Caruso, F.J. Sierro, C. Cosentino).

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2019)

The constructive discussion within the WG for Burdigalian and Langhian GSSPs lead to delineate a program to reach an agreement for a Langhian GSSP proposal, either for proposing a reliable/reproducible guiding criterium, complemented by additional criteria useful for correlation, and for deciding on the GSSP section. The research groups involved in the proposals will be asked to complete their studies and submit proposals within the 2016. A priority will be the organization of a meeting of the WG to visit the candidate section(s).
As regards the thorny issue of the Burdigalian GSSP, critical questions are: 1) 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, or 2) should the Burdigalian as Stage denotation be disused because no suitable onland stratigraphic sections are available.
Proposal(s) for the Langhian GSSP will be submitted and published, with the purpose of reaching a final decision within the WG and subsequently within the SNS Subcommission. A report of discussion about Burdigalian GSSP issue will provide the state of the art on it.

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

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 22 voting members and 24 corresponding members (*see Appendix for full list of officers and voting and corresponding members*). The SNS has presently one active working group for defining the GSSP remaining for the Langhian and Burdigalian chaired by Frits Hilgen, with 11 active members (listed below - section 9a). The SNS web site (www.sns.unipr.it) is used for news release and contains the following sections: Home, News, Board, Members, Newsletters, GSSP's, and Links.
Support for the SNS comes from the Chairman's Institution in Italy (Università degli Studi "G. d'Annunzio di Chieti-Pescara). The Secretary's Institution in Parma (Università degli Studi di Parma) hosts the SNS web-site.

9a. CURRENT OFFICERS, VOTING AND CORRESPONDING MEMBERS

Subcommission officers (Term 2012-2015)

Chairman: Isabella Raffi, Dipartimento di Ingegneria e Geologia, Università degli Studi "G. d'Annunzio" di Chieti-Pescara, Campus Universitario, Via dei Vestini 31, 66013 Chieti Scalo, Italy. E-mail: isabella.raffi@unich.it
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9c. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

There is a close link with (I)ODP 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.

There has been a link with the activity of the EARTHTIME-EU Research Networking Programme (RNP), that is part of a broader international initiative “EARTHTIME: a community-based scientific effort aimed at sequencing Earth history through an integrated geochronologic and stratigraphic approach”.

SUBCOMMISSION ON PALEOGENE STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommission on Paleogene Stratigraphy

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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 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 Subcommission 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.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

a) Among the main accomplishments of the subcommission, a new website (www.paleogene.org) was created with financial support from NSF-ICS. The website is updated by a new websmaster (Stephano Dominici from Florence University) and it includes information about the composition and activities of the subcommission, as well as the historical background and current state of the stages and GSSPs of the Paleogene.
b) The Subcommission was involved into the organization of the STRATI 2015 meeting in Graz (Austria), with a session dedicated to the Paleogene and another session dedicated to the Bartonian stage. A total of 25 abstracts were presented within the frame of these sessions. A general meeting of the Subcommission was also held during STRATI. A special issue of Newsletters on Stratigraphy will be published with the most relevant contributions presented to these sessions.
c) A proposal for the definition of the GSSP for the base of the Chattian was submitted, and voted and accepted by 95% of the voting members. After correction of a few remarks made by the voting members, the proposal will be submitted to ICS, for approval during the next IGC 2016.
d) The working group on the Bartonian participated in a field trip to the classical Barton area in Southern England (October 22nd-28th), led by Dr. Jerry Hooker. This field trip was funded by NSF-ICS, and it will contribute to the discussions and definition of the GSSP.

e) The new board of ISPS has been elected by the voting members. The new board, with Simonetta Monechi as chair and Laia Alegret as vicechair, was elected by unanimity among the voting members. The chair designated Aitor Payros as the next Secretary.

At present there are only three Paleogene GSSPs pending formal definition: the proposal for the Chattian has been approved by the voting members and will be submitted to ICS over the next months, and two working groups have been making progress on the definition of the bases of the Bartonian and Priabonian. According to Coccioni et al. (Bartonian session in STRATI 2015), the Bottaccione section in Italy seems to fulfill all the requirements for the GSSP of the Bartonian. An improved chronological framework (including cyclostratigraphy and radiometric dating) of Alano, the potential section for the GSSP of the Priabonian, has been completed and submitted for publication.

3b List of major publications of subcommission work

Agnini C., Fornaciari E., Giusberti L., Grandesso P., Lanci L., Luciani V., Muttoni G., Palike H., Rio D., Spofforth D.J.A., Stefani C., 2011. Integrated bio-magnetostratigraphy of the Alano section (NE Italy): a proposal for defining the Middle-Late Eocene boundary. *Geological Society of America Bulletin*, v. 123 (5/6), p. 841-872; doi: 10.1130/B30158.1.

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3c. Problems encountered

The current political situation in some N African countries has significantly limited the accessibility to the GSSP sections for the bases of the Danian and Ypresian. This situation makes it extremely difficult for the Paleogene community to assess several scientific issues regarding these stratotypes. As a consequence, auxiliary sections need to be defined, and the subcommission with need to dedicate efforts and additional funding to investigate and define potential auxiliary sections, including those is poorly studied areas from eastern Europe and Asian countries.

4a. OBJECTIVES AND WORK PLAN FOR THE NEXT YEAR (2016):

- Full support will be given to the working groups on the GSSPs of the Bartonian and Priabonian.
- Submit to ICS the proposal for the definition of the GSSP of the Chattian (already approved by the voting members of ISPS).
- Organization of the ceremony to place the golden spike for the GSSP of the Chattian in the Monte Cagnero section (Marche, central Italy), in Spring 2016.
- The proposal for the GSSP of the Priabonian will be submitted by the Working group, and voted by the subcommission.

-Set up working groups to identify potential auxiliary sections for the bases of the Danian and the Ypresian.

4b. Specific GSSP Focus for 2016

Bartonian GSSP: The Bottaccione section will be proposed by Coccioni et al. as a candidate for GSSP of the basal Bartonian. The proposal will be sent by ISPS to the voting members of the subcommission.
Data collected during the field trip to the Barton area and Isle of Wight will be compiled by members of the working group, including magnetostratigrahic and biostratigraphic analyses.

Priabonian GSSP:

The working group has decided to propose the Alano section as the candidate for the GSSP of the Priabonian. As soon as the proposal has been received by ISPS, it will be submitted to the subcommission of the voting members.

Chattian GSSP:

The proposal for the definition of the GSSP of the Chattian has already been approved by the voting members of ISPS, and the primary marker is the Last Common Occurrence of the planktic foraminifer *Chiloguembelina cubensis*. When the proposal is accepted by ICS, ISPS will organize the ceremony to place the golden spike, possibly in spring 2016.

5. SUMMARY OF EXPENDITURES IN 2015:

INCOME

Carried forward from 2013	Euro 0
ICS Allocation for 2014	Dollar 1700
TOTAL	Dollar 1700

EXPENDITURE FROM 2015 BUDGET

General office expenses	Dollar 400
ISPS website	Dollar 700
Support travel expenses STRATI 2015 and Field Trip England	Dollar 600
TOTAL	Dollar 1700

6. BUDGET REQUEST AND ICS COMPONENT FOR 2016

Projected Budget for 2016:

General office expenses	Dollar 400
Webmaster for the website	Dollar 600
Official ceremony to place the GSSP of the Chattian	Dollar 3000
Contributions to Officers travel costs to IGC	Dollar 4000
Support for GSSP's field meetings for auxiliary sections	Dollar 1500
TOTAL BUDGET PROJECTED	Dollar 9500

Please note that the financial situation has deteriorated in recent years, an increase would help us to support the travel cost and the participation of the members of the ISPS to GSSP's field meetings in Italy, Spain, England and Strati 2015.

APPENDICES

7 . CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)

See Accomplishments in ICS Annual Reports 2011 to 2014 for additional details.

- The Subcommission sponsors International Meeting on the Paleogene: Salzburg, Austria (2011), Lisbona (2013) and Ferrara (2014).
- Formalization of the GSSP for the bases of the Selandian (Middle Paleocene) and Thanetian (Upper Paleocene) stages have been defined at Zumaia, Spain. The GSSP was officially published in *Episodes* (2011).
- Formalization of the GSSP for the base Lutetian Stage (early/middle Eocene boundary) was defined in the Gorrondatxe section (Basque Country, northern Spain). The GSSP was officially published in *Episodes* (2011).
- On February 13, 2012 the official ceremony to define the Global Stratotype Section and Point (GSSP) for the base of the Lutetian Stage took place in Getxo village and Gorrondatxe beach (Northern Spain).
- Field workshop of the Priabonian WG in Alano (June 2012) and proposal of the Alano section as the Stratotype section of the base of Priabonian.
- Ninth International Workshop on Aglutinated Foraminifera, Zaragoza, Spain, 3-7, September, 2012.
- VIII South American Symposium on Isotope Geology (VIII. SSAGI), Medellin, 2012
- The Subcommission helds a session "Paleogene events, evolution and stratigraphy" during the Strati 2013 meeting in Lisbon.
- The Subcommission helds a meeting during the CBEP in Ferrara.
- The Subcommission sponsors the Armenian field trip "The Bartonian and Priabonian boundaries in Southern Armenia: Problems and solution", August 24- September 8, 2014
- The proposal for the definition of the GSSP of the Chattian has been presented and approved by the voting members of ISPS, and the primary marker proposed is the Last Common Occurrence of the planktic foraminifer *Chiloguembelina cubensis*.
- The website of the Subcommission has been updated.
- the Subcommission sponsors the partecipation to STRATI 2015 in Graz.

Regarding the rest of the Paleogene Stages, good progress has been made in the search for the remaining GSSPs (Bartonian, Priabonian, Chattian).

The detailed reports of activities during the past four years of the Working Groups and Regional Committees are included in the ISPS website: http://www.paleogene.org/

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2019)

- Complete and publish the GSSPs of the Paleogene.
- To submit the Chattian proposal approved by the Subcommission to ICS and possibly to Episodes for publication during 2016

To submit the proposal of Priabonian and Bartonian GSSPs to the Paleogene Subcommission voting members, and then to ICS and possibly to Episodes for publication during 2016-2017

- To advance on the definition criteria for identifying the base of Bartonian, choose a type section and submit a proposal to Paleogene Subcommission voting members 2016.
- To submit the proposal Bartonian GSSP to ICS and possibly to Episodes for publication within 2017.
- Support of the organization of the field workshops and meeting of the remaining GSSPs.
- Support the attendance at IGC 34 in South Africa.
- 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.
- Revise and find auxiliary sections to better characterize the:
    - P/E boundary (i.e., Alamedilla, Caravaca and Zumaia in Spain, Forada and Contessa Highway in Italy, Polecat Bench in Wyoming);
    - Danian/Selandian: Contessa and Bottaccione in Italy; Caravaca and Sopelana in Spain;
      Selandian/Thanetian: Contessa, Italy
    - Bartonian: Contessa and Bottaccione in Italy; Alum Bay and Barton in the UK;
    - Priabonian: Egypt Wadi HitanValley, in the Fayum; Urdsadzor, Armenia;
      E/O: Monte Cagnero in Italy, Fuente Caldera in Spain, Landzhar in Armenia;

9) ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

The Palegeone Subcommission consists of 21 Voting Members elected for their personal expertise and experience and about 100 Corresponding Members, who have a responsibility for communication in both directions between the Subcommission 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.

9a Names and Addresses of Current Officers and Voting members

Subcommission officers

Chair:

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

Vice-Chair:

Noël Vandenberghe, Departement Earth and Environmental Sciences, Celestijnenlaan 200 E, B-3001 Heverlee-Leuven, Belgium.
noel.vandenberghe@ees.kuleuven.be

Secretary:

Laia Alegret, Departamento de Ciencias de la Tierra, Universidad de Zaragoza, Calle Pedro Cerbuna, 12, E-50009 Zaragoza, Spain. **laia@unizar.es**

List of Voting Members

Laia Alegret Departamento de Ciencias de la Tierra, Facultad de Ciencias. University of Zaragoza. 50009 Zaragoza Spain, laia@unizar.es

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Margaret Collinson, Department of Earth Sciences Royal Holloway University, of London Egham, Surrey, TW20 0EX, UK, m.collinson@es.rhul.ac.uk

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Richard H. Fluegeman, Department of Geological Sciences, Ball State University, Muncie, IN 47306. Indiana, USA, fluegem@bsu.edu

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Andrey Gladenkov, Geological Institute Russian Academy of Sciences. Pyzhevskii per., 7Moscow 119017, Russia gladenkov@ginras.ru

Yuri Gavrilov, Geological Institute Russian Academy of Sciences. Pyzhevskii per., 7Moscow 119017, Russia, yugavrilov@gmail.com

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Christopher Hollis, GNS Science, Institute of Geological and Nuclear Sciences, PO Box 30-368, Lower Hutt, New

Zealand., c.hollis@gns.cri.nz
Eustoquio Molina, Departamento de Ciencias de la Tierra, Facultad de Ciencias. Universidad de Zaragoza. 50009 Zaragoza, Spain, emolina@unizar.es
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James Zachos, Earth & Planetary Sciences Univ. of Calif., Santa Cruz CA, USA, jzachos@ucsc.edu

9b *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: Claudia Agnini claudia.agnini@unipd.it
Rupelian/Chattian Boundary Stratotype Working Group. Chairwoman: Rodolfo Coccioni, Italy. rodolfo.coccioni@uniurb.it
Paleogene Planktonic Foraminifera Working Group. Chairman: Bridget Wade, USA. b.wade@ucl.ac.uk Secretary: Helen Coxall, UK. hkc@gso.uri.edu
Paleogene Deep-Water Benthic Foraminifera Working Group. Chairman: Michael Kaminski, UK. kaminski@kfupm.edu.sa Secretary: Laia Alegret, Spain. laia@unizar.es
Paleogene Calcareous Nannofossils Working Group. Chairwoman: Simonetta Monechi, Italy. simonetta.monechi@unifi.it
South-American Regional Committee on Paleogene Stratigraphy. Chairman: Juan Carlos Silva Tamayo, Colombia. jsilvatamayo@yahoo.com Secretary: Diana Ochoa, Panama. dianita.ochoa@gmail.com
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, agladenkov@ilran.ru
Paleogene Larger Foraminifera Working Group, Chairman: Cesare Papazzoni, Italy. cesareandrea.papazzoni@unimore.it Secretary: Carles Ferrandez Cañadell, Spain carlesferrandez@ub.edu

9c Interfaces with other international project
Some of our members participate also in the work of the following International projects:
Integrated Ocean Drilling Programme
International Subcommissions on Cretaceous and Neogene Stratigraphy
International Geoscience Programme (IGCP)
ProGEO, Geosites and Geoparks Initiatives
UNESCO World Heritage Sites

SUBCOMMISSION ON CRETACEOUS STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommission on Cretaceous Stratigraphy (SCS)

SUBMITTED BY
Prof. Malcolm Hart, Chair
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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.

ORGANIZATION

SCS is a Subcommission of the International Commission on Stratigraphy.

Membership:	Chair:	Prof. Malcolm Hart, UK
	Vice Chairs:	Dr James Haggart, Canada
		Dr Brian Huber, USA
	Secretary:	Prof. Bruno Granier, France

[Note that nominations/elections are in progress for the 2016–2020 period;
Dr James Haggart is standing down after serving two terms.]

In addition, there are **18** Voting Members of the Subcommission, from most 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 Subcommission. Effectively, anyone with interest and expertise that can contribute to our objectives is welcome to do so. ***The great bulk of the Subcommission's work is carried out by these Working Groups***.

Officers for 2013-2016:

Chair:	Prof. Malcolm Hart (Plymouth, UK)
Vice-Chairs:	Dr James Haggart (Canada)
	Dr Brian Huber (Washington D.C., USA)
Secretary:	Prof. Bruno Granier (Brest, France)

Thanks to Silvia Gardin, former SCS secretary for her work with the website. The SCS website is now relocated at http://www.univ-brest.fr/geosciences/ISCS/

INTERFACES WITH OTHER INTERNATIONAL PROJECTS

The Subcommission 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 since taken over the responsability for selection of future venues, though the successful applicants will organize individual congresses. The *8th International Symposium on the Cretaceous System* was held in Plymouth during September 2009, and the *9th International Symposium on the Cretaceous System* was held in Ankara (Turkey) during September 2013. This Symposium was held from the 1st to 7th September 2013 at the Middle East Technical University in Ankara. The local organisation was managed by Ass. Prof. Dr. Ismail Omer Yilmaz, who will also act as an Editor of a special volume of *Cretaceous Research*. The *10th International Symposium on the Cretaceous System* is planned for July or September 2017 and will be held in Austria (Vienna or Saltzburg) organised by Prof. M. Wagreich.

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

The Subcommission had strong links with IGCP projects: IGCP 507 – "Cretaceous paleoclimatology", IGCP Project 506 - Marine and Non-marine Jurassic: Global correlation and major geological events (Project Co-Leader W. Wimbledon) and IGCP Project 608 "Asia – Pacific Cretaceous Ecosystems". The 1st Meeting of IGCP 608 was held at the Birbal Sahni Institute of Paleobotany over the Christmas period in December 2012.

IGCP 609 "Climate-environmental deteriorations during greenhouse phases:Causes and Consequences of short-term sea-level change" involves many Cretaceous workers and has had its 1st meeting in Ankara (2013), a 2nd meeting in Bucharest (2014) and a 3rd meeting in Nanjing (September, 2015).

SCS has always been directly or indirectly linked to important international Projects such as IODP, IGCP, CHRONOS (Mesozoic Planktonic Foraminifera Working Group, MPFWG), EARTH TIME EUROPE (ESF-European Science Fundation), and ICDP (International Continental Scientific Drilling Project).

CHIEF ACCOMPLISHMENTS IN 2014 and 2015

Highlight

One of the most important highlights for 2014 was the inscription of the Stevns Peninsula (Denmark) on the UNESCO World Heritage List. The Stevns Peninsula was 'inaugurated' at a reception on the 22nd October 2014, graced by Her Royal Highness Princess Marie of Denmark. The Cretaceous Subcommission applauds the work of Tove Damholt and Finn Surlyk in achieving this international recognition for an important Cretaceous succession. Reference to the nomination document is given below.

Damholt, T. & Surlyk, F. 2012. *Nomination of Stevns Klint for inclusion in the World Heritage List*. Østsjælands Museum, St. Heddinge, Denmark

General Activities

A wealth of data on various aspects of Cretaceous stratigraphy has continued to be published during 2013 and 2014 providing a continuous stream of new data that spans the whole Cretaceous in increasingly higher resolution. This is particularly true in the fields of stable isotopes and the astronomical tuning of sedimentary sequences.

Battenberg, S.J., Sprovieri, M., Gale, A.S., Hilgen, F.J., Hüsing, S., Laskar, J., Liebrand, D., Lirer, F., Orue-Extebarria, X., Pelosi, N., and Smit, J., 2012, Cyclostratigraphy and astronomical tuning of the Late Maastrichtian at Zumaia (Basque country, Northern Spain): *Earth and Planetary Science Letters*, v. 359–360, p. 264–278.

N. Thibault, D. Husson, R. Harlou, S. Gardin, B. Galbrun, E. Huret, F. Minoletti, 2012. Astronomical calibration of upper Campanian–Maastrichtian carbon isotope events and calcareous plankton biostratigraphy in the Indian Ocean (ODP Hole 762C): Implication for the age of the Campanian–Maastrichtian boundary. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **337–338**, 52–71.

Important Cretaceous GSSP issues were discussed in two sessions at the STRATI meeting in Graz, July 2015. One session was a general meeting of the SCS at which the chair presented the current status of Cretaceous GSSPs, followed by general discussion. The other session was a Thematic Session comprising papers on the J/K boundary (base Berriasian GSSP).

The Kilian Group (Lower Cretaceous Ammonite Working Group).

The Kilian Group met in September 2013 at the 9th International Symposium on the Cretaceous System in Ankara (Turkey). The Kilian Group has focussed on the Berriasian, Valanginian and Hauterivian stages, attempting to calibrate different ammonite zonations of the Tethyan, Boreal and Austral realms with the "standard" Mediterranean region zonation.

Reboulet, S. & 18 others, 2014, Report on the 5th International Meeting of the IUGS Lower Cretaceous Ammonite Working Group, the Kilian Group (Ankara, Turkey, 31st August 2013). *Cretaceous Research*, v. 50, p. 126–137.

The Berriasian GSSP and the J/K boundary.

This is a summary of progress for the Berriasian WG, written by the chair, W.A.P. Wimbledon.

Since the setting up of a new Berriasian Working Group in July 2007, there has been a new phase of activity on refining Tithonian and Berriasian correlations, in particular, directed towards addressing the outstanding issue of the choice of a Jurassic/Cretaceous boundary. The J/K boundary level is one where long-range correlation is difficult. Both austral and

boreal regions were isolated and far from Tethys, had more impoverished biotas; also, extensive areas of the world were then land with non-marine sedimentation and biotas. Therefore, there has always been much effort put into trying to improve correlation between marine to non-marine areas and from the core area of oceanic Tethys to isolated seas, seaways and landlocked basins towards the two poles.
A decision was made early by the Berriasian WG to dispense with previous diversions and pre-occupations, and to direct all energies towards factual matters that would promote a decision on selecting a primary marker for the base of the Berriasian. Therefore, the WG has concentrated on the detailed documentation of known key sections and seeking out new useful localities, giving special attention to integrating data from as many fossil groups as possible, vitally and preferably calibrated with magnetostratigraphy. Numerous sites, from California and Mexico to Tibet and the Russian Far East, have been studied and assessed. Past decisions dictate that a Tithonian/Berriasian boundary and a GSSP should be defined in marine sequences in Tethys. Tethys was the largest geographical entity at that time, and thus many sites in western Tethys have received special attention. Work in the last several years has concentrated on calibration of markers in an attempt to construct a useful matrix that will constrain a boundary level near to the base of the Berriasella jacobi Subzone, in magnetozone M19n. Unlike some upper Cretaceous stages, where one fossil taxon is the only useful tool for definition of a GSSP, in Tethys in the Tithonian/Berriasian boundary interval several groups may be present and complement one another, so that calpionellids, calcareous nannofossils, dinoflagellates, radiolarians and ammonites may all contribute to give an integrated matrix. The intention has always been to define a GSSP level in Tethys and then use all available proxies to derive correlations of chosen biotic markers with the more problematic marginal regions towards the poles and on the continents
Prior to 2007, J/K correlation had already shifted away from a concentration on ammonites. This was because widespread endemism in ammonites had been been repeatedly recognised as an obstacle to correlation, even in western Tethys. Various authors have attempted definition of the boundary level using calpionellids, nannofossils, radiolaria etc, and magnetostratigraphy. In recent times, calpionellids have been seen as the most useful fossil group, and the turnover from *Crassicollaria* species to small orbicular *Calpionella alpina, Crassicollaria parvula and Tintinopsella carpathica* has been documented consistently as a widespread marker in the middle part of M19n.2n. At the WG meeting in Warsaw in October 2013, the consensus was in favour of using *C. alpina* as the primary marker for the boundary. This level lies in the interval traditionally labelled as the "Berriasella jacobi Subzone" (though the ammonite faunas are being radically revised), and it is constrained also by the FADS of species of nannofossil (*Cruciellipsis cuvillieri, Nannoconus wintereri, Hexalithus geometricus* and *Nannoconus globulus globulus*). Work focuses also on finding proxies for these key markers in the biotically impoverished austral and boreal regions and in non-marine areas. A decision by the Berrriasian Working Group on the primary marker for the Tithonian/Berriasian boundary is expected soon and the suggestion of a contender GSSP later in 2016.
In 2015, the WG held a workshop in France in May (St Privat, Gard) with a visit to Berrias; members contributed talks to the Strati Meeting at Graz in July; members of the WG were amongst the organisors and speakers at the IGCP 632 conference on J/K correlations at Shenyang, China, in September; and, simultaneously, Russian colleagues held an all-Russian meeting on the J/K topic at Samara, on the Volga.

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, undertaken the study with a multidisciplinary approach of the Vergol section, which has the advantage of including also the base of the Upper Valanginian.

Barbarin, N., Bonin, A., Mattiol,i E., Pucéat, E., Cappetta, H., Gréselle, B., Pittet, B., Vennin, E. & Joachimski, M. 2012. Evidence for a complex Valanginian nannoconid decline in the Vocontian basin (South East France). *Marine Micropaleontology*, **84-85**, 37–53.

Base Hauterivian GSSP.
The section at La Charce section (Drome, France), is the probable candidate for the Hauterivian GSSP. There was an 'event' (on the 5th December 2014) at Serre de l'Ane near La Charce in the Department of Drôme (France). This is at the site of the proposed GSSP for the Valanginian- Hauterivian boundary, and accepted by the Hauterivian Working Group. Luc Bulot and Stephane Reboulet have indicated that the formal proposal will shortly be submitted to the SCS. Once this is done, and approved, there should soon be an agreement on the proposal and the GSSP can proceed to official ratification.

Base Barremian GSSP.
In the 2014 Report of SCS there were extracts of a report, prepared by Peter Rawson (Chairman of the WG) and Miguel Company (Vice-Chair), is a summary of the formal proposal of the Río Argos section as GSSP of the Barremian stage, which will be submitted shortly to the Sub-commission for approval.

The candidate section is located on the right bank of the River Argos, some 8 km west of Caravaca (SE Spain). From a geological point of view it belongs to the Subbetic Domain, which corresponds to the pelagic domain of the southern passive margin of the Iberian plate during the Alpine cycle (Triassic-Miocene). The analyzed interval of the section (beds 144 to 193) is 40 m thick and encompasses the uppermost Hauterivian (*Pseudothurmannia ohmi* Zone, with the *Ps. ohmi*, *Ps. mortilleti* and *Ps. picteti* Subzones) and the lowermost Barremian (*Taveraidiscus hugii* Zone, with the *T. hugii* and *Psilotissotia colombiana* Subzones). The lithological succession consists of a monotonous alternation of marls and marly limestones, belonging to the Miravetes Formation, only broken by the occurrence of a thin laminated black shale interval near the base of the section (bed 148), which represents the local equivalent of the Faraoni Level, a well-known organic-rich horizon that has been recognized within the uppermost Hauterivian sediments in several basins of the western Mediterranean Tethys.

The Río Argos section has provided a rich and diverse ammonite fauna, which has been the subject of several studies. We have collected more than one thousand specimens from the studied interval. All of them belong to Mediterranean taxa.
The primary marker event of the base of the Barremian stage (first occurrence of *Taveraidiscus hugii*) has been recorded in bed 171 (23 m above the base of the studied interval). Other significant bioevents that take place in this interval are the first occurrences of *Pseudothurmannia ohmi* (bed 144), *Pseudothurmannia mortilleti* and *Pseudothurmannia sarasini* (148), *Discoidellia favrei* (149), *Ps. picteti* (156), *Barremites* spp. (160), *Taveraidiscus intermedius* (170), *Psilotissotia chalmasi* (174), *Psilotissotia colombiana* (183), and *Kotetishvilia nicklesi* (193).

Although foraminifera are present in all the samples studied, their abundance and degree of preservation varies throughout the section. The diversity of planktonic foraminifers is, in general, relatively low, whereas the benthic ones are more abundant and diverse. The calcareous nannofossils assemblages are mostly composed of cosmopolitan and Tethyan taxa, the dominant genera being *Watznaueria*, *Nannoconus* and *Micrantholitus*. All of the interval studied corresponds to the Zone NC5. The most significant events recognized in the section are: the last occurrence of *Lithraphidites bollii* (which marks the base of Subzone NC5C, in bed 148), the first occurrence of typical forms of *Nannoconus circularis* (154) and the first occurrence of *Micrantholitus* sp 1 (194). The last occurrence of *Calcicalathina oblongata*, which defines the base of Subzone NC5D, takes place somewhat above the interval studied, within the *Kotetishvilia nicklesi* Zone.

Stable isotopes and organic matter, cyclostratigraphy have all been investigated, but magnetostratigraphy is not possible as the area is over-printed by Neogene remagnetization. The Cretaceous outcrops of the Río Argos area are catalogued as a Site of Geological Interest in the General Urban Development Plan of the municipality of Caravaca. We expect the next declaration of the Río Argos section as Palaeontological Zone, with the category of Heritage of Cultural Interest, according to the Law of Cultural Heritage of the Region of Murcia.

Base Aptian GSSP.
A wealth of data have been collected and published on the Aptian stage in the last years by our French collegues on the stratotype sections of the Bedoulian and Gargasian substages including revised biostratigraphies, $\delta^{13}C$ curve and cyclostratigraphy. 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 still pending and the new data from the 'historical' French sections have recently been summarized by Moullade *et al.* (2011, 2015) potentially making these sections more suitable.

Moullade, M., Granier, B. & Tronchetti, G. 2011. The Aptian Stage: Back to Fundamentals. *Episodes*, **34**(3), 148–156.

Moullade, M., Tronchetti, G., Granier, B., Bornemann, A., Kuhnt, W. & Lorenzen, J. 2015. High-resolution integrated stratigraphy of the OAE1a and enclosing strata from core drillings in the Bedoulian stratotype (Roquefort-La Bédoule, SE France). *Cretaceous Research*, **56**, 119–140.

Base Albian GSSP.

In 2015, the paper by Kennedy *et al.* (2014) has been circulated to the Voting members of the SCS and, aside from one vote, has been agreed. This has now been submitted to ICS for ratification. Some supplementary data have been added to that contained in the following paper.

Kennedy, W.J., Gale, A.S., Huber, B.T., Petrizzo, M.R., Bown, P., Barchetta, A. & Jenkyns, H.C. 2014. Integrated stratigraphy across the Aptian/Albian boundary at Col de Pré-Guittard (Southeast France): A candidate Global Boundary Stratotype Section. *Cretaceous Research*, **51**, 248-259.

Base Coniacian GSSP.

The main paper describing the criteria for identifying the base Coniacian and the proposal of a candidate composite GSSP section was published in *Acta Geologica Polonica* at the end of 2010. Besides multiple up-dated biostratigraphies, the paper also includes the isotope curves for both the Salzgitter-Salder (northern Germany) and Slupia Nadbrze~na (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.

In September 2011 the chair of the WG, Irek Walaszczyk, circulated the published proposal to the Working Group members asking for comments and eventual approval. All comments received indicated support for a composite GSSP, although the Working Group has been advised that a single GSSP (with a subsidiary location providing additional information) is the preferred option.

In 2013-2014 there was research on the Turonian/Coniacian sections in the US and Canadian Western Interior, northern Mexico, and in Mangyshlak Mountains, Kazakhstan. It seems that neither of the US and Canadian western interior sections is promising. The sections are either quite condensed or the boundary succession is with gaps (Walaszczyk et al. 2014). A potential has the Rosario section in Mexico studied and described by Ifrim et al. (2014); the sections still needs further works, and moreover, there are some safety issues in this part of the country. Attention is now focussed on successions in the Big Bend National Park in SW Texas, which is a part of the same basin to check the succession there. The Big Bend area is in a National Park and, if the succession appears complete and with good potential for the basal Coniacian stratotype, it could easily be accessible and studied.

Walaszczyk, I., Wood, C.J., Lees, J.A., Peryt, D., Voigt, S. & Wiese, F., 2010. Salzgitter-Salder Quarry (Lower Saxony, Germany) – Slupia Nadbrzena river cliff section (central Poland): a proposed candidate composite Global Boundary Stratotype Section and Point for the Coniacian Stage (Upper Cretaceous). *Acta Geologica Polonica*, **60**/3, 445-477.

Ifrim, C., Wiese, F. & Stinnesbeck, W., 2014. Inoceramids and biozonation across the Turonian - Coniacian boundary (Upper Cretaceous) at El Rosario, Coahuila, northeastern Mexico. *Newsletters on Stratigraphy*, **47** (2), 211–246.

Walaszczyk, I., Shank, J.A., Plint, A.G., & Cobban, W.A., 2014. Interregional correlation of disconformities in Upper Cretaceous strata, Western Interior Seaway: Biostratigraphic and sequence-stratigraphic evidence for eustatic change. *Geological Society of America Bulletin*, in press.

Walaszczyk, I., Kopaevich, L.F. & Beniamovski, V.N., 2013. Inoceramid and foraminiferal record and biozonation of the Turonian and Coniacian (Upper Cretaceous) of the Mangyshlak Mts., western Kazakhstan. *Acta Geologica Polonica*, **63** (4), 469–487.

Base Santonian GSSP.

This is now approved and an inaugural event at the site is being held in late November 2015. The article in *Episodes* was published in 2014.

Lamolda, M.A., Paul, C.R.C., Peryt, D. & Pons, J.M. 2014. The Global Boundary Stratotype Section and Point (GSSP) for the base of the Santonian Stage, "Cantera de Margas", Olazagutia, northern Spain. *Episodes*, v. **37**/1, p. 2–13.

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. The

distribution of planktonic Foraminifera across the Santonian-Campanian interval at Bottaccione was recently revised and up-dated (Petrizzo *et al.,* 2011). Moreover, as the available carbon isotope stratigraphy was considered at too low a resolution for reliable supra-regional correlation, a new set of carbon isotope analyses across the critical interval has been undertaken by Silke Voigt on the original samples (Premoli Silva & Sliter 1995), calibrated to paleomagnetic scale, and on new samples collected at higher resolution along the same road section and on the opposite side of the valley by Gale and Voigt. A paper with the new carbon isotope curves correlated to that from Lägerdorf (Northern Germany) is ready to be submitted for publication. The main bias of the Bottaccione section is that planktonic foraminifera across the critical interval could not be properly disaggregated from the hard limestones, using cold acetolysis method, and are poorly preserved.

M.R. Petrizzo, F. Falzoni & I. Premoli Silva, 2011. Identification of the base of the lower-to-middle Campanian *Globotruncana ventricosa* Zone: Comments on reliability and global correlations. *Cretaceous Research*, **32**, 387-405.
S. Bey, J. Kussa, I. Premoli Silva, M.H. Negrab, S. Gardin, 2012. Fault-controlled stratigraphy of the Late Cretaceous Abiod Formation at Ain Medheker (Northeast Tunisia). *Cretaceous Research*, **34**, 10-25.

Base Maastrichtian GSSP.
To overcome the problem of correlation between the ratified GSSP and coeval sections, stable isotopes were measured in high resolution from Tercis-les-Bains GSSP (Thibault *et al*., 2012). In this paper the Tercis $\delta^{13}C$ isotope curve was successfully correlated to the isotope curves from two Danish Basin cores (DK) that could represent the standard carbon isotope curve for the Boreal Realm, being calibrated to the nannofossil and dynocyst biostratigraphies. Moreover, Gardin *et al*. (2012) revised the biostratigraphy of the Bottaccione section, already calibrated to magnetostratigraphy, and gathered new calcareous plankton biostratigraphic and magnetostratigraphic data of the upper Campanian-Maastrichtian interval form the nearby Contessa section (Gubbio, central Italy). In addition, both the Contessa and Bottaccione sections have been analysed for stable isotopes by Voigt (2012) who reconstructed carbon isotope curves for both sections and correlated them to her new isotope curve from the Tercis GSSP.

S. Gardin, B. Galbrun, N. Thibault, R. Coccioni, I. Premoli Silva, 2012. Bio-magnetochronology for the upper Campanian – Maastrichtian from the Gubbio area, Italy: new results from the Contessa Highway and Bottaccione sections. *Newsletters on Stratigraphy*, **45**/1, 75–103.
M. Machalski, 2012. Stratigraphically important ammonites from the Campanian–Maastrichtian boundary interval of the Middle Vistula River section, central Poland. *Acta Geologica Polonica*, **62**/1, 91–116.
F. Surlyk, S.L. Rasmussen, M. Boussha, P. Schiøler, N.H. Schovsbo, E. Sheldon, L. Stemmerick, N. Thibault, 2013. *Cretaceous Research*, **46**, 232-256.
N. Thibault, R. Harlou, N. Schovsbo, P. Schiøler, F. Minoletti, B. Galbrun, B.W. Lauridsen, E. Sheldon, L. Stemmerik, F. Surlyk, 2012. Upper Campanian-Maastrichtian nannofossil biostratigraphy and high-resolution carbon-isotope stratigraphy of the Danish Basin: Towards a standard $\delta^{13}C$ curve for the Boreal Realm. *Cretaceous Research*, **33**, 72-90.
N. Thibault, D. Husson, R. Harlou, S. Gardin, B. Galbrun, E. Huret, F. Minoletti, 2012. Astronomical calibration of upper Campanian–Maastrichtian carbon isotope events and calcareous plankton biostratigraphy in the Indian Ocean (ODP Hole 762C): Implication for the age of the Campanian–Maastrichtian boundary. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **337–338**, 52–71.
S. Voigt, Gale A., Jung C., Jenkyns H., 2012. Global correlation of Upper Campanian - Maastrichtian successions using carbon isotope startigraphy: development of a new Maastrichtian timescale. *Newsletters on Stratigraphy*, **45**/1, 25–53.
P.D. Ward, J.W. Haggart, R. Mitchell, J.L. Kirschvink, T. Tobin, 2012. Integration of macrofossil biostratigraphy and magnetostratigraphy for the Pacific Coast Upper Cretaceous (Campanian–Maastrichtian) of North America and implications for correlation with the Western Interior and Tethys. *GSA Bulletin*, **124** (5/6), 957–974.

One issue of some concern to those working on the Maastrichtian is the gradual closure of the classic ENCI quarry near Maastricht, Netherlands. Parts of the quarry are being landscaped for biological conservation and there are on-going discussions about the preservation of the geological interest. This is especially important now that some of the oldest sea grass fossils (and associated macrofauna/microfauna) have been described from the location – including an almost complete sea grass meadow that was discovered in October 2015.

CHIEF PROBLEMS ENCOUNTERED IN 2015
The need, today, for a high-resolution stratigraphical framework that is applicable worlwide has resulted in the necessity of re-visiting several candidate sections, already studied paleontologically, by implementing multiple biostratigraphies and stratigraphic tools other than fossils (many of which are profoundly affected by provincialism in several intervals), such as like magnetostratigraphy, stable isotope stratigraphy, etc. In several cases, especially in the Late Cretaceous, the integration of multiple biostratigraphical data, together with physical stratigraphies, has shown that the candidate

sections were unsuitable as a potential GSSP. Consequently, new sections have had to be considered and studied from scratch. This has resulted in a delay in submitting some GSSP proposals, also taking into account that scientists from different sub-disciplines do not necessarily work at the same speed.

Another problem is the lack of fundings in most countries for carrying out studies that are strictly stratigraphical in nature as these are often deemed of low priority when compared to other more 'sexy' proposals. Funds for just attending workshops and/or conferences are also becoming more limited.

SUMMARY OF EXPENDITURES IN 2015:

I. INCOME

ICS subvention for 201	£ 0.00
Other income	£ 0.00
Carried forward	£ 5152.99
Total income	**£ 5152.99**

II. EXPENDITURE

Attendance of a number of participants at STRATI 2015 in Graz	£ 2547.07
Attendance at a GSSP discussion at GFC meeting in Paris in December 2015 (being done by video-conference)	£ 80.00 (estimate)
Total expenditure (to date)	**£ 2547.07**
Current Reserves (26th November 2015)	**£ 2605.92**

WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED IN 2016:

During late 2015 it is hoped that the ***Albian GSSP*** will be approved by the ICS. It is also expected that proposals for the ***Hauterivian GSSP*** and the ***Coniacian GSSP*** will be submitted to SCS early in 2016, closely followed by the ***Barremian GSSP***. With the Albian GSSP proposal submitted, it is the Hauterivian GSSP that is the leading priority for 2016.

Meetings

- The 4th meeting of IGCP 609 will be held in 2016; location not yet decided..
- The International Geological Congress (IGC) which will be held in Cape Town (South Africa), 27th August to 4th September 2016.
- The 10th International Symposium on the Cretaceous System will be held in 2017 in either Saltzburg or Vienna. This will be hosted by Michael Wagreich and Hans Egger.

BUDGET AND ICS COMPONENT FOR 2015

Office expenses (Fax, phone, postage, etc)	£ 50.00
Contribution to a J/K boundary Meeting (organization+ participants' support), April 2016	£ 1000.00
Contribution to a J/K boundary Meeting (organization+ participants' support), October 2016	£ 1000.00
Some support for SCS representation at IGC in 2016	£ 5000.00
Albian/Hauterivian Inauguration events	£ 2000.00
Total estimated expenditure in 2016	**£ 9550.00**

10. SUMMARY OF CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011–2015)

See Accomplishments in ICS Annual Reports 2007 to 2014 for additional details.

- The 9th International Symposium on the Cretaceous System, Ankara, September 2013. This major meeting at the Middle East Technical University, Ankara, Turkey was organised by Ass. Prof. Ismail Omer Yilmaz.

Though less well attended than comparable meetings in Western Europe, there was a full programme of lectures, although the number of posters was down on the symposium held in Plymouth. There were informative mid-symposium and post-symposium field trips. Prof. Bruno Granier was accepted as the new SCS Secretary and there were thanks to the past Chair (Isabella Premoli Silva) and Secretary (Sylvie Gardin). There were updates on outstanding GSSP definitions. The 10th International Symposium on the Cretaceous System will be held in 2017 in Austria. It is expected that this could be well-attended and prove to be a scientifically good meeting at which **remaining** GSSP issues should be resolved.

- The inauguration of the Turonian GSSP at Pueblo, Colorado, 25th October 2013. At an event organised by Rangers at the Pueblo State park, the GSSP 'marker' was ceremonially placed in the succession. Within the park there is now a comprehensive display board, static binoculars that can be used by visitors to view the 'marker' and a programme of outreach events to involve the community (especially schools). Dr Brad Sageman was thanked for preparing the information boards and choreographing the event. There were speeches by Stan Finney (Chair, ICS), Malcolm Hart (Chair, SCS), Suzanne Mahlburg Kay (President, Geological Society of America) and Brad Sageman. All the speakers and guests were thanked for their attendance and support by the Park Ranger responsible for education and outreach. Later, Brad Sagemen led a geological walk around the site and the various features of the Cenomanian to Turonian succession.

- The inauguration of the Santonian GSSP is scheduled for late November 2015, in northern Spain.

OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2020)
Future Meetings

- August 2016 – International Geological Congress, Cape Town, South Africa.
- September 2017 – 10th International Symposium on the Cretaceous System (Vienna or Saltzburg, Austria).

Details of other meetings are not yet available.

Objectives

- To submit the proposal for the Hauterivian GSSP to the Cretaceous Subcommission Voting Members, then submit it to ICS, and possibly to *Episodes* for publication;
- To submit the proposal for the **Coniacian GSSP** to the Cretaceous Subcommission Voting Members, then submit it to ICS, and possibly to *Episodes* for publication;

·To submit the proposal for the **Barremian GSSP** to the Cretaceous Subcommission 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 possibile;

- **To prepare the definition of the criteria for the recognition of the base of the Berriasian and the J/K boundary. This is deemed as 'High Priority' and the Working Group have been informed of this, with the expectation that this will be resolved as soon as possible (end-2016).**

Work Plan
2016 – Finalize proposals for the base of Hauterivian, Barremian, Aptian, and Coniacian Stages, and to continue with work on the Valanginian and Campanian.
2016 – Finalize the proposal for the base of Berriasian (Jurassic/Cretaceous boundary)
2017 – Definition of substages for discussion at the ISCS in 2017.

APPENDIX [Names and Full Addresses of Current Officers and Voting Members]
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[Note James Haggart has served 2 terms and replacement being sought]

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List of Task Groups and their officers

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Campanian WG: Andy Gale (UK). Andy.Gale@port.ac.uk
Santonian WG: *GSSP ratified*. Marcos Lamolda <gpplapam@lg.ehu.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: *GSSP submitted* Paul Bown and Brian Huber. HUBER@si.edu
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Berriasian (J/K boundary) WG: William A. P. Wimbledon, UK. mishenka1@yahoo.co.uk

Kilian Group *[formerly Lower Cretaceous ammonite WG]:*
Chairman: Stéphane Reboulet, France. stephane.reboulet@univ-lyon1.fr
Vice-Chairmen: Peter Rawson, UK. peter.rawson1@btinternet.com
Jaap Klein, NL. j.klein@amc.uva.nl

SUBCOMMISSION ON JURASSIC STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommission on Jurassic Stratigraphy

SUBMITTED BY
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2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

2a. Mission statement

The Subcommission 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 two 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.

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 Congresses on the Jurassic System, held in every fourth year and sponsored by ISJS. The next congress will be held in 2018.

In addition, the Subcommission 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 Subcommission's goals.

2c. Fit within IUGS Science Policy

The objectives of the Subcommission 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 Subcommission also has links to the Management Group of the UNESCO East Devon and Dorset Coast (The Jurassic Coast) World Heritage Site.

3. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

The chief accomplishments in 2015 were as follows:

- *Base Kimmeridgian Workshop, Polish Geological Institute, Warsaw*. A workshop organized by Prof. Andrzej WIERZBOWSKI (Polish Geological Institute-National Research Institute, Warszawa, Poland) was held from 18–21 May 2015. The workshop was attended by 14 researchers from the UK, Germany, Poland, Russia and Italy. Following a day and a half of scientific presentations and examination of ammonite collections from the Oxfordian/Kimmeridgian the Isle of Skye, Scotland (proposed GSSP), Poland, and Spain, the workshop continued with one day field-trip in the Wieluń Upland visiting quarries at Bobrowniki and Łobodno (Katarowa Góra). The workshop was wrapped up with a further half day of discussion. There was general agreement amongst workshop participants that a satisfactory GSSP definition with broad international support was now achievable.
- *Report of the base-Oxfordian field workshop, Redcliff, Dorset, June 2014*. A workshop report has been authored by PAGE and MELENDEZ and will be published in Volumina Jurassica in the last issue for 2015.
- *Honorary ISJS membership*. The ISJS agreed to elect Dr Tadashi Sato as an Honorary Member of the ISJS as proposed by Atsushi Matsuoka, and to put in place an alternative process for honouring exceptional contributions to Jurassic Stratigraphy against an agreed set of criteria, once every four years, and announced at each Jurassic congress (details to be developed).
- Progress and prospects for ISJS business were discussed in July at a business meeting at Stati, Graz, Austria.

3b List of major publications of subcommission work (books, special volumes, key scientific paper).

There were no collected scientific outputs sponsored by the ISJS this year, but there were many papers published concerning integrated geochronology, cyclostratigraphy, magnetostratigraphy and biostratigraphy, such that the chronostratigraphic scale for the Jurassic has been advanced significantly.

3c. Problems encountered, if appropriate

We are still encountering problems launching a new website for the subcommission. To this end a meeting has been arranged between the secretary and chair for mid-December 2015 at which new web pages will be constructed and made live.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2016)

The principal objective is to get formal agreement and draft GSSP proposals for both the base-Oxfordian and base Kimmeridgian stages.

4b Specific GSSP Focus for 2016

Oxfordian Task Group. Following the successful workshops in Provence in 2013 and Dorset in 2014 (and the publication of reports from both workshops) we expect rapid progress towards a formal proposal. The Chair has been liaising with the Task Group convenors with a view to agreeing a timetable for progress in 2016.

Base Kimmeridgian GSSP. After the Oxfordian, the Kimmeridgian Task Group is the closest to being able to make a GSSP recommendation to ICS. Following the successful completion of a base-Kimmeridgian workshop in 2016, the Chair has been liaising with the Task Group convenors with a view to agreeing a timetable for progress in 2016

Base Tithonian and base Callovian GSSP We expect the base Tithonian to follow shortly after that of the Kimmeridgian and finally the base Callovian. This would complete all of the definitions of the base of all the Jurassic stages.

5. SUMMARY OF EXPENDITURE IN 2015

Item	Amount (£)
Opening balance (transfer from Oxford University to Exeter University)	1696.35
Transfer from ICS	1944.89
Sponsorship of Base-Kimmeridgian Task Group workshop (Polish Geological Institute)	-2434.43
Bank charges (currency exchange)	-2.50
Travel and accommodation expenses Kimmeridgian Task Group Workshop, Warsaw (Hesselbo, Chair ISJS).	-767.43
Travel and accommodation expenses K Page (Oxfordian Task Group, keynote talk at Strati, Graz, Austria)	-436.88
Closing balance	0.00

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2016

We request £4000 to support a Toarcian GSSP dedication event in Peniche, Portugal, in 2016, to be organized by Luis Duarte (University of Coimbra).

APPENDICES

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)

- **Volumina Jurassica** Since 2010 the ISJS entered into a partnership with the open access periodical Volumina Jurassica. Volumnia Jurassica hosts a 'news and views section' which now routinely contains Jurassic Newsletter articles – previously only available as an informally assembled PDF available from the ISJS website. The editors of Volumina Jurassica, Andrzej WIERZBOWSKI and Grzegorz PIEŃKOWSKI, have also encouraged the Jurassic community to contribute to a discussion on the problems of the Jurassic substage boundaries. The journal continues to receive significant manuscripts focused on Jurassic stratigraphy and aims to gain ISI listing.

- **Triassic-Jurassic Boundary** Definition of the base Hettangian GSSP, Kujoch, Austria.

- **Base of the Toarcian Stage** Definition of the base Toarcian GSSP, Peniche, Portugal.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2020)

- Completion of the stage GSSP definition process
- Develop strategy for substage definition process
- Develop strategy for integration of cyclostratigraphy and geochronology into knowledge of stages and substages (including integration with relevant IODP and ICDP)
- Develop website as forum for exchange ideas in relation to Jurassic stratigraphy

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

9a Names and Addresses of Current Officers and Voting Members

The Subcommission has an Executive consisting of Chairman, Vice-Chairman and Secretary, who are all Voting Members of the Subcommission. 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. An election of new executive members is underway.

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

The objectives of the Subcommission 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 Subcommission sponsors an International Congress on the Jurassic System every four years. The 9th Congress was held in 2014 in India, and preparation is now underway to organize the 10th Congress in 2014 in Mexico. The present ISJS Voting Membership is as follows.

Executive				
		Role	*e-mail*	*Address*
Hesselbo	Stephen	Chair	s.p.hesselbo@exeter.ac.uk	Camborne School of Mines, University of Exeter, Penryn Campus, Penryn, Cornwall TR10 9EZ, UK
Sha	Jingeng	Vice Chair	jgsha@nigpas.ac.cn	Nanjing Institute of Geology & Palaeontology, Chinese Academy of

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Coe	Angela	Sec	a.l.coe@open.ac.uk	Department of Environment, Earth and Ecosystems, The Open University, Walton Hall, Milton Keynes, Buckinghamshire, UK
Voting Members				
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Pálfy	Joseph		palfy@nhmus.hu	Department of Physical and Applied Geology, Eötvös University	Pázmány Péter sétány 1/C, Budapest, H-1117 Hungary
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Goričan	Špela		Spela@zrc-sazu.si	Institute of Paleontology, ZRC SAZU, Novi trg 2, SI-1000 Ljubljana, Slovenia

9b List of Working (Task) Groups and their officers

The active Task Groups are as follows

Callovian Task Group (Chair: Eckhard MÖNNIG, Naturkunde-Museum Coburg, Park 6, 96450 Coburg, Germany, Tel. 09561/8081-13, e.moennig@naturkunde-museum-coburg.de)

Oxfordian Task Group (Chair: Guillermo MELÉNDEZ, Dpto. Geología (Paleontología), Universidad de Zaragoza, c./ Pedro Cerbuna 12, 50009 Zaragoza (SPAIN), Tel: (34) 976. 761076, Fax: (34) 976. 761088, e-mail: gmelende@unizar.es; Secretary Kevin PAGE, School of Geography, Earth & Environmental Sciences, Plymouth University, Drake Circus, Plymouth, PL4 8AA, UK)

Kimmeridgian Task Group (Chair: Andrzej WIERZBOWSKI, Polish Geological Institute - National Research Institute, 4 Rakowiecka St., 00-975 Warszawa, Poland, Andrzej.Wierzbowski@pgi.gov.pl)

Tithonian Task Group (Chair: Federico OLORIZ, Department of Stratigraphy and Paleontology, Faculty of Sciences, University of Granada, Av. Fuentenueva, s/n - 18071 Granada, Spain, floriz@ugr.es)

Geoconservation Working Group (Chair: Kevin PAGE, School of Geography, Earth & Environmental Sciences, Plymouth University, Drake Circus, Plymouth, PL4 8AA, UK)

Liaison Working Group (Chair: Robert CHANDLER, aalenian@blueyonder.co.uk)

9c Interfaces with other international projects

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

International Continental Drilling Program (IGDP) Proposal Workshop – Mochras Revisited: A New Global Standard for Early Jurassic Earth History. This project, led by ISJS Chair Stephen HESSELBO (UK), was approved for $1.5M funding in July 2015. The aim is to re-drill the >1 km thick Early Jurassic succession of the Cardigan Bay Basin, UK, as a means to calibrate biostratigraphy, chemostratigraphy, magnetostratigraphy and astrochronology for what appears to be an exceptionally complete mudrock succession. ISJS members Linda HINNOV, Susana

DAMBORENEA, Christian MEISTER, and Gregory PIENKOWSKI, have contributed to the proposal and/or will be members of the science team. A proposal for further funding for drilling is presently under consideration by the UK NERC.

ProGEO and Geoparks Initiatives. The Subcommission 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 WIMBLEDON, UK). These groups include ProGEO (the European association for the conservation of the geological heritage), BIGC (the British Institute for Geological Conservation.

UNESCO World Heritage Sites. ISJS liaises with the WH management group of the management of the UNESCO East Devon and Dorset Coast (informally known as the Jurassic Coast) World Heritage Site and engages in debates about approaches to conservation, in particular palaeontological heritage.

Stratigraphy Commission of the Geological Society, London. Bown, Coe, and Hesselbo are all members of Stratigraphy Commission of the Geological Society, London.

German Subcommission for Jurassic Stratigraphy. Eckhard Mönnig is currently chair of the German Subcommission for Jurassic Stratigraphy (https://www.jurasubkom.pal.uni-erlangen.de/)

S.P. Hesselbo December 3rd 2015.

SUBCOMMISSION ON TRIASSIC STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER
International Subcommission on Triassic Stratigraphy

SUBMITTED BY
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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.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015
Two meetings were originally included in the program of the STS for 2015.
STRATI 2015, 2nd International Congress on Stratigraphy, July 19-23, Graz, Austria.
The STS organized the session S17 "Progress in Triassic stratigraphy", convenors M. Balini (University of Milano), S. Richoz (University of Graz) and L. Krystyn (University of Vienna), that was very successful. Seventeen talks and 6 posters were included in the session program. Five talks out of 17 were on P/T and Early Triassic, 1 on the Anisian, 11 on the Upper Triassic, and 2 mostly focused on fossil groups rather than time intervals. The 11 talks on the Upper Triassic included 3 talks on the Carnian/Norian boundary, 2 talks on the two GSSP candidate sections for the definition of the Rhaetian, and 2 talks on the Triassic/Jurassic boundary. As regards to the posters, 1 was on fossil group, 1 on the Anisian, 1 on C/N boundary and 3 on the N/R boundary and the Rhaetian.
The presentations testify a significant progress on high-resolution integrated chronostratigraphy and correlations especially of the C/N and N/R boundaries.
The calibration of magnetostratigraphy of the Pizzo Mondello section, candidate for the C/N boundary, with the ammonoid, conodont and Halobia integrated chronostratigraphy has been accurately refined and the FO of *Halobia austriaca* is located in the lowermost part of the Pm5n magnetozone (**Balini et al.**). Ammonoid, conodont and bivalve records of Pizzo Lupo, a test section nearby Pizzo Mondello, are fully consistent with that of the candidate section (**Balini et al.**). The most important conodont bioevents identified at Pizzo Mondello can be correlated with other localities in the Western Tethys, such as Csővár and the Buda Mts (Hungary: **Karadi & Mazza**) and Silická Brezová (Slovakia), Bölücektasi Tepe and Erenkolu Mezarlik (Turkey)(**Mazza & Krystyn**).
The most significant progress on the definition of the Rhaetian stage, consists of a second option for the GSSP, proposed in the section Pignola-Abriola (Lagonegro, Basilicata, southern Italy) by **Rigo et al.**
The suggested primary marker event is also quite innovative and consists of a prominent negative shift of ca. 6‰ of the d13C org, which occurs at 44.4 m from the base, about 50 cm below the FAD of conodont *Misikella posthernsteini* s.s.
Concerning the magnetostratigraphy, conodont and radiolarian bio-chronostratigraphy, this proposal is based on data published by **Maron et al.,** in **Spring 2015** on the **GSA Bulletin** and has been published **Rigo et al.** in September 2015 on **Lethaia**.
The business meeting of the STS provided the opportunity to compare and to discuss more in detail the new proposal by **Rigo et al.** with respect to the proposal by **Krystyn et al.** (FAD of *Misikella posthernsteini* at Steinbergkogel, Austria)

already announced in 2007 and 2008, and updated for STRATI 2015. The two proposals are based on different events, namely the FAD of the conodont *M. posthernsteini* the proposal by Krsytyn et al., and a shift of the d13C org the one by Rigo et al., but, more important, the diagnosis of *M. posthernsteini* that was used by Krystyn and Rigo is not the same, at least at this stage of work. This different interpretation of the species whose FAD was already voted by the Working Group as primary marker event for the GSSP, was matter of lively discussion between Krystyn and Rigo during the meeting. No final conclusion was attained, especially because the paper containing the data cited by Rigo, was not yet available.

2nd Boreal Triassic Conference 2015, Svalbard and 12th International Workshop on the Permo-Triassic, Svalbard August 27 – September 1, 2015.
Sixtyseven scientists and accompanying persons attended the conference. The two day program included 4 sessions. Two of them on Triassic geology and sedimentology of Svalbard, one on Triassic paleontology of Arctic Norway and the last one on Triassic Geology. The total number of talks given was of 25, with 16 posters. On the whole, 75% of the presentations were on the Svalbard and Arctic Norway. The remaining presentations were from Tethys, mostly on the P/T boundary and Early Triassic. Overall, the meeting emphasized the tremendous improvement of the knowledge on the Triassic of the Svalbard over the past 10 years, but unfortunately it did not attract specialists from Siberia, Artic Canada and US.

3b List of major publications of subcommission work (books, special volumes, key scientific paper)

- ***Albertiana n. 42.*** This issue will be distributed at the end of December, and is dedicated to the Rhaetian stage.
- **Ammonoid Paleobiology**, Klug, C., Korn, D., De Baets, K., Kruta, I., Mapes, R.H. (Eds.), 2015, Springer. This two-volume publication is a monumental summary of the state of the art of our knowledge on Ammonoids, a systematic group of Cephalopods that has played crucial role in the development of bio- and chronostratigraphy. Although most of the chapters deals with paleobiology s.l. and with other time interval than the Triassic, some contributions are very important for Triassic stratigraphy such as Monnet et al. "Evolutionary Trends of Triassic Ammonoids"; Brayard et al. "Biogeography of Triassic Ammonoids"; Jenks et al. "Biostratigraphy of Triassic Ammonoids". **Jenks et al chapter includes the most advanced global correlation chart of the Triassic ammonoid chronozones**.
- **Der Lettenkeuper - ein Fenster in die Zeit vor den Dinosauriern**, Sp.issue of Paleodiversity, v. 8 Hagdorn H., Schoch R., Schweigert G. (Eds.). This german-written special issue illustrates the state of the art of paleontology of the Lettenkeuper, Upper Triassic succession of the Germanic Basin.

3c. Problems encountered, if appropriate
The main problems influencing the life of the Subcommission are the same described in the past years. In summary, the main problem is the reduction of interest on the definition of the timescale of the Triassic. One component of this problem is "historical", and due to the pressure on researchers to publish results in short time on journals with high IF, but the consequences on the Triassic community are much more severe than in other systems, because of the peculiarity of the Triassic, that is the only system in the Earth history that is bounded by two of the "big five" mass extinctions. Triassic scientists are then more attracted to study the Early Triassic recovery and the T/J mass extinction, than to study the rest of the Triassic.
In this general framework, the problem of overlaps of the program of the IGCP 630 and the mission of the STS duties, already highlighted in the STS annual report 2014, in 2015 has become a true conflict.
Notwithstanding several public announcements since 2014, anticipating the inclusion in the Scientific program of STRATI 2015 of a Triassic session sponsored and co-organized by STS, the board of IGCP 630,that includes the STS Vice chairman Tong Jinnan, independently submitted a proposal of an independent session on Triassic, not only dealing with IGCP 630 aims, but including also "Triassic integrated stratigraphy" as main topic, highlighted not only in the title, but also in the short title and presentation (http://strati2015.uni-graz.at/sessions/S_18/). This proposal was in full overlap and conflict with the STS proposal (http://strati2015.uni-graz.at/sessions/S_17/). Surprisingly both the proposals were accepted by the Organizing Committee, thus generating a significant confusion in the submission of the abstracts.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2016)
The workplan of the STS for 2016 includes two main points:

a) Revision of the Voting member list. Several Voting Members have not been active in the past 4 years, then a significant turnover is necessary for the life and future of the STS. This turnover s also necessary to motivate the best young scientists.
b) Field workshop in Lagonegro, Basilicata on the Rhaetian boundary, April 2016. This is the most important event of the STS scheduled in 2016 and will include one day of excursion and one day of presentations. The Pignola-Abriola section, the second candidate section for the GSSP of the Rhaetian, is a quite new section and

it has never been visited by a field trip of the STS. This excursion will provide the opportunity to see the succession and to group together the specialists working on Steinbergkogel (Krystyn et al.) and Pignola-Abriola (Rigo et al.).
Some members of the N/R boundary Working Group are also active in the C/N boundary Working Group, then this field workshop will be an important opportunity to discuss also this boundary.

The international conference program for 2016 includes two events that might be of interest for STS members. However, only a limited number of them will attend these meetings, then it is not expected that these meetings will improve specifically the discussion on Triassic GSSPs. As consequence we have preferred to invest time and a significant portion of the STS budget on the Pignola-Abriola Field Workshop.

- 35 IGC Cape Town, AUGUST 27-SEPTEMBER, 4, 2016 Session "Phanerozoic Earth History, Stratigraphy and the Geologic Time Scale" (convenors W. Alterman, Z.-Q. Chen, J. Ogg and F. Gradstein).
- 13th International Triassic Field Workshop, August 1-6, 2016, Xingyi, Guizhou, South China, convenors G.H. Bachmann (Halle-Wittemberg University), D.-y. Jiang (Peking University) and Z.-y. Sun (Peking University). The workshop includes four days of excursion and one evening with 8 oral presentations.

4b Specific GSSP Focus for 2016

- **Rhaetian**. The schedule defined in Annual Report 2014 has been notably delayed, mostly because the publication by Rigo et al. of a second candidate section and point, announced at the end of 2014, actually took much longer time than expected. This delayed publication notably slowed down the discussion within the Working Group.
  The composition of the WG was revised between the end of 2014 and the beginning of 2015 and 3 new members have been added (Simonetta Cirilli, Manuel Rigo and Dave Taylor). The WG was in full power and ready to act since March, however the manuscript by Rigo et al., submitted to Lethaia, was accepted only in late April. Proofs were revised at the end of July, too late for the discussion planned during STRATI 2015, and the paper was finally published in September.
  Despite of the significant delay, the discussion on the Rhaetian GSSP is in progress and it will be the priority of the STS for 2016. The key points needing further discussion are: 1) the clarification of the diagnosis of the conodont *Misikella posthernsteini*, within the lineage *M. hernsteini->M. posthernsteini*, and 2) the correlatability of the d13Corg shift recorded at Pignola-Abriola section.
  A ballot on the GSSP could be possible by the end of 2016.
- **Norian**. Apart of the progress on the GSSP candidate section Pizzo Mondello (see section 3a of this report), in 2015 the research group working on the other candidate section, Black Bear Ridge, has submitted to Paleo3 an interesting manuscript on stable isotope variations (Onoue et al., accepted). Chemostratigraphy on the BBR succession in the past years was not studied in detail. In this manuscript the stable isotope curves are calibrated with conodonts, and the correlation of BBR section with Pizzo Mondello mostly relies on this group of fossils. In order to come to a conclusion with this GSSP, the main problem that still requires a solution is the calibration of the FO of the bivalve *Halobia austriaca* in both the candidate sections. Few years ago it has been proposed as primary marker event. In both the candidate sections The FO of H. austriaca is comprised within an interval of very few meters without age diagnostic ammonoids. According to Orchard, the conodonts are the best tool for this calibration, however, his proposed correlations do not conform with the correlations based on ammonoids. Such a discrepancy is explained by Mazza and Rigo as due to different interpretation of conodont taxonomy.
  In 2016 Karadi & Mazza will submit a manuscript on conodont bio-chronostratigraphy of Csővár and the Buda Mts (Hungary) and Mazza & Krystyn will publish the conodont data from Silická Brezová (Slovakia), Bölücektasi Tepe and Erenkolu Mezarlik (Turkey). This data, integrated with new data from both Pizzo Mondello and Pizzo Lupo (Balini et al.,in progress), will provide support for the formal proposal of the GSSP at Pizzo Mondello.
  Taking into account that the problem of conodont taxonomy is under discussion since several years, it is hard to believe that the WG will be able to vote on the final proposals by the end of 2016. More realistically a ballot might be scheduled for the first half of 2017.
- **Olenekian**. The Induan/Olenekian boundary is one of the most complex stage boundaries of the Triassic. A lot of work has been done in the past years in eastern Russia, China and low paleolatitudes in Salt Range (Pakistan) and Spiti (Himalaya,India). In 2015 new data from these areas have been published, however the main contribution on conodont bio-chronostratigraphy of Salt Range and Spiti sections has not yet been submitted by Nicolas Goudemand who worked did his PhD on this topic some years ago. The unavailability of

his work is the major hurdle on the definition of this boundary. Formal invitations will be sent again to N. Goudemand and H. Bucher (PhD supervisor).

- **Anisian**. No progress is expected on the definition of the GSSP of this stage. Reasons were already given in the 2014 report.

5. SUMMARY OF EXPENDITURES IN 2015

ICS FUNDING to STS (in US $)		**3500**
• Contribution to participants to STRATI 2015		**2400**
• Organization of the Business meeting of the STS during STRATI 2015		**100**
• Travel costs of Working Group leaders		**500**
• Organization of the visit to Pignola Abriola section candidate for the GSSP of the Rhaetian (money kept for 2016)		**500**
	TOTAL	**3500**

Remarks:
Three young researchers (two of them without any position), one research assistant and one associate professor have been supported by STS for attending STRATI 2015. They presented talks on the Carnian to Rhaetian integrated stratigraphy and their presentations have been of great significance for the discussion on the Carnian/Norian and Norian/Rhaetian boundaries.
No one of the participants to the 2nd Boreal Triassic Conference, actually asked for financial support, probably because of the very high cost of travel and registration.
Only one of the STS Working Group leaders asked for financial support in 2015, to attend STRATI 2015.

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2016 (in US$)

- Contribution to the organization of the Pignola Abriola Field workshop the Norian/Rhaetian boundary, Southern Italy **5000**
  This workshop is conceived to group together the members of the research groups working on the Steinbergkogel section (Austria) and Pignola-Abriola (Italy) in order to discuss in depth the problems of: 1) impact on correlations of the different views on the conodont marker *Misikella posthernsteini*; 2) correlatability of the stable isotope curves. The requested budget will be used to support part of the travel costs of some WG members, as well as to rent two mini-van.

- Travel costs of Working Group leaders **1000**

Total **6000**

APPENDICES

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)

Organization

- Renewal of STS corresponding membership in 2011. Thirtyone new corresponding members have been involved in the STS.
- In November 2012 W. Kuerschner has replaced L. Krystyn as chair of the Carnian/Norian boundary Working Group, being Krystyn involved in one boundary proposal.
- In 2013 Albertiana, the newsletter of the STS, has been completely renewed. The new Editor is Chris McRoberts and the Editorial Board is now consisting of M. Balini, A. Baud, A. Brayard, P. Gianolla, M. Fraser, M. Hounslow, W. Kuerschner, S. Lucas, M. Orchard, Yu.Zakharov.
- New chair for the Norian/Rhaetian boundary Working Group appointed in 2013. M. Balini has replaced L. Krystyn, who is directly involved in the preparation of the proposal.
- Composition of the Norian/Rhaetian boundary WG updated in 2014 and beginning of 2015. Uodate has been done by asking the WG members for nominations, then by vote of the WG.

Meetings/ workshops

- Canadian Paleontology Conference, Vancouver, Canada, August 19-22, 2011. *Special session: Studies on the Triassic, in commemoration of Edward Timothy Tozer*.
- About 10 meetings and field workshops organized in the framework of the IGCP 572 between 2008 and 2012.
- Five International field workshops on Triassic organized every year: Dolomites (2010), Southern France (2011), western Lombardy (2012), Spain (2013) and Israel (2014).

- 2nd International Symposium on Triassic and later marine Vertebrate faunas, Xingyi (China), September 10-15, 2013.
- Special session on Triassic during the 9th International Symposium Cephalopods – Present and Past, September 4-12, 2014 .
- STRATI 2015, 2nd International Congress on Stratigraphy, July 19-23, Graz, Austria. Session S17 "Progress in Triassic stratigraphy", convenors M. Balini, S. Richoz and L. Krystyn.

Publications

- Three issues of **Albertiana** (#40-42) were published in 2011-2015. Each of these issues was made available for download from the Albertiana and STS websites.
- Abstract volumes/ field guides prepared for meetings in Vancouver, Xingyi and Zurich.
- The Proceedings of the Palermo workshop "New developments on Triassic integrated stratigraphy", held in September 2010 have been printed in March 2012 in the **Rivista Italiana di Paleontologia e Stratigrafia**, volume 118/1.
- **New Mexico Museum of Natural History & Science Bulletin 61**, "The Triassic System: New Developments in Stratigraphy and Paleontology". Tanner L.H., Spielmann J.A. and Lucas S.G. eds. Printed in 2013, 612 pp.
- **New Mexico Museum of Natural History & Science Bulletin "**Conodonts from the Carnian/Norian boundary (Upper Triassic) of Black Bear Ridge, northeastern British Columbia, Canada," by M.J. Orchard, about 200 pp. PDF available in December 2014, paper copy printed in 2015.
-

Working Groups

Induan-Olenekian boundary Working Group

- After intensive samplings, in 2010 Hugo Bucher and his team (Switzerland), emphasized Nammal Nala section in Salt Range (Pakistan) as another possible candidate for the GSSP.
- In 2012, after the publication of ammonoid and of some conodont data, the Nammal Nala section results to be the more complete section and the best candidate for the GSSP. The data are presented by Goudemand et al. at 34 IGC, Brisbane, Session 35.1 GSSPs as global geostandards.
- In 2013, in the lack of the publication of the revision of the I/O boundary conodonts, the WG has improved the taxonomy and correlation of ammonoid faunal successions.
- In 2014 the WG has discussed the correlation between Tethys and Boreal realms. This correlation is not easy, but it is important to try to address this issue, because the Induan stage was proposed with a low paleolatitude type area, while the Olenekian stage was based on boral successions.
- Further refinements in the Boreal Realms.

Olenekian-Anisian boundary Working Group

- In 2012 Goudemand et al. published the discovery of *Chiosella timorensis* from the Olenekian Haugi Zone of western Nevada (USA). This finding questions the adequacy of the FAD of this species for the definition of the GSSP of the Anisian Stage.
- Since 2013 E. Gradinaru has been reporting several times that from his study of new ammonoid collections from Desli Caira, the record of the earliest Anisian ammonoid zones in this section is complete. However, neither manuscript nor written report have been submitted for publication.

Carnian-Norian boundary Working Group

- Two candidate sections are under study for this GSSP: Black Bear Ridge in British Columbia and Pizzo Mondello in Italy.
- In 2011 the bivalve faunas from British Columbia, including the Black Bear Ridge section have been described in a large monograph by McRoberts. The possibility to define the GSSP at Black Bear Ridge section, on the basis of the FAD of the bivalve *Halobia austriaca* in anticipated by McRoberts & Krystyn, at Vancouver Conference.
- In 2011 McRoberts & Krystyn proposed in a poster presentation the FAD of the bivalve *Halobia austriaca* as possible marker events. Such proposal was already discussed in some informal and formal meetings of the Working Group (2010).
- The taxonomy and biostratigraphy of ammonoids (Balini et al.), bivalves (Levera) and conodonts (Mazza et al.) from Pizzo Mondello section have been published in 2012 in the Proceedings of the Palermo workshop (**Rivista Italiana di Paleontologia e Stratigrafia**, v. 118/1), together with a paper on nannofossils (Preto et al.).

- A first paper on Black Bear Ridge conodonts has been published in 2013. This paper includes the description of five new genera.
- In 2014 a paper on integrated bio-chronostratigraphy of the Carnian/Norian boundary section at Berlin (central Nevada) has been published (Balini et al., 2014). In this contribution, first study of this locality based on bed-by-bed collections, the ammonoid, bivalve and conodont record is described. The problems of correlations with the sections in British Columbia and western Tethys are also discussed. Berlin is the best locality in North America for the latest Carnian ammonoid faunas but provides also a good record of the earliest Norian.
- The conodont taxonomy and bio-chronostratigraphy of the Black Bear Ridge is published in January 2015 (PDF already available in December 2014).
- Several presentation on the C/N boundary in western Tethys are given in the Session S17 of STRATI 2015, July 2015. These presentations demonstrate the correlatability of Pizzo Mondello section with several sections in Hungary, Turkey and Carpathians. The quality of the fossil record of Pizzo Mondello is tested by studying the ammonoid, conodont and bivalve record of Pizzo Lupo section, about 25 km from Pizzo Mondello. The two sections show the same record.
- Stable isotope data from C/N boundary interval at Black Bear Ridge is published in September 2015.

Norian-Rhaetian boundary Working Group
Since 2008, Steinbergkogel (Austria), in the historical Hallstatt area, has became the most significant section for the definition of the Norian-Rhaetian boundary. In 2009 the FAD of *M. posthernsteini* was voted by the members of the WG as the best event to be used to define the boundary.

- At Steinbergkogel 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. A 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*.
- The thickness of the boundary succession is unfortunately rather thin, and the facies is not constant, then from 2009 the research group working on the Steinbergkogel section is engaged with the search and sampling of some reference sections, in Northern and Southern Alps, crucial to demonstrate the significance of the rather thin Steinbergkogel section.
- Gardin et al. (2012) reported the occurrence of the first coccolithophores from the Norian-Rhaetian boundary interval in three sections from Northern Alps, including Steinbergkogel section. This first occurrence strengthens the position of Steinbergkogel as the best GSSP proposed section for the base of the Rhaetian.
- In 2014 Krystyn states that the correlation chart of sections from 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.
- In 2014 Rigo et al. announced a second candidate section at Pignola (Lagonegro, southern Italy). A manuscript has been submitted for publication. The succession exposed at this site was deposited in a deep setting then bio-chronostratigraphy is based on conodonts and radiolarians. The section is under study for magnetostratigraphy and stable isotope variation.
- During Session S17 of STRATI 2015, Rigo et al. present their proposal of definition of the GSSP for Pignola-Abriola section, on the basis of a prominent negative shift of ca. 6per mil of the d13Corg, which occurs at 44.4 m from the base, about 50 cm below the FAD of conodont *Misikella posthernsteini* s.s.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2019)
Brief bullet points - using previous reports and longer term plans, beyond the single GSSP focus

- Revision of the STS Website.
- Definition of the GSSP of the Rhaetian Stage by 2016. The field workshop at PignolaAbriola, (April 2016) will be crucial for the solution of the pending uncertainties on the taxonomic definition of the marker species, as well as on the correlatability of the d13Corg shift suggested as primary marker event.
- Definition of the GSSP of the Norian stage by 2017. Most of the members of the Carinan/Norian boundary WG are involved also in the Norian/Rhaetian WG. For this reason, realistically this decision will not be possible before the end of 2016. The Triassic session of STRATI 2015 will be an important deadline for the discussion on the correlatability of the possible marker events for this GSSP.
- Definition of the GSSP of the Olenekian. At the present is not possible to estimate a deadline for the final decision. In 2014 H. Bucher has re-opened the discussion on the marker events by emphasizing the problem of

the correlatability of events recorded in low paleolatitude tethyan sections (Nammal Nala, Pakistan, and Mud, India) with high paleolatitude siberian successions. These successions provided support for the formalization of the Olenekian Stage of the Lower Triassic Series, while the Induan Stage was proposed on low paleolatitude successions. New investigations by H. Bucher are going to be planned, but at present no research project on this topic has been submitted, then it is impossible to estimate a timing or schedule for the WG.

- Definition of the base of the Anisian Stage by 2018. This is the most difficult boundary to be defined, for the combination of scarcity of sections and frequent condensation. The activity of the WG has been delayed in the last 10 years by the very slow progress of the study on the Desli Caira section in Romania. The FAD of the conodont *Chiosella timorensis*, that was voted several years ago by the WG, is now known to be recorded together with late Olenekian ammonoids in north America. This datum is unfortunately from a loose block, then no candidate section is available.
- Improvement of the marine-land correlations. Important continental successions are documented in the Western Interior (USA), Karoo (South Africa), Germanic basin and Newark basins (USA) and are under study by an informal Working Group of the STS. Over the years, this WG has established a Triassic continental scale consisting of 8 stages, whose correlations with the marine scale is updated year by year. The goal is very ambitious and but S. Lucas, the very active leader of this WG, keeps the members of this WG under pressure.
- Improvement of the numerical calibration of the Triassic chronostratigraphic scale, with special care on the definition of the duration of the Induan, Norian and Rhaetian stages. The main problem of the Induan Stage is its short duration, based on radioisotopic dating on zircons, while interpretation of sedimentary cycles in terms of Milankovitch cyclicity would suggest an about 50% longer duration. The duration of the Norian Stage has been a matter of strong discussions during the last 9 years, mostly because of the lack of tuff layers in biostratigraphically calibrated sections. Two notably different estimates have been thus far suggested, one postulating a short 10-12 myr duration while the second estimates a much longer 28myr duration.
- Establishment of Working Groups aimed at the definition of the stratotype of the Triassic Substages. This important step towards the increasing of the power of resolution of the Triassic timescale, is always kept in the program of the STS, but the launch of the Substage definition program will be possible only after the completion of the definition of all the GSSP of the Stages and in agreement with the ICS board.

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

STS is a Subcommission of the International Commission on Stratigraphy.
Officers (chairman, two vice-chairmen, secretary), Editor/ Webmaster of newsletter Albertiana, 23 voting members and 117 corresponding members. The Secretary hosts a web site for STS announcements and task group discussions. Subcommission 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.

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9b List of Working (Task) Groups and their officers
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Base Rhaetian**:** M. Balini, Italy. Marco.balini@unimi.it
Non-marine auxiliaries**:** S. Lucas, USA. spencer.lucas@state.nm.us

9c Interfaces with other international projects
The IGCP 572, that was proposed with the support of the STS, ended in 2013. The IGCP 630 "Permian-Triassic climatic and environmental extremes and biotic response" has been approved by UNESCO in 2014, (http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/international-geoscience-programme/igcp-projects/global-change/project-630/). Some of the goals of this new project fully overlap with the mission and the activities of the STS but, surprisingly, the Triassic Subcommission was not asked for any support and cooperation neither during the preparation of the IGCP proposal nor after its approval. The **Induan/Olenekian boundary Working Group is affected by this unusual situation** and its members are obviously pressed to follow the tight schedule of the IGCP 630.

SUBCOMMISSION ON PERMIAN STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommission on Permian Stratigraphy (SPS)
Submitted by:
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2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Subcommission Objectives: The Subcommission'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 Subcommission 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.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2014

The proposals of the Sakmarian-base and Artinskian-base GSSPs have been published in *Permophiles* (Issue 58). After the proposals were published, we received a couple of comments and discussions on the conodont taxonomy for the index species and quality of the sections from the working group members, which have also been published in the subsequent *Permophiles* 59. Since discrepancies on the taxonomy of conodonts and selection of the conodont index species for the definition of the two GSSPs are present in the working group, a special workshop on these issues were discussed in a business meeting during the ICCP 2015 in Kazan. The Russian Stratigraphic Committee agreed to excavate the sections and organize another joint field excursion during 2016.

In addition, we organized an international group to do the second joint field excursion on the Guadalupian Series in West Texas in April, 2015. During this field excursion more than 800 kg samples were collected for conodont and high-resolution geochemical analyses. Seven ash bed samples were collected.

3b List of major publications of subcommission work (books, special volumes, key scientific paper)

Three issues of *Permophiles* (Issues 60, 61 and 61 suppl.) have been published since June, 2014.

An updated Permian timescale has been published in the proceeding volume of STRATI 2013 by Shen and Henderson (2014). A special issue titled "The Permian Timescale" has been organized by Spencer Lucas and Shuzhong Shen. This will be published on Geological Society of London, Special Publications in 2016.

3c. Problems encountered, if appropriate

We have encountered problems that discrepancies in conodont taxonomy and selection of the index species of the two proposals for Sakmarian-base and Artinskian-base GSSPs are present. The section for the Kungurian-base GSSP in southern Urals is still too short as a GSSP section. The Russian Stratigraphic Committee promised to excavate the section as soon as possible.

We also met a problem for the Lopingian-base GSSP which will be flooded after a dam established in 5 years for electronic power in the downstream of the Hongshui River in Guangxi, South China. We have extensively discussed with the local government and a detailed plan for searching the replacement of the GSSP section nearby the GSSP has been made. Field work to search replacement section in South China was carried out too during 2015.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2015)

The primary objectives are to complete the last three GSSPs (Sakmarian, Artinskian, and Kungurian stages). The Russian Stratigraphic Committee has made a plan to excavate the section, then SPS will organize an international joint field excursion to collect various samples. In addition, the chair of the Sakmarian-base GSSP Working Group, Valery Chernyk, has agreed during the ICCP 2015 in Kazan to provide the detailed taxonomic data for the section to complete the GSSP proposal for voting soon.

4b. Specific GSSP Focus for 2015

The priority of 2015 for GSSP is to send the Sakmarian-base GSSP proposal for voting in the Working Group and SPS.

5. SUMMARY OF EXPENDITURES IN 2015

1) As planed in the Annual Report 2014, a field excursion on the three potential GSSP sections in southern Urals was organized by Valery Chernyk (18th ICCP) partly under the support of SPS. We invited all voting members to attend the field excursion, six voting members finally attended the excursion, four of them are supported by SPS (1980 US$). In addition, we also supported the vice-chair for his field trip to the terrestrial PTB sections in Kazan (440 US$)
2) A session and an SPS business meeting on the Permian GSSPs were organized during the 18th ICCP meeting (580.54US$).
3) Supporting a part of Lucia Angiolini's stay in Nanjing in May, 2015 and editing *Permophiles* (US$1000).
4) A second field excursion for the three GSSPs of the Guadalupian Series in the Guadalupe National Park was organized in April. This costed a lot of money which is mostly covered by Shuzhong Shen's project, approximately 1000US$ was used for the field trip.

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2016

1. Shuzhong Shen will organize a session in the 35th IGC which will be held at Cap Town, South Africa and attend the ICS business meeting during the 35th IGC. This will cost more than US$2000. It depends upon how much ICS will support to cover his trip to Cap Town.
2. SPS secretary Lucia Angiolini will be invited to Nanjing to edit the next *Permophiles* and work on the proposal for the three Cisuralian GSSP proposals (1000US$).
3. A working group led by Valery Chernykh will excavate the Kungurian-base and Artinskian-base GSSP sections in southern Urals. The Working Group will invite SPS voting members to work on those sections. SPS will partly support this important activity with a total amount (US$2000).
4. A workshop organized by the Marine and non-marine Working Group (Joerg Schneider) will be held in the late 2016. SPS will try to support this workshop for 1000US$ depending upon how much ICS will support SPS.

In total: **US$6000**

APPENDICES

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2010-2015)

1) A new SPS website has been established.
2) Three GSSP bronze markers have been placed on the GSSPs in the Guadalupe National Park in USA.
3) A high-resolution timescale of the Permian system has been significantly refined (see SPS webpage Permian Timescale).
4) SPS decided to search new GSSP candidate for the Kungurian Stage after an investigation on the previous candidates. Now two candidates for the Kungurian-base GSSP are available, but further work is necessary before a voting process is conducted.
5) Significant progress on the Sakmarian-base and Artinskian-base GSSP candidates has been made. Proposals for voting have been published and extensively discussed.
6) Two monuments have been built and a protected area has been established at Penglaitan, Laibin, Guangxi Province, China for the Wuchiapingian-base GSSP.
7) Seven formal issues and three supplementary issues of *Permophiles* have been published since 2010.
8) A Working Group on the Carboniferous-Permian transition between marine and non-marine sequences has been organized in 2015.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2015-2019)

1) Publishing the revised version of the proposals, organizing the field excursions and establishing the three (at least two) GSSPs for the Cisuralian.
2) Continue to work on the Guadalupian and global correlation for chemostratigraphy and geochronologic calibration. Publish the official papers for the three Guadalupian GSSPs.
3) Searching the replacement of the Lopingian-base GSSP nearby the stratotype section at Penglaitan, Guangxi, South China because the original will be flooded in 5-10 years by a dam for electronic power.
4) Developing a large working group on the correlation between marine and continental sequences. This has already been organized.

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9a Names and Addresses of Current Officers and Voting Members

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9b List of Working (Task) Groups and their officers

1) Kungurian-base GSSP Working Group; Chair-Bruce Wardlaw.
2) Sakmarian-base and Artinskian-base GSSPs Working Group; Chair-Valery Chernykh.
3) Guadalupian Series and global correlation; Chair-Charles Henderson.
4) Correlation between marine and continental Carboniferous-Permian Transition; Chair-Joerg Schneider.
5) Neotethys, Paleotethys, and South China correlations; Chairs Lucia Angiolini and Yue Wang.

9c Interfaces with other international project

SPS interacts with many international projects on formal and informal levels. SPS has taken an active role in the development of a project on the correlation between marine and continental Permian sequences bilaterally supported under the foundation of the Sino-German Centre for Research Promotion (SGCRP) by NSFC and DFG. In 2014, SPS chair Shuzhong Shen organized an international cooperative project on the correlation of the Guadalupian Series between South China and Mt. Guadalupe in Texas, USA, which has been approved by NSFC.

SUBCOMMISSION ON CARBONIFEROUS STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

SUBMITTED BY

Barry C. Richards, Chair of SCCS

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 on La Serre Hill in southern France (Paproth & 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), and it subdivides the Carboniferous into two subsystems, the Mississippian Subsystem below and the Pennsylvanian Subsystem above. 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.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN November 1st 2014 - October 31st 2015 fiscal year

Task Group Progress Reports

The joint Devonian-Carboniferous Boundary GSSP Reappraisal Task Group [base of Carboniferous is also the base of Lower Mississippian Series and Tournaisian Stage] was established in early 2008 and is chaired by Markus Aretz (France; aretz@get.obs-mip.fr).

Introduction and general activities

During the fiscal year, the group made continued progresss with it primary tasks – the search for a suitable criterion for redefinition of the D-C boundary and the hunt for a suitable section for the GSSP. Studies by Ji *et al*. (1989) and subsequent analysis (Kaiser, 2009) demonstrated severe problems exist with the D-C boundary GSSP (Paproth *et al*., 1991). The boundary GSSP on La Serre Hill in France is defined by the first occurrence of the conodont *Siphonodella sulcata* (Huddle, 1934) in the lineage *Siphonodella praesulcata* Sandberg, 1972 to *S. sulcata*.

The current work and results of the task group have been presented and discussed in formal and informal discussions with task-group members and interested researchers at three international meetings: STRATI 2015 in Graz, Austria (Aretz & Corradini, 2015), 18th International Congress on Carboniferous and Permian, in Kazan, Russia (Aretz, Corradini & Working Group, 2015), and IGCP 596 – Subcommission on Devonian Stratigraphy (SDS) Symposium in Brussels, Belgium (Corradini, Aretz & Working Group, 2015). Highlights of the research are: the conodont *Protognathodus kockeli* (Bischoff) has good potential for boundary definition, the geochemical signature of the mulita-phase Hangenberg Event (Kaiser *et al*., 2008) is well known, and the base of the Hangenberg Black Shale has substantial potential for international correlation.

Reports from Task-Group members

Italian Group: Carlo Corradini and Claudia Spaletta

Research of the Italian group focused on the revision of conodonts from the latest Devonian and earliest Mississippian (Corradini *et al*., 2015). All genera occurring in that time frame were evaluated and a new zonation across the boundary proposed. They suggest the FAD of the conodont *Protognathodus kockeli* (Bischoff) should be considered as a new index for boundary definition. Conodonts from a new section across the D-C boundary in Sardinia were also studied (Mossoni *et al*., 2015).

Czech group

The Czech researchers report that the research grant of Czech Grant Agency on the high-resolution multiproxy stratigraphic analysis of the D-C boundary in Europe was completed at the end of 2014. Outputs include: Kalvoda *et al*. (2015), Kumpan *et al*. (2014a, 2014b; 2015). In addition, a manuscript by Bábek, O., Kumpan, T., Kalvoda, J., and Matys Grygar, T. titled "Devonian/Carboniferous boundary glacioeustatic fluctuations in a platform-to-basin direction: A geochemical approach of sequence stratigraphy in pelagic settings" is nearing completion.

Thomas Becker and Münster Group

The results of the Münster Group were published in a series of papers and the highlights are presented here. 1) Kaiser *et al*. (2015) concentrated on the extinction, sedimentary and geochemical patterns of the global Hangenberg Crisis, which represent a first-order global ecosystem turnover at the same scale as the "Big Five" mass extinctions. A crisis scenario was developed, with globally recognizable lower, middle, and upper crisis intervals that have significant correlation potential. 2) Becker *et al*. (2015a) summarized the biostratigraphy and lithostratigraphy across the D-C boundary in the Rhenish pelagic and Ardennes neritic successions. They concluded the base of the Hangenberg Black

Shale presents the best option for international correlation because it can be recognized by more methods and is more widely recognizable than other levels. 3) Revisions of the main ammonoid group that spans the D-C boundary and Hangenberg Crisis, the Prionoceratidae (Fischer & Becker, 2014), showed a much higher pre-crisis diversity than previously assumed. Two prionoceratid lineages survived and new data Zong *et al*. (2014) Becker *et al*. (2015a,b) confirmed that the re-radiation, the onset of *Acutimitoceras* (Stockumites), started either immediately after the extinction or immediately after the hypoxic/anoxic interval. Therefore, the black-shale extinction event would make is an acceptable marker for the D-C boundary from the perspective of ammonoid experts. 4) Further sampling in several Rhenish D-C sections (Kumpan *et al*., 2015; Becker *et al*., 2015a,b) provided more precision concerning the development of hypoxia, extinctions, and re-radiation of ammonoids and conodonts. The marker clymeniid *Postclymenia evoluta* crosses the main ammonoid extinction level and, for the first time, has been found in the Hangenberg Black-Shale at Drewer (where it is much more common in the basal crisis interval Drewer Sandstone) and in the basal Hangenberg Shale at Oberrödinghausen.

Barry Richards (Canada)

Richards and colleagues continued studies of the upper Famennian to lower Tournaisian in the Western Canada Sedimentary Basin (WCSB) and adjacent Montana to see if events in the multi-phase Hangenberg Event interval can be located in the region using a multidisciplinary approach. Sedimentologic evidence for the stages of the Hangenberg event are not clearly expressed and significant ($\delta^{13}C_{org}$) excursions similar to those documented for the phases of the Hangenberg in Western Europe have not been recognized even in sections that must contain the D-C boundary and Hangenberg level.

Task Group to establish the Tournaisian-Viséan Boundary [which is also the base of the Middle Mississippian Series] is chaired by George Sevastopulo (Ireland; gsvstpul@tcd.ie).

Following approval of the proposed GSSP (Devuyst *et al*., 2003) at Pengchong in southern China, by the SCCS in 2007 and its ratification by the ICS and IUGS, task-group member François-Xavier Devuyst had been preparing the final report about the Tournaisian-Viséan boundary GSSP but the task-group chairman George Sevastopulo has taken over that role. Substantial progress has been made with writing the final report on the base of the Viséan but Sevastopulo was not well during 2015 and was not able to complete the manuscript as planned. Sevastopulo and his task group hope to complete a draft during the 2016 fiscal year. The report provides a brief resume of the GSSP and then lists the successful attempts to identify the boundary in Eurasia by Jiri Kalvoda and others, and discusses the problems of identifying (and best approximation to) the boundary in North America and Gondwana. It also includes contributions by relevant paleontological experts on the up-to-date knowledge of the ranges of different fossil groups over the boundary interval, which is useful because many taxa that were considered to be of early Viséan age are actually restricted to the latest Tournaisian or first occur there.

Task Group to establish the Viséan-Serpukhovian Boundary [which is also the base of the Upper Mississippian Series] is chaired by Barry Richards (Canada; barry.richards@canada.ca).

Introduction and general activities

An index for boundary definition has been selected, but not voted on by the task group and SCCS for final approval, and work is well advanced at the two prime GSSP candidate sections: the Verkhnyaya Kardailovka in the southern Ural Mountains of Russia and the Naqing (Nashui) section in southern Guizhou Province, China. In the Cantabrian Mountains of northwest Spain, work continued on the Millaró and Vegas de Sotres sections, two other potential candidate sections for the GSSP. For boundary definition, the group is using the first evolutionary occurrence of the conodont *Lochriea ziegleri* Nemirovskaya, Perret & Meischner, 1994 in the lineage *Lochriea nodosa* (Bischoff, 1957) –*Lochriea ziegleri*. *L. ziegleri* appears in the Brigantian Substage of NW Europe somewhat below the current base of the Serpukhovian as defined by its lectostratotype section in the Zaborie quarry near Serpukhov in the Moscow Basin, Russia (Kabanov *et al*., 2009, 2012, 2014a,b).

Progress in southern Guizhou Province, China

In south China, the boundary index – the FAD of *L. ziegleri* has been precisely located in the Naqing section (Qui *et al*., 2013). In 2015, a major accomplishment in south China was the completion of a sedimentological/geochemical study across the Viséan/Serpukhovian boundary by Jitao Chen and Isabel Montanez (Chen *et al*., in press). The studied sections include the limestone-dominated, shallow-marine Yashui section and deep-water (slope) Naqing, Narao, Luokun, and Dianzishang sections. The new sedimentological and lithostratigraphic work confirms interpretations presented by the task group in previous annual reports and by Groves *et al*. (2012). It also demonstrates the boundary level in the Naqing, Narao, Luokun, and Dianzishang sections is dominated by carbonate-slope lithofacies, whereas the Yashui section comprises restricted-shelf carbonates. The $\delta^{13}C_{carb}$ record in the Naqing section (Buggisch *et al*., 2011, Chen *et al*., in press) and nearby sections shows a prominent negative $\delta^{13}C$ excursion in chert-rich facies slightly above the FAD of *Lochriea ziegleri*.

The manuscript titled "Conodonts of the genus *Lochriea* near the V/S boundary (Mississippian) at the Naqing section, Guizhou Province, South China" by Yuping Qi, Tamara Nemyrovska, Qiulai Wang, and Keyi Hu was

completed. Their study enables confirmation and refinement of known lineages within the genus, and two lineages are proposed: 1) noded *Lochriea* species, such as *L. mononodosa–L. nodosa–L. ziegleri, L. senckenbergica* and *L. multinodosa*, and 2) ridged *Lochriea* species such as *L. monocostata–L. costata–L. cruciformis*. The numerous and variable species of *Lochriea* across the V/S boundary in the Naqing section are sorted out and the possibilities for their derivation evaluated.

After the foraminiferal study of Groves *et al*. (2012), foraminifers across the V/S boundary in south China have been intensely studied by Paul Brenckle and Qingyi Sheng, who found age-diagnostic Serpukhovian foraminiferal species including *Janishewskina delicata* (Malakhova, 1956), an auxiliary index to the base of the Serpukhovian. They were collected about two meters above the V/S boundary (at 60.1m) as defined by the FAD of *L. ziegleri* in the Naqing section.

Progress in South Ural Mountains, Russia

The task group completed sedimentologic and stable-carbon isotope studies across the boundary level in the Verkhnyaya Kardailovka section and presented a summary of their work in the field guide for the XVIII International Congress on the Carboniferous and Permian (ICCP) in Kazan, Russia (Kulagina *et al*., 2015) and in talks at the ICCP (Nikolaeva *et al*., 2015; Richards *et al*., 2015). The studies confirmed results presented by the task-group members in previous reports Nikolaeva *et al*. (2014, 2009) and demonstrated the boundary level lies in stylonodular, deep-water, pelagic carbonate lithofacies. A preliminary $\delta^{13}C_{carb}$ study across the boundary within the Kardailovka section was also completed (Nikolaeva *et al*., 2015; Richards *et al*., 2015). In contrast to $\delta^{13}C$ trends observed in South China (Buggisch *et al*., 2011; Chen *et al*., in press), the pattern in the Kardailovka section lacks significant excursions near the boundary and shows a substantial positive shift of about 1‰ (from +2 to +3‰) between 3.05 and 1.97 m below the boundary and very stable $\delta^{13}C_{carb}$ values from 1.97 m below the boundary to the top (at 21.75 m) of the lower segment of the section at 2.05 m above the boundary. The presence of a negative excursion in the Naqing section and not at Kardailovka suggests $\delta^{13}C_{carb}$ excursions are of little use for global correlations at the boundary. At Verkhnyaya Kardailovka, the Viséan-Serpukhovian boundary recognized by the FAD of the conodont *L. ziegleri* lies within the *Hypergoniatites-Ferganoceras* Genozone. Three foraminiferal zones in the Serpukhovian and the beds with *Endostaffella asymmetrica* in the Upper Viséan are recognized.

Progress Moscow Basin

Gibshman continued to study the foraminifers in upper Viséan and lower Serpukhovian using new specimens from the Polotnyany Zavod section (Kaluga Region). The distribution of *Janischewskina* species indicates a succession from *J. minuscularia* (Ganelina) (Aleksinian substage) to *J. typica* Mikhailov (Venevian substage) and *J. delicata* (Malakhova, 1956) (basal Serpukhovian Tarusian substage) (Gibshman, 2015a,b).

Progress Cantabrian Mountains Spain

Work continued on the Millaró and Vegas de Sotres sections in the Cantabrian Mountains to precisely locate the FAD of the conodont *Lochriea ziegleri*. The Vegas de Sotres section yielded an important record of foraminifers (Cózar *et al*., 2015). The sedimentology and stable-isotope geochemistry of the deep-water, limestone-dominated Vegas de Sotres and Millaró sections is progressing.

Task Group to establish the Bashkirian-Moscovian Boundary [which is also the base of the Middle Pennsylvanian Series] is chaired by Alexander Alekseev (Moscow State University, Russia; aaleks@geol.msu.ru).

Introduction

In 2015, continued progress was made toward the selection of a marker species and a section for the GSSP at the base of the Moscovian Stage. The conodont *Diplognathodus ellesmerensis* Bender, 1980 is the best candidate for boundary definition and the Naqing section in south China shows great potential for the GSSP (Qi *et al*., 2010, 2013). *D. ellesmerensis*, derived from *Diplognathodus* aff. *orphanus* (Merrill, 1972), is easily recognized by conodont workers and has been recovered from China, Western and Eastern Europe (Moscow Basin and South Urals), boreal Canada, and South America making it one of the most widely recovered conodonts in the Pennsylvanian. The conodont *Declinognathodus donetzianus* Nemyrovska, 1990 shows potential as an auxiliary index. The fusulinid *Verella* is a useful indicator for the uppermost Bashkirian and *Depratina prisca* (Deprat) and *Aljutovella aljutovica* (Rauser) lowermost Moscovian markers. A disadvantage of *D. ellesmerensis* is its long stratigraphic range (to upper Moscovian).

Progress in Middle Urals, Russia; Alexander S. Alekseev

In the Mariinsky Log section (western slope Middle Urals, Perm region) uppermost Bashkirian (Asatauian) foraminiferal and conodont assemblages were found in the topmost beds of the Mariinsky Formation. The assemblages contains conodonts *Idiognathoides ouachitensis* (Harlton), *I. sinuatus* Harris and Hollingsworth, *Idiognathodus aljutovensis* Alekseev *et al*., *Neognathodus* cf. *atokaensis* Grayson (Ponomareva *et al*., 2015). In the nearby Kremennoy section, conodont data indicate a gap and probable absence of Vereian Substage at the B-M boundary, thereby reducing the GSSP potential of both sections.

Ivanova (2015) studied the fusulinid subfamily Eofusulininae including *Verella* from the B-M interval in the Middle and South Urals. *Verella* is a latest Bashkirian genus but its species are commonly absent in B-M boundary sections

because of unconformities. Ivanova found that the Sokol section (Chusovaya River, Middle Urals) contains abundant *Verella*; however, the associated conodonts have not been studied. Studies in this region and elsewhere indicate *Verella* is useful for latest Bashkirian correlations, because it is widely distributed.

South Urals, Russia

The Basu River section, which contains in the B-M boundary interval, contains the fusulinids *Depratina prisca* (Deprat) and *Aljutovella aljutovica* (Rauser) as well the conodont *Declinognathodus donetzianus* Nemyrovska but *Verella, Eofusuilina* and *D. ellesmerensis* have not been found (Kulagina *et al*., 2009).

Cantabrian Mountains, Spain; Elisa Villa

The Carboniferous of Central Asturias (Cantabrian Mountains) includes a thick stratigraphic package comprising siliciclastics with abundant limestone intercalations in which the B-M transition is well-represented. The B-M transition was studied in three sections but the Los Tornos and La Camocha are most relevant because they include strata containing abundant archaediscids and fusulinids showing mixed Bashkirian and Moscovian features. This B-M transition appears to fill a gap at the base of the Moscovian stratotype in the Moscow Basin. The third section, at Santo Firme, contains a volcanic ash that provided a radiometric age within the transition.

Because of marked povincialism, the fusulines have little potential as markers for the B-M boundary but some are useful auxiliary indices. The Cantabrian assemblages show close affinities to Central Asian fusulines, indicating that they belong to the Paleo-Tethys province. In spite of difficulties introduced by the gap at the Moscovian stratotype and provincialism, approximate correlations using fusulinids can be established with the Moscow Basin, South Urals, and Donets Basin. The transition interval in the Cantabrians is partially equivalent to the *Depratina prisca* Zone (Kulagina, 2009) of the South Urals, where the fusuline record could be somewhat more complete than in the Moscow Basin.

Elements in the assemblages from the Cantabrians are representatives of the lineage leading from *Eowedekindellina* to *Verella* and then to *Eofusulina*. The first appearance of one advanced *Verella* species (*Verella transiens* van Ginkel and Villa, *in* van Ginkel, 1987), is used in the Cantabrians as a marker for a level slightly older than the base of the *Aljutovella aljutovica* Zone at the base of the Moscovian stratotype in the Moscow Basin (Makhlina *et al*., 2001), whereas the first appearance of *Eofusulina* emerges as a local marker for a younger level within the Vereian.

South China; Yuping Qi

Yuping Qi, Tamara Nemyrovska, and Lance Lambert continued working on the abundant and diverse conodonts from the B-M boundary interval in the Naqing section. Many important chronomorphoclines, especially "*Streptognathodus*" *expansus* Igo & Koike,1994 "*Streptognathodus*" *suberectus* Dunn, 1966 and *Diplognathodus* aff. *orphanus* (Merrill) to *D. ellesmerensis* Bender 1980, were recognized.

Yuping Qi and his students collected more conodonts across the B-M boundary at the Naqing, Narao, and Luokun sections. Because of the new conodonts, the FAD of *D. ellesmerensis* was lowered from 176.9 m to 175.9 m in the Naqing section. In the Luokun section, *D. ellesmerensis* was found at 121.0 m, 0.9 m below the appearances of *Profusulinella aljutovica* Rauser and *P. prisca* (Deprat), which are traditional biomarkers for the basal Moscovian in the Moscow Basin. Many specimens of *Neolochriea* and ridged *Declinognathodus* across the B-M boundary were observed in the Naqing and Luokun sections.

Task group to establish the Moscovian–Kasimovian [which is also the base of the Upper Pennsylvanian Series], and the **Kasimovian –Gzhelian boundaries** is chaired by Katsumi Ueno (Japan; katsumi@fukuoka-u.ac.jp).

Introduction

In the past fiscal year, task-group members continued to study the Moscovian-Kasimovian and Kasimovian-Gzhelian stage boundaries in their respective areas. The search continued for an index within an evolutionary lineage for definition of the base of the Kasimovian. Two conodont species, *Idiognathodus turbatus* Rosscoe & Barrick, 2009 and *I. sagittalis* Kozitskaya, 1978, were proposed as potential markers by Villa and Task Group (2008). Rosscoe & Barrick (2013) suggested that using *Idiognathodus heckeli* Rosscoe & Barrick 2013, the precursor species to *I. turbatus*, might be more appropriate. The first appearance datum (FAD) of the conodont *Idiognathodus simulator* (Ellison, 1941) *s.s*. in its potential lineage *Idiognathodus eudoraensis - I. simulator* (Heckel *et al*., 2008; Villa *et al*., 2009) has been formally selected for defining the base of the Gzhelian Stage but the ancestry of *I. simulator* (=*Streptognathodus simulator*) is now uncertain (Qi *et al*., 2015). The search for a suitable section for the GSSP at the base of the Gzhelian has been narrowed down to three sections. Carlos A. Méndez (University of Oviedo, Spain) stepped down from task-group membership, and Guzel Sungatullina (Kazan Federal University, Russia) joined the group.

MOSCOVIAN-KASIMOVIAN BOUNDARY

Southern Urals, report of Guzel Sungatullina and Valery Chernykh

Guzel Sungatullina studied the conodonts from the Moscovian–Kasimovian boundary interval of the Usolka section in the Southern Urals of Russia. The Moscovian in this section yielded a conodont assemblage characteristic of the *Neognathodus roundyi* Zone, which includes the following taxa: *Gondolella laevis*, *G. magna*, *Idiognathodus delicatus*, *I. obliquus*, *I. podolskensis*, *I. trigonolobatus*, *Neognathodus dilatus*, *N. inaequalis*, *N. roundyi*, and *Swadelina* sp. 1

(Chernykh *et al*., 2015). The lower part of the Kasimovian Stage contained conodonts typical for the *Streptognathodus subexcelsus* Zone, such as *Idiognathodus delicatus*, *I. trigonolobatus*, *Gondolella magna*, *S. subexcelsus*, and *Swadelina* sp. 1. The Usolka section holds a continuous conodont succession across the Moscovian–Kasimovian boundary.

South China, report of Yuping Qi

The complete evolutionary lineage of *Idiognathodus swadei–I. heckeli–I. turbatus* has been documented in the Moscovian–Kasimovian (M-K) boundary interval in the Naqing (Nashui) section, southern Guizhou province, South China. The Naqing section has been well sampled for conodonts, and either *I. turbatus* or *I. heckeli* can serve as an acceptable bio-marker for the base of the Kasimovian. Yuping Qi and Jim Barrick are preparing a paper dealing with the conodont succession across the Moscovian-Kasimovian boundary in the Naqing section.

The detailed conodont and fusulinid biostratigraphy of the M-K boundary interval in the Narao section of southern Guizhou province are also being studied, which should provide additional information for correlation of the M-K boundary. Jitao Chen carried out bed-by-bed sedimentologic logging and description for the M-K boundary interval, and collected rock samples for further petrographic and isotope geochemical analysis in Naqing and Narao sections in June and July, 2015. The isotope geochemistry analyses for the M-K boundary interval in both sections are in progress.

KASIMOVIAN–GZHELIAN BOUNDARY

Southern Urals, report of Guzel Sungatullina and Valery Chernykh

From 2012 to 2014 Guzel Sungatullina and Valery Chernykh reinvestigated the Usolka section, which had been previously proposed as a candidate for the GSSP by Davydov *et al*. (2008), to confirm the precise position of the FAD of *Streptognathodus simulator* (=*Idiognathodus simulator*), and collected additional conodonts from the section (Sungatullina *et al*., 2015). Conodonts from the Kasimovian–Gzhelian boundary intervals are diverse and have the potential to permit the Usolka section to be considered again as a GSSP candidate for the base of the Gzhelian.

In the Usolka section, the upper Kasimovian yielded a conodont assemblage characteristic of the *Streptognathodus firmus* Zone, which includes: *Idiognathodus excedus*, *I. magnificus*, *Idiognathodus toretzianus*, *Streptognathodus crassus*, *S. firmus*, *S. gracilis*, *S. pawhuskaensis*, *S. praenuntius*, and *S. zethus*. In the lower part of the Gzhelian at Usolka, conodonts are typical for the *Streptognathodus simulator* Zone: *Idiognathodus toretzianus*, *I. undatus*, *I.* aff. *verus*, *Streptognathodus* aff. *auritus*, *S. crassus*, *S. dolioliformis*, *S. gracilis*, and *S. simulator* (Chernykh *et al*., 2015). The lower boundary of the Gzhelian in the Usolka section is fixed by the appearance of *S. simulator* in the evolutionary lineage *S. praenuntius–S. simulator–S. postsimulator*, a different lineage than that proposed by Heckel *et al*., (2008) and Villa *et al*., (2009).

South China, report of Qui Yuping

Although *Idiognathodus simulator* (= *Streptognathodus simulator*) has been selected as the index for the base Gzhelian (Heckel *et al*., 2008), the lineage leading to this species is no longer clear (Qi *et al*., 2015). The conodont successions across the Kasimovian–Gzhelian (K-G) boundary have been investigated in detail in the Naqing and Narao sections in southern Guizhou, South China. Abundant conodonts were obtained from new collections from both sections. The conodont faunas are large and highly diverse in the K-G boundary interval in the Naqing section. *I. simulator* and its variations appear in sample LDC 255.55~255.75 m and range three meters upward. The interval between 254 and 255.55 m that was originally regarded as barren is now known to contain small elements, which could be transitional from an ancestral species to *I. simulator*. The Narao section also contains abundant and diverse conodonts around the K-G boundary interval. In that section, *I. simulator* appears at 229.61 m and ranges about four meters upward, and many ancestral and some transitional elements to *I. simulator* occur below 229.61 m.

According to Jim Barrick, the *I. simulator* group in North America contains a series of "morphospecies" that can be separated using simple characters based on biometric work. These conodonts from the K-G boundary interval in the Naqing and Narao sections can also be separated into morphospecies by the same methodology. The manuscript on conodonts from the K-G boundary intervals in both the Naqing and Narao sections is being prepared by Yuping Qi and Jim Barrick. The sedimentology, stable-isotope geochemistry, and fusulinid faunas through the K-G boundary interval in southern Guizhou, South China are being studied by Jitao Chen, Yue Wang and Katsumi Ueno.

The Project Group on Carboniferous Magnetostratigraphy, chaired by Mark Hounslow (United Kingdom) m.hounslow@lancaster.ac.uk.

A preliminary set of samples from the Scottish sections at Cove Harbour (covering the Famennian into the middle Viséan) and the Fife coast (covering the middle to late Viséan) were collected by Mark Hounslow, Andy Biggin and Louise Hawkins. The samples showed that the palaeomagnetic behaviours of the samples showed isolation of a primary palaeomagnetic signal, and so should prove suitable for a more extensive study, when funding becomes available. The palaeomagnetic behaviours of the Cove Harbour section samples appeared the most promising. The low maximum burial depth of this section is also likely to be advantages to further study. There are no new published works on Carboniferous magnetostratigraphy related to the project.

The Project Group on Carboniferous and Permian Nonmarine and Marine Correlations, chaired by Jörg W. Schneider (Germany) Joerg.Schneider@geo.tu-freiberg.de

The Project Group continued to be active during the year, holding organizational meetings and talks at conventions. They held a session "Marine-Non-marine Carboniferous and Permian Correlation" at the XVIII International Congress on the Carboniferous and Permian in Kazan, Russia on August 14 2015 in which several papers were presented. In their session, organizational plans were presented in a multi-author presentation (Schneider *et al*., 2015). Schneider *et al*. called for contributors willing to join the project and to contribute to a Pennsylvanian-Permian-Early Triassic nonmarine-marine correlation chart. In volume 61 of Permophiles, Schneider and Lucas (2015) provide detailed instructions on how participants should construct their correlation charts and provide supporting stratigraphic information.

RESULTS FROM CONFERENCES AND FIELD MEETINGS NOVEMBER 1ST, 2014 - OCTOBER 31ST, 2015

During the November 1, 2014 - October 31, 2015 fiscal year, there were several conferences and field meetings in which the SCCS membership participated but the most important two were the 2nd International Congress on Stratigraphy (STRATI 2015) in Graz, Austria during July, and the August 11-15, 2015 XVIII International Congress on the Carboniferous and Permian (XVIII ICCP) in Kazan, Russia.

STRATI 2015

At the July STRATI meeting in Graz, Markus Aretz, the chairman of Task Group to redefine the **Devonian-**Carboniferous (D-C) boundary, had the group evaluate the results of multi-discipline compilations made by most of the task-group members over the last two years. Results of that workshop will provide future direction for the task group. Two important talks about the D-C boundary were given: Aretz & Corradini (2015) and Corradini *et al*. (2015).

XVIII ICCP in Kazan, Russia

The XVIII ICCP was attended by 165 scientists representing some 33 countries. Russia and China had the most delegates. Because of the political tensions, few came from Canada and the U.S.A. None of the SCCS task groups held workshops and business meetings at the XVIII ICCP; however, the SCCS held a general business meeting at the conference and the minutes prepared by Markus Aretz and Svetlana Nikolaeva are provided in volume 32 of the Newsletter on Carboniferous Stratigraphy. Many of our members were be deeply involved with the congress organization, leading field trips and giving presentations. The first circular was published in volume 31 of the Newsletter on Carboniferous Stratigraphy and the second and third circulars were available on the conference website: http://www.iccp2015.ksu.ru.

A succinct summary of the accomplishments of the congress are available on the conference website. Of particular relevance to the SCCS is the statement made about progress toward establishing GSSPs "The Congress demonstrated considerable progress in the studies of candidate GSSP sections of the Carboniferous and Lower Permian stages, which have not yet obtained complete formal status in the International Stratigraphic Scale. These are primarily the Serpukhovian Stage sections (Verkhnyaya Kardailovka section in Russia and Naqing section in China). New data have also been obtained for the base of the Gzhelian (Usolka section in Russia and Naqing in China)."

Papers presented at the congress cover all aspects of Carboniferous Earth history. Participants reported on: the boundary definitions of the International Chronostratigraphic Scale and GSSP choices, high-resolution stratigraphy, Late Paleozoic glaciations and interglacials, tectonics and orogenies, the evolution of marine and continental biotas, sequence stratigraphy, correlation of marine and non-marine strata, and Carboniferous coal and mineral resources. Task-group members gave progress reports in session S1 "Carboniferous stage boundaries, stratotype sections and GSSPs" chaired by Barry Richards and Alexander Alekseev. The abstract volume (D.K. NURGALIEV, A.S. ALEKSEEV, G. DELLA PORTA, O.L. KOSSOVAYA, G.V. KOTLYAR, S.V. NIKOLAEVA, V.V. SILANTIEV, & M.N. URAZAEVA eds. (2015): XVIII International Congress on the Carboniferous and Permian August 11–15, 2015, Kazan, Russia. Abstracts Volume, Kazan University Press, 228 p.) is on the congress website at http://kpfu.ru//staff_files/F102932714/2015__ICCP2015_ABSTRACT_VOLUME.pdf

Two pre-congress excursions that are of particular interest to SCCS members are: A1 "Lower Carboniferous of the St. Petersburg region (north-western Russia)." by Savitsky *et al*., (2015) and A3 "Southern Urals. Deep water successions of the Carboniferous and Permian." by Chernykh *et al*., (2015). The post-congress excursions that are of particular interest to the SCCS members are: C2 "Middle Urals. Carboniferous and Permian marine and continental successions." by Ponomareva *et al*. eds. (2015) and C3 "Carboniferous reference sections: potential candidates for the base of the Serpukhovian GSSP and organic buildups, South Urals." by Kulagina *et al*., (2015). Pdf files for these field guides are available for download at the congress website.

The "Permanent Committee" met at the end of the conference and determined the next International Congress on the Carboniferous and Permian (XIX ICCP) will be held in the summer of 2019 (probably August) in Cologne Germany at Institute of Geology and Mineralogy, University of Cologne. See the proposal on the XVIII ICCP website. The proposal was presented by Hans George Herbig (Congress chairman)

CARBONIFEROUS STRATOTYPE SECTIONS N. ENGLAND

In October 2015, the subcommission held a field meeting with members of the Yorkshire Geological Society (YGS) and visited several stratotype sections for Carboniferous substages in northern England (see http://www.yorksgeolsoc.org.uk for itinerary and guide books). Purpose of the field trip was to see the condition of the sections and criteria used for defining their boundaries. Prior to the revision of the Carboniferous time scale by Heckel and Clayton (2006a, b) the substages were widely considered as Western European stages.

3b. Output

The **Newsletter on Carboniferous Stratigraphy, Volume 32**, published in December, 2015 and available for download from our website www.stratigraphy.org/carboniferous/index.asp includes commentaries by the SCCS executive on various current issues, summaries about field meetings and workshops, the full reports of the task groups for November 1st 2013 to October 31st 2014, and articles on various topics of interest. Volume 32 also contains a revised directory for the corresponding membership. During the last fiscal year, task-group and corresponding members 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 progress reports included in this Annual Report. Some of the most important outputs during the year are:

BECKER, R. T., KAISER, S. I. & M. ARETZ (2015a in press): Review of chrono-, litho- and biostratigraphy around the global Hangenberg Crisis and Devonian-Carboniferous boundary. *In:* BECKER, R. T., KÖNIGSHOF, P. & C.E. BRETT (eds.), Devonian Climate, Sea Level and Evolutionary Events, — *Geological Society of London,* Special Publications, **423**: 38 p.

CHEN, J., MONTAÑEZ, I.P., QI, YU., WANG, X., WANG, Q. & W. LIN, W. (in press): Coupled sedimentary and δ 13C records of late Mississippian platform-to-slope successions from South China: Insight into δ 13C chemostratigraphy. Palaeogeography, Palaeoclimatology, Palaeoecology. 2015. doi: 10.1016/j.palaeo.2015.10.051

KUMPAN, T., BÁBEK, O., KALVODA, J., MATYS GRYGAR, T., FRÝDA, J., BECKER, T.R. & S. HARTENFELS (2015): Petrophysical and geochemical signature of the Hangenberg Events: an integrated stratigraphy of the Devonian-Carboniferous boundary interval in the Northern Rhenish Massif (Avalonia, Germany). — *Bulletin of Geosciences* 90(3): 667-694. doi:10.3140/bull.geosci.1547.

3c. CHIEF PROBLEMS ENCOUNTERED IN 2015

Several ongoing problems confronted the SCCS task groups during the fiscal year but the most significant issue confronting the SCCS has been 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 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. 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.

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.

4a. WORK PLANS, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2016):

The following activities are planned for the Nov. 1, 2015 to Oct 31, 2016 fiscal year by the task groups, as communicated by task-group chairs.

Our principal mandate

The establishment of GSSPs for the Carboniferous and its main subdivisions is our principle mandate from the ICS. During the current four-year term, the ICS executive wants to have the SCCS establish GSSPs for as many of the Carboniferous Stage boundaries as possible. At present, GSSPs need to be established for the Viséan-Serpukhovian, Bashkirian-Moscovian, Moscovian-Kasimovian and Kasimovian-Gzhelian boundaries. In addition, the GSSP at the base of the Tournaisian has been reassessed and both a new marker event and a new section will probably be required for that boundary. Based on the information our task-group leaders have provided us in the last two issues of the SCCS annual report to the International Commission of Stratigraphy and volume 32 of the Newsletter on Carboniferous Stratigraphy, we are confident that during the next two to four years GSSPs can be established for most of the boundaries with the possible exception of the base of the Tournaisian.

Within the next two years, 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 direct full effort toward selecting sections for the GSSPs. Most SCCS task groups have either selected events to define their respective boundaries and held votes (Kasimovian-Gzhelian task group) or have located an event and are preparing proposals in preparation for taking the proposal to ballot.

Task-group and project-group work plans

The joint Devonian-Carboniferous Boundary GSSP Reappraisal Task Group A biostratigraphic analysis by Ji *et al*. (1989) and further work (Kaiser, 2009) indicates there are problems with the D-C Boundary GSSP (Paproth *et al*., 1991) at La Serre Hill, France and the conodont lineage used for boundary definition. Therefore, the primary tasks for the D-C boundary task group are to locate a suitable event marker to define the boundary and then find a suitable section for the GSSP.

To help achieve these goals, the task group plans to hold a workshop in the summer of 2016 in either France or Italy to discuss the data gathered to date during the reappraisal of the Devonian-Carboniferous boundary and propose and eventually decide on a new criterion for defining the boundary. Once the new boundary index has been decided upon the task group will search for a suitable section for the GSSP.

In addition to holding the summer 2016 workshop, ongoing work by members of the task group will continue in several regions. 1) Yuriy 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. 2) Chinese colleagues plan to continue their re-assessment of the best D-C boundary sections in China. 3) In western Canada, Barry Richards and several colleagues intend to continue ongoing studies of the latest Famennian to early Tournaisian Exshaw Formation (see Richards *et al*., 2002) and its correlatives to see if the main events in the Hangenberg Event Interval can be more precisely located in the formation by using an approach that includes radiometric dating and stable carbon isotope ($\delta^{13}C$) stratigraphy. 4) Carlo Corradini has several ongoing projects related to the D-C boundary study in various part of northern Gondwana. 5) Thomas Becker (Münster) and his research group plan to continue their investigation of the D-C boundary transition in Morocco, in the Rhenish Massif, Belgium, and China.

Task Group to establish the Tournaisian-Viséan Boundary The task group plans to continue with preparation of the final manuscript for the project. George Sevastopulo, the task group chairman, is leading that work but may require some additional help.

Task Group to establish the Viséan-Serpukhovian Boundary The task group has determined that the FAD of the conodont *Lochriea ziegleri* in the lineage *Lochriea nodosa–Lochriea ziegleri* is the best index for boundary definition. The best two candidate sections are the Naqing (Nashui) section by the village of Naqing in southern Guizhou Province, China and the Verkhnyaya Kardailovka section on the Ural River in southern Russia. The FAD of *L. ziegleri* has been precisely located in these sections and the preliminary sedimentologic and geochemical studies completed. During the 2015 fiscal year, Qi Yuping and Tamara Nemyrovska completed their manuscript on the systematics and phylogeny of conodonts within the genus *Lochriea* from the Naqing section. Consequently, the phylogeny of *L. ziegleri* is now well established. The principal task for the group in the 2016 fiscal year will be to complete a proposal advocating the use of the FAD of *L. ziegleri* for boundary definition. During the year, the team will also continue to direct its attention toward selecting the best candidate section for the GSSP.

Activities in South China

Paul Brenckle is continuing with the study of foraminifers in the Naqing section and several other sections in southern Guizhou Province including the important Yashui and Dianzishang sections (see Groves *et al*. 2012). To place the Naqing section into its sedimentologic and paleoenvironmental context and to determine the relationship of shallow-water foraminiferal zones to the deeper-water (carbonate slope) *L. nodosa - L. ziegleri* transition in south China, the investigation of four reference sections - the Yashui, Dianzishang, Luokun, and Narao sections - will continue.

Activities in Southern Urals, Russia

With conodonts of the *L. nodosa-L. ziegleri* transition, abundant ammonoids, and moderately common foraminifers, the Kardailovka section, a deep-water, basinal-carbonate succession on the Ural River near the village of Verkhnyaya Kardailovka in the Urals remains the other strong candidate for the Viséan-Serpukhovian boundary GSSP. Conodonts, foraminifers and ammonoids in the section have been studied in detail (Nikolaeva *et al*., 2009; Pazukhin *et al*., 2010) but additional work across the boundary level is required. Sufficient conodont work been done to precisely locate the position of the FAD of the conodont *L. ziegleri*.

Preliminary work on the sedimentology, stable-isotope geochemistry and geophysical characteristics of the section have been completed but additional work is required and will be a focus of the team's investigations in 2016. The Kardailovka section contains numerous volcanic ash layers near the boundary level and the task group is having the

most important ashes dated using the U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology.

Activities in Cantabrian Mountains, northern Spain

The FAD of *L. ziegleri* has been precisely located in the Millaró and Vegas de Sotres sections and the group plans to publish the details of the conodont sequence in those sections. Little detailed work has been done on the sedimentology and geochemistry of these carbonate-dominated, condensed, basin to lower-slope sections. In the 2016 fiscal year, the group plans to embark on a comprehensive sedimentologic and stable-isotope geochemistry investigation of the Millaró and Vegas de Sotres sections. As part of this work, the group plans to search for shallow-water sections correlative with the sections.

Task Group to establish the Bashkirian-Moscovian Boundary The task group plans to continue evaluating conodont lineages suitable for definition of the Bashkirian-Moscovian boundary and it is anticipated that during the 2016 fiscal year a lineage and taxon suitable for boundary definition will be selected and formally voted upon. The group also plans to continue its search for suitable GSSP candidate sections particularly in South China and the southern Urals. At present, the conodont *Diplognathodus ellesmerensis* Bender, 1980 appears to be the best candidate for boundary definition and the Naqing section in south China shows great potential for the GSSP (Qi *et al*., 2010, 2013). *D. ellesmerensis*, derived from *Diplognathodus* aff. *orphanus* (Merrill, 1972), is easily recognized by conodont workers and is one of the most widely recovered conodonts in the Pennsylvanian.

A major effort will be devoted to study of the conodonts within the Bashkirian-Moscovian transitional interval in the Naqing (Nashui) section and nearby sections in southern Guizhou Province, South China. Special attention will be directed toward the study of the lineage containing *Diplognathodus ellesmerensis* Bender 1980, the taxon considered to have the best potential for boundary definition. Qi Yuping, Tamara Nemyrovska, and Lance Lambert are doing the detailed taxonomy work on the conodonts from the Bashkirian-Moscovian boundary interval in the Naqing section. In former years, it was thought that *Diplognathodus coloradoensis* (Murray & Chronic, 1965) was the immediate ancestor of *D. ellesmerensis*. Instead, the ancestor is likely to be a new species and its taxonomic status needs to be proven. *D. ellesmerensis* appears a little above the FAD of *Declinognathodus donetzianus* Nemirovskaya, 1990 in the Donets Basin, Ukraine. If the ancestry of *D. ellesmerensis* is established in time, the group will plan to prepare a proposal for using this taxon for boundary definition in 2016.

Work on the sedimentology, stable-isotope geochemistry, and geophysical characteristics of the boundary interval in the Naqing and nearby sections are not as advanced as the paleontological investigations and will be the focus of the work of Jitao Chen and Isabel Montanez in 2016.

Task group to establish the Moscovian–Kasimovian and the **Kasimovian –Gzhelian bo**undaries

MOSCOVIAN-KASIMOVIAN BOUNDARY

Until 2013, the task group had concluded the first appearance datum (FAD) of either *Idiognathodus sagittalis* Kozitskaya, 1978 or *Idiognathodus turbatus* Rosscoe & Barrick, 2009 had the best potential as a marker for the base of the Kasimovian (Villa & task group, 2008; Ueno & task group, 2011). Now, a lower level defined by the first occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013, which is considered as the direct ancestor of *I. turbatus*, is newly proposed as a more appropriate position of the base of the Kasimovian. In 2016 the group needs to decide which conodont to use as the index for the M-K boundary and then prepare a proposal and have it voted on by the task group and SCCS. After such a proposal is made and voted on, additional taxonomic work and comparison of morphotypes from different regions can be continued.

Activities in southern China

Qi Yuping & James Barrick will continue with studies to provide more detailed information on the conodont succession across the Moscovian-Kasimovian boundary in the Naqing section and several other limestone-dominated, turbiditic sections in the region as a potential GSSP candidate sections. Work on the sequence stratigraphy, sedimentology, stable-isotope geochemistry, and geophysical characteristics of the Moscovian-Kasimovian boundary interval at Naqing and Narao sections will be largely completed by Jitao Chen and Isabel Montañez in 2016.

To place the Naqing 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 reference sections including the Zhongdi (Ueno *et al*., 2007), Luokun, and Narao sections will continue. Foraminifers are more abundant and better preserved than at Naqing and it is anticipated that a better correlation between conodonts and foraminifers can be achieved by the study of the other sections.

Activities in Moscow Basin, Russia

The task group will continue to study the conodonts *Idiognathodus turbatus* and *I. sagittalis* as possible markers for the base of the Kasimovian Stage in the Moscow Basin. At this moment, they considered that the mid-Khamonvnikian Substage is the best potential level for the fixation of the base-Kasimovian boundary.

KASIMOVIAN-GZHELIAN BOUNDARY

Since 2007, when the task group voted in favor of using the first appearance of the conodont *Idiognathodus simulator* (Ellison, 1941) in the lineage *Idiognathodus eudoraensis* - *I. simulator* as the boundary-defining event (Heckel *et al*., 2008), the search for a suitable section for the GSSP had been the task-group's main objective. However, the ancestry of *I. simulator* (=*Streptognathodus simulator*) is no longer agreed upon and needs to be investigated more carefully and another index may need to be proposed and voted on. Qi *et al*. (2015) found a new species that they claim is the ancestor for *I. simulator*. In the Moscow Basin *S. simulator* is apparently in the evolutionary lineage *S. praenuntius* Chernykh–*S. simulator*–*S. postsimulator* (Alekseev and Goreva, 2015). Three sections are currently being considered as potential candidate sections: the type Gzhelian in the Moscow Basin (Alekseev and Goreva, 2015), the Usolka section in the southern Urals (Sungatullina *et al*., 2015), and the Naqing/Narao sections in Guizhou Province, south China (Qi *et al*., 2015).

Activities in Russia

The Usolka section in the southern Ural Mountains of Russia was proposed as a candidate section for the GSSP at the base of the Gzhelian (Chernykh *et al*., 2006; Davydov *et al*., 2008) but examination by members of the SCCS on a field trip to the locality in 2009 revealed the section required substantial new lithostratigraphic, sedimentologic and conodont-based biostratigraphic work before it could be considered as a candidate section. During 2013-2014, the section was extensively excavated to improve exposure and was resampled for conodonts (Sungatullina *et al*., 2015; Chernykh *et al*., 2015). Guzel Sungatullina (Kazan University) has been reevaluating the conodonts from the newly-exposed Usolka section and will continue that work in 2016.

Activities in China Yuping Qi and colleagues will continue their investigation across the proposed Kasimovian-Gzhelian boundary level in the Naqing and Narao sections in Guizhou Province, south China. At the Naqing and Narao sections in Guizhou Province, south China, Qi and his colleagues are going to continue with detailed studies in the coming years to better understand both the conodont and fusulinid evolutionary changes across the Kasimovian–Gzhelian boundary interval. Sedimentologic and stable-isotope geochemical investigations will be continued by Jitao Chen and Isabel Montanez.

The Project Group on Carboniferous Magnetostratigraphy Future plans are for Louise Hawkins and the Lancaster and Liverpool groups to sample the Cove Harbour section in more detail in early 2016, covering the interval from the Late Devonian to close to the Devonian-Carboniferous boundary. The Carboniferous-Devonian boundary can approximately be defined in the section based on previous palynology studies. Pending a grant funding decision which will be taken in mid-2016, work will continue into the Early Carboniferous in the Cove Harbour section, along with the Fife coast sections, and probably Bashkirian sections in Ebbadalen on Spitzbergen, coordinated through the work of Lars Stemmerik in these Spitzbergen sections.

The Project Group on Carboniferous and Permian Nonmarine and Marine Correlations The project group plans to continue their work on the correlation of the system and stage boundaries into the vast successions of Carboniferous and Permian continental deposits. In 2016 members of the project group will contribute to the compilation of a Pennsylvanian-Permian-Early Triassic nonmarine-marine correlation chart. The work will include drafting of charts for the basins members are currently concerned with along with providing supporting stratigraphic information.

Meeting-field workshop schedule with themes and anticipated results.

During the November 1st, 2015 - October 31st, 2016 fiscal year, there will be several conferences and field meetings in which the SCCS membership will participate but the most important one is the 35th International Geological Congress in Cape Town, South Africa from August 27 to September 4, 2016 http://www.35igc.org/. The SCCS will hold a general business meeting at the congress but individual workshops have not yet been planned. The SCCS Chairman has submitted a symposium proposal titled “The Carboniferous World: Assembly of Pangaea and Onset of Late Paleozoic Glaciations” under the scientific program theme: Phanerozoic Earth History, Stratigraphy and the Geologic Time Scale”. The symposium will provide a forum for discussion of the most relevant topics on Carboniferous geology, paleontology, and environments including: the terrestrial Carboniferous World, paleoceanography, glaciations and interglacials, assembly of Pangaea, reefs and carbonate mounds, and the biota.

Russian members of the task groups for the Serpukhovian, Moscovian, Kasimovian and Gzhelian boundaries plan to hold an international conodont workshop in Saint Petersburg, Russia in early September, 2016. The chief organizers are Olga Kossovaya (Chairman of Russian Commission of Carboniferous Stratigraphy and Vice-chairman Alexander Alekseev. The aim of workshop is to discuss the phylogeny and stratigraphic distributions of potential marker conodont taxa for the Late Mississippian and Pennsylvanian stages. The Karpinski Russian Geological Research Institute in Saint Petersburg will provide the place for the workshop.

4b. Specific GSSP Focus for 2016
Viséan-Serpukhovian boundary

5. SUMMARY OF EXPENDITURES IN 2015: STATEMENT OF OPERATING ACCOUNTS FOR NOVEMBER 1st, 2014 TO OCTOBER 31st, 2015
Prepared by Barry Richards, Chairman SCCS
(Accounts maintained in Canadian currency)

INCOME (November 1, 2014 – October 31, 2015)		
IUGS-ICS Grant – April 6, 2015: $1,500.00 US =$1,771.50 Canadian	$1,771.50	
Donations from Members; November 1, 2014 - October 31 2015	$0.00	
Interest Bank of Montreal; November 1, 2014 - October 31, 2015	$0.00	
TOTAL INCOME		$1,771.50
EXPENDITURES (November 1, 2014 – October 31, 2015)		
Bank Charges: Bank of Montreal	$0.00	
Travel and conference registration support for SCCS voting members and executive to attend and give presentations (XVIII ICCP, Kazan, Russia 2015; field meeting on Carboniferous substages in England, Oct., 2015)	$2,000.00	
TOTAL EXPENDITURE		$2,000.00
BALANCE SHEET (2014 – 2015)		
Funds carried forward from October 31, 2014		$1,688.93
Plus Income November 1, 2014 – October 31, 2015		$1,771.50
Total assets		**$3,460.43**
Less Expenditures November 1, 2014 – October 31, 2015		$2,000.00
BALANCE CARRIED FORWARD (to Nov. 1, 2015 - Oct. 31, 2016 fiscal year)		**$1,460.43**

6. BUDGET AND ICS COMPONENT FOR Nov. 1, 2015 - Oct. 31, 2016 fiscal year
PROJECTED EXPENSES
Support for voting members to participate in August 27th - Sept. 4th IGC 2016 in Cape Town South Africa, and September 2016 workshop in St. Petersburg, Russia $3,000.00

TOTAL PROJECTED EXPENSES		$3,000.00
INCOME		
Carryover (from CREDIT balance at end Nov. 1, 2014 - Oct. 31 2015 fiscal year)	$1,460.43	
Estimated donation		$00.00
TOTAL PROJECTED INCOME		$1,460.43
BALANCE		
Estimated (deficit) /credit from above	-$1, 539.57	
BUDGET REQUEST FROM ICS for 2015		$2,000.00

APPENDIX A
7. SUMMARY OF CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)
Background: A vote by the ICS in late 1999 resulted in approval of the names Mississippian and Pennsylvanian along with a reconfirmation of the previous decisions of the SCCS to regard their rank as subsystems. 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 its official global series and stage names (Heckel & Clayton, 2006a, 2006b), and effort is now focused on selecting events and GSSPs for stage boundaries.
The joint Devonian-Carboniferous Boundary GSSP Reappraisal Task Group Studies by Ji *et al*. (1989) and subsequent analysis (Kaiser, 2009) demonstrated problems exist with the Devonian-Carboniferous Boundary GSSP (Paproth *et al*., 1991) at La Serre Hill, France. Because of the problems with the integrity of the GSSP, the Devonian-Carboniferous Boundary GSSP reappraisal task group was established in 2008.

Initial work plans were outlined in the 2008 SCCS Annual Report submitted to the ICS: 1) the use of the first evolutionary occurrence of the conodont *Siphonodella sulcata* (Huddle, 1934) in the lineage *S. praesulcata* Sandberg, 1972 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 or a more suitable section located, and 3) because the first appearance of *S. sulcata* may not be the best marker, other conodont lineages require evaluation. Later

in the reappraisal, the multi-phase Hangenberg Event (Kaiser *et al*., 2008) was identified as a level of interest for boundary definition.

Progress

The *S. praesulcata* to *S. sulcata* conodont lineage used to define the boundary has been re-evaluated by several scientists including Kaiser & Corradini (2011), and the protognathodids, the other conodont group that had shown potential for boundary definition is being re-studied (Corradini *et al*. 2011; Corradini *et al*., 2013; Corradini *et al*., 2015). Up to 2015, the conodont studies were disappointing because it appeared that neither the siphonodellid lineage nor the protognathodids would be suitable for D-C boundary definition and other appropriate taxa had not been discovered. In 2015, however, Corradini *et al*. (2015) concluded that the FAD of the conodont *Protognathodus kockeli* (Bischoff) should be considered as a new index for boundary definition. By the end of the 2015 fiscal year, the geochemical and sedimentologic signatures of the mulita-phase Hangenberg Event (Kaiser *et al*., 2008) were well established, and it appears the base of the Hangenberg Black Shale has substantial potential for international correlation.

From the work completed through 2015, it is clear that the La Serre section is not suitable for the GSSP. A major issue is the base of bed 84b, which contains the FAD of *S. sulcata,* is a sharp facies change Kaiser (2009) and probably erosional; in addition, underlying strata lack the evolutionary lineage from *S. praesulcata* to *S. sulcata*. The search for better GSSP sections is progressing although potential events for boundary definition have been identified but not selected and voted on.

Task Group to establish the Tournaisian-Viséan Boundary By 2003 work by the Tournaisian-Viséan Boundary task group progressed to the point that a proposal for the GSSP in south China was published (Devuyst *et al*., 2003), unanimously approved by the SCCS, and ratified by the ICS and IUGS. Task-group Chairman George Sevastopulo is preparing the final report and should have it completed during the 2016 fiscal year. The report provides a brief resume of the GSSP and then lists successful attempts to identify the boundary in Eurasia by Jiri Kalvoda and others, and discusses the problems of identifying (and best approximation to) the boundary in North America and Gondwana.

Task Group to establish the Viséan-Serpukhovian Boundary The Viséan-Serpukhovian Boundary task group plans to use the FAD of *Lochriea ziegleri* Nemirovskaya, Perret & Meischner 1994 in the conodont lineage, *Lochriea nodosa* (Bischoff, 1957) -*Lochriea ziegleri,* for boundary definition. The *L. nodosa-L. ziegleri* lineage has become widely recognized in Western Europe, Russia and Asia (Nikolaeva *et al*., 2009; Qi *et al*., 2013). A proposal for using *L. ziegleri* for boundary definition is being written in preparation for discussion and a subsequent vote by the task group and SCCS. The Naqing (Nashui) section in south China and the Verkhnyaya Kardailovka section in Russia have the best potential as GSSP candidates. The FAD of *L. ziegleri* has been precisely located in both sections and preliminary sedimentologic and stable-isotope geochemical studies completed (Chen *et al*., 2015; Kulagina *et al*., 2015; Richards *et al*., 2015).

The identification of the *Lochriea* lineage along with recognition of the ammonoid, ostracode, and foraminiferal zones in a deep-water (basinal), carbonate section at Verkhnyaya Kardailovka in the south Urals of Russia established that section as a strong GSSP candidate. The section has been thoroughly examined and synthesis published about the ammonoids, conodonts, and ostracodes (Pazukhin *et al*., 2010; Nikolaeva, 2013). Conodonts that are transitional between *L. nodosa* and *L. ziegleri* occur immediately below the FAD of *L. ziegleri*. From 2010 to 2012 the extensive covered intervals in the section were excavated and permanent aluminum marker pins placed at one meter intervals. Bed-by-bed sedimentologic analysis and preliminary stable-isotope geochemical analyses have been completed across the boundary (Nikolaeva *et al*., 2015; Richards *et al*., 2015, Richards *et al*., in press; Kulagina *et al*., 2015). Volcanic ash layers lie shortly below the proposed boundary level and Schmitz and Davydov (2012) dated an ash sample from about 1.48 m below FOD of *Lochriea ziegleri*. Four dated zircons gave a weighted $^{206}Pb/^{238}U$ date of 333.87+/-0.08 Ma and that was interpreted as the eruptive age.

The Naqing (Nashui) section in southern Guizhou Province, China is the other strong candidate for a GSSP (Qi *et al*., 2013) and conodonts spanning the Viséan-Serpukhovian boundary in the section have undergone intensive study. Conodonts within the *L. nodosa - L. ziegleri* lineage are well preserved and abundant. Elements transitional between *L. nodosa* and *L. ziegleri* are plentiful, occurring through several metres of section. A detailed stratigraphic section extending from the upper Viséan into the Bashkirian has been measured at Naqing and aluminum marker pins placed at one-metre intervals. A bed-by-bed sedimentologic and geochemical study across the boundary interval has been completed (Chen *et al*., 2015; Wang *et al*., 2015). Studies of the foraminifers (Groves *et al*., 2012) and Brenckle (in progress) indicate they can be used to bracket the level of the FAD of *L. ziegleri,* thereby facilitating correlations into shallow-water carbonate sections lacking diagnostic conodonts. The measurement and intensive study of several other sections (Yashui, Luokun, Narao, & Dianzishang sections) in the region from 2010 through 2015 is enabling the task group to place the Naqing section into its paleogeographic, stratigraphic, and lithofacies contexts (Chen *et al*., 2015). Volcanic ash beds were recently discovered in the upper Viséan and another in the lower Serpukhovian at Naqing and Narao. Zircons have been extracted from the ash samples and are being processed in the U.S.A. by Jitao Chen and Isabel Montanez with the ID-TIMS U-Pb age dating method.

Several sections span the Viséan-Serpukhovian boundary in the Cantabrian Mountains of Spain and two of them, the Vegas de Sotres and Millaró in the Alba Formation, are excellent deep-water carbonate sections rivaling the better known Kardailovka and Naqing exposures. In the Vegas de Sotres and Millaró sections, 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 that are being studied by Svetlana Nikolaeva. The conodont biostratigraphy has been relatively well established in the two sections (Blanco-Ferrera *et al*., 2009) and is still being studied. Sedimentologic and geochemical work at the two localities is progressing well.

The *L. nodosa - L. ziegleri* lineage had not been identified in North America but *L. ziegleri* has been found in the Barnett Shale in Texas and other species of *Lochriea* have been identified at several localities. Work has been initiated on ammonoid-rich successions in the western U.S.A. (Korn & Titus, 2011) and on foraminifer- and coral-rich successions in western Canada in order to bracket the level of the first appearance of *L. ziegleri* in North America.

Task Group to establish the Bashkirian-Moscovian Boundary An index for the boundary has not been selected but the conodont *Diplognathodus ellesmerensis* Bender, 1980 is considered to be a good potential candidate for boundary definition and the Naqing section in south China shows great potential for the GSSP (Qi *et al*., 2013). *D. ellesmerensis*, derived from *Diplognathodus* aff. *orphanus* (Merrill, 1972), is easily recognized by conodont workers and is one of the most widely recovered conodonts in the Pennsylvanian. The ancestor of *D. ellesmerensis* is probably a new species and its taxonomic status needs to be proven.

The conodont *Declinognathodus donetzianus* Nemyrovska, 1990 makes its first appearance near that of *D. ellesmerensis* and shows great potential as an auxiliary index for the boundary. Substantial work has gone into evaluating the *Declinognathodus marginonodosus—D. donetzianus* lineage for boundary definition but the lineage appears to lack a sufficiently wide geographic distribution. The fusulinid *Verella* is a useful indicator for the uppermost Bashkirian and *Depratina prisca* (Deprat) and *Aljutovella aljutovica* (Rauser) lowermost Moscovian markers.

An evolutionary lineage of *Declinognathodus marginonodosus—D. donetzianus* occurs in the Basu River section in the southern Urals of Russia, which also contains rich foraminiferal faunas, and might be a candidate for a GSSP. The well-exposed Basu section contains the first appearance of the fusulinid *Profusulinella prisca* a few metres below that of *D. donetzianus*. 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. *D. ellesmerensis* has not been reported from the Basu River section but may be present in the underlying covered interval.

A detailed stratigraphic section extending from the upper Bashkirian through the Moscovian has been measured at Naqing, Narao, and Luokun and the FAD of *D. ellesmerensis* precisely located. Aluminum marker pins have been placed at one-meter intervals in these sections. Jitao Chen and Isabel Montanez are well advanced with their detailed sedimentologic and stable-isotope geochemical study across the B-M boundary in the Naqing and adjacent sections and may complete their work in 2016.

Task group to establish the Moscovian–Kasimovian and the **Kasimovian –Gzhelian bo**undaries

MOSCOVIAN-KASIMOVIAN BOUNDARY

The first appearance datum (FAD) of *Idiognathodus sagittalis* Kozitskaya, 1978 and *Idiognathodus turbatus* Rosscoe & Barrick, 2009a have good potential as markers for the base of the Kasimovian (Ueno & task group, 2011). Their occurrence (near base of Khamovnikian regional Russian Substage, the second substage of the Kasimovian in current definition) is approximately one substage higher than the traditional base of the Kasimovian (base of Krevyakinian Substage). In 2013, a slightly lower level defined by the occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013, which is considered as the direct ancestor of *I. turbatus* is newly proposed as a more appropriate position of the potential base of the Kasimovian.

In 2013 and 2014, Yuping Qi and colleagues discovered a conodont evolutionary lineage of *Idiognathodus swadei – I. heckeli – I. turbatus* in the Moscovian–Kasimovian boundary interval of the Naqing section, southern Guizhou province and during future studies they will consider the FAD of *Idiognathodus heckeli* as the potential boundary marker. In 2013 and 2014, sedimentologic and stable-isotope geochemical investigations at the Naqing and Narao sections were initiated by Chen Jitao and Isabel Montanez.

KASIMOVIAN-GZHELIAN BOUNDARY

Members of the Kasimovian-Gzhelian Boundary task group plan to use the FAD of the conodont *Idiognathodus simulator s.s*. (Ellison, 1941) to define the boundary. Up to 2015, the immediate ancestor of *I. simulator* was considered to be *Idiognathodus eudoraensis* (Heckel *et al*., 2008; Barrick *et al*., 2008). Unfortunately, the ancestry of *I. simulator* (=*Streptognathodus simulator*) is no longer agreed upon and needs to be investigated more carefully and another index may need to be proposed and voted on. Qi *et al*. (2015) found a new species in south China that they claim is the ancestor for *I. simulator*. In the Moscow Basin *I. simulator* is apparently in the evolutionary lineage *S. praenuntius* Chernykh–*S. simulato*r–*S. postsimulator* (Alekseev and Goreva, 2015).

Three sections are currently being considered as potential candidate sections: the type Gzhelian in the Moscow Basin (Alekseev and Goreva, 2015), the Usolka section in the southern Urals (Sungatullina *et al*., 2015; Chernykh *et al*.,

2015), and the Naqing/Narao sections in Guizhou Province, south China (Qi *et al*., 2015). In 2013-2014, the Usolka section, once proposed as a potential candidate of GSSP for the base of the Gzhelian Stage (Davydov *et al*., 2008), was extensively excavated to better expose the boundary level. Sungatullina *et al*., (2015) and Chernykh *et al*. (2015) completed a preliminary assessment of the conodonts across the boundary in that section. Alekseev and Goreva, (2015) consider the type section of the Gzhelian in the Moscow Basin has good potential for the GSSP and are actively working on it. The other potential candidate intervals for the GSSP lie within the Naqing (Nashui) and Narao sections in south China and are undergoing a thorough biostratigraphic, sedimentologic and geochemical investigation. Within the sections, the presence of the lineage containing *I. simulator* has been proven by Yuping Qi and his colleagues. In 2013 and 2014, sedimentologic and stable-isotope geochemical investigations at the Naqing and Narao sections were initiated by Chen Jitao and Isabel Montanez and by 2015 they were well advanced.

Project Group on Carboniferous Magnetostratigraphy

During the last several years, there was considerable progress in refining and integrating the magnetostratigraphy previously obtained from the Maritime Provinces in Canada and the Mauch Chunk Formation in the Appalachian Basin of the eastern USA by integrating magnetostratigraphy with palynostratigraphy through the work of Opdyke *et al*. (2014). An integrated graphical summary compiled from sections and sources described in their study with existing magnetostratigraphic data from lavas in the Asbian-Brigantian substages described in Hounslow *et al*. (2004) demonstrates a clear and validated pattern of polarity changes through the Brigantian, Pendleian and lower Arnsbergian substages (late Viséan and Serpukhovian), from several overlapping sections. Opdyke *et al*. (2014) clearly identify the base of the Kiaman reverse superchron in the *Raistrickia saetosa* biozone (approximately near the base of the Langsettian substage), which they place at ~318 Ma using the 2012 timescale of Davydov *et al*. (2012).

The Project Group on Carboniferous and Permian Nonmarine and Marine Correlations

The project group was established in 2014 and held a very successful conference and field meeting in Freiberg, Germany in July 2014. Presentations at the Freiberg meeting indicated reliable correlations between nonmarine and marine successions at stage and system boundaries could be achieved through the use of several methods including palynological studies, U-Pb dating, and stable isotope studies. Marine microfossils fossils, particularly ostracodes, foraminifers and conodonts, could be used to a limited extent in sections where marine and nonmarine strata intertongue.

Radiometric dating Precise radiometric U-Pb zircon dating (CA and ID-TIMS U-Pb methods) now being undertaken by several groups including the Permian Research Group at Boise State University on ash beds from the latest Devonian and Carboniferous successions in several basins has led to the precise dating and correlation of important Carboniferous events and assisted substantially with calibration of the Carboniferous time scale (Schmitz & Davydov, 2012). 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 and plan to continue with that work.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2019)

Within the next two years, we think it will be possible to select the defining events for all of the stage boundaries with the possible 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 Moscovian-Kasimovian task groups).

The joint Devonian-Carboniferous Boundary GSSP Reappraisal Task Group

The main four-year goal of the Devonian-Carboniferous Boundary task group is the selection of an event for defining the base of the Carboniferous because the current definition, the FAD of *Siphonodella sulcata* is apparently deficient. Following selection of the event, suitable candidate sections for the GSSP must be located.

A suitable section for the GSSP must be located because recent studies at the GSSP section on La Serre Hill in south France 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,* immediately overlies a probable erosion surface and major lithofacies facies change (Corradini & Kaiser, 2009; Kaiser, 2009). Several sections in Western Europe and 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.

The task group will continue to explore the possibility of using either a sedimentological or geochemical event such as a component of the multiphase Hangenberg extinction event (Kaiser, 2005; Cramer *et al*., 2008) for boundary definition. The event presents potential for correlation into both shallow and relatively deep-water marine facies; consequently, the task group wants to know how the phases of the Hangenberg are represented in different facies and how well they can be correlated globally.

Tournaisian-Viséan Boundary By 2003 work by the Tournaisian-Viséan Boundary task group progressed to the point that a proposal for the GSSP in south China was published (Devuyst *et al,* 2003). The principal work of the task group

has come to completion and the task-group chairman George Sevastopulo plans to complete the final report within the 2016 fiscal year.

Viséan-Serpukhovian Boundary Task Group The Viséan-Serpukhovian task group plans to use the FAD of *Lochriea ziegleri* in the conodont lineage *Lochriea nodosa - Lochriea ziegleri* for boundary definition. The task group plans to complete a proposal for submission to the task group and SSCS voting membership for a vote on either accepting or rejecting the FAD of *L. ziegleri* for GSSP definition. Two sections, Verkhnyaya Kardailovka (Nikolaeva, 2013; Pazukhin *et al*., 2010) and Naqing (Qi *et al*., 2013), present the best potential for the GSSP, and the ongoing integrated biostratigraphic, sedimentological and geochemical studies of those sections will continue to project completion. Most of the field work has been completed at both localities and the remaining objective is to complete the sample study and compile the final synthesis. 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 the GSSP. In the Naqing section in southern Guizhou Province, China the *Lochriea* lineage has been intensively studied and the FAD of *L. ziegleri* precisely located. Field work is essentially complete at Naqing and the remaining objective is to complete the analytical work and prepare the final synthesis for publication.

The *Lochriea* lineage has not 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 will continue.

Bashkirian-Moscovian Boundary Task Group The high-priority plans for the Bashkirian-Moscovian Boundary task group during the next four years are to select an event marker for the Bashkirian-Moscovian boundary and then to look for GSSP candidate sections. Two conodont lineages show substantial potential for boundary definition and their evaluation requires immediate completion: 1) derivation of *Declinognathodus donetzianus* from *D. marginodosus* and 2) the lineage containing *Diplognathodus ellesmerensis*, which appears at the base of the Moscovian in the Naqing section (Nashui) in Guizhou Province, China (Qi *et al*., 2007, 2009) and has been widely recognized globally. In former years it was thought that *Diplognathodus coloradoensis* Murray & Chronic, 1965 was the immediate ancestor of *D. ellesmerensis*; however, additional work has demonstrated it has a different ancestor, *Diplognathodus* aff. *orphanus* (Merrill, 1972), and that relationship requires evaluation.

The carbonate-dominant Naqing section in Guizhou Province is one of the best candidates for the GSSP at the base of the Moscovian because the conodonts being considered for boundary definition are abundant and their first occurrences precisely located. Foraminifers are also present and have been thoroughly investigated (Groves, 2010). Work on the sedimentology, stable-isotope geochemistry, and geophysical characteristics of the boundary interval at Nashui are less advanced than the paleontological investigations and will be the focus of the team's work in 2015 and 2016. 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 three reference sections - the Zhongdi, Luokun and Narao sections - will continue.

The **Moscovian-Kasimovian Boundary and Kasimovian-Gzhelian Boundary Task Groups**

MOSCOVIAN-KASIMOVIAN STAGE BOUNDARY

During the next four years, the group needs to decide which conodont to use as the index for the M-K boundary and then prepare a proposal and have it voted on by the task group and SCCS. After such a proposal is made and voted on, additional taxonomic work and comparison of morphotypes from different regions can be continued. After selecting the event marker for the boundary, the task group will select a GSSP candidate section for a vote by the SCCS and ICS.

Until 2013, the task group had concluded the first appearance datum (FAD) of either *Idiognathodus sagittalis* Kozitskaya, 1978 or *Idiognathodus turbatus* Rosscoe & Barrick, 2009 had the best potential as a marker for the base of the Kasimovian (Villa & task group, 2008; Ueno & task group, 2011). Now, a lower level defined by the first occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013, which is considered as the direct ancestor of *I. turbatus*, is newly proposed as a more appropriate position of the base of the Kasimovian. The FAD of *I. heckeli* is a better position because its first appearance is closer to that of the traditional definition of the Kasimovian than that of either *Idiognathodus sagittalis* or *Idiognathodus turbatus*. *I. heckeli* is also present in the Naqing section in Guizhou Province of South China, which would allow that section to serve as the GSSP for the base of the Kasimovian.

KASIMOVIAN-GZHELIAN BOUNDARY

The ancestry of the chosen index for the base of the Gzhelian is the highest priority goal of the task group. Since 2007, when the task group voted in favor of using the first appearance of the conodont *Idiognathodus simulator* (Ellison, 1941) in the lineage *Idiognathodus eudoraensis - I. simulator* as the boundary-defining event (Heckel *et al*., 2008), the search for a suitable section for the GSSP had been the task-group's main objective. However, the ancestry of *I. simulator* (=*Streptognathodus simulator*) is no longer agreed upon and needs to be investigated more carefully and another index may need to be proposed and voted on. Qi *et al*. (2015) found a new species that they claim is the

ancestor for *I. simulator*. In the Moscow Basin, *S. simulator* is apparently in the evolutionary lineage *S. praenuntius* Chernykh–*S. simulator*–*S. postsimulator* (Alekseev and Goreva, 2015).

Three sections are currently being considered as potential candidate sections: the type Gzhelian in the Moscow Basin (Alekseev and Goreva, 2015), the Usolka section in the southern Urals (Sungatullina *et al*., 2015), and the Naqing/Narao sections in Guizhou Province, south China (Qi *et al*., 2015). The group needs to determine which of these will make the best section for the GSSP.

The Project Group on Carboniferous and Permian Nonmarine and Marine Correlations The project group plans to continue their work on the correlation of the system and stage boundaries into the vast successions of Carboniferous and Permian continental deposits. In 2016/2017 members of the project group will contribute to the compilation of a Pennsylvanian-Permian-Early Triassic nonmarine-marine correlation chart and associated manuscript. The work will include drafting of charts for the basins members are currently concerned with along with providing supporting stratigraphic information. Subsequent to completing the correlation chart, project-group members will search for event markers within the nonmarine successions they are working on to facilitate correlation with the global stages, the bases of which are based on marine taxa.

Magnetostratigraphy, chemostratigraphy, 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 will eventually 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, 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 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.

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP
In addition to the three executive voting members, the SCCS has 17 rank-and-file voting members and approximately 280 corresponding members (see latest issue of Newsletter on Carboniferous Stratigraphy for contact information).
9a. ***NAMES AND ADDRESSES OF CURRENT OFFICERS AND VOTING MEMBERS***
Chairman: Barry C. Richards, Geological Survey of Canada-Calgary, 3303-33rd St. N.W. Calgary, Alberta, Canada T2L 3A7; E-mail: barry.richards@canada.ca; FAX: 1 (403) 292-4961; Office phone: 1 (403) 292-7153; cellular phone 1 (403) 650-3682
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9b. ***WORKING GROUPS/TASK GROUPS AND OFFICERS***
The SCCS has six current task groups and two exploratory project groups:
Task Groups and officers
The joint Devonian-Carboniferous Boundary GSSP Reappraisal Task Group [base of Carboniferous is also the base of the Lower Mississippian Series and Tournaisian Stage] is a task group that was established in early 2008 and is chaired by Markus Aretz (France; aretz@get.obs-mip.fr). Carlo Corradini is the Vice-chairman. Aretz has summarized the recent work of the group through October 31st 2015 in this annual report.

Task Group to establish the Tournaisian-Viséan Boundary [which is also the base of the Middle Mississippian Series] is chaired by George Sevastopulo (Ireland; gsvstpul@tcd.ie). Using e-mail communications from the chairman, the recent activities of the group are summarized herein through October 31st 2015.
Task Group to establish the Viséan-Serpukhovian Boundary [which is also the base of the Upper Mississippian Series] is chaired by Barry Richards (Canada; barry.richards@canada.ca), who summarized the recent work of the group through October 31st, 2015 in this annual report.
Task Group to establish the Bashkirian-Moscovian Boundary [which is also the base of the Middle Pennsylvanian Series] is chaired by Alexander Alekseev (Moscow State University, Russia; aaleks@geol.msu.ru), who summarized the recent work of the group through October 31st, 2015 in this annual report.
Task Group to establish the Moscovian-Kasimovian Boundary [which is also the base of the Upper Pennsylvanian Series], and the **Kasimovian-Gzhelian Boundary** is chaired by Katsumi Ueno (Japan; katsumi@fukuoka-u.ac.jp). Ueno summarized the recent work of the group through October 31st, 2015 in this annual report.
Project Group on Carboniferous magnetostratigraphy is chaired by Mark Hounslow (United Kingdom) m.hounslow@lancaster.ac.uk, who summarized the recent work of the group in this annual report.
The Project Group on Carboniferous and Permian Nonmarine and Marine Correlations is chaired by Jörg W. Schneider (Germany) Joerg.Schneider@geo.tu-freiberg.de. The project group was established in 2013 and their recent work is summarized in this annual report. and in volume 32 of the Newsletter on Carboniferous Stratigraphy.

9c. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

The SCCS works closely with the subcommissions and task groups on Devonian (SDS) and Permian Stratigraphy (SPS) 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.

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SUBCOMMISSION ON DEVONIAN STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY
Subcommission on Devonian Stratigraphy
Submitted by:
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2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY
SDS has continued in 2015 its work on the revision of problematical GSSPs (Emsian, Devonian-Carboniferous boundary). Discussions on GSSP revisions were held at the Annual Business Meeting during the IGCP/SDS joint meeting in Brussels (September 2015) in addition to the STRATI 2015 meeting. Other continued activities include multidisciplinary international correlation, the organisation of Devonian stratigraphic symposia, publication of the SDS Newsletter and of monographic books/journal volumes.

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.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

- The joint SDS/Uzbekistan/RAS field expedition to Zinzilban George, Uzbekistan to resample and redefine the base Emsian GSSP using multiproxy criteria. This was supported by the ICS. The SDS members collected samples for conodonts and these have been shipped to their laboratories.
- Annual Business Meeting, jointly with IGCP 596 in Brussels, Belgium (September 2015). Pre and Post-conference fieldtrips to Belgium and Germany.
- Organising a Symposium in July at STRATI 2015 on *Devonian Events, Correlation and Time*
- Contributed to *Devonian-Carboniferous boundary* Symposium and technical discussions at STRATI 2015
- Editorial work for a volume on *Devonian Climate, Sea Level and Evolutionary Events* as a Special Publication of the Geological Society of London, edited by Becker, Brett & Königshof.
- Publication of SDS Newsletter 30.
- Update of SDS homepage (pdf files of former SDS Newsletters and new GSSP illustrations).
- Supporting the IGCP application *From a full understanding of Magnetic susceptibility to cyclostratigraphy: generating the next generation of Palaeozoic time scales*

3b List of major publications of subcommission work (books, special volumes, key scientific papers)
Geological Society of London Special Publication- **Devonian climate, sea-level and evolutionary events** most papers online by October 2015.

3c. Problems encountered, if appropriate

- The rarity of polygnathids at Zinzilban in the critical interval for a re-definition of the Emsian GSSP.
- Access to the base Emsian GSSP in Uzbekistan
    - The still unpublished early siphonodellids from the Uppermost Famennian of Franconia/Thuringia.
    - The decline of Devonian stratigraphy in other countries (e.g., Canada, Australia) by the lack of replacement of retiring specialists by new active researchers.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2016)
The major SDS objectives for 2016 onwards can be summarized as:

- Revision of the basal Emsian GSSP in Uzbekistan. Processing of conodonts, integration with isotope data and multi-spectral data to generate a multiproxy definition for the GSSP. Presentation of results at ICOS meeting, Valencia, 2017.

- Revision of the D/C boundary in the frame of the D/C Boundary Task Group (Chairman: M. Aretz) and in close collaboration with the Carboniferous Subcommission.
- Complete publication of volumes on Devonian stratigraphy, partly in co-operation with IGCP 596.
- Publish Brussels meeting presentations in *Palaeobiodiversity & Palaeoenvironments*.
- Compilation and distribution of SDS Newsletter 31.
- Annual Business Meeting in conjunction with the 35th IGC in Cape Town, South Africa.
- Sponsoring a symposium at the IGCP 591 Closing Meeting in Ghent, Belgium

4b Specific GSSP Focus for 2016

- Active work on the redefinition and sub-division of the Emsian Stage. SDS members are collaboratively working on conodonts from Zinzilban, Uzbekistan and the Pyrenees, Spain in an attempt to find a resolution. Czech colleagues are actively pursuing the problem in the Barrandian Basin.
- Active participation in joint Devonian/Carboniferous Boundary Task Group with a focus on conodont revisions and pelagic-neritic correlations.

5. SUMMARY OF EXPENDITURES IN 2015

INCOME	
Balance from 2014	0 $
EXPENSES 2015	
SDS Newsletter 31	600 $
Support for SDS Officers to attend STRATI 2015	1500 $
Support/subvention from IUGS/ICS	**2100 $**

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2014

$600 for 2016 SDS Newsletter	600$
$3000 for Vice-Chair and Secretary to attend the IGC in Cape Town	3000$

Total Request $3600

APPENDICES

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)

- Being a highly proactive subcommission with at least yearly meetings.

2011 SDS Novosibirsk, Russia
2012 34rd IGC Brisbane, Australia
2013 SDS/IGCP 596 Morocco
2014 4th IPC, Mendoza, Argentina
2015 SDS/IGCP 596, Brussels, Belgium
2015 STRATI 2015, Graz, Austria

- Sponsoring a regular series of publications in international journals and special publication series.
- Promoting and proposing the next level of stratigraphic subdivision: sub-stages
- Time sub-division within the Devonian Period is well organized and defined. This allows us to have highly successful IGCP Projects on Devonian environment, time, evolution, extinctions and sea-levels.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2019)

- Redefine the base of the Emsian Stage and the new 'Zinzilbanian' sub-stage. To bring the technical work to completion for the ICOS meeting in Valencia in 2017.
- Redefinition of the Devonian/Carboniferous Boundary with the joint Task Group.
- Publish the definitions of the Givetian and Frasnian substages in *Lethaia*.
- Define and publish the Famennian substages.
- Annual meetings

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

9a Names and Addresses of Current Officers and Voting Members

CHAIR
John E. A. Marshall, Ocean and Earth Science, University of Southampton, National Oceanography Centre, European Way, Southampton SO14 3 ZH, UK; +44 2380592015 jeam@noc.soton.ac.uk

VICE-CHAIRMAN
Carl Brett, Department of Geology, University of Cincinnati, Cincinnati, Ohio, OH 45221, USA, 513-566-4556, **carlton.brett@uc.edu**

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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. Zhu Huaicheng, Nanjing, China; palynology, hczhu@nigpas.ac.cn
18. R.T. Becker: Germany, ammonoids, rbecker@uni-muenster.de

9b List of Working (Task) Groups and their officers
There is a working group appointed to reinvestigate the D-C boundary. This has 10 members from the SDS and 10 from the SCS.

The Devonian members are:
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 <Jirod@cags.net.cn>
Sandra Kaiser, Germany: conodonts, isotope stratigraphy <kaiser.smns@naturkundemuseum-bw.de>
John 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>

The Carboniferous members are:
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 <brichard@NRCan.gc.ca>
Yuan Jin-Liang, China: trilobites <yuanjl403@sohu.com>

9c Interfaces with other international project

SDS is traditionally strongly tied with IGCP projects that have a Devonian focus. The main current project is IGCP 596 on “Climate change and biodiversity patterns in the Mid-Paleozoic”, led by P. Königshof, T. Suttner, and others. We have a joint meeting in Brussels in September 2015.

SUBCOMMISSION ON SILURIAN STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY

International Subcommission on Silurian Stratigraphy ISSS

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2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Mission statement

The objectives of the Subcommission 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

1. Rationalization of global chronostratigraphical classification.
2. Intercalibration of fossil biostratigraphies, integrated zonations, and recognition of global datums.
3. Establishment of magneto- and chemo-stratigraphic scales.
4. Redefinition of stage boundaries and restudy of global stratotype sections.
5. Correlation of Silurian rock successions and events, including marine and non-marine.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

Silurian Times No 22 was edited by the secretary, Renbin Zhan, and distributed in March, 2015, posted on the web site for the ISSS, and circulated as an email attachment to all titular, corresponding and interested members of the Subcommission. It contained the reports on previous meetings, announcements of upcoming meetings and publications, and the latest news and recent publications on Silurian research.

The 5th International Symposium on the Silurian System was held jointly with the IGCP Project 591, Annual Meeting 2015, in Québec, Canada, July 8-11, plus pre-meeting and post-meeting field trips to Gaspé Peninsula and Anticosti Island, respectively. There was also a mid-conference trip within the Québec City area. The meeting was very well organized and attended by 68 participants from 11 different countries. Strong commendations are extended to the organizing committee of this meeting on behalf of the ISSS.

Work proceeds on the restudy of potential GSSP candidate sections for the Base of Wenlock, the Base of Aeronian and base of the Telychian stages. Six papers were presented at the IGCP 591/ISSS meeting in Québec pertaining to recent progress related to these boundaries. In addition, the working group for the Base of Aeronian Stage GSSP held a field workshop to visit a proposed candidate section in the Prague region, Czech Republic, July 29-30. Ten ISSS members participated in the field meeting, which was supported by funding from an NSF grant to ICS. The ISSS particularly thanks organizers Drs Petr Štorch, Štěpán Manda and Zuana Tasáryová, as well as several of their students and colleagues, for their hard work in organizing this trip. This trip also examined a section that may, in the future, be considered in the restudy of the GSSPs for the base of the Homerian, as well as other localities of interest in the region.

The ISSS is a key partner in IGCP 591 – The Early to Middle Paleozoic Revolution. The following additional IGCP 591 meetings occurred in 2015, involving the ISSS members of IGCP 591:

- 12th International Symposium on the Ordovician System (ISOS), James Madison University, Harrisonburg, Virginia, June 8–11, 2015

- An International Conference on the Rise of Animal Life: Cambrian and Ordovician biodiversification events (RALI 2015), Marrakesh, Morocco, October 5–9, 2015

The Chair of ISSS and a number of other ISSS members participated in STRATI 2015 — 2nd International Congress on Stratigraphy held in Graz, Austria, 19–23 July 2015. This was followed by a successful workshop focusing on databases in stratigraphy.

A new award, to be given by the ISSS once every four years at the International Silurian Symposium, was initiated at the Lund meeting in 2013 and approved in principle at the Kunming meeting in 2014 to recognize outstanding research contributions by young Silurian researchers, particularly post-graduate researchers under the age of 40. The award is named in honor of Dr. Tatiana Koren' and was presented for the first time at the Québec meeting to Dr. Emilia Jarochowska.

3b. ISSS MAJOR PUBLICATIONS IN 2015
A volume of conference abstracts and three field trip guidebooks were produced for the Québec meeting.

A special issue of *Palaeoworld*, Volume 24, Issues 1-2, Pages 1-250 (March-June 2015), was published containing the conference proceedings from the 2014 meeting in Kunming (co-organized by ISSS, ISOS and IGCP 591). This issue is entitled "Geologic and biotic events and their relationships during the Early to Middle Paleozoic" and was edited by Renbin Zhan, Jisuo Jin and David A.T. Harper. It includes 7, 9 and 7 papers of Cambrian, Ordovician and Silurian related, respectively, and Silurian papers are mainly on systematic paleontology, biostratigraphy, chemostratigraphy, paleoecology, paleobiogeography, etc.

3c. CHIEF PROBLEMS ENCOUNTERED IN 2015
There remains the old problem related to difficulties in obtaining grants for research on stratigraphical topics and travel to meetings of Subcommission. Applications are often given low priority by national grant-awarding agencies in most countries.

Another major problem is the lack of communication between experts from developed and developing countries on those key issues related with the regional and global correlations of Silurian rocks.

4a. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2016):
Regular updating the website for Silurian Subcommission by Junxuan Fan. We gratefully acknowledge the support of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences for this work.

The major meeting for the ISSS for 2016 will be held in association with the final annual meeting of IGCP 591, together with the ISCS, ISOS and ISDS. This will be held in Ghent, Belgium, July 6-9 and will be followed by a field trip that is tentatively planned to examine key early Paleozoic localities in the Welsh Basin. The theme of the conference will be "A combined data-model approach to understand the Early to Middle Paleozoic Revolution".

ISSS members continue to collaborate on the process of full integration of the various regional and global biostratigraphic, lithostratigraphic, sequence stratigraphic, and chemostratigraphic scales for the entire Silurian. 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 time scale, which has been a serious weakness for the Silurian System.

4b. Specific GSSP Focus for 2016

As noted above, GSSPs currently under active restudy are the bases of Aeronian, Telychian and Sheinwoodian (base of Wenlock). Several research groups are currently undertaking studies specifically focused on candidate sections for these boundaries.

The base of Aeronian boundary working group is tentatively planning a trip to visit the third candidate section for this boundary, which is at Rheidol Gorge, Wales. The other two candidate sections were visited in 2015 (Prague region, Czech Republic) and 2014 (Shennongjia region, China). The tentative plan is to incorporate a visit to Rheidol Gorge as an optional part of Welsh Basin Transect trip that will be held in association with the ICGP591/ISCS/ISOS/ISSS/ISDS

meeting in Ghent, Belgium in early July. At that point, we hope to have detailed information pertaining to all of the GSSP candidate sections for this boundary, and will then soon be in a position to propose a new GSSP.

A detailed biostratigraphic and chemostratigraphic study of a GSSP candidate section for the base of the Telychian, which is in south-western Spain, is now in press and work continues on documentation of the other main candidate section for this boundary in the Shennongjia region, China.

The Rhuddanian-Aeronian and Aeronian-Telychian Boundary Working Groups are in the process of implementing a new, innovative approach to consider the GSSP candidate sections and improving correlation among sections. It is proposed that as the data from each candidate section are assembled, all of the biostratigraphic, chemostratigraphic, and other data useful for correlation, will be assembled into a database (the Geobiodiversity Database, GBDB), along with data from other sections, globally. These data will then be studied using quantitative correlation methods, such as CONOP9 and Horizon Annealing. These methods allow for simultaneous correlation of many sections using a range of different types of stratigraphic data, producing a high-resolution correlation between all sections. This approach permits integration of data from different fossil groups that only rarely co-occur, as well as chemo- and lithostratigraphic and radiometric data, thus permitting correlation between different facies and paleogeographic regions. They also permit quantitative assessment of the precision with which particular levels at any given section can be placed within the composite succession. We feel that this may be a good approach to find a GSSP level that can be correlated globally with the highest level of precision and confidence. Presentations outlining these methodologies for Silurian GSSP research were presented at the Strati 2015 conference by Mike Melchin.

5. SUMMARY OF EXPENDITURES IN 2015

Income	
Carried forward from 2014	US$1,690
ICS Allocation	US$5,000
Total	US$6,690
Expenditures	
Expenses for ISSS Chair related to Silurian Symposium in Quebec, Strati 2015, Graz, and GSSP Workshop, Prague	US$2,305
Financial support for 5th International Symposium on the Silurian System, Quebec	US$4,000
Koren' Award for Outstanding Contributions to Silurian research by a young researcher	US$ 300
Bank fees for ISSS account	US$ 85
Total	US$6,690
Balance	US$ 0

In addition, ISSS received from ICS NSF funds (up to US$6,000) for ISSS members to attend a field workshop in the Prague Synform, Czech Republic, in July, 2015, and to study candidate sections for restudy of the GSSPs for the Base of Aeronian and Base of Homerian and present results of GSSP-related research. Final accounting of this fund is not yet complete but will be provided as soon as it becomes available.

6. BUDGET AND ICS COMPONENT FOR 2016

Contribution toward transportation, accommodation & registration of the Chair and Vice-Chair, to participate in the joint meeting of IGCP 591/ISCS/ISOS/ISSS/ISDS in Ghent Belgium	US$2,500
Contribution to assist other ISSS titular members to participate in the IGCP 591/ISCS/ISOS/ISSS/ISDS in Ghent Belgium	US$2,500

Contribution toward transportation, accommodation & registration of the outgoing and incoming Chair and Vice-Chair to attend IGC in South Africa	US$4,000
Financial support for GSSP working group members studying potential GSSP candidate sections for the base of Aeronian, Telychian and Wenlock.	US$5,000

The ISSS has done pioneering work in the area of restudy of previously ratified GSSPs. 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. Three working groups are currently focusing on restudy of the base of the Aeronian Stage (R-A boundary), base of the Telychian Stage (A-T boundary) and the base of the Wenlock Series. Future working groups will study the other GSSPs of Silurian System. The funds will be particularly directed at young members of the working group, and members who have no access to other funds for international travel to participate this ongoing research.

The ISSS will be submitting a separate proposal for funds to support the costs of the R-A Boundary Working Group workshop and field trips to Wales to study the potential GSSP candidate section there.

Total proposed budget for 2016	US$14,000
Balance forward from 2015	US$ 0
Total requested from ICS for 2016:	**US$14,000**

Potential funding sources outside IUGS
Most of the remaining costs of preparing Silurian Times, Working Group newsletter, meetings and other activities will be met by local support from host institutions and participation by individuals through national research grants and travel grants from their own authorities.

APPENDIX

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)
Over the period of 2011-2015 the Subcommission 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 2015". In addition to those, the following are the most significant accomplishments of the past five years.

The 4th Annual Meeting of IGCP 591 was held in Estonia in 2014: Bauert, H., Hints, O., Meidla, T. and Männik, P. (eds). 2014. 4th Annual Meeting of IGCP 591, Estonia, 10-19 June 2014. Abstracts and Field Guide. University of Tartu, Tartu, 202 pp. The meeting resulted in papers published in two special issues of the Estonian Journal of Earth Sciences (volume 63, number 4, 2014 and volume 64, number 1, 2015) edited by K. Histon and Ž. Žigaitė.

A volume of papers from the 2013 Lund meeting was published as a special issue of the journal GFF (the journal of the Geological Society of Sweden) volume 136, issue 1, 2014, pages 1-340, EPGC - Early Palaeozic Global Change, edited by Mikael Calner, Oliver Lehnert, and Per Ahlberg.

Zhan Renbin and Huang Bing (eds) 2014. IGCP Project 591 Field Workshop 2014 (with ISSS, ISOS and ISCS) Extended Summary, Kunming China, 12-21 August, 2014, Extended Summary. Nanjing University Press. 246 p.

Zhang Yuandong, Wang Yi, Zhan Renbin, Fan Junxuan, Zhou Zhiqiang and Fang Xiang, 2014. Ordovician and Silurian Stratigraphy and Palaeontology of Yunnan, Southwest China. Science Press, Beijing, 138 p.

The ISSS Website was moved to a more secure server in 2013 and also extensively redesigned by our webmaster, Junxuan Fan. The new web site can be found at: http://silurian.stratigraphy.org/.

A major Silurian meeting was held in Lund, Sweden, in June 2013, in association with IGCP 591, as well as the Ordovician and Cambrian subcommissions. The principal conference organizers were Mikael Calner and Oliver Lehnert. An excellent field trip visited localities in SE Sweden and the Oslo region of Norway. The proceedings of this conference were published as:

Lindskog, A. & Mehlqvist, K., 2013: Proceedings of the 3rd IGCP 591 Annual Meeting – Lund, Sweden, 9–19 June 2013. Lund University. 368 pp.
As noted above, another volume of papers emerging from the Lund meeting was published as a special issue of GFF in 2014.

Another recent publication focusing on Silurian research was:
Holloway, D.J. & Laurie, J.R., 2013. Siluro-Devonian Studies 2. Memoirs of the Australasian Association of Palaeontologists 44, 207 pp.

ISSS members organized or participated in 15 conferences related to IGCP 591. ISSS members were also leaders in the initial planning and co-leading of IGCP 591.

The International Symposium on the Silurian System "Siluria Revisited" took place July 9-15, 2011, in Ludlow, England. There were two days of oral presentations focusing on a wide range of Silurian topics and many of the presentations were also contributions to IGCP 591. Of particular significance were the pre- and post meeting field trips that toured the type areas for the Llandovery Series in Wales and the Wenlock and Ludlow series in England. These trips gave the opportunity to a new generation of Silurian researchers to view the GSSPs for all of the Llandovery, Wenlock and Ludlow series and stages (except the base of the Llandovery, which is in Scotland). This meeting resulted in the publication of a program and abstracts volume, a field guide, which includes many new observations and interpretations of the localities, including the GSSPs visited. This field guide is available for download at: http://www.igcp591.org/books.php. In addition, a conference volume of submitted papers, was published as a special issue of Bulletin of Geosciences in 2012, edited by David Loydell.

The ISSS Chair has interacted with scientists at the British Geological Survey in the development of collaborative research between BGS scientists and members of the Silurian Subcommission, 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 is forming 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 or redefinition and these features were highlighted during the Siluria Revisited field trips. 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 a result, a number of the BGS researchers were key participants and co-leaders of the Siluria Revisited field trips and made substantial contributions to the field guide for that trip. The results of some of the research in the type Llandovery area were recently published in: Jeremy R. Davies, Richard A. Waters, Stewart G. Molyneux, Mark Williams, Jan A. Zalasiewicz, Thijs R. A. Vandenbroucke and Jacques Verniers. 2012. A revised sedimentary and biostratigraphical architecture for the Type Llandovery area, Central Wales. Geological Magazine, Available on CJO doi:10.1017/S0016756812000337

As part of the ongoing efforts to resolve this problem of the GSSP for the Base of the Wenlock, the ISSS voting member Dr. Petr Štorch has been working with Chinese researchers on a Llandovery-Wenlock boundary section in Ziyang, China. Another complete and well-exposed Llandovery-Wenlock boundary section has recently found also in Ziyang where conodonts, graptolites and chitinozoans are found. Preliminary study shows potential for regional and global correlation across the L-W boundary. Detailed paleontological, sedimentological and chemostratigraphical studies are being conducted. So, at current stage, there are still no strong candidates for a new GSSP for the Base of Wenlock. As noted above, new research on this problem is under way.

Five of the ISSS Titular Members, including the Chair and Vice-Chair, were co-authors on a paper published in Lethaia in 2011, outlining a proposed, informal subdivision of the Silurian time scale into stage slices. The paper also presented a generalized carbon isotope curve for the Silurian as well as an updated proposed correlation of the North American regional stages with the global standard scale.

The ISSS Chair, with several colleagues, published the chapter on the Silurian System for the 2012 edition of The Geologic Time Scale.

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 was published in November, 2011. Invited papers focus on current research in graptolites, including contributions from Silurian graptolite researchers.

IGCP 591 held a special session at the International Geological Congress in Brisbane, Australia in August, 2012, co-organized by ISSS member Kathleen Histon and ISSS chair, Mike Melchin. IGCP 591 also held its annual meeting in July in Cincinnatti, co-organized by ISSS members Carl Brett and Brad Cramer. Special symposium volumes were published from both conferences in refereed journals.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2019)
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 Subcommission for the next four years include:

Research is currently under way by ISSS members, colleagues and students on the bases of Aeronian, Telychian and Sheinwoodian sections in UK, Czech Republic, Spain and China, as part of the process of selection of possible new GSSP sections. We hope to be in a position to vote on proposals for the Base of the Aeronian within the next year.

The research objectives for 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 is being conducted in collaboration with the International Subcommissions on Ordovician, Silurian, and Devonian Stratigraphy (SOS, SSS, SDS), and will be accomplished over the five-year duration of the project (2011-2016).

Other future ISSS field meetings and GSSP workshops remain in the planning stages.

We are working on the development of databases that 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. Junxuan Fan, who is also Webmaster for ISSS. This database, called Geobiodiversy Database (GBDB), is fully operational and has been named as the official database of the ICS.

9. ORGANIZATION
The ISSS is a Subcommission of the International Commission on Stratigraphy. The Subcommission is organized by an Executive consisting of Chairman, Vice-Chairman and Secretary, who are all Voting Members of the Subcommission. In the Subcommission elected for 2012-2016 there are fifteen other Voting Members. The network of Corresponding Members has first of all a responsibility for communication in both directions between the Subcommission 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.

Current research activities and future plans are communicated through publication of an annual ISSS newsletter, *Silurian Times*, distibuted by both email attachment and as a web release.

Websites: http://silurian.stratigraphy.org/ contains newsletters, meeting announcements, discussion posting-boards, bibliography of Silurian articles, links to related sites, and other information.

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; peep.mannik@ttu.ee.
Secretary: Renbin Zhan, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China, rbzhan@nigpas.ac.cn

List of Voting Members in 2015
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Renbin Zhan, Nanjing, China, rbzhan@nigpas.ac.cn

Working Task Groups
Base of Aeronian GSSP Restudy – Chair – Petr Štorch
Base of Telychian GSSP Restudy – Chair – Michael Melchin
Base of Wenlock GSSP Restudy – Chair – David Loydell

Interfaces With Other International Projects
Collaboration on IGCP Project 591, "The Early to Middle Paleozoic Revolution", which was approved and began its work in May 2011.

SUBCOMMISSION ON ORDOVICIAN STRATIGRAPHY

ANNUAL REPORT 2015

1. Name of constituent body:
Subcommission on Ordovician Stratigraphy (SOS)

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2. Overall objectives, and Fit within IUGS science policy:

The Subcommission promotes international cooperation on all aspects of Ordovician geology, specifically stratigraphy. It has a global network involving both academia and industry.

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.

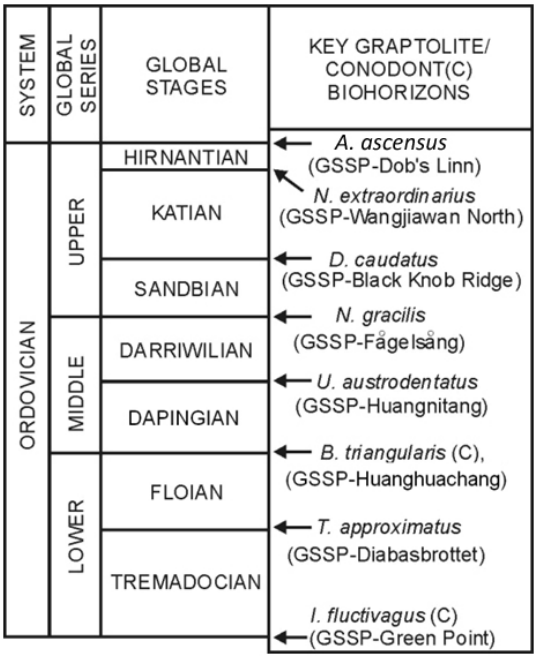
b. To promote regular international meetings on all aspects of Ordovician geology, especially those devoted to clarifying stratigraphic procedures, nomenclature and methods for use in establishing a unified global time scale and to prepare correlation charts with explanatory notes (the main phase of 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 Subcommission 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 Subcommission thus involves much of the global geological community.

3. Summary table of Ordovician subdivisions



4. Organization

a. Subcommission Executive (from August 2012-August 2016)
Chairman, David A.T. Harper (UK)
Vice Chairman, Andrei Dronov (Russia)
Secretary, Ian G. Percival (Australia)
16 other Voting Members
Over 100 Corresponding Members

The Subcommission officers and voting members have been agreed for the next term from 2012-2016. Prior to the Subcommission's business meeting during the Brisbane IGC (2012) a postal ballot confirmed the election of the new Subcommission officers, and elected a new group of voting members. The new Subcommission 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)
D. Goldman (USA)
M. Ghobadi Pour (Iran)
D.A.T. Harper (UK)
O. Hints (Estonia)
Zhan Renbin (China)
S. Leslie (USA)
A.T. Nielsen (Denmark)
I.G. Percival (Australia)
M.R. Saltzman (USA)
A. Sa (Portugal)
T. Servais (France)
T. Tolmacheva (Russia)
T. Vandenbroucke (Belgium)
M. Williams (UK)
Zhang Yuandong (China).

5. Interfaces with other international projects

IGCP Project 591: The early to middle Palaeozoic revolution. This project involving some 400 participants from nearly 40 countries has a strong Ordovician component and is supported by the subcommission. The project has already featured at international congresses in Spain, the UK, China, Sweden, Canada and the USA. The final meeting will be held in Ghent during July 2016.

IGCP Successor project: An application has been made to the IGCP to support a new project entitled 'The onset of the Great Ordovician Biodiversification Event', led by Thomas Servais.

6. Chief accomplishments and products in 2015 cycle

a. Publication of **Ordovician News 32**, distributed to all members of the subcommission by email and added to the subcommission's webpages (www.ordovician.stratigraphy.org).

b. Support for 12th ISOS, June 2015 on the James Madison Campus, Harrisonburg, Virginia; organised by Stephen Leslie and his colleagues. Over 80 delegates from some 15 different countries attended the four day meeting with field

excursions, before, after and during the conference, focussed on key Ordovician in the region and beyond. A conference proceedings volume and fieldtrip guides are available electronically (http://www.jmu.edu/2015ISOS/).

c. Support for publication of ISOS thematic issue in Stratigraphy, to be available by the end of 2015.

d. Election of new officers: David Harper is standing down as chair, Andrei Dronov as vice-chair and the following have served out their terms of office or wish to stand down: F. Gilberto ACEÑOLAZA (Argentina) and Oldrich FATKA (Czech Republic). At the business meeting in Harrisonburg the voting members present supported the nomination of Andrei Dronov as chair and Thomas Servais as vice-chair. Two new members one from Argentina (Matilde Beresi) and one from central Europe (Petr Kraft) were elected by the voting members of the subcommission following an electronic ballot.

e. Book on the Global Ordovician System. The content, format and deadlines for a comprehensive, up-date-date on global Ordovician sections were the main topics for discussion at the business meeting.

f. Andrei Dronov's proposal to hold the 13th ISOS in Novosibirsk (2019) was favourably received by the Subcommission, and those members present voted unanimously to support the proposal.

7. Chief problems encountered in 2015

Critical to the development of the research on the system is the improvement of regional chronostratigraphies, isotope curves, palaeogeographies and zonal schemes. The coming years will see an emphasis on renewed data collection and its integration with the global standard. But this will require global participation of all our regional groups. It is also clear that the system has few reliable, absolute dates. This forms part of a new ISOS sponsored project with StarPlan in the University of Copenhagen.

8. Summary of expenditure for 2014-2015

TOTAL INCOME (from ICS): USD 3000

a. Support for attendance of colleagues at ISOS 2015 (Harrisonburg, VA) and STRATI (Graz): 1000 USD.
b. Support of students, who presented, to attend ISOS 2015 (Harrisonburg, VA). 2000 USD

TOTAL EXPENDITURE **USD 3000**

9. Work plan, critical milestones, anticipated results and communications to be achieved next year

a. To design and execute a programme of radiogenic dating of key Ordovician horizons (using Pb-Pb isotopes) in collaboration with Dr James Connolly and the state-of-the-art StarPlan laboratory in the University of Copenhagen. **Work has already commenced on some key sections in Baltoscandia, Russia and Scotland.**

b. 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. In additional regional isotope and sea-level data will be added. **During the Harrisonburg meeting a final line-up of chapters was discussed; these will be progressed to publication as a Special Paper, Geological Society.**

c. The subcommission participated in various meetings (and publications arising from these meetings) during 2015, notably in **Nanjing** (May), **Harrisonburg** (June), **Anticosti** (July) and **Graz** (August).

10. Budget and ICS component requested for 2015-2016

1. Attendance and participation of subcommission officers at IGC, Cape Town, South Africa (2016): 3000 USD
2. Continued support for the ISOS-StarPlan terrestrial dating project on the Ordovician System: 1000 USD
3. Support for attendance and participation of subcommission officers at the ISOS/IGCP Ghent meeting (2016): 3000 USD

As in previous years it is envisaged that officers will supplement any aid from the ICS with their own research funds. I have not quantified this support.

TOTAL 2015-2016 BUDGET: 7000 USD
REQUESTED FROM ICS: **7000 USD**

Potential funding sources outside IUGS

The Subcommission officers are mainly supported by their research projects for most of their activities.

11. Review chief accomplishments over last 14 years (2001-2015)

This year the list focusses on the achievements during the 2015 cycle. Those prior to 2015 have been listed in previous reports.

a Publication of Ordovician News 32, distributed to all members of the subcommission by email and added to the subcommission's webpages (www.ordovician.stratigraphy.org).

b 12th ISOS, June 2015 held on the James Madison Campus, Harrisonburg, Virginia; organised by Stephen Leslie and his colleagues. Over 80 delegates from some 15 different countries attended the four day meeting with field excursions, before, after and during the conference, focussed on key Ordovician in the region and beyond. A conference proceedings volume and fieldtrip guides are available electronically (http://www.jmu.edu/2015ISOS/).

c Publication of ISOS thematic issue in Stratigraphy, to be available by the end of 2015.

d Election of new officers for the 2016-2020 cycle. See above

e Book on the Global Ordovician System, final planning stages.

f Andrei Dronov's proposal to hold the 13th ISOS in Novosibirsk (2019) accepted by the subcommission.

SUBCOMMISSION ON CAMBRIAN STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY

International Subcommission on Cambrian Stratigraphy

Prepared by: Prof. Per AHLBERG, Secretary, per.ahlberg@geol.lu.se
Prof. Loren E. BABCOCK, Chair, babcockloren@gmail.com
Date: 16 November 2015

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

2.a. Mission Statement

The Subcommission is the primary body for facilitation of international communication and scientific cooperation on Cambrian stratigraphy.

2.b. Goals

The two principal goals of the Subcommission are:
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.

2.c. 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. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

3.a. Strati 2015, 2nd International Congress on Stratigraphy, Graz, Austria

The Cambrian Subcommission held its annual meeting in association with the Strati 2015 Meeting in Graz, Austria (organized by Werner Pillar). The Subcommission sponsored a day-long session devoted primarily toward the lower part of the Cambrian System. Most of the major Cambrian stratigraphic issues remaining to be solved are in the lower half of the system, and the session was primarily aimed at addressing potential solutions. In addition, Subcommission members delivered talks or posters in other sessions.

3.b. ISCS Webpage

The Cambrian Subcommission's webpage was updated in 2015. The webpage accounts for the many important changes that have occurred with respect to global chronostratigraphy of the Cambrian System, and includes updated contact information, lists of important publications, and other essential information.

3.c. Cambrian Stage 5

In 2015, the Working Group on Cambrian Stage 5 provided its recommendation on which stratigraphic horizon (of five options) to be used to mark the base of the stage. The base of provisional Stage 5 is likely to be selected at the FAD of the oryctocephalid trilobite *Oryctocephalus indicus*. This position lies just above the base of a eustatic rise, lies somewhat above a globally recognizable extinction interval (the redlichiid trilobite-olenellid trilobite extinction), and is within the interval defined by the ROECE $\delta^{13}C$ excursion.

3.d. List of major publications of subcommission work

1) A theme issue of *Annales de Paléontologie* (Volume 101, Issue 3, 2015), containing papers resulting from presentations at the ISCS Subcommission meeting in Morocco (2014), was published under the editorship of Sébastien Clausen, J. Javier Álvaro, and Léa Devaere.

2) A large theme issue of *Palaeoworld* (Volume 24, Issues 1-2), Geologic and Biotic Events and their Relationships during the Early to Middle Paleozoic, edited by Renbin Zhan, Jishou Jin, and David A. T. Harper, was published. The issue contains papers resulting from the IGCP 591 meeting in Yunnan, China (2014). The meeting was held jointly with the meetings of the Cambrian, Ordovician, and Silurian Subcommissions.

3.e. Problems encountered
1) A planned field meeting of the Cambrian Subcommission, to be held to Newfoundland, Canada, had to be cancelled due to unforeseen logistical problems. The Subcommission nevertheless did meet, holding its annual meeting in association with the Strati 2015 meeting in Graz, Austria.

2) The principal difficulties encountered in 2015 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.

4. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2016)
In 2016 the Cambrian Subcommission will continue work toward defining GSSPs for its remaining provisional stages. The general plan is to finalize Stage 5 and arrive at a decision on how to define Stage 10 in 2016; then to arrive at decisions on stages 2, 3, and 4 in subsequent years. In addition, the Subcommission will examine issues surrounding definition of the Cambrian GSSP.

Specific GSSP Foci for 2016
The Cambrian Subcommission is finalizing a decision on provisional Stage 5 (and Series 3), and expects to submit a proposal to ICS for ratification in 2016.

In 2016, the Subcommission hopes to make significant progress toward a decision on provisional Stage 10.

5. SUMMARY OF EXPENDITURES IN 2015

INCOME	
Carried forward from 2014	$ 0.00
ICS Allocation	$ 4000.00
SUBTOTAL 2015 income	$ 4000.00
EXPENDITURE FROM 2015 BUDGET	
Contribution to officer's travel expenses	$ 3926.31
(actual travel expenses exceeded the budget slightly)	
SUBTOTAL 2015 expenditures	$ 3926.31
To be carried forward to 2016	$ 73.69

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2016
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. This will be especially important in 2016 because of the need for Voting Members of the Subcommission to be present at the ISCS field meeting in Australia, where we will have the opportunity to examine and discuss potential GSSP stratotypes in the lower part of the Cambrian System. The proposed increased funding is also targeted at field research on key sections by Working Group members and young scientists. Also, we request support for Voting Members to attend the International Geological Congress meeting in Cape Town, South Africa.

INCOME	
Carry-over from 2015	$ 73.69
PLANNED EXPENDITURES FOR 2016	
Preparation for the 20th Cambrian Stage Subdivision Working Group Conference in South Australia	$ 1000.00
Executive and VMs travel costs, Cambrian Subcommission field meeting	$ 3000.00
Support for 2 young scientists to attend the field meeting	$ 2000.00
General office expenses	$ 100.00
TOTAL 2016 PLANNED EXPENSES	$ 6100.00
ICS 2016 BUDGET REQUEST	$ 6100.00

APPENDICES

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011–2015)

- From 2011 to 2015 the Cambrian Stage Subdivision Working Group has made four reconnaissance visits to sections in association with international field conferences. Areas visited are the southern Great Basin, USA (2011), Guizhou, China (2012), Scandinavia (2013), and Morocco and South China (2014).
- In association with each of the field conferences, regional and/or global correlation charts have been published in technical papers.
- The Cambrian Subcommission has devised a plan for subdividing the Cambrian System into four series and 10 stages. The two lower series will embrace two stages each, and the upper two series will embrace three stages each. Through 2007, two series (Terreneuvian and Furongian) and four stages (Fortunian, Drumian, Guzhangian, and Paibian) had been ratified. Since that time, one stage, the Jiangshanian has been ratified (2011).
- Beginning with the Jiangshanian Stage, the Cambrian Subcommission has been interested in establishing ASSPs. An ASSP for the Jiangshanian was approved in 2012.

8. OBJECTIVES AND WORK PLAN FOR NEXT FOUR YEARS (2016–2019)

- The principal objective of the Subcommission for 2015 is to narrow possibilities for horizons and GSSP stratotypes for the remaining undefined stages, which are provisionally identified as stages 2, 3, 4, 5, and 10.
- The ISCS has developed a prioritized plan for formalizing definition of the remaining undefined GSSPs. The plan is:
    1) Within the next year, provisional Stage 5 is expected to be defined.
    2) Provisional Stage 10 is expected to be defined next, but a decision on a GSSP is likely to be at least one or two years away.
    3) Following a decision on Stage 10, provisional stages 2, 3, and 4, are expected to be defined in rapid succession. A decision on the preferred GSSP horizon of any one of the three stages will restrict choices for the remaining two stages, so the ISCS is approaching work toward definition of the three stages as closely linked.
    4) A more long-term objective is re-examination of the Cambrian System (Terreneuvian Series, Fortunian Stage) GSSP. Imprecision in correlating the lower boundary of the Cambrian System has been encountered on all paleocontinents, and the ISCS is now engaged in seeking a practical solution to remedy the problem (see Babcock, L.E. et al. 2014: Proposed reassessment of the Cambrian GSSP. *Journal of African Earth Sciences 98*, 3–10). A decision on how to proceed with the Cambrian GSSP is expected to be made following ratification of GSSPs for stages 2, 3, and 4.

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

9.a. Names and Addresses of Current Officers and Voting Members

Subcommission officers (2012–2016)

Chairman: Loren E. Babcock (USA, Sweden) babcockloren@gmail.com
Vice-Chair: Xingliang Zhang (China) xzhang69@nwu.edu.cn
Secretary: Per Ahlberg (Sweden) per.ahlberg@geol.lu.se

List of Voting Members (including officers) for 2012–2016

1) Per Ahlberg, Lund, Sweden per.ahlberg@geol.lu.se
2) José-Javier Álvaro, Villeneuve d'Ascq, Spain jose-javier.alvaro@uni-lille1.fr, alvarobjj@cab.inta-csis.es, jj.alvaro@csic.es
3) Loren E. Babcock, Columbus, Ohio, USA, and Lund, Sweden babcockloren@gmail.com
4) Gabriella Bagnoli, Pisa, Italy bagnoli@dst.unipi.it
5) Duck K. Choi, Seoul, Korea dkchoi@snu.ac.kr
6) Olaf Elicki, Freiberg, Germany elicki@geo.tu-freiberg.de
7) Gerd Geyer, Germany gerd.geyer@uni-wuerzburg.de
8) Rodolfo Gozalo, Valencia, Spain rodolfo.gozalo@uv.es
9) James B. Jago, Mawson Lakes, Australia jim.jago@unisa.edu.au
10) Pierre D. Kruse, Darwin, Australia archaeo.kruse@gmail.com

11) Linda B. McCollum, Cheney, Washington, USA lmccollum@ewu.edu
12) Malgorzata Moczydlowska-Vidal, Sweden malgo.vidal@pal.uu.se
13) Elena B. Naimark, Moscow, Russia naimark@paleo.ru
14) Tatyana V. Pegel, Novosibirsk, Russia pegel@mail.ru
15) Shanchi Peng, Nanjing, China scpeng@nigpas.ac.cn
16) Leonid Popov, Wales, UK leonid.popov@museumwales.ac.uk
17) Brian R. Pratt, Saskatchewan, Canada brian.pratt@usask.ca
18) Matthew R. Saltzman, Columbus, Ohio, USA saltzman.11@osu.edu
19) Michael Steiner, Berlin Germany michael.steiner@FU-Berlin.de
20) Alexey I. Varlamov, Moscow, Russia varlamov@vnigni.ru, info@vnigni.ru
21) Mark Webster, Chicago, Illinois, USA mwebster@geosci.uchicago.edu
22) Xingliang Zhang, Xi'an, China xzhang69@nwu.edu.cn
23) Maoyan Zhu, Nanjing, China myzhu@nigpas.ac.cn
24) Anna Zylinska, Warsaw, Poland anna.zylinska@uw.edu.pl

9.b. List of Working (Task) Groups and their officers

1. WG on Stage 10 GSSP, chaired by Per Ahlberg (Sweden)
2. WG on Stage 5 GSSP, chaired by Linda B. McCollum (USA)
3. WG on Stage 4 GSSP, chaired by James B. Jago (Australia)
4. WG on Stage 3 GSSP, chaired by Xingliang Zhang (China)
5. WG on Stage 2 GSSP, chaired by Michael Steiner (Germany)

9.c. Interfaces with other international projects

In July 2015, the Cambrian Subcommission held its annual meeting in association with the 2nd International Congress on Stratigraphy (STRATI 2015) in Graz, Austria. The congress and the ISCS meeting attracted numerous Cambrian researchers, and more than 30 talks and posters dealing with Cambrian stratigraphy and paleontology were presented during the conference.

In 2016, the Cambrian Subcommission will hold its annual field meeting in Adelaide, South Australia, 10-15 July, in association with Palaeo Down Under 2, a meeting of the Association of Australasian Palaeontologists. Pierre Kruse, Diego García-Bellido, Trevor Worthy, and James B. Jago are organizing the meeting.

The *IGCP Project 591 Closing Meeting: A Combined Data-model Approach to Understand the Early to Middle Paleozoic Revolution* will be held in Ghent, Belgium, 6–9 July 2016. Given that deep-time data-model comparison requires a profound understanding of the stratigraphy, this will be a joint meeting of the Cambrian, Ordovician, Silurian, and Devonian Subcommissions.

The Cambrian Subcommission is working jointly with the Ediacaran Subcommission on restudy of the Cambrian base. Members of both subcommissions comprise the membership of the Terreneuvian/Fortunian Working Group. The Cambrian Subcommission is involved jointly with the Ordovician and Silurian Subcommissions in IGCP Project 591, and has recently co-sponsored a field meeting (Morocco, 2014) with the Ediacaran Subcommission.

SUBCOMMISSION ON EDIACARAN STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY

Subcommission on Ediacaran Stratigraphy

Submitted by:

Dr. Shuhai Xiao, Chairman
Department of Geosciences, Virginia Tech, Blacksburg, VA 24061, USA
Tel. 540-231-1366, Fax. 540-231-3386
Email: xiao@vt.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 Ediacaran 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 (circa 635 – 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

The main goals of this Subcommission are

(a) To search for criteria useful in the subdivision and correlation of Ediacaran strata;

(b) To define the basal boundaries of Ediacaran epochs (series) and ages (stages) through the establishment of global stratotype sections and points (GSSP's);

(c) To facilitate international collaboration in research on Ediacaran stratigraphy and Earth history through subcommission sponsored field trips, workshops, and meetings;

In addition, the Subcommission is committed to further communication with a wider public through grassroots initiatives to conserve important Neoproterozoic geological sites, to support International Geoscience Programme projects, and to encourage the wider dissemination of research findings on the internet 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) 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)** and **Cryogenian Subcommission (Graham Shields-Zhou, chair)** to subdivide the late Precambrian.
(3) Working towards an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs and important fossil localities. This relates to, *inter alia*, the IUGS Geosites Programme.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

- The third annual newsletter of the Subcommission was disseminated in February 2015. See attached.
- Two working groups focusing on the Second Ediacaran Stage (SES) and the Terminal Ediacaran Stage (TES) have been officially established. These working groups are chaired by Dr. Chuanming Zhou (SES) and Dr. Guy Narbonne (TES).
- The Subcommission organized a symposium "Precambrian Stratigraphy" at STRATI 2015 in Graz. Shuhai Xiao and Graham Shields chaired the symposium. All three executives, both working group leaders, and ten voting members (Dmitri V. Grazhdankin, Alan Jay Kaufman, Marc Laflamme, Malgorzata Moczydlowska-Vidal, Guy M. Narbonne, Graham A. Shields-Zhou, Shuhai Xiao, Chongyu Yin, Chuanming Zhou, Maoyan Zhu) participated in the symposium.

- An open meeting and a business meeting were held at STRATI 2015 in Graz. A wide range of topics have been discussed at these two meetings, including election of new executives and plans for 2016. See attached minutes.
- Election of subcommission executives was completed in September 2015. Voting member Guy Narbonne coordinated the voting. On 9/20/2015, Narbonne communicated via email the results to all voting members as well as ICS chair Stan Finney: "All eighteen Voting Members of the ICS Ediacaran Subcommission have cast their ballots, and the result is unanimous support (18-0-0) for the election of Shuhai Xiao as Chair and Dima Grazhdankin as Vice-Chair of the ICS Ediacaran Subcommission for 2016-2020. The executive have indicated that they wish Marc Laflamme to continue in his role as Secretary of the Ediacaran Subcommission."
- A white paper on Ediacaran subdivision and correlation has been completed by subcommission and working group officers, and will soon be submitted to *Episodes* for review and publication.
- Recognizing the importance of integrative stratigraphy in the investigation of the Ediacaran System, members of the Ediacaran Subcommission actively participated in the GRIND workshop (***G**eological **R**esearch through **I**ntegrated **N**eoproterozoic **D**rilling*) on 11/2/2015 organized by Frances Macdonald (Department of Earth & Planetary Sciences, Harvard University) to develop an ICDP proposal to acquire drill cores across the Ediacaran-Cambrian transition in South China and Brazil.
- Geological Society of America Annual Meeting Pardee Symposium P3 "Earth-Life Systems at the Dawn of Animals" organized by J. D. Schiffbauer (corresponding member), M. Laflamme (voting member), and S.A.F. Darroch
- Geological Society of America Annual Meeting Topical Session T152 "Geobiology of Critical Transitions: Integrating Fossils, Proxies, and Models" organized by A.D. Muscente, N. Bykova, J.S. Broce, and J.D. Schiffbauer (corresponding member).
- Preparation for 2016 Namibian Field Trip: Corresponding member Patricia Vickers-Rich and voting members Guy Narbonne and Marc Laflamme have been working with Gabi Schneider (Director of Namibian Geological Survey) to coordinate an official IGC Ediacaran trip in Namibia. In addition, the possibility of an informal TES working group trip attached to the formal IGC trip has been investigated.
- 2016 IGC symposium proposal "The Dawn of Animals: Cryogenian to Cambrian" has been submitted by corresponding/voting members Douglas Erwin, Rachel Wood, Marc Laflamme, and Shuhai Xiao.
- 2016 IGC symposium proposal "Cloudinids and Allied Metazoans" has been submitted by corresponding members Dermeval Aparecido Do Carmo and Detlef Walde.
- Ediacaran research in South Australia has continued with further excavations at the National Heritage Listed Ediacara Fossil Site at Nilpena, a new site in the northern Flinders Ranges of South Australia, and for the first time, at the historic discovery site in the Ediacara Conservation Park. The research is led by Jim Gehling (voting member) and Mary Droser (corresponding author). Other members of the Ediacaran community, including Diego Garcia-Bellido, Lidya Tarhan, Scott Evans, Christine Hall, Felicity Coutts, Lily Reid, Guy Narbonne, Alex Liu, Alex Dececchi. Doug Erwin, Jon Antcliff and Jennifer Hoyal-Cuthill have also participated in the excavation or visited the excavation site.

3b. LIST OF MAJOR PUBLICATIONS OF SUBCOMMISSION WORK (BOOKS, SPECIAL VOLUMES, KEY SCIENTIFIC PAPER)

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3c. PROBLEMS ENCOUNTERED IN 2015

None.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2016)

- Subcommission annual newsletter will be distributed in February 2016. Secretary Dr. Marc Laflamme will be leading the effort to compile and edit the annual newsletter.
- Continue maintaining and updating Subcommission webpage (http://www.paleo.geos.vt.edu/Ediacaran/).
- Activities planned for 2016 will focus on the criteria to define the second and terminal stages of the Ediacaran Systems. These activities will be coordinated by the SES (Second Ediacaran Stage) and TES (Terminal Ediacaran Stage) working groups. Currently, the following activities are in the discussion or planning stages.
    - Palaeo Down Under 2, co-sponsored by the Ediacaran Subcommission and organized by the Association of Australasian Palaeontologists (AAP), will be held on July 10–15, 2016, at the University of Adelaide in South Australia. The conference is preceded by a Field Excursion to key Cambrian localities of Kangaroo Island, the Fleurieu Peninsula and the Cambrian and Ediacaran of the Flinders Ranges on July 3-9. The field excursion will help TES working group to assess criteria for the subdivision of correlation of the Terminal Ediacaran Stage.
    - Submission workshop and field trip in Namibia (in association with 35th IGC) to examine sections pertinent to TES.
    - A possible workshop and field trip to examine sections in northern India pertinent to SES.
    - A field trip to celebrate the 50 year anniversary of the discovery of the Mistaken Point biota is planned for the year 2017. This will be a good opportunity to discuss criteria for the subdivision of the Ediacaran System into series.
    - Members of the Ediacaran community continue to work on Ediacaran stratigraphy in Siberia, NW Canada, Oman, Saudi Arabia, Brazil, South China, India, Namibia, western US, and many other parts of the world.
    -

4b Specific GSSP Focus for 2016

- As described in 4a, the SES (Second Ediacaran Stage) and TES (Terminal Ediacaran Stage) working groups will focus our discussion on the second and terminal stages of the Ediacaran System. At least two field workshops will be organized in 2016 to discuss and examine the criteria to be used to define and correlate these two stages.

5. SUMMARY OF EXPENDITURES IN 2015:

INCOME
Forwarded from 2014 US$ 739
ICS allotment US$ 0
NSF grant administered through CSULB US$ 4000
Total US$ 4739

EXPENDITURES
Xiao STRATI travel (ICS) US$ 375
Office and administrative supplies (ICS) US$ 250
Laflamme STRATI travel (NSF; unclaimed as of 11/22/2015) US$ 750
Total US$ 1375

To be carried forward to 2016: ICS US$ 114
To be carried forward to 2016: NSFUS$ 3250

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2016

The Subcommission plans two or three field workshops in 2016. Currently, firm plans have been made for a field workshop in Namibia and another in South Australia. A third field workshop in either northern India or Oman is in the early stage of discussion. In addition, members of the Subcommission will participate in the 35th IGC in Cape Town and the Palaeo Down Under 2 conference in University of Adelaide in South Australia. These field workshops will require significant financial assistance, because travel to Australia, Namibia, and South Africa is expensive. We have requested that a portion of the 2015 NSF allotment to be spent in 2016. Additionally, we request **$6,486** from ICS to support Subcommission field workshops in 2016.

PROJECTED EXPENSES
General office expenses and website maintenance US$ 350
Field workshop preparation (trip leaders) US$ 3000
ICS travel US$ 2500
Namibia field workshop travel US$ 2000
Australia field workshop travel US$ 2000
Total US$ 9850

PROJECTED INCOME:
Carried over from 2015: ICS US$ 114
Carried over from 2015: NSF US$ 3250
Total US$ 3364

BUDGET REQUESTS US $6486

APPENDICES

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)

2011:

- International conference on Neoproterozoic Sedimentary Basins and a Neoproterozoic Subcommission workshop on Ediacaran paleobiology (Novosibirsk, 30 July – 1 August, 2011), followed by a field excursion to the East Sayan Mountains (2 – 14 August, 2011).
- Publication of ***Neoproterozoic Ice Ages*** (editors: Arnaud, Halverson and Shields; Geological Society of London Memoir 36: ISBN 978-1-86239-334-9).
- Ballot on dissolution of Neoproterozoic Subcommission and establishment of two separate subcommissions for the Cryogenian and Ediacaran periods, respectively.

2012:

- Voting members Shuhai Xiao, Chuanming Zhou, and Ganqing Jiang, as well as ICS chair Stan Finney and vice chair Shanchi Peng, participated in a field workshop on Ediacaran stratigraphy in South China, organized by Dr. Xiaofeng Wang at the Wuhan Center of the China Geological Survey. They examined a number of key sections where important fossils and geochemical events have been reported.
- A 3-day international symposium *Neoproterozoic to Cambrian Evolution of the Earth and Life* (organized by Guy Narbonne, Jim Gehling, and Galen Halverson) and a 4-day field trip through the Ediacaran of the Avalon Peninsula (organized by Guy Narbonne and Marc Laflamme) took place in conjunction with the annual meeting of the Geological Association of Canada in eastern Newfoundland. Both events were sponsored by the Neoproterozoic Subcommission.
- Jim Gehling, Jim Jago, John Paterson, Glenn Brock, and Mary Droser led a 5-day field workshop to examine Ediacaran-Cambrian successions in South Australia. This field workshop was part of the 34th IGC field trips and was sponsored by the Ediacaran Subcommission.
- The Ediacaran Subcommission was established in August 2012 at the 34th IGC in Brisbane, Australia.
- A business meeting was held on August 7, 2012, on the side of the 34th IGC in Brisbane. Participants included voting members Shuhai Xiao, Guy Narbonne, Kathleen Grey, Nicholas Christie-Blick, James Gehling, Malgorzata Moczydlowska-Vidal, and Maoyan Zhu, as well as several corresponding members (Patricia Vickers-Rich, Robert Rainbird, Michael Meyer). At the meeting, members discussed the need to more actively engage members of the community, to start an annual newsletter, and to update the Subcommission webpage. Other issues discussed at the meeting include potential criteria for Ediacaran subdivision and global correlation, possible field workshops and symposia for 2013, and a timeline toward the establishment of GSSPs.
- On September 19–21, 2012, voting members Shuhai Xiao, Jay Kaufman, Martin Brasier, Guy Narbonne, Chongyu Yin, and Graham Shields-Zhou participated in the Geological Society Fermor meeting in London that focused on the evolution, glaciation, and oxygenation of the Neoproterozoic Era.
- ***The Geologic Time Scale 2012*** was published. Voting members Guy Narbonne, Shuhai Xiao, Graham Shields-Zhou, and James Gehling contributed a chapter on the Ediacaran Period in this volume.
- In October 2012, the Subcommission webpage has been updated and migrated to a new server at Virginia Tech.

2013:

- An international field workshop, sponsored by the Subcommission and entitled "The Neoproterozoic Paraguay Belt (Brazil): glaciation, iron-manganese formation and biota" was held at Campo Grande and Corumbá, Brazil, August 4-9, 2013. The workshop was organized by corresponding member Detlef Walde at Universidade de Brasília. Voting members (Alan J. Kaufman, Chuanming Zhou) and corresponding members (Paulo Boggiani, Claudio Gaucher, Patricia Rich) participated in the workshop.
- Following the 2012 Subcommission field trip in South China and in preparation for the 2014 Subcommission field workshop in Yichang (June 11-22, 2014), Subcommission chair Shuhai Xiao, voting members (Chuanming Zhou and Xunlai Yuan), and corresponding member (Pengju Liu) carried out joint field excursion to examine outcrops and sections to be visited in 2014. Extensive discussion with members of the Cryogenian Subcommission (Graham Shields-Zhou, Maoyan Zhu, and Linzhi Gao) resulted in a joint field workshop with the Cryogenian Subcommission. Logistic arrangement has been made and the first circular has been sent out.

- Preparation for the 2014 International Field Workshop on the Marwar Supergroup, Rajasthan, Western India (Corresponding member Mukund Sharma) and International Field Workshop on the Ediacaran-Cambrian Stratigraphy of Morocco (Voting member Jose-Javier Alvaro).

2014:

- Preparation to establish two working groups to focus on the second stage and the terminal stage of the Ediacaran System.
- The Subcommission sponsored the International Field Workshop on the Marwar Supergroup, Rajasthan, western India, 20th-28th January 2014. This field trip examined Ediacaran and Cambrian successions in Rajasthan. Corresponding member Mukund Sharma was the organizer of this field workshop, Chair-person Shuhai Xiao and several corresponding members (e.g., Ulf Linnemann and Mukund Sharma) participated in this field workshop. A report has been published in *Episodes*.
- The Subcommission sponsored and organized the 2014 Subcommission field workshop "*International Symposium and Field Workshop on Ediacaran and Cryogenian Stratigraphy*" in South China (June 11-22, 2014). Nearly 60 scientists from Australia, Brazil, China, Germany, Mongolia, Russia, UK, and USA participated in this field workshop. Chair-person Shuhai Xiao, Vice-Chair Dmitry Grazhdankin, nine other voting members (James Gehling, Ganqing Jiang, Alan J. Kaufman, Guy Narbonne, Graham Shields-Zhou, Chongyu Yin, Xunlai Yuan, Chuanming Zhou, Maoyan Zhu), and six corresponding member (Carlos Alvarenga, Douglas Erwin, Alex Liu, Pengju Liu Konstantin Nagovitsin, Linzhi Gao) participated in this field trip. In addition, several voting and corresponding members of the Cryogenian Subcommission (Carlos Alvarenga, Linzhi Gao, Alan J. Kaufman, Graham Shields-Zhou, Shuhai Xiao, Qirui Zhang, Chuanming Zhou, Maoyan Zhu) participated in this field workshop. A symposium was also organized as part of the field workshop, and there were 31 oral presentations and 20 poster presentations at the symposium. A report has been published in *Episodes*.
- The Subcommission co-sponsored and voting member Jose-Javier Alvaro organized a field workshop on the Ediacaran-Cambrian stratigraphy of Morocco (September 15-24, 2014; Ouarzazate, Morocco). A special volume entitled "*Geological Evolution of the Ediacaran and Cambrian in the High Atlas and Anti-Atlas Ranges, Morocco*" was published in the October 2014 issue of "*Journal of African Earth Sciences*". Voting members Jose-Javier Alvaro and Chuanming Zhou participated in this field workshop.
- Corresponding member James D. Schiffbauer and Chair-person Shuhai Xiao assembled a *Journal of Paleontology* special issue on the Ediacaran-Cambrian transition (*Journal of Paleontology*, 2014, vol. 88, no. 2).
- Secretary Marc Laflamme and corresponding members James D. Schiffbauer and Simon A.F. Darroch organized a short course on exceptional preservation—"*Reading and Writing the Fossil Record: Preservational Pathways to Exceptional Fossilization*"—at the 2014 Geological Society of America annual meeting. This short course included several papers associated with the Ediacaran/Cambrian transition.
- Voting members Jim Gehling and Guy Narbonne organized a symposium entitled "*Neoproterozoic palaeobiology: preservation, palaeobiology, environments and phylogeny*" at the 4th International Paleontological Congress (September 28 - October 3, 2014; Mendoza, Argentina).
- Secretary Marc Laflamme organized a symposium entitled "*Ediacaran Environments and Ecosystems*" at the 10th North American Paleontological Convention (February 15-18, 2014; Gainesville, Florida). Several voting and corresponding members (Martin Brasier, Mary Droser, James Gehling, Marc Laflamme, Alex Liu, Guy Narbonne, Shuhai Xiao, Xunlai Yuan, Chuanming Zhou) co-authored abstracts or presented talks at this symposium.

2015:

- Two working groups focusing on the Second Ediacaran Stage (SES) and the Terminal Ediacaran Stage (TES) have been officially established. These working groups are chaired by Dr. Chuanming Zhou (SES) and Dr. Guy Narbonne (TES).
- Election of subcommission executives was completed in September 2015. Voting member Guy Narbonne coordinated the voting. On 9/20/2015, Narbonne communicated via email the results to all voting members as well as ICS chair Stan Finney: "All eighteen Voting Members of the ICS Ediacaran Subcommission have cast their ballots, and the result is unanimous support (18-0-0) for the election of Shuhai Xiao as Chair and Dima Grazhdankin as Vice-Chair of the ICS Ediacaran Subcommission for 2016-2020. The executive have indicated that they wish Marc Laflamme to continue in his role as Secretary of the Ediacaran Subcommission."
- The Subcommission organized a symposium "Precambrian Stratigraphy" at STRATI 2015 in Graz. Shuhai Xiao and Graham Shields chaired the symposium. All three executives, both working group leaders, and ten

voting members (Dmitri V. Grazhdankin, Alan Jay Kaufman, Marc Laflamme, Malgorzata Moczydlowska-Vidal, Guy M. Narbonne, Graham A. Shields-Zhou, Shuhai Xiao, Chongyu Yin, Chuanming Zhou, Maoyan Zhu) participated in the symposium.

- An open meeting and a business meeting were held at STRATI 2015 in Graz. A wide range of topics have been discussed at these two meetings, including election of new executives and plans for 2016.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2019)

The Ediacaran Subcommission aims to encourage research that will facilitate a consensus subdivision of the Ediacaran System (circa 635 – 541 Ma).

2016:

- Publication in *Episodes* of a white paper on Ediacaran subdivision and correlation. This will be a guiding document for the Subcommission's work in the next few years.
- Field workshop and symposium in association of Palaeo Down Under 2, to be held at the University of Adelaide in South Australia. The Field Excursion will examine Cambrian and Ediacaran of the Flinders Ranges. The field excursion will help TES working group to assess criteria for the subdivision of correlation of the Terminal Ediacaran Stage.
- Field workshop and symposium in association of 35th IGC, to be held in Cape Town, South Africa. The Field Excursion will examine late Ediacaran successions in southern Namibia. The field excursion will help TES working group to assess criteria for the subdivision of correlation of the Terminal Ediacaran Stage.

2017:

- A field trip to celebrate the 50 year anniversary of the discovery of the Mistaken Point biota is planned for the year 2017. This will be a good opportunity to discuss criteria for the subdivision of the Ediacaran System into series.
- Organize two international field workshops to focus on the second and terminal stages of the Ediacaran System, including a field trip in northern India and one in Oman.
- A vote will be called to decide what criterion or criteria will be the most useful in dividing the Ediacaran System into series and stages (particularly the second and terminal stages of the Ediacaran System).

2018-2019:

- Submission and discussion of formal proposals for Ediacaran Series/Stage GSSP(s);
- Review and vote on Ediacaran Series/Stage GSSP proposals.
- Ratification of Ediacaran Series/Stage GSSP(s).

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

9a Names and Addresses of Current Officers and Voting Members

The Subcommission is organized by an Executive consisting of Chairman, Vice-Chairman and Secretary, who are all Voting Members of the Subcommission. These officers were nominated by the Executive of the predecessor Neoproterozoic Subcommission and appointed by ICS executives in August 2012. There are currently 15 other Voting Members, making a total of 18 voting members. There are currently over 30 additional corresponding members. The Voting Members have been specifically selected for their international reputations, recognized expertise in an area of geoscience relevant to the subcommission, and their willingness to take an active role in the Subcommission's activities. The term of the current executives will end in August 2016. In September 2015, the executives were re-elected to serve a second term in 2016-2020.

Officers

- Chair: Shuhai Xiao (Department of Geosciences, Virginia Tech, Blacksburg, VA 24061, USA; xiao@vt.edu)
- Vice Chair: Dima Grazhdankin (Institute of Petroleum Geology and Geophysics, Koptyug Avenue 3, Novosibirsk 630090, Russia; dima.grazhdankin@googlemail.com)
- Secretary: Marc Laflamme (Department of Chemical and Physical Sciences, University of Toronto Mississauga, 3359 Mississauga Road N., Mississauga, ON L5L 1C6, Canada; marc.laflamme@utoronto.ca)

Voting Members

- Alvaro, Jose-Javier alvarobjj@cab.inta-csic.es Centre of Astrobiology, Spain

• Christie-Blick, Nicholas	ncb@ldeo.columbia.edu	Columbia University, New York, USA
• Gehling, James G.	Jim.Gehling@samuseum.sa.gov.au	South Australian Museum, Australia
• Grazhdankin, Dmitri V.	dima.grazhdankin@gmail.com	Novosibirsk, Russia
• Grey, Kathleen	kath.grey@gmail.com	Perth, Australia
• Jensen, Sören	soren@unex.es	Spain
• Jiang, Ganqing	ganqing.jiang@unlv.edu	University of Nevada Las Vegas, USA
• Kaufman, Alan Jay	kaufman@geol.umd.edu	Maryland, USA
• Laflamme, Marc	marc.laflamme@utoronto.ca	U of Toronto at Mississauga, Canada
• Moczydlowska-Vidal, Malgorzata	malgo.vidal@pal.uu.se	Uppsala, Sweeden
• Narbonne, Guy M.	narbonne@queensu.ca	Queens, Kingston, Canada
• Rai, Vibhuti	vibhutirai@rediffmail.com	Lucknow, India
• Shields-Zhou, Graham A.	g.shields@ucl.ac.uk	University College London, UK
• Xiao, Shuhai	xiao@vt.edu	Virginia Tech, USA
• Yin, Chongyu	chongyuyin@cags.ac.cn	Beijing, China
• Yuan, Xunlai	xlyuan@nigpas.ac.cn	Nanjing, China
• Zhou, Chuanming	cmzhou@nigpas.ac.cn	Nanjing, China
• Zhu, Maoyan	zhumaoyan@gmail.com	Nanjing, China

Corresponding Members (a partial list; membership continues to grow)

• Antcliffe Jonathan	Bristol University, UK
• Boggiani, Paulo César	São Paulo, Brazil
• Butterfield, Nicholas	Cambridge, UK
• Chen, Xiaohong	Wuhan
• Chumakov, Nikolay	Moscow, Russia
• Dermeval Aparecido Do Carmo	Brazil
• Erwin, Douglas	Smithsonian NMNH, USA
• Bernd-D. Erdtmann	Germany
• Evans, David A.D.	Yale University, USA
• Fedonkin, Mikhail	Moscow, Russia
• Frimmel, Hartwig	Wuerzburg, Germany
• Gaucher, Claudio	Montevideo, Uruguay
• Hoffmann, Karl-Heinz	Windhoek, Namibia
• Hofmann, Mandy	Germany
• Jenkins, Richard	Adelaide, Australia
• Knoll, Andrew H.	Harvard University, USA
• Kochnev, Boris	Novosibirsk, Russia
• Linnemann, Ulf	Dresden, Germany
• Liu, Alex	Cambridge, UK
• Liu, Pengju	Beijing
• Melezhik, Victor	Norway
• Nagovitsin, Konstantin	Novosibirsk, Russia
• Patricia Vickers-Rich	Monash University, Australia
• Pokrovskii, Boris G.	Russia
• Rainbird, Robert	Ottawa, Canada

• Schiffbauer, James D.	University of Missouri, USA
• Semikhatov, Mikhail A.	Moscow Russia
• Sergeev, Volodya	Russia
• Sperling, Erik	Harvard University, USA
• Van Kranendonk, Martin	University of New South Wales
• Detlef Walde	Universidade de Brasília
• Walter, Malcolm	Sydney, Australia
• Wang, Xiaofeng	Wuhan
• Sun, Weiguo	Nanjing, China

9b List of Working (Task) Groups and their officers

Task Group to investigate the Ediacaran-Cambrian boundary, led by voting member Dr. Maoyan Zhu, with Shuhai Xiao and Guy Narbonne as members;
SES (Second Ediacaran Stage) working group: chaired by Chuanming Zhou to focus on the Second Stage of the Ediacaran System.
TES (Terminal Ediacaran Stage) working group: led by Guy Narbonne (Chair) and Malgorzata Moczydlowska-Vidal (secretary) to focus on the Terminal Stage of the Ediacaran System.

9c Interfaces with other international project
Members of the Ediacaran Subcommission 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 **Patricia Vickers-Rich** (School of Geosciences, Monash University, Melbourne, Victoria), **Mikhail Fedonkin** (Paleontological Institute, Russian Academy of Sciences, Moscow, Russia), **Guy Narbonne** (Dept of Geological Sciences and Engineering, Queens University, Kingston, Ontario, Canada), **Jim Gehling** (South Australian Museum, South Australia), and **Alan Jay Kaufman** (Department of Geology, University of Maryland).
- ICDP GRIND (***G**eological **R**esearch through **I**ntegrated **N**eoproterozoic **D**rilling*) led by **D. J. Condon** (British Geological Survey, Nottingham, UK), **P. Boggiani** (Instituto de Geociências, Universidade de São Paulo, São Paulo, Brazil), **D. Fike** (Department of Earth & Planetary Sciences, Washington University, USA), **G. P. Halverson** (Department of Earth & Planetary Sciences, McGill University, Montreal, Canada), **S. Kasemann** (Department of Geosciences, University of Bremen, Bremen, Germany), **A. H. Knoll** and **F. A. Macdonald** (Department of Earth & Planetary Sciences, Harvard University, Cambridge, USA), **A. R. Prave** (Department of Earth & Environmental Sciences, University of St Andrews, St Andrews, UK), and **M. Zhu** (Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China).

SUBCOMMISSION ON CRYOGENIAN STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY

Subcommission on Cryogenian Stratigraphy

Submitted by:

Dr. Graham Shields-Zhou, Chair
Department of Earth Sciences, University College London, Gower Street, London WC1E 6BT, UK
Tel. +44 207 679 7821
Email: g.shields@ucl.ac.uk

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 Cryogenian stratigraphy and a range of multidisciplinary activities directed at better understanding Earth system evolution during the Cryogenian Period (c.720 – c.635 Ma). Its priority is the unambiguous definition, by means of a global stratotype section and points (GSSP), of a hierarchy of chronostratigraphic units that provide the framework for global correlation of the Cryogenian Period.

Goals

The main goals of this Subcommission are:

(a) To establish for the first time a rock-based GSSP for the base of the Cryogenian that will also serve as the top of the underlying Tonian.

(b) To search for criteria useful in the subdivision and correlation of Cryogenian (*and upper Tonian*) strata;

(c) To define the basal boundaries of Cryogenian epochs (series) and ages (stages) through the establishment of GSSPs;

(d) To facilitate international collaboration in research on Cryogenian stratigraphy and Earth history through subcommission sponsored field trips, workshops, and meetings.

In addition, the Subcommission is committed to expanding communication to a wider public through grassroots initiatives to conserve important Neoproterozoic geological sites, to support International Geoscience Programme projects, and to encourage the wider dissemination of research findings on the internet, in popular science publications, and through public lectures.

Fit within IUGS Science Policy

The objectives of the Subcommission relate to three 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 Cryogenian Period;
(2) The establishment of frameworks and systems to encourage international collaboration in understanding the evolution of the Earth during the middle Neoproterozoic (*c.850-c.635 Ma*), in cooperation with the Precambrian Subcommission (Martin Van Kranendonk, chair) and Ediacaran Subcommission (Shuhai Xiao, chair).
(3) Working towards an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs and important fossil localities. This relates to, *inter alia*, the IUGS Geosites Programme.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

- The third Cryogenian Subcommission field workshop took place in Death Valley, California, USA, in December 2014, attended by 5 voting and several corresponding members. The field trip was led by Francis Macdonald (Harvard University).
- A Subcommission meeting was held on December 15, 2014, in Death Valley, in conjunction with the field trip where it was concluded that the most appropriate criterion for defining the base of the Cryogenian GSSP would be the lowermost occurrence of unambiguously glaciogenic strata. In this regard, the best candidate for the GSSP might be in South China, where the onset of glaciation is recorded in apparently continuous deep

water sediments. This questions earlier criteria proposed by the Neoproterozoic Subcommission that emphasized potential for isotopically-based correlation, which implied that the Cryogenian GSSP could only be placed within a carbonate-rich, platformal succession that would most likely underlie an erosional unconformity, marking the onset of glaciation. Although the onset of glaciation is likely to vary from region to region, glacial influence was argued to be the most reliable way to establish a recognizable and consistent system boundary, with strata below unambiguously belonging to the Tonian, and strata above belonging to the Cryogenian. Email discussions continued thereafter among the entire voting membership.

3B LIST OF MAJOR PUBLICATIONS OF SUBCOMMISSION WORK (BOOKS, SPECIAL VOLUMES, KEY SCIENTIFIC PAPER)

Shields-Zhou, G.A, Porter, S. and Halverson, G.P. (accepted for publication) A new rock-based definition for the Cryogenian Period (circa 720 – 635 Ma). *Episodes*.

3c. PROBLEMS ENCOUNTERED IN 2015

The likely cost of subcommission field excursions to potential GSSP localities in Svalbard, NW Canada, Yukon and Greenland, as well as related logistic difficulties appears to make such excursions prohibitive for the near future. For this reason, the subcommission has so far focused on more easily accessible regions (Scotland (2013), China (2014), USA (2015) and Namibia (2017) and on consolidating new and existing data relevant to the Tonian-Cryogenian boundary.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2016)

- To compile a special volume of Precambrian Research to provide overviews of each potential GSSP section and relevant methodologies (chemostratigraphy, palaeomagnetism, geochronology, biostratigraphy), addressing their suitability for defining the future GSSP. Submission deadline: November 2016.
- To construct an interactive, updated website for the Cryogenian Subcommission listing new publications and relevant meetings. Deadline February 2016.

4b Specific GSSP Focus for 2016

The basal GSSP for the Cryogenian System will remain the priority of the subcommission for the foreseeable future. Criteria for definition of the GSSP will be revisited during the course of 2016.

5. SUMMARY OF EXPENDITURES IN 2015:

Carried forward from 2014	US $ 1347
ICS	US $ 2000

EXPENDITURE none

Total US $ 0

To be carried forward to 2016 US $ 3347

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2014

None. (The next planned field excursion will now take place in Namibia in 2017. A portion of unspent funds may be used in 2016 for website development, while other subcommission-related activities may be considered for funding.)

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)

2011:

- International conference on Neoproterozoic Sedimentary Basins and a Neoproterozoic Subcommission workshop on Ediacaran paleobiology (Novosibirsk, 30 July – 1 August, 2011), followed by a field excursion to the East Sayan Mountains (2 – 14 August, 2011).
- Publication of ***The Geological Record of Neoproterozoic Glaciation*** (editors: Arnaud, Halverson and Shields-Zhou; Geological Society of London Memoir 36: ISBN 978-1-86239-334-9).

- Ballot on dissolution of Neoproterozoic Subcommission and establishment of two separate subcommissions for the Cryogenian and Ediacaran periods, respectively.

2012:

- The Cryogenian Subcommission was established in August 2012 at the 34th IGC in Brisbane, Australia and launched in September 20th, 2012 at the Geological Society of London attended by 10 voting members and various corresponding members.
- September 19–23, 2012: voting members and corresponding members contributed to a large interdisciplinary 'Fermor' meeting in London – '***The Neoproterozoic Era: evolution, glaciation, oxygenation***'.
- ***The Geologic Time Scale 2012*** was published, including for the first time a full chapter on the Cryogenian Period.

2013:

- International Association of Sedimentologists Meeting in Manchester, UK, September 5th: **The geological record of climatic, atmospheric and environmental changes in the Neoproterozoic Era** (Fairchild, Spence)
- The first Cryogenian Subcommission field workshop took place in the Dalradian Supergroup, Scotland, in September 2013, attended by 6 voting and 4 corresponding members.
- A Subcommission Meeting was held September 9th, 2013, in Oban, Scotland, in conjunction with the Dalradian field workshop, at which a revised numerical age for the start of the Cryogenian was proposed that would more closely correspond to the likely level of the future rock-based GSSP. There was broad support for an age of 720 Ma with no objections from any voting member following email discussion.
- Creation of a Subcommission Google Group, which allows discussion and easy dissemination of information among voting members and other interested scientists.

2014:

- Field workshops and symposia in South China, June 2014, with a focus on the search for appropriate criteria for the subdivision of the Ediacaran Period and base of the Cryogenian. Subcommission meeting in Guilin.
- October 21, 2014. Geological Society of America annual meeting in Vancouver, BC. Topical Session: **The Tonian–Cryogenian World** (Riedman, Sperling, Porter, chairs).
- From December 12–14, Francis Macdonald led a pre-AGU AGU/Cryogenian Subcommission/GRIND fieldtrip in the Saddle Hills, Death Valley.
- December 18, 2014. American Geophysical Union Fall Meeting, San Francisco. Session: **Neoproterozoic Glaciation: Interrogation of Data and Models** (Fairchild, Macdonald, Bao, chairs).
- Ratification of interim 'calibrated' age for the base of the Cryogenian of 720 Ma (revised from the now obsolete GSSA age of 850 Ma).

2015:

- **The Neoproterozoic Earth System: Records from an Earth in Transition**. Joint Assembly Meeting, Montreal (Sperling, Strauss, chairs), May 7.
- Geological Society of America annual meeting in Baltimore, MD. November 4, 2015, session: **Deconstructing Rodinia: Neoproterozoic-Cambrian Geologic Evolution of Laurentia's Margins** (Merschat, Holme-Denama chairs). November 2, 2015, poster session: **Fossils of the Neoproterozoic**.
- 'Precambrian Stratigraphy and Earth System History' session at the STRATI 2015 meeting in Graz (July 19-23, 2015).
- Shields-Zhou, G.A, Porter, S. and Halverson, G.P. (accepted for publication) A new rock-based definition for the Cryogenian Period (circa 720 – 635 Ma). *Episodes*.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2016-2019)

Publish a special volume of overviews of candidate sections to guide discussions and eventual establishment of rock-based Cryogenian GSSP by the 2020 IGC. Thereafter, focus on the establishment of subdivisions within the newly defined Cryogenian.

2016-2017:

- Special session at the Geological Association of Canada annual meeting in Whitehorse, Yukon
- Special volume in Precambrian Research….

- Review and vote on Cryogenian proposals.

2017-2020:

- Ratification of Cryogenian GSSP.

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

9a Names and Addresses of Current Officers and Voting Members

The Subcommission is organized by an Executive consisting of Chairman, Vice-Chairman and Secretary, who are all Voting Members of the Subcommission. These officers were first appointed by ICS executives in August 2012 and reappointed in November 2015. There are currently 15 other Voting Members, making a total of 18 voting members. There are also additional corresponding members.

Officers

- Chair: Graham Shields-Zhou (Department of Earth Sciences, University College, Gower Street, London WC1E 6BT, UK; g.shields@ucl.ac.uk)
- Vice Chair: Galen P. Halverson (Department of Earth and Planetary Sciences, McGill University, 3450 University St., Montreal, QC H3A 0E8, Canada; galen.halverson@mcgill.ca)
- Secretary: Susannah Porter (Department of Earth Science, University of California at Santa Barbara, Santa Barbara, CA 93106-9630, USA; porter@geol.ucsb.edu)

Voting Members

1)	David A.D. Evans	Yale University, USA
2)	Hartwig Frimmel	University of Würzburg, Germany
3)	Karl-Heinz Hoffmann	Geological Survey of Namibia
4)	Andrew H. Knoll	Harvard University, USA
5)	Robert Rainbird	Geological Survey of Canada
6)	Carol Dehler	Utah State University, USA
7)	Vladimir Sergeev	Russian Academy of Sciences, Moscow, Russia
8)	Shuhai Xiao	Virginia Tech, USA
9)	Carlos de Alvarenga	University of Brasilia, Brazil
10)	Mukund Sharma	Birbal Sahni Institute, Lucknow, India
11)	Gao Linzhi	Chinese Academy of Geological Sciences, China
12)	Anton Kuznetsov	Russian Academy of Sciences
13)	Ian Fairchild	University of Birmingham, UK
14)	Chuanming Zhou	Nanjing Institute of Geology and Palaeontology, China
15)	Malcolm Wallace	University of Melbourne, Australia

9b List of Working (Task) Groups and their officers

No Working (Task) Groups are formed yet.

9c Interfaces with other international projects
Members of the Cryogenian Subcommission are lead investigators and officers in a number of related international projects, including:
IGCP 587 (*Of Identity, Facies and Time, the Ediacaran Puzzle: Factors Controlling the Observed Diversity and reality of the Relationships of the Earliest Metazoans*).
GRIND initiative (*Geological Research through Integrated Neoproterozoic Drilling*)

SUBCOMMISSION ON PRECAMBRIAN STRATIGRAPHY

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY

Subcommission on Precambrian Stratigraphy

- **Not yet submitted**
-

SUBCOMMISSION ON STRATIGRAPHIC CLASSIFICATION

ANNUAL REPORT 2015

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Stratigraphic Classification (ISSC)

submitted 1st December 2015 by:

Prof. Brian R. Pratt[1]
Chair, ISSC
Dr. Maria Rose Petrizzo[2]
Secretary, ISSC

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. Its future goal is a revision of the celebrated International Stratigraphic Guide in order to keep it current but also open to new approaches.

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. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2015

ISSC NEWSLETTER

ISSC Newsletter 19 is in preparation and will be distributed in December 2015. It advertises the status of review papers on the subdisciplines of Stratigraphy. Newsletters and other documents are available on the ISSC website: http://users.unimi.it/issc

CONFERENCE PARTICIPATION

ISSC organized the session SSP2.1.1 Earth Systems History – the Need for Integrated Stratigraphy at the EGU General Assembly 2015 (12–17 April 2015, Vienna, Austria).

The session convened by Maria Rose Petrizzo, Helmut Weissert, Brian Pratt, Werner Piller, Jan Zalasiewicz was a great success and with this motivation it inspired a new session in the EGU2016 program. Stratigraphic themes were suggested as topical sessions for STRATI 2015 and a number of these were adopted.

PROJECT: NEW DEVELOPMENTS IN STRATIGRAPHIC CLASSIFICATION

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 who were 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 of these review articles 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 *Newsletters on Stratigraphy* where the various review articles are being published. This series of articles falls under the umbrella of "New Developments on Stratigraphic Classification." After all the various review articles in the coordinated series are published, 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 2016 would be a fitting tribute to the fine achievements made by IUGS in so many stratigraphic matters.

STATE OF THE ART (as of December 2015)

Papers published:

Cita, M. B., 2007. New developments in stratigraphic classification. A project of the International Subcommission 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.

Catuneanu, O., Galloway, W.E., Kendall, C.G.St.C., Miall, A.D., Posamentier, H.W., Strasser, A., and Tucker, M.E., 2011. Sequence stratigraphy: Methodology and nomenclature: Newsletters on Stratigraphy, Vol. 44(3), p. 173–245.

Papers in progress:

BIOSTRATIGRAPHY

A new Working Group has been appointed, owing to retirement/commitments of previous members.

Leader: **Maria Rose Petrizzo**, Italy, mrose.petrizzo@unimi.it
Mike Melchin, Canada, mmelchin@stfx.ca
Yuri Gladenkov, Russia, gladenkov@ginras.ru
Brian Pratt, Canada, brian.pratt@usask.ca

Outline in preparation.

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.
Opinion piece was published in *GSA Today* and favourably received by readership.

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, awaiting final contributions from co-authors.

PROBLEMS ENCOUNTERED IN 2015

The allocation for 2014 ($1000) was devoted to maintaining the website, assembling the newsletter, and subsidizing the chair's attendance at the EGU meeting in Vienna to attend the sponsored special session and meet with secretary to plan for ISSC's role in STRATI 2015, and travel to Graz for STRATI. Fortunately, Vice-Chairs Zalasiewicz and Weissert and Secretary Petrizzo were able to attend the EGU because they had separate funding, and Vice-Chair Weissert and Secretary Petrizzo could attend STRATI for the same reason.

In the meantime, progress is somewhat slow but sure, and headway is being made in the preparation of the three remaining chapters on facets of Stratigraphy. The Lithostratigraphy chapter will be ready for submission early in 2016.

4. OBJECTIVES AND WORKPLAN FOR NEXT YEAR (2016):
Final drafts of the following summary papers:
- *Biostratigraphy*
- *Chronostratigraphy*
- *Lithostratigraphy*

5. SUMMARY OF EXPENDITURES IN 2015:
I. INCOME

2015 ICS subvention	$1000

II. EXPENDITURES

Newsletter preparation, website maintenance, EGU and STRATI	$1000

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2016

ISSC Newsletter 21, Annual Report and website maintenance	$ 1000
Subsidies to help attendance to IGC and working group meeting for manuscripts	$ 4000
Total request	$ 5000

Rationale—The remaining manuscripts should be prepared in 2016. 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.

Potential funding sources outside IUGS—The Subcommission 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.

APPENDIX

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2011-2015)
See Accomplishments in ISSC Annual Reports 2011–2015 as well as relevant newsletters.

8. OBJECTIVES AND WORK PLAN FOR NEXT 2 YEARS (2016–2019)
1. All the remaining review papers on the various branches of Stratigraphy will have been submitted and printed over this period.
2. The series of papers may form the core of a textbook. Publication details, including arrangements with Nägeli & Obermuller, Stuttgart (the publishers of *Newsletters on Stratigraphy*) remain to be worked out.
3. ISSC will take the initiative to encourage special sessions and symposia at conferences that advance stratigraphic principles, in collaboration with other ICS subcommissions. A session entitled Earth Systems History – the Need for Integrated Stratigraphy will be held at the EGU General Assembly 2016 (EGU 2016), 17–22 April 2016, Vienna, Austria.
4. ISSC will continue to participate in GSSP discussions with ICS subcommissions.
5. ISSC continues to interface with national stratigraphic commissions although only in an advisory capacity.
6. ISSC is updating its membership list, in order to eliminate dormant colleagues and incorporate new ones.
7. Potential new executive members will be canvassed from stratigraphically disposed colleagues.
8. 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.

9. ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

Subcommission officers for 2012-2016 (renewed from 2008-2012)

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INTERFACES WITH OTHER INTERNATIONAL PROJECTS
ISSC has always been directly or indirectly linked to big international projects such as deep-sea drilling 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.