



International Commission on Stratigraphy

ANNUAL REPORT 2018

1. TITLE OF CONSTITUENT BODY

The International Commission on Stratigraphy (ICS)

Summary and compilation of subcommission reports submitted jointly by:

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2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

Objectives

The International Commission on Stratigraphy (ICS) is a body of expert stratigraphers founded for the purpose of promoting and coordinating long-term international cooperation and establishing standards in stratigraphy. Its principal objectives are:

- (a) Establishment and publication of a standard global stratigraphic time scale and the preparation and publication of global correlation charts, with explanatory notes.
- (b) Compilation and maintenance of a stratigraphic database centre for the global earth sciences.
- (c) Unification of regional chronostratigraphic nomenclature by organizing and documenting stratigraphic units on a global database.
- (d) Promotion of education in stratigraphic methods, and the dissemination of stratigraphic knowledge.
- (e) Evaluation of new stratigraphic methods and their integration into a multidisciplinary stratigraphy.
- (f) Definition of principles of stratigraphic classification, terminology and procedure and their publication in guides and glossaries.

Fit within IUGS Science Policy

The objectives satisfy the IUGS mandates 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 geology worldwide.
- Attracting competent students and research workers to the discipline.
- Fostering an increased awareness among individual scientists worldwide of what related programmes are being undertaken.

In particular, the current objectives of ICS relate to three main aspects of IUGS policy:

- (a) Development of an internationally agreed scale of chronostratigraphic units, fully defined by Global Stratotype Sections and Points (GSSPs) where appropriate and related to a hierarchy of units to maximize resolution throughout geological time.
- (b) Promotion of international consensus on stratigraphic classification and terminology, which is essential for advancement of earth-science research and education.
- (c) Establishment of frameworks and systems to encourage international collaboration in understanding the evolution of the Earth.

3. ORGANISATION

ICS is organized in two types of constituent bodies: Subcommissions for longer-term study, and Executive Task Groups (working groups) for more limited, shorter-term tasks. ICS is managed by the Executive Committee, which consists of elected and appointed officers. The current structure of ICS consists of the Executive Committee and 16 Subcommissions that deal with the major chronostratigraphic units and aspects of stratigraphic classification. The ICS Executive has initiated two new Executive Task Groups on geochronology and web-page development. The web-age task group has produced revisions to the ICS website and encouraged the rejuvenation of websites for several subcommissions. Members are being recruited for the geochronology task group under the leadership of Dr Brad Cramer.

Subcommissions:

Quaternary
 Neogene
 Paleogene
 Cretaceous
 Jurassic
 Triassic
 Permian
 Carboniferous
 Devonian
 Silurian
 Ordovician
 Cambrian
 Ediacaran
 Cryogenian
 Precambrian
 Stratigraphic Classification

- (a) Establishment and publication of a standard global stratigraphic time scale and the preparation and publication of global correlation charts, with explanatory notes.
- (b) Compilation and maintenance of a stratigraphic database centre for the global earth sciences.
- (c) Unification of regional chronostratigraphic nomenclature by organizing and documenting stratigraphic units on a global database.
- (d) Promotion of education in stratigraphic methods, and the dissemination of stratigraphic knowledge.

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES

The reports of each Subcommittee are appended to this ICS summary compilation. The subcommittees of ICS together approximately 350 titular members. When the corresponding members of Subcommittees are added, several thousand stratigraphers worldwide participate in the activities of ICS, and several thousand more over the 50-year history of ICS. In addition, ICS maintains contacts with many national stratigraphic committees. The members of the Full Commission (i.e. the 3 voting members of the Executive and the chairs of the 16 Subcommittees) represent eight countries: United Kingdom (6 members), Canada (1), Italy (3), USA (4), China (2), Russia (1), Austria (1) and Czechia (1). Among all subcommittee officers and the ICS executive, 16 countries are represented: United Kingdom (8 members), Canada (4), USA (9), China (5), Italy (7), Australia (1), Spain (2), Russia (3), Czech Republic (2), France (2), Germany (3), Brazil (2), Sweden (1), Poland (1), Austria (3) and Norway (1). The voting members of ICS, i.e. all voting members of all subcommittees who replied to our request to report include officers, represent over 39 countries: USA (53), China (32), United Kingdom (29), Russia (30), Canada (16), Germany (20), Italy (28), Australia (13), Spain (12), France (9), Japan (8), New Zealand (6), Argentina (6), Belgium (6), Netherlands (5), Brazil (8), Poland (7), Czech Republic (8), Denmark (5), Sweden (6), Switzerland (3), Hungary (3), India (4), South Africa (2), Austria (4), Tunisia (2), Bolivia (1), Guyana (1), Swaziland (1), Estonia (2), Finland (2), Iran (2), Namibia (1), Norway (1), Portugal (1), Turkey (1), Korea (1), Slovenia (1) and Jordan (1). The ICS is proud of its gender equality across all the subcommittees. ICS and its subcommittees maintain websites; the URLs of the websites are as follows:

Websites:

ICS main site:	www.stratigraphy.org
Quaternary:	www.quaternary.stratigraphy.org
Neogene:	www.geo.uu.nl/SNS
Paleogene:	wzar.unizar.es/isps/
Cretaceous:	www.univ-brest.fr/geoscience/?ISCS/
Jurassic:	www.jurassic.stratigraphy.org
Triassic:	paleo.cortland.edu/sts/
Permian (newsletter):	www.permian.stratigraphy.org
Carboniferous	www.stratigraphy.org/carboniferous/
Devonian:	www.unica.it/sds/
Silurian:	www.silurian.stratigraphy.org
Ordovician:	www.ordovician.stratigraphy.org
Cambrian:	www.palaeontology.geo.uu.se/ISCS/ISCS_home.html

Ediacaran: www.paleo.geos.vt.edu/Ediacaran/
Cryogenian: being established
Precambrian: www.precambrian.stratigraphy.org
Stratigraphic Classification: issc.uni-graz.at/

3a. ICS Executive Officers for 2016-2020:

Chair: David Harper (Durham, England)

Vice-Chair: Brian Huber (Washington, USA)

Secretary General: Philip Gibbard (Cambridge, England)

Non-voting officers:

Information Officer: Dr Junxuan Fan (Nanjing, China)

Graphics Officer: Dr Kim Cohen (Utrecht, Netherlands)

ICS Subcommission officers:

A full listing of current officers (with addresses) is at the end of this main ICS report. The individual subcommission reports include a listing of all voting members (typically 20 in each subcommission).

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

Only a very few of the subcommissions have formal financial contributions from external sources other than IUGS (through ICS), and they are very limited and listed in the individual reports. Some activities that are associated with ICS goals, such as distributing charts of the Geological Time Scale and placing this information onto public websites, have received some minimal support from private companies and professional organizations. Informally, every officer and member of ICS donates their own time, office space, institutional facilities, and other components to the activities of the organization. No officer nor executive receives any salary compensation from IUGS or other ICS funds. Indeed, most officers personally contribute towards their own travel and operational expenses.

5. INTERFACES WITH OTHER INTERNATIONAL PROJECTS

Active and highly fruitful interfaces with many international organizations and geo-projects are a standard feature of ICS activities. ICS maintains a strong link with the International Quaternary Association (INQUA) Commission on Stratigraphy regarding the stratigraphy of the Quaternary, and with the Commission for the Geological Map of the World (CGMW) in Paris regarding standardization of chronostratigraphy and its colour scheme on charts, as well as producing the ICS International Chronostratigraphic Chart. In addition, ICS is collaborating with the IUGS Commission on Geoscience Information (CGI) as it develops GeoSciML as an interchange format for geoscience data. ICS subcommissions are traditionally affiliated with a considerable number of IUGS and IGCP activities. For example, ICS

members lead or participate or have participated in numerous, active IGCP projects: e.g. 572, 575, 580, 587, 591, 596, 632, 653 and 655, and others serve on IGCP national committees and the scientific board. ICS members maintains active links with international research groups, including The Micropalaeontology Society (TMS), the North American Micropaleontology Society (NAMS), International Nannoplankton Association (INA) and the Association of American Stratigraphic Palynologists (AASP), and international paleontological research groups on Graptolites, Conodonts, Ammonites, Radiolarians (Interrad), Nannofossils, Foraminifers, etc., and many ICS members serve on national stratigraphic commissions and as editors of journals. There are close links between many ICS stratigraphers and the International Ocean Drilling Project (IODP). ODP cores routinely test the global correlation potential of a great number of bio-events since the Jurassic, and this record is vital to develop integrated timescales at several scales of resolution, and global paleo-climate models. The designation of GSSPs necessitates close interaction with local and international groups concerned with conservation, such as UNESCO (Geoparks Program), IUGS (Geosites Program) and ProGEO (Geosites and Geoparks initiatives).

6. CHRONOSTRATIGRAPHIC STAGE AND SERIES NAMES AND DEFINITIONS ESTABLISHED IN ICS

Quaternary:

- Base Meghalayan Stage (=Base Upper Holocene Subseries)
- Base Northgrippian Stage (=Base Middle Holocene Subseries)
- Base Greenlandian Stage (=Base Lower Holocene Subseries)
- Base Holocene Series
- Base Calabrian Stage
- Base Gelasian Stage (= Base Pleistocene Series and Base Quaternary System)

Neogene:

- Base Piacenzian Stage
- Base Zanclean Stage (= Base Pliocene Series)
- Base Messinian Stage
- Base Tortonian Stage
- Base Serravallian Stage
- Base Aquitanian Stage (= Base Miocene Series and Base Neogene System)

Paleogene:

- Base Chattian Stage
- Base Rupelian Stage (= Base Oligocene Series)
- Base Lutetian Stage
- Base Ypresian Stage (= Base Eocene Series)
- Base Thanetian Stage
- Base Selandian Stage
- Base Danian Stage (= Base Paleocene Series and Base Paleogene System)

Cretaceous:

- Base Maastrichtian Stage
- Base Santonian Stage
- Base Turonian Stage
- Base Cenomanian Stage (=Base Upper Cretaceous Series and Base

Cretaceous System)

Jurassic:

Base Bathonian Stage
 Base Bajocian Stage
 Base Aalenian Stage (= Base of Middle Jurassic Series)
 Base Toarcian Stage
 Base Pliensbachian Stage
 Base Sinemurian Stage
 Base Hettangian Stage (= Base Lower Jurassic System and Base Jurassic Series)

Triassic:

- Base Carnian Stage (= Base Upper Triassic System)
- Base Ladinian Stage
- Base Induan Stage (= Base Triassic System)

Permian:

- Base Changhsingian Stage
- Base Wuchiapingian Stage (= Base Lopingian Series)
- Base Capitanian Stage
- Base Wordian Stage
- Base Roadian Stage (= Base Guadalupian Series)
- Base Sakmarian Stage
- Base Asselian Stage (= Base Cisuralian Series and Base Permian System)

Carboniferous:

- Base of Bashkirian Stage (= Base Lower Pennsylvanian Series and Base Pennsylvanian Subsystem)
- Base Viséan Stage
- Base Tournaisian Stage (= Base Lower Mississippian Series and Base Mississippian Subsystem and Base Carboniferous System)

Devonian:

- Base Famennian Stage
- Base Frasnian Stage (= Base Upper Devonian Series)
- Base Givetian Stage
- Base Eifelian Stage (= Base Middle Devonian Series)
- Base Emsian Stage
- Base Pragian Stage
- Base Lochkovian Stage (= Base Lower Devonian Series and Base Devonian System)

Silurian:

- Base Pridoli Series
- Base Ludfordian Stage
- Base Gorstian Stage (= Base Ludlow Series)
- Base Homerian Stage
- Base Sheinwoodian Stage (= Base Wenlock Series)
- Base Telychian Stage
- Base Aeronian Stage
- Base Rhuddanian Stage (= Base Llandovery Series and Base Silurian System)

Ordovician:

- Base Hirnantian Stage
- Base Katian Stage
- Base Sandbian Stage (= Base Upper Ordovician Series)
- Base Darriwilian Stage
- Base Dapingian Stage (= Base Middle Ordovician Series)
- Base Floian Stage
- Base Tremadocian Stage (= Base Lower Ordovician Series and Base Ordovician System)

Cambrian:

Base Jiangshanian Stage
Base Paibian Stage (= Base Furongian Series)
Base Guzhangian Stage
Base Drumian Stage
Base Wuliuan Stage (= Base Miaolingian Series)
Name Terreneuvian Series
Base Fortunian Stage (= Base Terreneuvian Series and Base Cambrian System)

Neoproterozoic:

Base Ediacaran System

7. CHIEF ACCOMPLISHMENTS IN 2018

Full commission

- 2018 version of ICS Chronostratigraphic Chart, which includes revised numerical ages, was posted on the ICS website (there were about 8 versions of the chart in 2018).
- Several authors, university professors and other educators, and professional societies were granted permission to use and reproduce the ICS International Chronostratigraphic Chart in their productions.
- The GSSP for the base of the Cambrian Wuliuan Stage and the Miaolingian Series was ratified by IUGS in June 2018. The article will be published in *Episodes* in 2019.
- The GSSP for the base of the Permian Sakmarian Stage was ratified by IUGS in July 2018. The article will be published in *Episodes* in 2019.
- The GSSPs for the base of the Holocene into the Greenlandian, Northgrippian, and Meghalayan stages and their respective subseries/subepochs were ratified by IUGS in June 2018. The article was published in *Episodes* in late 2018.
- The ICS Chair (D. Harper) and Secretary-General (P. Gibbard) were interviewed by journalists of several different publications and television regarding consideration of the 'Anthropocene Epoch' by ICS following publication of the Holocene divisions.
- Also concerning the Holocene Subdivisions, record 'Twitter' responses were received following publication of a press release compiled by Professor Stanley Finney (IUGS Secretary General) following announcement of ratification of the Holocene divisions.

Quaternary Subcommission

- Subdivision of the Holocene Series/Epoch into the Greenlandian, Northgrippian, and Meghalayan stages and their respective subseries/subepochs, defined by an existing GSSP (the base of the Holocene) and two new GSSPs, was ratified by the IUGS EC on 14 June, 2018. This set of proposals was published as follows:

News of this subdivision has been reported widely in the international media, drawing significant attention to the important work of the ICS/ IUGS. The GSSP for the Meghalayan Stage is in a speleothem and as such is the first

GSSP capable of being displayed in a museum without melting! It will be showcased at the 36th International Geological Congress in Delhi in 2020.

- Chiba section approved by SQS to serve as GSSP for the Chibanian Age/Stage and Middle Pleistocene Subseries/Subepoch. The Chiba proposal passed scrutiny by high-level Japanese national committees. Voting within SQS concluded on 16 November, 2018. The proposal received the following votes: 19 in favour, 2 against, 1 abstain. Following a recent amendment to the ICS statutes whereby abstentions do not count towards the total used for determining percentages, the proposal was passed by the SQS voting membership with 90.5% and hence a clear supermajority. All 22 members of SQS returned their ballot forms: 20 in favour, 1 against; approved by a supermajority of 95%. The Chiba proposal will be submitted to ICS for approval in 2019 after minor revision. If the Chiba section is ratified, it will be the first GSSP to be hosted by Japan. There is already substantial media interest in this prospect.

This follows SQS voting on November 8, 2018 on the following proposals: 1) formalize the Lower/Early Pleistocene Subseries/Subepoch comprising the Gelasian Stage/Age and the superjacent Calabrian Stage/Age, at the Monte San Nicola GSSP. 20 in favour, 1 against. Approved by a supermajority of 95%. 2) formalize the term Middle Pleistocene. 20 in favour, 1 against. Approved by a supermajority of 95%. 3) formalize the terms Upper/Late Pleistocene. 19 in favour, 2 against. Approved by a supermajority of 90.5%. These three proposals are therefore approved by supermajority and will be submitted to ICS before the end of the year.

- The Anthropocene Working Group held an international workshop on October 6–8 at the Max Planck Institute for Chemistry in Mainz, Germany. It was well attended (42 participants, including Phil Gibbard as AWG member and Secretary General of ICS) and saw numerous presentations during the course of two days including two talks on prospective GSSP sites: one by An Zhiseng on a marine site in China, and another by Martin Head on the meromictic varved deposits of Crawford Lake, southern Ontario.

Neogene Subcommission

- Discussion within some members of the Langhian and Burdigalian GSSP Working Group (chair: Frits Hilgen) is an ongoing process. The main topic for the WG would be to reach a consensus on a proposal for the Langhian GSSP. Unfortunately, most of the WG members did not actively participate in the discussion and this situation is slowing down the accomplishment of a decision. It has been established that taxonomic issues exist as for the historical criterion, the *Praeorbulina* datum. This problem, together with the uncertainty related to the choice of what calcareous plankton event could be associated with the top of C5Cn and useful for the recognition of the Langhian base at low-latitudes, are still debated. Discussion among the few participating members pointed to the option of having the Langhian GSSP defined at the top of C5Cn in the La Vedova section in Italy (Turco et al., 2016), and

encouraged to explore the option of having an auxiliary boundary stratotype, for which two alternatives were suggested. Namely it could be defined in the: i) St. Peter's Pool section (Malta), but the benthic oxygen and carbon stable isotope record and the independent astronomical tuning have been not published yet or ii) a Pacific (I)ODP core, at the equivalent stratigraphic level, with the aim of incorporating the open ocean benthic isotope record and low-latitude calcareous plankton events. Work is in progress for a proposal that will be presented at the next STRATI 2019 meeting in Italy.

- The chair of SNS, as member of the Scientific Committee for the next STRATI 2019 meeting, participated to the preliminary activities related to the approval of the proposed scientific sessions and program. Two sessions related to SNS and to the activity of the Burdigalian-Langhian WG are scheduled during STRATI 2019 meeting.

Paleogene Subcommission

- In 2018 three important works have been published: 1) the ratified proposal of the Chattian GSSP in the journal *Episodes* early 2018. 2) the "Atlas of Oligocene Planktonic Foraminifera" by Wade, Olsson, Pearson, Huber, Berggren (Eds.), a comprehensive re-assessment of the taxonomy, evolutionary relationships, stratigraphic distributions, and paleoecology of planktonic foraminifera from the Oligocene Epoch. This volume completes the trilogy and the work of the Paleogene Planktonic Foraminifera Working Group.
<https://cushmanfoundation.allenpress.com/SpecialPublications.aspx>, chapters open access from UCL:
<https://www.ucl.ac.uk/earthsciences/research/micropalaeontology/research/atlas>, 3) a special monograph on The Cenozoic key sections of the West Kamchatka structural-formational zone edited by Gladenkov Yu.B., Gladenkov A.Yu., Bordunov S.I. et al.. Moscow: Geokart-GEOS, 2018.
- The study on the Barton area (England) has been carried out, pointing out the relevance and problems of these sedimentary successions for Paleogene stratigraphy and timescales. A synthesis by Jerry Hooker and Chris King on "The Bartonian unit stratotype: assessment of its correlation problems and potential" has been published, showing that despite the problems of correlation of the base of the type unit Bartonian, the Bartonian succession in the Hampshire Basin as a whole does have important correlation value. The multidisciplinary results of the Alum Bay section will be submitted by Cotton et al. at the beginning of 2019 in a peer-reviewed journal.
- A sampling campaign has been carried out for the Rio Gor section (Granada province, southern Spain) with the aim of studying a new section for the Paleocene-Eocene transition, and to Monte Vaccaro (Piobbico, central Italy) for the Eocene-Oligocene transition.

Cretaceous Subcommission

- Campanian GSSP: Members of the WG visited the Bottaccione section (possible GSSP candidate) in May 2018 to refine the log and photograph the S/C boundary. Further sampling for magnetostratigraphy and biostratigraphy

was undertaken in September 2018 by G. Muttoni, R. Coccioni and others. Results of these studies will be available in early 2019. Potential GSSP/regional reference sections across the Santonian/Campanian boundary will be studied through a Canada-Japan joint research on Vancouver Island (Hasegawa and Haggart). Haggart and Graham described a new occurrence of the crinoid *Marsupites* from the Upper Cretaceous strata of the Nanaimo Group of Vancouver Island, British Columbia. It is the first occurrence of *Marsupites* in the North Pacific Province and provides an important link with the uppermost Santonian of the European standard stage succession.

- Coniacian GSSP: The WG re-sampled the Salzgitter-Salder section for foraminifera, dinoflagellate, calcareous nannofossil and carbon-isotope studies. Preliminary results of the foraminiferal studies were presented at Forams 2018, manuscript in preparation. The dinoflagellate analysis is in progress. Dinoflagellate analysis of the Turonian-Coniacian boundary succession of the Folwark quarry (SW Poland) has been completed; the results were presented during the 19th Czech-Slovak-Polish Palaeontological Conference & 11th MIKRO 2018 Workshop in Prague, October, 2018. The WG worked on the Turonian-Coniacian succession of the Cauvery Basin, SE India.
- Albian GSSP: Officers of the SCretS contacted the local authorities of the Commune of Arnayon (Département of Drôme) concerning the establishment of a geopark for the protection of the site.
- Aptian GSSP: Discussion was initiated within the WG on the proposed GSSPs and on the questions related to the selection of a GSSP. The proposed chemostratigraphic correlation between Gorgo a Cerbara and the French sections remains problematic. This indicates that there are still problems related to biostratigraphy and chemostratigraphy. The chairs of this WG concluded that the problems have to be discussed during a workshop planned for STRATI 2019.
- Barremian GSSP: The formal proposal for the Barremian GSSP at Rio Argos (Spain) is in preparation and will be presented to the members of the WG in early 2019.
- Hauterivian GSSP: A formal proposal of a GSSP site (La Charce, SE France) has been compiled throughout the first half of 2018 and includes data on biostratigraphy (ammonites, calcareous nannofossils), stable isotope stratigraphy, organic matter and cyclostratigraphy. The protection of the La Charce site is ensured by an Espace Naturel Sensible (ENS) considering the major geological interest of the site.
- Valanginian GSSP: The WG has carried out denser sampling of one of the GSSP candidate sections (Cañada Luenga, SE Spain) for chemostratigraphic analysis better to constrain some biostratigraphic (ammonite, calcareous nannofossils and calpionellids) events.
- Berriasian (J/K boundary) GSSP: In May 2018 the WG held a workshop at Kroměříž (Czech Republic) to discuss the compilation of a shortlist of sites for

consideration as GSSPs. Fiume Bosso and the Vocontian Trough sites were judged to be the best candidates; question marks remain over the localities of Puerto Escano and Kurovice.

- Kilian Group: Results of the 6th meeting of the IUGS Lower Cretaceous Ammonite Working Group (the Kilian Group) (20 August 2017 Vienna, Austria) are now published. The Vienna meeting mainly dealt with the West Mediterranean zonation (standard zonation) and its calibration with the Boreal, Austral and Central Atlantic realms.

Jurassic Subcommittee

- 10th International Jurassic Congress held in San Luis Potosí, Mexico

The 10th International Jurassic Congress was held in San Luis Potosí, Mexico. The congress was co-organized by the Universidad Nacional Autónoma de México (UNAM) and the Universidad Autónoma de San Luis Potosí (UASLP). Preparatory work for the congress started in 2013 and the Organising Committee had expended an enormous amount of time and resources on the organization and a complex set of arrangements. The Congress sessions were all held at the Centro Cultural Bicentenario of the Universidad Autónoma de San Luis Potosí, Mexico. The theme chosen for the Congress was “Marine and Non-marine Jurassic Systems”, organized with a variety of 10 scientific sessions

Altogether, 81 delegates from 16 countries participated in the Congress and 77 oral and 15 poster presentations were given, triggering many interesting debates. Besides the accomplishment of the working group for the base of the Kimmeridgian (a formal proposal was submitted in 2016), progress with the last remaining GSSP definitions, the base-Callovian, base Oxfordian and base-Tithonian are progressing more slowly. A separate session was devoted to the base-Callovian issue, mainly regarding the historical proposed boundary stratotype for the Callovian Stage at Albstadt-Pfeffingen, Germany. Eckhard Mönning reported on current state of this site and the much advanced studies on ammonite fossils. However, strong condensation of the profile is a major concern, and there is still likely a need to find an alternative candidate that meets all the formal and practical requirements.

An extremely important part of any Jurassic Congress is the field excursion programme before and after the Congress. The Jurassic System in Mexico is developed in varied shallow marine, continental, and transitional environments, a wide variety of tectonic regimes including continental rifts, peri-arc marginal basins, epicontinental shelves, and pelagic environments, and the pre- and post-Congress field trips offered an opportunity to advance understanding in all these settings.

A special volume for 15 to 20 works presented at the congress, related to the American Jurassic will be published by Journal of South American Earth Science.

- The 11th Jurassic Congress will be held in Budapest in 2022 (with organization led by Josef Pálfy, Eötvös University, Budapest, Hungary).
- Base Kimmeridgian GSSP Proposal.

Under the leadership of Prof. Andrzej Wierzbowski, the task group for the base of the Kimmeridgian submitted a revised formal proposal to the ISJS on 4th October 2018. Discussion and voting is currently underway.

Triassic Subcommittee

- Norian GSSP candidate; Pizzo Mondello, Sicily: With the publication of Rigo et al. (2018) and Mazza et al. (2018), which deal with the conodont taxonomic issues connected with the Pizzo Mondello candidate the major obstacle in the way of making progress on this boundary has been bridged. In October-November 2018, a new Norian working group was assembled to move forward towards a discussion, report compilation and vote on the two proposed candidates. In addition Sr-isotope work on the Pizzo Mondello section has been published.
- Olenekian GSSP: During a 3-day symposium “International symposium on deep-time environmental & climatic extremes and biotic responses” (Wuhan, Chin, May 22-24, 2018), the IOBWG chaired by Yuri Zakharov (Secretary of the WG) met to discuss the GSSP candidate sections connected with conodont and ammonoid biostratigraphy issues. They also visited the Chaohu candidate section.
- Anisian GSSP: Spencer Lucas has accepted the task of leading a new WG on the Olenekian-Anisian boundary, and has been promoting ideas about possible new candidate sections. Sections in China remain some of the strongest possibilities, but so far have not been formally proposed.

Permian Subcommittee

- A formal proposal of the Sakmarian-base GSSP was submitted to International Commission on Stratigraphy, which was approved by 100% in ICS. This proposal then was submitted to IUGS on June 30, 2018 and formally ratified by IUGS EC on July 21, 2018.
- A volume of Special Publication (The Permian Timescales. Geological Society, London, Special Publication 450) has been published by Lucas, S.G. and Shen, S.Z. (2018). This volume reviews the state of the art of the Permian timescales of the SPS including geochronology, high-resolution biostratigraphy based on various fossil groups (conodonts, fusulinids, brachiopods, plant fossils, radiolarians etc.), magnetostratigraphy etc. and a latest Permian timescale is also presented.
- A Special Issue on Integrative Stratigraphy and timescale of China has been published online on Science China Earth Sciences (Springer) now. This issue includes 13 periods and summarized the advances in stratigraphy and timescale from Ediacaran to Quaternary in China during the last two decades.

The Chinese version will be published in late 2018 and the English version will be published on the first issue in 2019.

- One regular issue of *Permophiles* (Issues 66) and a supplementary issue of *Permophiles* for the 8th Brachiopod Congress (66-Suppl. Issue) have been published in 2018. They are all available on the SPS website (<http://permian.stratigraphy.org/pub/pub.asp>).

Carboniferous Subcommission

- **The base of the Carboniferous:** The members of the joined SDS/SCCS Task group continued to gather new data in the critical time interval. As in the last few years these data are often based on multi-disciplinary approaches, which combine palaeontological, sedimentological, geochemical and petrophysical methods and data. The focus of the activities of the task group members are to test the proposal combining several criteria for the redefinition of the Devonian-Carboniferous boundary agreed on at the Montpellier workshop and to write regional syntheses for the DCB interval, which will be published in special volume of *Palaeobiodiversity and Palaeoenvironments*. In the future some kind of calendar of palaeontological and geological events should be taken into consideration when determining the boundary. The phase of testing should terminate next summer with a formal decision of the task group at a meeting to be held during the 19th International Congress on the Carboniferous and Permian, followed by a formal vote on the new criterion by SCCS. Assuming that this process can be concluded in 2019, the look for a suitable section for the GSSP will start in 2020. It is the aim to present a detailed proposal for the GSSP defining the base of the Tournaisian Stage, and hence the base of the Carboniferous Period latest at the STRATI meeting in 2023, with the clear objective to finalize the ratification process before or at the International Geological Congress in 2024.
- **Carboniferous Magnetostratigraphy:** In the past years, the focus of the projects group has been to find suitable sections which work for Carboniferous magnetostratigraphy, which fill the data gaps in the Tournaisian to late Viséan and early Bashkirian (Chokerian to Yeadonian European regional substages). Mark Hounslow and colleagues have identified a number of potential targets in Northern England, Scotland and southern Poland which had potential in terms of their low thermal maturity ($CAI \leq 2$). Numerous samples have been collected from these successions and detailed analysis is currently underway to fully assess magnetostratigraphic data.
- **Carboniferous Strontium isotopic stratigraphy:** The residence time of Sr in the ocean (~106a) is far longer than the ocean mixing time (~103a), the world's oceans are considered homogeneous with respect to seawater $^{87}\text{Sr}/^{86}\text{Sr}$, which has long been used as a tool for precise stratigraphic correlation and dating. Chen et al. (2018) present a high-temporal-resolution and high-fidelity record of Carboniferous-early Permian seawater $^{87}\text{Sr}/^{86}\text{Sr}$ based on conodont bioapatite from the Naqing section in South China, in combination with high-resolution carbon isotopic stratigraphy and conodont biostratigraphy, providing an integrated stratigraphic framework and timescale of Carboniferous.

- Carboniferous cyclostratigraphy: Cyclostratigraphy is a powerful tool in high-resolution stratigraphic subdivision and correlation. As for the Palaeozoic strata, astronomically calibrated floating time scales with time resolution of 400 kyr could be provided by the interpretation of cyclic variations in the sedimentary records, and in combination of radiometric age, enable us to improve the accuracy and resolution of geologic time scale. High-resolution cyclostratigraphy based on magnetic susceptibility, covering the Serpukhovian to late Moscovian icehouse climate, has been investigated in the Luokun section of South China. They assigned the basal Serpukhovian in Luokun with the numerical ages from GTS 2012 to construct floating time scales ranging from 331.55 ± 0.5 Ma to 323.2 ± 0.5 Ma, and indicate that the Serpukhovian Stage has a duration of 7.68 ± 0.15 myr.

Devonian Subcommission

- Following failure of the joint SDS/Uzbekistan/RAS field expedition to Zinzilban Gorge, Uzbekistan to find the nominated conodont taxon *Polygnathus excavatus* 114, SDS reluctantly came to the conclusion that the base Emsian cannot be defined at this level in Zinzilban. The SDS is disappointed by this outcome as it was our intent that the GSSP should remain in Uzbekistan. During 2017-18 we have informally considered how to progress with redefinition of the GSSP. We continued these discussions at the IPC in Paris with two presentations on new GSSP sections from Spain and the Czech Republic. We meet again at STRATI 19 in Milan and will formally request proposals for the base Emsian GSSP. We can then vote on these and move one forwards for formal consideration by the ICS.

Silurian Subcommission

- Silurian Times No 25 was edited by the secretary, Renbin Zhan, and distributed in March, 2018, posted on the web site, and circulated announcements of upcoming meetings and publications, and the latest news and recent publications on Silurian research.
- Work continued on the restudy of several potential GSSP candidate sections for the Base of Aeronian (Yuxian section, China; Hlasna Treban section, Czech Republic and Rheidol Gorge section, UK and base of the Telychian (Bajiaomiao section, China and El Pintado Reservoir section, Spain).
- Formal proposal of the Hlasna Treban section for new Aeronian GSSP was published (Štorch et al. 2018). Detailed study on morphology, systematics and evolution of *Demirastrites triangulatus* (proposed Rh/Ae boundary marker species) and related graptolites was submitted by Štorch and Melchin for publication in Bulletin of Geosciences. Report on chitinozoan biostratigraphy and fauna is currently in preparation by A. Butcher.
- The restudy of the Rheidol Gorge section is nearly complete and full paper presenting the proposal of Rheidol Gorge as a candidate section for the base of the Aeronian Stage is currently in preparation.
- Final reports including biostratigraphical, geochemical and geochronological data on the base of Aeronian at the Yuxian section and base of Telychian at the Bajiaomiao section, China are in preparation.

Ordovician Subcommission

- An article on the second Auxiliary Boundary Stratigraphic Section and Point (ASSP) for the base of the Ordovician System in the Dayangcha section (Northern China) have been prepared and submitted for publication in *Palaeoworld* (Wang at al., in press). When it is published the proposal will be submitted for voting in the Subcommission.
- Ordovician News 35 was published and is available from the ISOS webpage (<http://ordovician.stratigraphy.org/>).
- ISOS supported Annual meeting of IGCP 653 in Athens, Ohio, USA during June 2018.

Cambrian Subcommission

- A proposal for the Wuliuan Stage (formerly provisional Stage 5) and the Miaolingian Series (formerly provisional Series 3) was forwarded to ICS in March 2018 for approval. The conterminous base of the Wuliuan Stage and the Miaolingian Series coincides with the FAD of the oryctocephalid trilobite *Oryctocephalus indicus*, and the proposed GSSP section, the Wuliu-Zengjiayan section, is at Balang Village in the Miaoling Mountains, eastern Guizhou, China. The GSSP proposal was ratified by the IUGS in June 2018.
- The Cambrian Subcommission held its annual meeting in association with the Ediacaran Subcommission (ISES) 12–16 August 2018 in Xi'an, China. The conference was entitled International Conference on Ediacaran and Cambrian Sciences (ICECS 2018). Chief organizers for the conference were Yaoping Cai, Jian Han, Hong Hua, Kangjun Huanh, Jianni Liu, Xingliang Zhang (chair) and Zhifei Zhang. The Subcommission sponsored one day-long session and one morning session devoted to Cambrian geology, stratigraphy and palaeontology. Several talks were devoted to primarily toward the base 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 sessions were partly aimed at addressing potential solutions. Subcommission members also delivered talks or posters on other topics dealing with Cambrian stratigraphy. An abstract volume and four field guides were published.
- The Subcommission's webpage was updated in 2018. 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, upcoming meetings, lists of important publications, and other essential information.

Ediacaran Subcommission

- Terminal Ediacaran field workshop in Oman, January 13-22, 2018. This field trip was sponsored by the Ediacaran. Six voting members of the Ediacaran Subcommission and the Terminal Ediacaran Working Group participated in this field workshop. The goal of this field workshop was to examine the Shuram Formation, to investigate the stratigraphic relationship between the Shuram negative carbon isotope excursion and the tubular fossil *Cloudina*, and to discuss the possibility of using either the Shuram excursion or *Cloudina* fossils as a criterion to define the terminal Ediacaran Stage.
- Terminal Ediacaran field workshop in Nevada (USA), 26 April – 2 May 2018. Participants included 10 voting members of the Ediacaran Subcommission and the Terminal Ediacaran Stage. Like the Oman field workshop, the Nevada

field workshop was also focused on the terminal Ediacaran stage, specifically to examine the Shuram excursion preserved in the Johnnie Formation as well as terminal Ediacaran tubular and trace fossils in the Deep Spring, Stirling, and Wood Canyon formations.

- Building upon the success of the 2017 International Symposium on the Ediacaran–Cambrian Transition (ISECT), which was co-sponsored by the Ediacaran Subcommission and resulted in a thematic issue in “Canadian Journal of Earth Sciences” focusing on the Ediacaran-Cambrian transition (see Appendix Attachment 1), the Ediacaran and Cambrian Subcommissions organized the 2018 International Conference on Ediacaran and Cambrian Sciences (ICECS), held on 12-16 August, 2018 in Northwest University, Xi’an, China (<http://www.icecs2018.cn>). Participants included 11 voting members of the Ediacaran Subcommission and the Terminal Ediacaran Stage Working Group. Four pre- and post-conference field trips were organized examine Cryogenian, Ediacaran, and Cambrian successions in North and South China. Of these four trips, Trip 2 (From Snowball Earth to Cambrian explosion, rocks and fossils in Yangtze Gorges) is directly relevant to the Second Ediacaran Stage Working Group, and Trip 3 (Precambrian-Cambrian transition in the northern margin of South China) is directly relevant to the Terminal Ediacaran Stage Working Group. With help from the Subcommission and several funding agencies, we were able to offer financial assistance to nine participants, seven of whom were graduate students and post-doctoral fellows.

Cryogenian Subcommission

- Publication of special volume of Precambrian Research in 2018 entitled: *Descent into the Cryogenian*. The special issue describes 10 key successions of interest over 220 pages.
- Summary of all potential stratigraphic criteria for defining the basal Cryogenian GSSP and critical appraisal of possible sections (Shields et al., 2018, Precambrian Research v. 319, p. 1-5; doi:20.1016/j.precamres.2018.08.15.
- A field workshop took place in the northern Flinders Ranges (October 20-26, 2018) attended by 18 corresponding members and 8 voting members of the subcommission, organised by Grant Cox (Adelaide) and Maree Corkeon (James Cook University).

Precambrian Subcommission

- The Subcommission is newly organized. The new Subcommission’s web page is set up. Two proposals for votes are finalized: to change the notation of the Precambrian in the ICS geological time chart; to define the boundary of the Archean/Hadean.

Stratigraphic Classification Subcommission

- A new homepage for the ISSC has been established within the Graz-University homepage: issc.uni-graz.at/. The old homepage at the University of Milan will not be further maintained.
- Maria Rose Petrizzo, the long-standing secretary of ISSC stepped down with the end of the year 2017.

- The new secretary of ISSC Jochen Erbacher (BGR, Hannover, Germany) was appointed.
- A proposal by Hilgen et al. on unit-stratotypes and astrochronozones was circulated. Following a lively discussion on this topic the proposal was revised and a discussion began in early 2018. Formal separate voting on the revised proposal by ISSC was divided into the two topics. The question: “Should unit-stratotypes be formally defined?” received: Yes: 8 votes; No: 6 votes, Abstention: 1 vote. “Yes” received 57,14%. Since the required majority of 60% was not reached, Unit-Stratotypes, were declined by the ISSC. The second question: “Should Astrochronozones be formally defined?” received: Yes: 9 votes; No: 5 votes, Abstention: 1 vote. “Yes” received 64,29%. Since the required majority of 60% was reached, Astrochronozones, as suggested in the Hilgen et al. proposal, was approved by the ISSC. Since only the Astrochronozones proposal was approved by ISSC members Frits Hilgen decided to withdraw the proposal(s) on 3.8.18 since the two topics were, he said, interdependent.
- New developments in stratigraphic classification The goal of ISSC is to update, upgrade and implement the International Stratigraphic Guide (ISG). 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 under the Chairmanship of Maria Bianca Cita following a workshop organized during the 32nd IGC in Florence, entitled “Post-Hedberg Developments in Stratigraphic Classification”. Background and motivation of this ambitious project “New Developments on Stratigraphic Classification” are clearly expressed in the introductory article (Cita, 2007 in Newsletters on Stratigraphy). 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.

8. SUMMARY OF EXPENDITURE IN 2018:

The IUGS Executive Committee awarded ICS a budget of \$40,000 for 2018 (a reduction on previous years, limiting significantly the requests of the 16 subcommissions and the ICS Executive. Thus, \$40,000 was available for ICS activities in 2018. Expenditure is detailed in the appended financial spreadsheet (Expenditure_Budgets).

9. SUMMARY OF INCOME IN 2018:

The IUGS Executive Committee awarded ICS a budget of \$40,000 for 2018, reducing significantly the requests of the subcommissions and the ICS Executive. No additional income to the ICS is declared.

8. BUDGET PROPOSALS FROM ICS IN 2019

These have been itemised in detail in the attached spreadsheet ((Expenditure_Budgets)).

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

Quaternary Subcommission

- Revise the Chiba proposal for submission to ICS, with the ultimate purpose of seeing the Chibanian Stage and its Middle Pleistocene Subseries ratified by IUGS EC. Intrinsic to this will be a separate advance proposal to approve the Lower/Early Pleistocene Subseries as defined by the Monte san Nicola GSSP that already defines the base of the Quaternary System, Pleistocene Series and Gelasian Stage; together with proposals to define the terms Middle and Upper/Late Pleistocene.
- Focus then on identifying a GSSP for the Upper/Late Pleistocene and its respective stage/age. This will, in part, require a reinvigoration of the Late Pleistocene Working Group under the new co-leadership of Martin Head. This objective ties closely with the INQUA Congress special session “The Last Interglacial and interglacial comparisons: local records and global signals” to be convened next summer 2019 by M.J. Head and E. Wolff.
- The Anthropocene Working Group is planning to hold a workshop in New Orleans, U.S.A., next summer (tentatively 7–8 November 2019). This will be an opportunity to assess progress on potential GSSPs including the Crawford Lake varved record. This meeting is timed to coincide with “The Mississippi: an Anthropocene River Project”, which takes place in New Orleans 9–16 November.

The work of SQS is financed almost exclusively through research grants of individuals working on prospective GSSP sections. Such funding is obtained primarily from national and regional governmental research agencies, institutes, and universities. The Anthropocene Working Group has been particularly successful in obtaining funding owing to the high visibility of the Anthropocene topic. However, it is difficult to obtain funding for SQS conference travel and working group field trips, and ICS funding is accordingly critical to the activities of SQS.

Neogene Subcommission

- The major plan is to finally reach an agreement for a Langhian GSSP proposal, that is on a reliable/reproducible guiding criterion, complemented by additional evidence useful for correlation, and reach a decision on the GSSP section and auxiliary deep-sea core. A proposal will be submitted.

Paleogene Subcommission

- Working will continue on the GSSPs for the Bartonian and Priabonian stages.
- A meeting of the Larger Foraminifera Working Group is scheduled for February, 2019 in Bolca (Italy) in order to collect and share new, unpublished data and to coordinate future work.

- In order to revise and find auxiliary sections better to characterize the Paleocene/Eocene (P/E) and Eocene/Oligocene (E/O) boundaries, three field campaigns will be organized: in Spain (Zumaia, Alamedilla, Rio Gor and Caravaca sections) and in the USA (Wyoming, Polecat Bench section) for the P/E boundary, and in the Marche area (Monte Vaccaro and Monte Cagnero sections) for the E/O boundary. The proposal for the definition of the GSSP of the Ypresian Stage (P/E boundary) in Dababiya (Egypt) was ratified by the IUGS in August 2004. However, concerns have subsequently arisen over this choice, since it was later found that the GSSP level was formed at the base of a laterally restricted submarine channel that removed part of the underlying Paleocene deposits. As a consequence, the ISPS Board is planning to propose auxiliary sections in Italy (Alano) and in Spain (Zumaia).
- Potential funding sources external to IUGS: Most of the research that is currently being done by the SPS members is financially supported by their home countries' research grants.

Cretaceous Subcommission

- Campanian GSSP. Restudy of the Bottaccione section, to provide a detailed lithological log and to identify the precise sample positions of published magneto- and biostratigraphical datasets, and take photographs of the boundary succession, in order to write a GSSP proposal. The WG chair and members will visit the Bottaccione section in early 2018.
- Coniacian GSSP. Fieldwork at the El Rosario section (NE Mexico) is planned for February 2018. The discussion and voting within the WG regarding the selection of the candidate GSSP section is planned for 2018.
- Albian GSSP. Finalisation of the official steps required for the protection and easy accessibility of the GSSP site.
- Aptian GSSP. The work plan for 2018-2019 includes the organization of a meeting to discuss events and candidate stratotype sections available in the literature. A proposal for a candidate GSSP section will be ready for the STRATI 2019 congress (July 2019).
- Barremian GSSP. The formal proposal of the Barremian GSSP is almost ready to be discussed and voted within the WG in the first months of 2018 and the outcome will be submitted to the SCS.
- Hauterivian GSSP. The proposal for the GSSP candidate La Charce section (SE France) is almost ready to be discussed and voted within the WG. The outcome will be submitted to the SCS in February 2018.
- Valanginian GSSP. Fieldwork is planned for late 2018 in order to resample the two candidate stratotype sections (Vergol, SE France, and Cañada Luenga, SE Spain) for chemostratigraphic analysis and to better constrain some biostratigraphic events. The proposal will be sent to the members of the WG for discussion and voting in 2019. An Upper Valanginian GSSP will be discussed as well.
- Berriasian (J/K boundary) GSSP. A WG meeting is planned for May 2018 in the Czech Republic, to discuss collected and published data from 2017/8. Fieldwork will be concluded (Tre Maroua, Kurovice, Bosso, Brodno etc). By the end of 2018, the WG should have a list of localities to be considered as candidate GSSPs.

- Kilian Group. The 6th Kilian Group report will be submitted at the end of 2017, and should be published in *Cretaceous Research* in 2018 as for previous reports (Hoedemaeker *et al.*, 2003; Reboulet *et al.*, 2006; 2009; 2011; 2014).

Jurassic Subcommission – no formal report received

- The principal objectives are to continue the formal processes for GSSP proposals for both the base-Oxfordian and base Kimmeridgian stages.
- Specific GSSP Focus for 2019
- Beyond the progress with the base Kimmeridgian GSSP as outlined above, the following goals are being actively worked towards.
- Oxfordian Task Group. Following the successful workshops in Provence in 2013 and Dorset in 2014 (and the publication of reports from both workshops) we had hoped for rapid progress towards a formal proposal. Unfortunately not much progress was made in 2018, but there will be renewed focus for 2019, with perhaps a change in working group leadership.
- 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.

Triassic Subcommission

- Norian GSSP: The plan is to move forward towards a vote on the boundary marker and GSSP section. This will be achieved by 1) the preparation of document detailing the correlation potential of suitable markers, and details on the candidate sections by the WG member for in early 2019. 2) Face to face discussions will then take place at STRATI2019 in, a) late Triassic presentation sessions, and b) a meeting of the STS. Following this the plan is to move towards a vote in late 2019.
- Olenekian GSSP: During 2019 it is planned to complete collation of information from IOBWG members to produce a document for distribution among all the group, as a prelude to discussion and moving to a vote within the WG before the end of 2019. Lower Triassic sessions and the STS meeting at STRATI 2019 in July should allow some time for problems to be resolved and new ideas to be developed. The goal of the WG chair is to have a GSSP proposal to submit to STS for ratification in early 2020.
- Anisian GSSP: It is hoped that Lucas can encourage additional formal proposals for Anisian GSSP candidate sections, since the Desli Caira section in Romania (the only one formally proposed) is unlikely to move forward, an important step which will bridge the major stumbling block at this boundary.

Permian Subcommission

- The primary objectives are to complete the remaining two GSSPs (Artinskian and Kungurian stages) and re-define/study the three GSSPs of the Guadalupian Series (Roadian, Wordian and Capitanian). The Russian Stratigraphic Committee has excavated the Dalny Tukus (Artinskian-base) and Mechetlino Quarry (Kungurian-base) sections as well. The next target of SPS

is to publish the Sakmarian GSSP paper and complete the proposal for these remaining two Cisuralian GSSPs.

- The priority for 2019 for the GSSP is to:
Completing the Artinskian-base GSSP proposal for discussion and voting in SPS; intensively study and clarify the problems in the three defined Guadalupian GSSPs; work on the replacement candidate section for the Lopingian-base GSSP at Penglaitan, South China.

Carboniferous Subcommission

- A special volume entitled as ‘Global review of the Devonian-Carboniferous boundary’ will be published in *Palaeobiodiversity and Palaeoenvironments* in early 2019.
- In 2019, most VMs and CMs will meet in Cologne at the 19th ICCP in July, 29th-August, 2nd, we will have a Carboniferous GSSPs session, and a detailed proposal for the GSSP defining the base of the Gzhelian Stage will be submitted to the SCCS.
- A task group meeting for the Devonian-Carboniferous Boundary GSSP reappraisal will be held in the 19th ICCP, and a formal vote on the new criterion will be held by the SCCS before the end of 2019.
- An index for the Viséan-Serpukhovian boundary needs to be voted on by the task group and SCCS in the next year.

Devonian Subcommission

- Formal proposals submitted for the revision of the basal Emsian GSSP at STRATI 2019.
- Revision of the D/C boundary with the D/C Boundary Task Group (Chairman: M. Aretz) in close collaboration with the Carboniferous Subcommission. Progress towards selection of candidate stratotypes at STRATI 2019. SDS contributions to the *Palaeo2* special volume on the D-C boundary.

Silurian Subcommission

- Three ISSS groups working on restudy of the base of the Aeronian GSSP, base of the Telychian GSSP and base of the Wenlock GSSP will continue their study of remaining candidate sections in Yuxian, China (Junxuan Fan et al., Aeronian GSSP); Bajiaomiao, China (Junxuan Fan et al., GSSP of the Telychian stage); El Pintado Reservoir, Spain (David Loydell et al., Telychian GSSP) and presumably also Trannon River section and Dyfnant Forest track section, Wales (David Loydell et al., GSSP of the base of the Wenlock Series). Further submissions of formal GSSP proposals are anticipated for early 2019.
- New results will be discussed within a special session “Silurian odyssey towards advanced Stratigraphy and correlation” and ISSS Business meeting at 3rd International Congress on Stratigraphy (STRATI 2019) in Milano.
- Further update of the website for Silurian Subcommission by Hou Xudong. The support of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences for this work is gratefully acknowledged.

Ordovician Subcommission

- ISOS supported Annual meeting of IGCP 653 project will be held in Novosibirsk, Russia during July 2019.
- An updated summary on Ordovician regional stratigraphy and geology: a 'Global Synthesis of the Ordovician System' is planned.
- Data will be gathered for Ordovician News 36.

Cambrian Subcommission

- From 2014 to 2018 the Cambrian Stage Subdivision Working Group has made five reconnaissance visits to sections in association with international field conferences. Areas visited are Morocco and South China (2014), South Australia (2016), Newfoundland (2017), and China (2018).
- 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, two stages have been ratified, the Jiangshanian in 2011 and the Wuliuan in 2018.
- Beginning with the Jiangshanian Stage, the Cambrian Subcommission has been interested in establishing ASSPs. An ASSP for the Jiangshanian was approved in 2012.

Ediacaran Subcommission

- The Subcommission plans to have one field workshop to examine terminal Ediacaran successions in Guadalupe, Extremadura, Spain, 17-24 October, 2019. Together with the field workshop, there will be a symposium to discuss criteria for the terminal Ediacaran stage.
- Four voting members will organize a symposium at STRATI 2019 (Milano, Italy, 2-5 July, 2019) to discuss criteria for the terminal Ediacaran stage. A symposium will also be held at NAPC (University of California, Riverside, 23-27 June, 2019) on Ediacaran palaeobiology and stratigraphy. Many voting members, including Subcommission executives, will participate in this symposium.
- Members of the Ediacaran Subcommission affiliated to ICDP GRIND (Geological Research through Integrated Neoproterozoic Drilling) will be meeting at the Annual American Geophysical Union meeting on 13 December, 2018, in Washington, USA. Specifically, they will be discussing the proposal

to drill 13 cores through the Ediacaran-Cambrian transition in Namibia, Brazil, and China.

Cryogenian Subcommittee

- Subcommittee discussions and a formal meeting took place at the IAS congress in Toulouse (10-12 October 2018) during which a list of potential GSSP successions, rated based ICS and Subcommittee criteria, was drafted for circulation. Australia was chosen to be the consensus target for the next field workshop, with Namibia a likely focus thereafter, although this may change following discussion of correlation criteria.

Precambrian Subcommittee

- The Subcommittee is currently preparing to vote on two issues that were discussed over the course of 2018. First, the Subcommittee will vote on a change of the ICS chronostratigraphic chart with respect to the currently incorrect notation of the Precambrian. Second, the Subcommittee is deciding on the definition on the Hadean/Archean boundary. Further activities included the preparation of a publication that summarizes the discussions on the Haden/Archean boundary. The paper is planned for the journal *Precambrian Research*. The activities of the Subcommittee were presented at the Annual Meeting of the Geological Society of America in Indianapolis, USA, 2018. The chair established collaboration with the Division for Geochronology of GSA.
- No major problems were encountered that would have prohibit or delayed functioning of the Subcommittee. The composition of the manuscript was the only item that was delayed due to the inertness of 19+ co-authors in responding to the manuscript layouts. This problem was addressed in October 2018 by forming a small author team of 3 to 4 colleagues, who work on the paper. The remaining authors will be listed once all agreed on the final version of the publication.

Stratigraphic classification

- For the chapters Biostratigraphy and Chronostratigraphy in the new stratigraphical guide, new members of the workgroups will be invited and the old concepts have to re-evaluated and/or new concepts have to be developed. Workshops for these initial states will be organized in 2019 at STRATI 2019 in Milan.
- The session SSP2.1 Integrated Stratigraphy - Recent advances in stratigraphic systems and age modelling will be held at the EGU General Assembly 2019 (EGU 2018), 7–12 April 2019, Vienna, Austria.
- A meeting of the Subcommittee is planned for STRATI 2019 in Milan.

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

The following is a summary of objectives of the ICS Executive Commission and a selection of key goals noted in the detailed reports of each subcommittee.

ICS Executive

- Define a substantial number of GSSPs, particularly for stages in the Carboniferous, Triassic, Jurassic, Cretaceous, and Cambrian systems; re-evaluate GSSPs for the several Silurian stages and the Devonian-Carboniferous boundary, and of the Cambrian System (Paleozoic Erathem, Phanerozoic Eonothem), and select GSSP-defined subdivisions of the Precambrian.
- Maintain website (and the ICS App) and its formal, permanent archive of the global geostandards - GSSPs and the ICS International Chronostratigraphic Chart.
- Coordinate websites and the information they contain among all subcommissions and the Commission in order that they become the primary global web-based entry point to information on the activities and accomplishments of the subcommissions and ICS.
- Encourage subcommissions to regularly re-assess GSSPs and to develop new initiatives and projects that utilise the refined International Stratigraphic Chart.
- Encourage the recruitment by subcommissions of members from under-represented countries/regions and of those at early career stages.
- Promote the preservation of GSSPs by local communities and national stratigraphic commissions and dedication ceremonies, including the placement of permanent markers, at all ratified GSSPs.
- Produce a new edition of the *International Stratigraphic Guide* with its joint publication by IUGS and the Geological Society of America
- Continue development of a strong link between ICS and the Geobiodiversity DataBase (GBDB) at the Nanjing Institute of Geology & Palaeontology
- Maintain close collaboration with all national stratigraphic commissions.
- Cooperate with One-Geology and the Commission on the Geologic Map of the World to ensure that these projects continually incorporate the latest revisions to the International Stratigraphic Chart.
- Serve as the primary international body setting global standards and illustrating best practices in stratigraphy.
- Develop a new task group on radiogenic data under the leadership of Dr Brad Cramer.

Quaternary Subcommission

- Develop and submit the GSSP proposal for definition of the Upper/ Late Pleistocene and its respective Stage/Age.
- Continue to search for an Anthropocene candidate GSSPs, encourage research on those already identified, hopefully for submission in 2020 or soon thereafter.
- Continue to explore the fine-scale subdivision of the Quaternary.

Neogene Subcommission

- Proposal(s) for the Langhian GSSP will be submitted, with the purpose of reaching a final decision within the WG and subsequently within the Neogene Subcommission.

- The recurrent problem related to definition of Burdigalian GSSP is still unresolved. The difficulty lies the absence of having the GSSP defined in an astronomically-tuned deep-marine section, possibly in the Mediterranean, that would guarantee the stratigraphic contiguity with the other GSSP sections. Until today no good candidate section is available and therefore the search for suitable sections and/or cores for defining the Burdigalian GSSP will continue. In the absence of suitable Mediterranean sections formally for defining the Burdigalian GSSP, the option to identify this boundary in an (IODP) core will be seriously considered within the SNS, and discussion within the WG will involve voting and corresponding members.

Paleogene Subcommission

- To submit the proposal of the Priabonian GSSP to the Paleogene Subcommission voting members, and subsequently to the ICS and the IUGS, and, if ratified, to *Episodes* for publication during 2019.
- To submit the results of the multidisciplinary study of the Barton area in a peer-reviewed journal.
- To advance the definition criteria for identifying the base of Bartonian Stage, choose a type section and submit a GSSP proposal. The report on the Bartonian GSSP proposal to be submitted to the ICS and the IUGS.
- To support the organization of field workshops and meetings to define the Paleogene GSSPs pending definition.
- To produce an updated version of an integrated Paleogene Time Scale.
- Preparation of standardized regional correlation charts and paleogeographical maps by the regional committees.
- Revise and find auxiliary sections better to characterise the following boundaries: the Thanetian/Ypresian (Paleocene/Eocene) boundary (i.e., Alamedilla, Caravaca and Zumaia sections in Spain; the Forada and Contessa sections in Italy; Polecat Bench in Wyoming); the Danian/Selandian boundary: Contessa and Bottaccione sections in Italy; the Caravaca and Sopelana sections in Spain; Selandian/Thanetian boundary: Contessa, Italy, the base of the Bartonian: the Contessa and Bottaccione sections in Italy; Alum Bay and Barton in the England; base of the Rupelian (Eocene/Oligocene boundary), and the Monte Cagnero and Monte Vaccaro sections in Italy.

Cretaceous Subcommission

- 2017-2019: Inauguration of the Albian GSSP.
- 2017-2019: Finalisation of the proposals by the Working Groups for the base of the Berriasian and the J/K boundary, base Valanginian, base Hauterivian, base Barremian, base Aptian, base of the Coniacian, base Campanian. Voting by members of the Working Groups to select a single GSSP candidate section.
- 2019-2020: Submission of the proposals GSSP candidate sections approved by the Working Groups to the Cretaceous Subcommission Voting Members, submit it to ICS, and possibly to *Episodes* for publication.
- 2017-2020: Continue to work and preparation of proposals for the definition of substages for discussions at the forthcoming meetings: 10th International Symposium on the Cretaceous (Vienna 21-26 August 2017), STRATI 2019-3rd International Congress on Stratigraphy (Milan, Italy, July 2019), 36th

International Geological Congress (Delhi, India, 2-8 March 2020).

Jurassic Subcommittee

- Completion of the stage GSSP definition process
- Develop strategy for substage definition process
- Develop website as forum for exchange ideas in relation to Jurassic stratigraphy
- Realization of the International Continental Drilling Program (IGDP) – Early Jurassic Earth System and Timescale (JET).

Triassic Subcommittee

- Norian and Olenekian GSSP: Both move towards preparing a discussion document among the working group members, as a prelude to moving towards a vote on the candidate markers and sections.
- Anisian GSSP: Obtaining formal proposals for new candidate sections in South China.
- Rhaetian GSSP: A 2-3 year stasis in this group has seen no significant prospects of change. If this continues into early 2019, a new chair of this working group will be sought to move forward at a faster pace.

Permian Subcommittee

- SPS Chair Shuzhong Shen, together with Junxuan Fan of the GBDB group, are actively involved in organizing the IUGS Recognized Big Science Programme “Reconstruction of Paleogeography and Deep Time Big Data (DDE Programme)”. The main purpose and mission of DDE Programme are to provide a dynamically linked, palaeogeologically- and palaeogeographically-referenced (spatially and temporally) digital earth database so a researcher, teacher or student cannot only access the comprehensive datasets, but also analyze the data spatially, temporally and genetically. A formal proposal has been submitted to IUGS EC. This plan will be finally decided in the IUGS EC meeting held in February, 2019 in Beijing.
- Publishing the revised version of the proposals, organizing the field excursions and establishing the remaining two GSSPs for the Cisuralian.
- Continue to work on the Guadalupian GSSPs and global correlation for chemostratigraphy and geochronological calibration. Publish the official papers for the three Guadalupian GSSPs.

Carboniferous Subcommittee

- Within the next 4 years, it will be possible to select the defining events for all of the stage boundaries and progress toward selecting candidate sections for the GSSPs. We intend to use high-resolution biostratigraphy and combine it with a multi-discipline approach (use of sedimentology, geochemistry, and geological events) to establish as many of the remaining GSSPs as possible. The realistic objective is to have two GSSPs ratified in the next four years.
- We will encourage and pay more attention to finding volcanic ash beds for radiometric dating, in order to establish a more precise Carboniferous time scale and facilitate the correlation of important Carboniferous events at global

scale.

- Using multi-discipline methods including palynological studies, U-Pb dating and stable isotope studies, we will further promote marine and non-marine correlation.
- We will organize at least one academic activity each year, either a workshop (maybe combined with conferences) or joint workshop/field excursion.
- To establish working groups on dividing the Tournaisian and Viséan stages because both of them represent too much time.
- To strengthen and to vivify the SCCS website, with membership lists revised, tasks and newsletters updated in time, making it a genuine platform to bring Carboniferous specialists together for collaboration and exchange of new ideas and results.
- Integrate the Carboniferous databases from the entire World, combining the Geobiodiversity Database (GBDB, a large compilation of data about sections) at Nanjing Institute of Geology and Palaeontology, the Paleobiology Database (a large compilation of data about fossils) at the University of Wisconsin-Madison, and other major databases, to facilitate the studies on Carboniferous biota and stratigraphy.

Devonian Subcommittee

- Redefine the base of the Emsian Stage.
- Redefinition of the Devonian/Carboniferous Boundary with the joint Task Group.
- Annual meetings

Silurian Subcommittee

- Principal work will be devoted to GSSP-related research activities – restudy of some previously ratified but currently inadequate basal stratotypes. Research on Aeronian and Telychian GSSP candidates will be completed within this time span and new stratotypes will be chosen. We aimed to vote on these candidate sections in 2019 in Milano but the date is not fixed at present by delayed work on some of the candidate sections. The Homerician working group will be established. Restudy of the Homerician GSSP will join the program, along with further study on other potential sections suitable for a new GSSP of the Wenlock Series.
- Application of astronomically tuned cyclostratigraphy integrated with radiometric data and high-resolution biostratigraphy in conjunction with IGCP no 652 “Reading geological time in Palaeozoic sedimentary rocks”.
- We will work on further development of databases that would bring together and make available information from all sources associated with the Silurian researchers. One such database, operated by the Nanjing Institute of Geology and Palaeontology (Geobiodiversity Database, GBDB), has been named as the official database of the ICS.
- Special session entitled “Silurian odyssey towards advanced stratigraphy and correlation” and ISSS annual business meeting will be held at 3rd

International Congress on Stratigraphy STRATI 2019 in Milano, Italy in July, 2019. This session will be focussed on GSSP-related research. Vote on new Aeronian stratotype is planned as a principal programme point of the ISSS Business meeting.

Ordovician Subcommission

For further advancement and increased precision in correlation we need to pay more attention to regional stratigraphy, regional scales and regional chronostratigraphic schemes. There is a growing awareness that many biotic, chemical and physical changes are not always synchronous, and that there are strong local and regional signals that often depart from global compilations. Ordovician regional stratigraphy and geology will be the main goal for the period 2016-2020.

- To compile and publish an updated summary on Ordovician regional stratigraphy and geology: a 'Global Synthesis of the Ordovician System'. Special attention will be paid to precise correlation of the Ordovician depositional sequences and sea level curves as well as stable isotope and regional biodiversity curves. The target should be to compile the book in time for the 13th International Symposium on the Ordovician System in Novosibirsk in July 2019.
- To correlate Ordovician depositional sequences throughout the World.
- To design and execute a programme of radiogenic dating of key Ordovician horizons (using Pb-Pb isotopes).
- The Ordovician website will be updated, including the development of a database for GSSPs and ASSPs.

Cambrian Subcommission

- The principal objective of the Subcommission for 2019 is to narrow possibilities for horizons and GSSP stratotypes for the remaining undefined stages, which are provisionally identified as stages 2, 3, 4, and 10.
- The ISCS has developed a prioritized plan for formalizing definition of the remaining undefined GSSPs. The plan is:
Provisional Stage 10 is expected to be defined next, but a decision on a GSSP is likely to be one or two years away.
- 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.
- A more long-term objective is re-examination of the Cambrian GSSP (Terreneuvian Series, Fortunian Stage). Imprecision in correlating the lower boundary of the Cambrian System has been encountered on all palaeocontinents, and the ISCS is now engaged in seeking a practical

solution to remedy the problem. 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.

Ediacaran Subcommission

- The Subcommission annual newsletter will be distributed in February 2019. Secretary Dr. Marc Laflamme will be leading the effort to compile and edit the annual newsletter.
- In 2019, the Subcommission will organize a field workshop in Spain and two Ediacaran symposia at STRATI 2019 and NAPC.
- The 36th International Geological Congress (IGC) will be held in Delhi, India, 2-8 March 2-8. Ediacaran successions in northern India are important for SES stratigraphy. Voting members Mukund Sharma and Shuhai Xiao have proposed a symposium on the Ediacaran System and, working with Nigel Hughes at UC Riverside, the Ediacaran Subcommission will develop a field workshop at IGC to examine the Ediacaran and Cambrian succession in northern India.
- Following a very successful ‘Geobiology 2017’ conference in Banff, Canada, the Geobiology Society will again host a 3-day meeting at the Banff Conference Center from 9-13 June, 2019. This conference will explore the modern tools of organic and inorganic geochemistry, molecular biology and microbial ecology, sedimentary geology and palaeontology, and ultimately will focus on the interpretation of the rock record, and how the modern can be used to interpret the past. This multidisciplinary conference is particularly relevant to Ediacaran Subcommission members interested in interpreting the geochemical signals that accentuate the Proterozoic.
- Building on two previous trips in Brazil sponsored by the Ediacaran Subcommission, we will sponsor an extended field trip to examine Ediacaran successions in Brazil and Argentina. The field trip is tentatively scheduled for 5-30 July, 2020.
- A vote will be called to decide what criterion or which 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). Our goal is to finalize the discussion on TES by 2020.

Cryogenian Subcommission

- Current efforts are geared towards consolidating all data pertaining to the Tonian-Cryogenian transition. This will inform future meetings and field workshops, in order to facilitate the GSSP nomination and voting process that we aim to complete in time for ratification at the 2020 IGC. We are on course for that goal with potentially decisive field workshops next year to Namibia and possibly Ethiopia.

Precambrian Subcommission

- The Subcommission will vote on the Hadean/Archean boundary and the proposed changes to the ICS chronostratigraphical chart. This vote will be conducted in February 2019. The discussions in 2018 raised questions on the establishment of subdivisions for the Hadean and in this context also the Archean subdivision 'Paleoarchean'. The focus of the activities of the Subcommission therefore will be to explore various suggested ways of subdividing the Hadean. The Subcommission will also consider practical approaches for the Paleoarchean lower and upper boundaries. The Subcommission is currently establishing collaboration with Dr. Brian Zimmer, Appalachian State University, USA, to develop a plan to travel to Australia and to digitalize the oldest fossils preserved in the Pilbara region. A digital learning tool will contribute to the education of geoscience students in the future. The chair of the Subcommission is considering the EGU General Assembly in Vienna 2019, where a splinter session will offer the discussion of the activities of the Subcommission with the attending geoscientists. An ODU student will continue to help the chair assembling information on Precambrian stratigraphic sections into a preliminary digital catalogue.

Stratigraphic Classification

- All the remaining review papers on the various branches of Stratigraphy will be submitted and printed over this period.
- The series of papers may form the core of a textbook. Publication details, including arrangements with Nägele & Obermiller, Stuttgart (the publishers of Newsletters on Stratigraphy) remain to be worked out.
- ISSC will take the initiative to encourage special sessions and symposia at conferences that advance stratigraphic principles, in collaboration with other ICS subcommissions.
- ISSC will continue to participate in GSSP discussions with ICS subcommissions.
- ISSC continues to interface with national stratigraphic commissions although only in an advisory capacity.
- The current 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 worldwide distribution and acceptance.

APPENDIX 1: ICS DIRECTORY OF OFFICERS 2016-2020

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APPENDICES: REPORTS OF INDIVIDUAL SUBCOMMISSIONS

These were edited by the respective officers of the named subcommissions and are presented here as submitted.