



International Commission on Stratigraphy

ANNUAL REPORT 2019

1. TITLE OF CONSTITUENT BODY

The International Commission on Stratigraphy (ICS)

Summary and compilation of subcommission reports submitted jointly by:

Chair: David Harper

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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 organised 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 task group has produced revisions to the ICS website and encouraged the rejuvenation of websites for several subcommissions. International Subcommission on Timescale Calibration (ISTC*) under the leadership of Dr Brad Cramer is now established and will commence operations from the next inter-Congress period.

Subcommissions:

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

- (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 (7 members), Canada (4), USA (9), China (7), Italy (6), Australia (2), Spain (2), Russia (4), Czech Republic (1), France (2), Germany (1), Brazil (2), Sweden (1), Portugal (1), Austria (2) 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 35 countries: USA (52), China (30), United Kingdom (22), Russia (3), Canada (15), Germany (20), Italy (21), Australia (12), Spain (9), France (7), Japan (8), New Zealand (5), Argentina (5), Belgium (7), Netherlands (4), Brazil (8), Poland (7), Czech Republic (7), Denmark (4), Sweden (5), Switzerland (2), Hungary (2), India (3), South Africa (2), Austria (3), Tunisia (1), Swaziland (1), Estonia (2), Finland (2), Iran (1), Namibia (1), Norway (2), Portugal (1), Turkey (1) and Ireland (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 Subcommittee 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 organisations 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 standardisation 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

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 of Lower and Upper Pleistocene Subseries*
- Base Chibanian Stage (= base Middle Pleistocene Subseries)*
- 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)
- Base Hauterivian Stage*

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

* in process of ratification at time of writing.

7. CHIEF ACCOMPLISHMENTS IN 2019

Full commission

- The 2019 version of ICS Chronostratigraphic Chart, which includes revised numerical ages, was posted on the ICS website (there were about 4 versions of the chart in 2019).
- 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, ratified by IUGS in June 2018, was published in *Episodes* in 2019.
- The ICS' STRATI congress was held in Milano, Italy in July 2019. It was attended by XXX participants and was heralded a major success.
- A change in the status of the term Precambrian has been agreed by the Precambrian Subcommission. It is now regarded as an informal time division.
- The GSSPs for the base of the Hauterivian, the Chibanian and Priabonian stages are currently being evaluated. The former two have been approved by ICS at the time of writing, and are awaiting ratification by IUGS.
- 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.

Quaternary Subcommission.

- 1. Proposal to approve definition of the Chibanian Stage and Middle Pleistocene Subseries by GSSP at the Chiba section, Japan – submitted to the ICS.
- 2. Proposal to approve formalisation of the Lower/Early Pleistocene Subseries/Subepoch, comprising the Gelasian Stage/Age and the superjacent Calabrian Stage/Age, with a GSSP corresponding to that of the Gelasian Stage, the Pleistocene Series, and the Quaternary System. Also, proposal to approve formalization of the terms Upper/Late Pleistocene, at the rank of subseries/subepoch, with a base currently undefined but provisionally dated at ~129 ka – submitted to the ICS. At the time of writing the ICS has approved both these proposals (voting closed on 27.11.19).

- 3. Zalasiewicz, J., Waters, C.N., Williams, M., and Summerhayes, C. (Eds.), *The Anthropocene as a Geological Time Unit. A Guide to the Scientific Evidence and Current Debate*. Cambridge University Press, Cambridge, U.K. 391 pp.: ISBN 9781108475235. Published 26 February, 2019. Editors and most contributors are members of the Anthropocene Working Group.

Neogene Subcommission

- The ongoing discussion within the Langhian and Burdigalian GSSP Working Group (WG chair: Frits Hilgen) about the Langhian GSSP finally succeeded in finding a consensus on a proposal. The two possible GSSP sections considered were La Vedova section (Italy) and St. Peter's Pool section (Malta), and the WG decided to define the Langhian GSSP at the top of C5Cn in the La Vedova section in Italy (Turco *et al.*, 2017). Most of the constructive discussion occurred during the last STRATI 2019 meeting in Italy (July 2019). Uncertainty related to the choice of calcareous plankton events associated with the top of C5Cn, and useful for the recognition of the Langhian base at low-latitudes, is still matter of debate. As an example, the taxonomic issues related to the *Praeorbulina* datum (the historical criterion for recognising the base of Langhian) are overt, as well as the low reliability for global correlation of the LCO *Helicosphaera ampliaperta*, an event proposed for the best one approximating to the top of C5Cn in the Mediterranean. This problem encouraged to follow the suggestion of having an auxiliary boundary stratotype in a Pacific (I)ODP core, at the equivalent stratigraphic level, for having the direct correlation to the open ocean benthic isotope record and low-latitude calcareous plankton events. The proposal is planned to be presented within the early 2020.
- The chair of SNS, as member of the Scientific committee for the STRATI 2019 meeting, organised (with the help of Secretary Elena Turco) a scientific session, related to SNS themes: Session ST3.10 "Integrated stratigraphy and paleoclimatic and paleoceanographic events in the Neogene" (Convenor: Elena Turco; Co-convenor: Ken Miller, Frits Hilgen, Isabella Raffi). The business meeting of SNS, mostly related to the activity of the Burdigalian-Langhian WG, was also held at STRATI 2019.
- During the scientific Session ST3.10, some members of the Langhian and Burdigalian GSSP WG presented an interesting study related to the problem of the definition of the Burdigalian GSSP. They focused on the reference Mediterranean section of Contessa (Central Italy) in the portion corresponding to the early Miocene, obtaining a detailed integrated bio-magnetostratigraphic study. The section chronologically corresponds to the 24.80 - 18.10 Ma interval, and includes the calcareous nannofossil biohorizon Base *Helicosphaera ampliaperta*, placed within Chron C6An.2n. because this event, according to the literature, provisionally defines the Aquitanian/Burdigalian boundary, the authors suggested the Contessa Section is a possible candidate for the definition of the Burdigalian GSSP. The section will be certainly considered in the future discussion within the Burdigalian Working Group devoted to find a suitable GSSP section.
- During the summer of 2019, a postal ballot has been organised for the election of the new officers for the SNS for the term 2020-2024. The majority of the voting and corresponding members answered to a first call for nominating the candidates, and all supported the two proposed candidates Kenneth Miller (for

SNS Chair) and Elena Turco (for SNS Vice-chair). The official ballot for election was completed in September 2019.

Paleogene Subcommission

- The final proposal for the base of the Priabonian Stage was presented to the Paleogene Subcommission and approved with a supermajority (80%). The primary marker for the GSSP coincides with the base of a prominent crystal tuff layer, the Tiziano bed, at 63.57 meter in the Alano section in NE Italy. The new cyclostratigraphic analysis of the Bartonian-Priabonian transition of the Alano, as well as the radiometric data from the Tiziano tuff provided an absolute age (37.71–37.76 Ma; Galeotti *et al.*, 2019). The proposal has been submitted to the ICS members for their evaluation and vote, it is hoped that it will be approved so that the Alano GSSP proposal can be submitted to IUGS for ratification during the IGC36 in New Delhi.
- Numerous studies have been carried out on the Paleogene successions of the Caucasus, Baltic, East and West Russia pointing out the importance of this area for interregional correlation.
- In Europe, a multidisciplinary study on the Barton area (Great Britain) has been carried out by Cotton *et al.* and the results of the Alum bay section are now in press in Newsletter on Stratigraphy. This study, together with the work of Hooker and King (2018), points out the relevance and a new integrated bio-magnetostratigraphy of this sedimentary succession for Paleogene stratigraphy and timescales. Two main areas have been studied in the European Mediterranean region: the first on the Rio Gor section (Granada province, southern Spain), with an integrated study on the PETM transition that shows the presence of *Microcodium*-rich turbidites and provides new insights into Paleogene Mediterranean climate (Pujalte *et al.* 2019). The second, in the Umbria area of Italy, where a high resolution sampling for bio-magnetostratigraphic study has been performed on the Bottaccione and Contessa sections with the aim of characterising the evolution of *Fasciculithus*, primary marker of the Danian/Selandian boundary. In addition, a new orbital tuning of the middle Eocene (Lutetian/Bartonian) interval has been proposed. The study of the Eocene-Oligocene transition in the Monte Vaccaro section records an impactoclastic layer with a prominent Ir anomaly, and shocked quartz, just as at Massignano, GSSP for the Eocene-Oligocene (E/O) boundary (Boschi *et al.* 2019). Additionally, the Torrente Caravello section is being studied for the Lutetian/Bartonian boundary and related climatic events.

Cretaceous Subcommission

- Campanian GSSP. The Bottaccione section (Italy) will be proposed as candidate stratotype section. The WG agreed on proposing the base of the magnetostratigraphic zone 33r as primary criterion for the base of the Campanian. Secondary criteria include planktonic foraminifera and calcareous nannofossil events. Carbon isotope excursions will be used to better constrain the S/C boundary and to trace high resolution correlations with boreal sections. Auxiliary sections, possibly containing the macrofossils record, include Seaford Head (UK), Postalm (Austria), Waxahachie Dam Spillway (Texas), and other sections in the Western Interior Basin of North America. The Bottaccione section was sampled for magneto-bio-chemostratigraphy in

September 2018, and results are now available for discussion within the WG and integration toward the preparation of the GSSP proposal.

- Coniacian GSSP The Salzgitter-Salder (Germany) will be proposed as candidate stratotype section. The section was re-studied for planktonic and benthic foraminifera and dinoflagellate cysts. Primary criterion is the appearance of the inoceramid *Cremnoceramus deformis erectus*. Secondary criteria include a minimum in the $\delta^{13}\text{C}$ values (Navigation Event) useful for correlation among sections. Possible auxiliary sections include El Rosario (NE Mexico), Strelec Quarry railroad cut (Bohemia, Czech Republic), Hot Spring (Big Bend National Park, SW Texas), and sections in the Cauvery Basin (SE India). Jarvis and Pearce are studying dinocysts from the Salzgitter-Salder section (preliminary report presented during STRATI 2019); additional samples will be treated and the entire report will be published soon. Cech and Uličný are working on the auxiliary candidate section from Bohemia. The section is an expanded siliciclastic succession that improves the understanding of the boundary (manuscript in prep.). The candidate section was also presented during the SCS meeting at STRATI 2019. Foraminifera and dinocysts are studied from the Opole Cretaceous, southern Poland (1 manuscript submitted and 1 in preparation by Peryt, Dubicka and Walaszczyk that should be submitted to Newsletters on Stratigraphy by early 2020). Further works were continued in the Pueblo section, Colorado, USA (Walaszczyk, Sept. 2019) needed to compile the chemostratigraphy and biostratigraphy for the entire Coniacian of the section (by Walaszczyk, Sageman and Todes).
- Albian GSSP. Officers of the SCS contacted the local authorities of the Commune of Arnayon (Département of Drôme) on the official steps to follow for the establishment of a geopark for the protection of the site.
- Aptian GSSP. The WG met in Milan at STRATI 2019 and discussed the best primary criterion for the definition of the base of the Aptian Stage. Together with the paper on the Gorgo a Cerbara section by Frau et al. (2018), the work by Coccioni (2019, in press) forms a new baseline for discussion on the use of the base of M0 for definition of the base of the Aptian. According to the revisions of the stratigraphy at Gorgo a Cerbara the base of M0r falls into the Barremian. The WG has to consider now other possible markers for defining the base of the Aptian, including the $\delta^{13}\text{C}$ negative anomaly (segment C3 sensu Menegatti et al. 1998) at the onset of Oceanic Anoxic Event (OAE) 1a. Shifting the Barremian/Aptian boundary to the C3 negative spike, would change the age of some ammonite species from Aptian to Barremian. Any change to the previous definition (base of M0) might have a significant impact on the stratigraphy of many known outcrops and subsurface sections, as well as on the definition of the Bedoulian substage.
- Barremian GSSP. The Rio Argos section (Caravaca, SE Spain) will be proposed as candidate stratotype section for the Barremian Stage. Foraminiferal and calcareous nannofossil, stable-isotope and cyclostratigraphic analyses are concluded. The primary criterion is the lowest occurrence of the ammonite *Taveriaidiscus hugii*. Secondary criteria are ammonite, calcareous nannofossil and foraminiferal events. Auxiliary sections are identified in the Subbetic zone, the Arroyo Gilico section near Caravaca and other two sections nearby Rio Argos. Correlation between Rio Argos and the Gorgo a Cerbara and Fiume Bosso sections (central Italy) can be performed by using ammonite and isotope stratigraphy within the upper part of

magnetochron M5n.

- Hauterivian GSSP. The proposal to formalize the base of the Hauterivian Stage at the FO of the ammonite genus *Acanthodiscus* at the La Charce section (SE France) was voted on in August 2019 within the SCS and approved by a majority of 91% of delivered votes. The proposal is currently under voting within ICS.
- Valanginian GSSP. Possible GSSP candidates for the base of the Valanginian are the Cañada Luenga section (SE Spain) and the Vergol section (SE France). The proposed primary criterion for the base of the Valanginian is the lowest occurrence of *Calpionellites darderi*, which correlates with the lowermost part of magnetochron M14. Integrated analysis of ammonites, calpionellids and calcareous nannofossils correlated with magnetostratigraphic and chemostratigraphic data are nearly completed for the Cañada Luenga section. Cyclostratigraphy is available for the Vergol section; calpionellid, ammonite and calcareous nannofossil biostratigraphies are in progress; unfortunately, no magnetostratigraphic analysis is possible. The WG has carried out new sampling to prepare thin sections for the calpionellid study.
- Berriasian (J/K boundary) GSSP. In Spring 2019, the WG held a consultation and formal vote on selecting a GSSP for the base of the Berriasian Stage. By this vote the group selected the profile of Tre Maroua in the Vocontian Basin (France) with a 73% majority. Moreover, the WG held a conference jointly with the Jurassica Group on 10-14 June 2019 at Comenius University, Bratislava, superbly organised by a team led by Kamil Fekete. The GSSP proposal is currently under discussion within the WG.
- KILIAN Group. The WG was inactive in 2019.

Jurassic Subcommission

- 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 Mönnig 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 Pálffy, 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

- Rhaetian GSSP candidates: The two candidate sections at Pignola-Abriola (Italy) and Steinbergkogel (Austria) were discussed at STRATI and Leo Krystyn showed new work on the lineage and evolution of *Misikella posthernsteini*, which showed the inadequacy of the current holotype descriptions, and that division into an early (A) and late (B) morphotypes was preferable. This was supported by the good correlation of the magnetostratigraphy between the two candidate sections. In essence the formal proposals for the boundary marker at Pignola-Abriola is *M. posthernsteini* B and that at Steinbergkogel is *M. posthernsteini* A.
- Norian GSSP candidates: The issue of exactly how to relate the conodont faunas at the two candidate sections at Pizzo Mondello (Sicily) and Black Bear Ridge (Canada) was examined in more detail in Orchard (2019). This work identifies more similarities between the two sections, than hitherto concluded. It basically solidifies the identification of the T1, T2 and T3 turnovers identified by Orchard at Black Bear Ridge and Mazza, Rigo, Nicora at Pizzo Mondello. It also brings in new work being done to determine palaeotemperatures based on conodont apatite at Black Bear Ridge. Marco Balini and others have examined a section at Pizzo Lupo (not far from Pizzo Mondello), which basically confirms the ability to correlate the fauna and environmental conditions in Sicily across the base Norian. This ability for lateral correlation improves the strength of Pizzo Mondello as a candidate. Balini *et al.* are preparing a manuscript for the formal proposal of the clam *Halobia austriaca* as an alternative to a conodont primary marker for the base Norian. This will set the groundwork for the working group moving to a vote on this boundary, as requested by the working group members at STRATI.
- Anisian GSSP candidates: Considerable progress has finally been made at this boundary. The Wantou section (Guangxi, South China) has been studied for ammonoids, conodonts, radiometric dating, cyclostratigraphy and carbon isotope stratigraphy, and Chen *et al.* (2019) have proposed this as an Anisian GSSP candidate section. The Kçira section (Albania) has now also been formally proposed as a candidate (Muttoni *et al.*, 2019). At Kçira Isotope stratigraphic studies (Richoz, Katz and others) are also underway, as well as

higher resolution biostratigraphy. A 3rd candidate section at Immigrant Canyon (Nevada), under study by Arnaud Brayard and James Jenks *et al.* is being examined for conodonts and ammonoids, with the good likelihood of an expanded succession of ammonoids across the base Anisian..

Permian Subcommittee

- The official paper for the ratified GSSP of the base-Sakmarian has been submitted to Episodes and it has been reviewed. The revised version will be submitted shortly.
- General proposals for the bases of the Artinskian and Kungurian stages are prepared.
- A Special Issue has been published (Shen & Rong, 2019. Integrative Stratigraphy and Timescale of China: Science in China Series D: Earth Sciences, 62:1-348). One issue of Permophiles (Issue 67, SPS Newsletters) was published..

Carboniferous Subcommittee

- A SCCS business meeting was held at the University of Cologne during the 19th ICCP on July 29th, and several important issues have been discussed, including: 1) selection of new executives and voting members for the upcoming 2010-2024 mandate of the SCCS; 2) subdivision of the Tournaisian (12.2 Myr) and Viséan (15.8 Myr) stages; 3) “The Carboniferous Timescale” have been proposed to the Geological Society, London for publication in their Special Publications series; 4) the Carboniferous GTS 2020 is about to being published in 2020; 5) DDE (Deep-time Digital Earth) Big Science Program, IUGS, make data and information FAIR (Findable, Accessible, Interoperable, and Reusable); 6) A subsection ‘Reference’ has been added to the official SCCS website.
- A business meeting of the working group on the redefinition of the Devonian/Carboniferous Boundary was held at the University of Cologne, Room F, within the 19th International Congress on the Carboniferous and Permian, following the thematic session A1.1.-The redefinition of the base of the Carboniferous Period, where 10 talks and 5 posters were presented. Some talks in the session provided comments on the suitability of potential new DCB level in various areas and depositional settings: Belgium (Denayer), Moravian Karst (Kumpan), China (Qie), Sardinia (Corradini), the Carnic Alps (Spalletta), terrestrial environments (Marshall), beside other more taxonomic on conodonts (Kaiser), brachiopods (Mottequin), and bryozoans (Tolokonnikova). Also, some posters illustrated the DCB in the Rheinisch Massif, Montagne Noire, Kazakhstan and Graz Palaeozoic. The abstracts of these talks and posters can be found in volume 23 of the Kölner Forum für Geologie und Paläontologie.
- During the business meeting, three possible levels for the new DCB were discussed and voted on: 1) the base of the conodont *kuehni* Zone/the basal sulcata Zone & coastal plant extinction; 2) the base of the conodont kockeli Zone, beginning of radiation & top of major regression (top of HSS) and end of mass extinction; and 3) mass extinction level (‘big six mass extinction’) and base of the Hangenberg Black Shale. In the end, the second won the majority, but some concerns have been shown by other working group members. The next step is to provide a detailed global correlation chart with

regional subdivisions for different sedimentary facies. This correlation chart should be established by April 2020 and then be published in a joint paper by all members of the working group in a journal like *Newsletter on Stratigraphy*.

- Carboniferous conodonts from the candidate GSSPs of the four stages Serpukhovian, Moscovian, Kasimovian and Gzhelian in the Naqing and the adjacent sections of South China have been intensely studied in recent decades. The Carboniferous conodont zonation of China is updated based on the conodont material from South China; 39 conodont zones including 11 Tournaisian zones, 4 Viséan zones, 3 Serpukhovian zones, 6 Bashkirian zones, 5 Moscovian zones, 5 Kasimovian zones and 5 Gzhelian zones are separated and discussed in detail. Species of the genera *Siphonodella*, *Polygnathus*, *Protognathodus* and *Gnathodus* dominate the zonation for Early Mississippian strata, *Pseudognathodus*, *Lochriea* and *Gnathodus* are most important for the zonation for Middle and Late Mississippian strata, *Declinognathodus*, *Idiognathoides* and *Neognathodus* provide the zonation of early Bashkirian strata and *Diplognathodus*, *Mesogondolella*, *Idiognathodus* and the related genera *Swadelina* and *Streptognathodus* provide the zonation for late Bashkirian through the middle and late Pennsylvanian interval. In South China, the Carboniferous conodont zonation is mainly characterised by deep-water conodont biofacies with *Siphonodella*, *Lochriea*, *Gnathodus*, *Declinognathodus*, *Idiognathoides*, “*Streptognathodus*” *expansus* group, *Diplognathodus* and *Streptognathodus*. The updated Carboniferous conodont zonation of China is dominated mainly by cosmopolitan species, which allow refined global correlation.

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 met again at STRATI 2019 in Milan and had hoped to receive formal proposals for the base Emsian GSSP. We can then vote on these and move one forwards for formal consideration by the ICS. In August, SDS Secretary L. Slavik visited the GSSP area in Uzbekistan during a Geotourism forum and on behalf of the SDS communicated the main issues and problems to the local specialists..

Silurian Subcommission

- Silurian Times No 26 was edited by the secretary, Renbin Zhan, and distributed in April, 2019, 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, the latest news and recent publications on Silurian research.

- The restudy of the Rheidol Gorge section has been completed and full paper by Melchin *et al.* (in prep) presenting the proposal of Rheidol Gorge as a candidate section for the base of the Aeronian Stage will be submitted for publication by early 2020. Chitinozoan biostratigraphy and faunas have been already published by De Weirdt *et al.* (2019). Formal proposal of the Hlasna Treban section for new Aeronian GSSP (Štorch *et al.* 2018) was later supplemented by detailed study on morphology, systematics and evolution of *Demirastrites triangulatus* (proposed Rh/Ae boundary marker species) and related graptolites (Štorch & Melchin 2018). Report on chitinozoan biostratigraphy and fauna by A. Butcher was presented at STRATI 2019.
- New results of the Silurian GSSP-related studies have been presented and discussed within a special session ‘Silurian odyssey towards advanced Stratigraphy and correlation’ and ISSS Business meeting held at 3rd International Congress on Stratigraphy (STRATI 2019) in Milano.

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 *et 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

- A new executive team was selected to lead the Subcommission starting the 36th IGC. The new executive includes Dr. M. Laflamme (Chair), Dr. J. D. Schiffbauer (Vice Chair), and Dr. Lucas Warren (Secretary).
- The Subcommission organised or participated in several important symposia, including symposia at the 11th North America Paleontological Convention, the Royal Society Conference on the Origin and Rise of Complex Life, and the 3rd International Congress on Stratigraphy (STRATI 2019). Of particular importance is STRATI 2019 (Milano, Italy, 2–5 July, 2019), where voting members Narbonne, Xiao, Laflamme, and Grazhdankin organized a symposium to discuss criteria for the terminal Ediacaran stage. The STRATI symposium was held on 2 July, 2019, and included 12 oral presentations. Ediacaran Subcommission voting members Alvaro, Grazhdankin, Kaufman, Narbonne, Xiao, and Zhou participated in this symposium. A Subcommission business meeting followed the symposium. Issues discussed at the business meeting included Second Ediacaran Stage (SES) and Terminal Ediacaran Stage (TES) criteria, the necessity for a database of tubular fossils, and the need for the community to construct an integrated biostratigraphic, chemostratigraphic, and geochronological database.
- The Subcommission sponsored a field workshop (IMECT: International Meeting on the Ediacaran and the Ediacaran-Cambrian Transition) to discuss Ediacaran stratigraphy and to examine terminal Ediacaran and early Cambrian successions in Guadalupe, Extremadura, Spain, on 17-24 October, 2019. The workshop was organized by Soren Jensen, Javier Alvaro, Ivan Cortijo, Teodoro Palacios, and their colleagues. The workshop included a pre-conference field trip, a symposium, and a post-conference field trip. The symposium included 70 oral presentations, 20 posters, and 103 registered participants from 17 countries. Eleven of the 19 voting members of the Ediacaran Subcommission (Alvaro, Gehling, Grazhdankin, Kaufman, Laflamme, A. Liu, P. Liu, Moczydlowska-Vidal, Schiffbauer, Shields-Zhou, Xiao, Zhou) participated in the field workshop. A program of the workshop is attached. A Subcommission business meeting was held at the conference, where new executives were announced and future activities were discussed, including the 36th IGC in Delhi, a 2020 field workshop in Brazil and Argentina, and potentially a 2022 field workshop in Siberia.

Cryogenian Subcommission

- Field workshop guidebook to the Tonian-Cryogenian transition interval in the northern Flinders Ranges region of South Australia (Grant Cox and Maree Corkeron) attended by 26 participants (18 corresponding members and 8 voting members) *Precambrian Subcommission*. The Subcommission is newly organised. The new Subcommission's web page is established. Two proposals for votes are finalised: to change the notation of the Precambrian in the ICS geological time chart; to define the boundary of the Archean/Hadean.

Precambrian Subcommission

- The original task suite is now revised and published on the ICS web page. The

web page will now be regularly updated with information on the activities and upcoming events of the Subcommittee.

- The activities of the Subcommittee were presented at the Annual Meeting of the Geological Society of America GSA in Indianapolis, USA, 2018. Here, the chair also established collaboration with the Division for Geochronology of GSA.
- The change of the notation of the Precambrian in the ICS geological time chart has been made.

Stratigraphic Classification Subcommittee

- During STRATI 2019 in Milan, Italy ISSC held a business meeting on 7th July, 2019. The most important issue was submitted by M.-P. Aubry dealing suggesting to include 'subseries' as formal units in the upcoming International Stratigraphic Guide.
- The chair of ISSC, Werner Piller, was again invited and attended the annual meeting of the North American Commission on Stratigraphic Nomenclature (NACSN) during the GSA Annual Meeting in Phoenix (Arizona, USA) on 23rd September 2019. The major topics of this meeting were a proposal on the inclusion of a 'submember' in lithostratigraphy. This proposal was supported by a majority and the unit 'submember' will be included in an updated version of the North American Stratigraphic Code,
- A proposal to formalise chemostratigraphy has been received. This proposal was lengthily discussed, however, it is still in a very immature state. It is still unclear how formal chemostratigraphic units could be defined.
- A proposal by Aubry, M.-P.: "Should subseries be included and described among formal chronostratigraphic units in a new/revised version of the International Stratigraphic Guide, when published?" Voting on this proposal was completed in November 2019, approval of the proposal: Yes: 10 votes; No: 4 votes, Abstention: 0 vote. 'Yes' received 71,43% of the votes. The proposal is accepted by the ISSC. Voting members = 19; Votes received = 14, which is 73,68%, so the quorum is constituted (greater than 60%).

8. SUMMARY OF EXPENDITURE IN 2019:

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 2019:

The IUGS Executive Committee awarded ICS a budget of \$40,000 for 2019, reducing significantly the requests of the subcommissions and the ICS Executive. No additional income to the ICS is declared.

10. 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

- Assuming the Chiba proposal for the Chibanian Stage / Middle Pleistocene Subseries GSSP, currently under consideration by ICS, is approved and ratified, the priority for SQS will then be the selection of a GSSP for the Upper Pleistocene Subseries and its corresponding stage. Two potential candidates have already been identified (Fronte Section, Taranto, Italy; and an ice core in Antarctica). The aim is to have proposals submitted for these potential candidates during the coming year. The Upper Pleistocene Working Group will be reformed after 36 IGC under the co-convenership of Martin Head.
- A field workshop on the Neogene–Quaternary boundary and Gelasian GSSP is to be held in Palermo during the first week of June, 2020. This workshop will inaugurate a multidisciplinary multi-year research program to re-investigate the Gelasian type section.
- The SQS website will be updated under the direction of Martin Head as incoming Vice-Chair with explicit responsibility for this task.
- 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 present to ICS the official proposal for the Langhian GSSP, that is on a reliable/reproducible guiding criterium, complemented by additional criteria useful for correlation, and reach a decision on the GSSP section and auxiliary deep-sea core.

Paleogene Subcommission

- Full support will be given to the working groups on the GSSPs pending definition, i.e. those of the Bartonian and Priabonian stages.
- The 36th International Geological Congress will be held in New Delhi in 2020, which would be an exceptional opportunity for scientific discussion; financial support to attend the IGC36 in New Delhi is necessary in order to guarantee the attendance of representative members of the WGs and the Paleogene Subcommission.
- Contribute to a new edition of the international meeting on ‘Climatic and Biotic Events of the Paleogene’ (CBEP 2020), which will be held in Bremen, Germany (31/8/2020-3/9/2020).
- In order to revise and find auxiliary sections to better characterize the

Paleocene/Eocene (P/E) and Eocene/Oligocene (E/O) boundaries, the ISPS Board is planning to suggest auxiliary sections in Italy (Forada, Alano) and in Spain (Zumaia, Alamedilla) for the P/E boundary and the Monte Vaccaro and the Monte Cagnero sections for the E/O boundary.

- A field trip is planned in the Umbria area, Italy to the Bottaccione section to solve the problem of the base of Bartonian and to Monte Vaccaro and Monte Cagnero section for a bio-magnetostratigraphic study of Bartonian/Priabonian and Eocene/Oligocene transitions.
- A sampling campaign will be organized on the Elazığ Basin, eastern Turkey with the aim of studying the Lutetian-Bartonian boundary. The Baskil section represents an outstanding shallow- to deep marine sequence for integrated stratigraphy and palaeoceanographic studies to understand the middle Eocene climate evolution.

Cretaceous Subcommission

- Campanian GSSP. The GSSP proposal, including the Bottaccione section and the auxiliary sections, will likely be discussed and voted within the WG in 2020.
- Coniacian GSSP. The GSSP proposal, including the auxiliary sections, is in preparation and will be discussed and voted within the WG by the end of 2019.
- Albian GSSP. Finalisation of the official steps required for the protection and easy accessibility of the GSSP site.
- Aptian GSSP. The WG is waiting for magnetostratigraphies from two French locations. As soon as the results are available the discussion on the selection of a physical marker and on the location will be restarted in the WG. The proposal, including the auxiliary sections, is planned to be discussed and voted within the WG by the end of 2020.
- Barremian GSSP. The WG is completing the study of the ammonite distribution in the Rio Argo section. The GSSP proposal, including the auxiliary sections, is planned to be discussed and voted within the WG during 2020.
- Hauterivian GSSP. A publication of the relevant data regarding La Charce as GSSP section is planned. The protection of the La Charce section is ensured by an Espace Naturel Sensible (ENS), considering the major geological interest of the site. The department and the municipality of La Charce cooperated and established an exceptional and world-renowned geological interpretation circuit for the public. An official ceremony will be held after the ratification of the GSSP by IUGS.
- Valanginian GSSP. The WG is now completing the analysis of the ammonite and calcareous nannofossil distribution in both GSSP candidate sections. Therefore, the selection of the candidate stratotype section will be discussed and voted within the WG by 2021.
- Berriasian (J/K boundary) GSSP. The proposal document for the selected GSSP will be sent to ISCS in earlier 2020 and, if approved, to ICS for voting.
- Kilian Group. The upper Aptian, lower-middle Albian zonal schemes will be in focus at the forthcoming Kilian meeting. The Kilian meetings are usually held every 3 years (2002; 2005; 2008; 2010; 2013; 2017). The

next meeting will be associated with the next Cretaceous Symposium (Poland, 2021). The local organization will be made by Izabela Ploch.

- Publication of a Cretaceous Research Virtual Special Issue entitled: 'Cretaceous integrated stratigraphy, greenhouse climate change and events' edited by SCS Officers in 2020. The Special Issue collects papers presented in the Cretaceous Subcommittee scientific session held at STRATI 2019.

Jurassic Subcommittee – 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 Subcommittee

- Rhaetian GSSP: Following publication of the article by Krystyn in late 2019-early 2020 on the taxonomy of conodont *Misikella posthernsteini*, the plan is to move to a vote in 2020 on the two proposed sections (markers and section together), which use as a primary marker *M. posthernsteini* B at Pignola-Abriola and *M. posthernsteini* A at Steinbergkogel.
- Norian GSSP: Following publication of the proposal of Balini et al for the formal proposal of *Halobia austriaca* as a primary marker, the working group will move towards a vote on: a) the choice of primary marker, and the b) the choice of one of the two proposed sections. Whichever section is not chosen will become an auxiliary stratotype to complement the GSSP selected.
- Olenekian GSSP: The decision made at STRATI was to move to a vote on the two existing candidate sections in 2020. The Chaohu and Mud sections have a proposed primary marker of *Novispathodus waageni waageni*. A second preferred suggestion is the FO of *Eurygnathodus costatus* or *E. hamadai* as a primary or secondary marker, since the latter occurs near the peak positive $\delta^{13}\text{C}$ excursion and both have wide distributions, particularly in Tethyan shallow-water successions. The working group will formally decide the primary marker in 2020 and later the selected section. Whichever section is not chosen will become an auxiliary stratotype to complement the GSSP selected.

Permian Subcommission

- It is hoped to complete the left two GSSPs (base of Artinskian and base of Kungurian in 2020).

Carboniferous Subcommission

- A special volume entitled as ‘Global review of the Devonian-Carboniferous boundary’ will be officially published in *Palaeobiodiversity and Palaeoenvironments* in early 2020.
- In 2020, many VMs and CMs will meet in Delhi, India at the 36th IGC on 2-8 March, and have a SCCS business meeting. The new executive and voting members will start to serve the 2020-2024 mandate of the International Commission of Stratigraphy (ICS).
- A field-based workshop for the Devonian-Carboniferous Boundary in South China will be organised in late October by Dr. Wenkun Qie, and most working group members will attend this workshop and visit some classical and new DCB sections in southern Guizhou and northern Guangxi.

Devonian Subcommission

- Formal proposals submitted for the revision of the basal Emsian GSSP.
- 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.
- Meet in New York State for fieldwork/conference in Geneseo with 3 days fieldwork before the meeting, 5 days after and 1 day during the 3 day conference.

Silurian Subcommission

- Two ISSS groups working on restudy of the base of the Aeronian GSSP and base of the Telychian GSSP will complete their work by submission of the formal proposals of remaining candidate sections (Junxuan Fan *et al.*, Yuxian, China, Aeronian GSSP and David Loydell *et al.*, El Pintado Reservoir, Spain, Telychian GSSP).
- ISSS discussion and formal voting on the Aeronian and Telychian GSSP replacement candidate sections is anticipated for 2020.
- Further update of the website for Silurian Subcommission by Hou Xudong. We gratefully acknowledge the support of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences for this work

Ordovician Subcommission

- Support for Annual Meeting of IGCP653 to be held in Copenhagen (8-12 June, 2020).
- Support for Seminar on Regional Stratigraphic Classification Standard in China in Baishan, Jilin Province, 14-16 May, 2020 (organised by the Chinese Commission on Stratigraphy), to include an inspection and unveiling ceremony for the Xiaoyangqiao ASSP section.
- Further work is needed to compile an updated summary on Ordovician regional stratigraphy and geology: A Global Synthesis of the Ordovician System. A meeting of editors and contributors is planned (possibly in

Nanjing).

Cambrian Subcommission

- In 2020 the Cambrian Subcommission will continue work toward defining GSSPs for its remaining provisional stages.
- Arrival at a decision on how to define Stage 10 in 2020 (two options: at the FAD of the agnostoid *Lotagnostus americanus* or at the FAD of the conodont); then to arrive at decisions on stages 2, 3 and 4 in subsequent years.
- Continue examining issues surrounding definition of the base Cambrian GSSP.

Ediacaran Subcommission

- The Subcommission plans to have a field workshop to examine Ediacaran successions in Brazil and Argentina in July 2020. Focus will be on the Corumba Group in western Brazil, the Bambui Group in central Group, and the La Providencia Group in Argentina. The Corumba and Bambui groups contain Cloudina and other tubular fossils that are being considered as key biostratigraphic criteria to define the terminal Ediacaran stage (TES), and thus they are highly relevant to the missions of the Subcommission. The field workshop will be organized and led by Lucas Warren and his colleagues in Brazil and Argentina. A preliminary field guide is attached (Appendix Attachment 2).
- Following the symposium at STRATI 2019, voting members Guy Narbonne, Shuhai Xiao, Marc Laflamme, and Dima Grazhdankin will put together a special volume in “Precambrian Research” to summarize regional Ediacaran stratigraphy and potential criteria for the definition of the terminal Ediacaran stage (TES).
- Voting member Dima Grazhdankin is exploring the possibility of a Subcommission-sponsored field workshop to examine Ediacaran successions in Siberia. This field workshop is in the early stage of planning.

Cryogenian Subcommission

- Green paper for future subdivision of pre-Cambrian time and strata. A key issue for the immediate future will be to assist plans to remove all pre-Cryogenian GSSAs to be replaced by GSSP concepts as was done for the Cryogenian. This issue has become urgent since the base of the Cryogenian Period was moved from precisely 850 Ma to c.720 Ma (Shields-Zhou *et al.*, 2016). Although expertise within the Cryogenian Subcommission was originally envisaged to cover the interval between 850-720 Ma, it seems likely that the definition of the now vastly extended Tonian Period/System will change in future as will most pre-Cryogenian subdivisions. Following wide-ranging discussions, subcommission members, together with others, including co-authors of all Precambrian chapters of the new Geological Timescale 2020 book, will submit a green paper to ICS in early 2020, and in time for the IGC in New Delhi, India (2-8 March, 2019), to propose a template for pre-Ediacaran subdivision of time and strata.
- Port Askaig Formation meeting, St. Andrews, Scotland, UK, 6-7 May, 2019. This two-day meeting coordinated by Catherine Rose (St. Andrews) will address in detail recent progress towards furthering the case for a Cryogenian GSSP in Scotland, judged at present to be the most promising location

(Shields *et al.*, 2018) based on the immediately pre-glacial timing of the ‘Garvellach’ negative C-isotope anomaly. A virtual field-trip will permit active participation by all voting and corresponding members as well as all other interested parties. The meeting will follow shortly after our first formal call for GSSP candidates for the basal Cryogenian System.

- Field meetings. 2-14 April, 2019, Grand Canyon (informal field meeting on the Tonian-Cryogenian transition interval with 28 participants); End-May, Ugab Supergroup, NW Namibia: An excursion to northern Namibia is set to take place in late May, 2019, organised by Paul Hoffman and Galen P. Halverson, to an area where a pre-glacial C-isotope excursion has been reported to be correlative with the Dalradian succession’s ‘Garvellach’ anomaly (Lamothe *et al.*, 2019).

Precambrian Subcommission

- The Subcommission will vote on the Hadean/Archean boundary and the proposed changes to the ICS chronostratigraphical chart. The submission of the proposal to define the boundary of the Hadean/Archean has been prepared and submission is planned for 2020.
- A short article is planned on the work of the Subcommission to engage the geoscientific community. The rock record of the Precambrian is highly incomplete and criteria that can be employed for the Phanerozoic may not be suitable for the Precambrian. Many events are not recorded but can be only concluded from subsequent rock successions. Many techniques for age determination will not work for older rocks. The aim of the Subcommission is to discuss methods of how to resolve such issues and to align the Precambrian-specific approach with the procedures of the Phanerozoic.

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.
- For the chapter on Chronostratigraphy new members of the workgroup have to be invited and the old concepts have to re-evaluated and/or new concepts have to be developed. A roundtable will be organised during the 36th IGC in New Delhi and a workshop will be organized on the occasion of the EGU General Assembly 2020 in Vienna.
- The session SSP2.2 ‘Integrated Stratigraphy - Recent advances in stratigraphic systems and geochronology’ will be held at the EGU General Assembly 2020 , 3–8 May 2020, Vienna, Austria.
- A workshop of the Subcommission on biostratigraphy is planned for GSA 2020, Montréal, Québec, Canada.

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 subcommission.

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 re-assess regularly 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.
- To integrate fully the new Subcommission on Timescale Calibration (ISTC) under the leadership of Dr Brad Cramer (cf. below) into the ICS structure.

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

- The proposal for the Langhian GSSP will be submitted and published, with the purpose of reaching a final decision within the SNS Subcommission.
- The recurrent problem related to definition of Burdigalian GSSP is still wide open. 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. To date no good candidate section is available and search for suitable sections and/or cores for defining the Burdigalian GSSP will continue. In absence of suitable Mediterranean (or extra-Mediterranean sections) for defining the Burdigalian GSSP, the option to formally designate this boundary in an (I)ODP core will continue to be seriously considered within SNS and discussion within the working group will involve voting and corresponding members.

Paleogene Subcommission

- To submit the proposal of the Priabonian GSSP to the IUGS, and possibly to Episodes for publication during 2020.
- The results of the multidisciplinary study of the Barton area will be published in the Newsletters on Stratigraphy.
- To advance in the definition criteria for identifying the base of Bartonian Stage, choose a type section and submit a GSSP proposal to the Paleogene Subcommission voting members.
- To prepare the report on the Bartonian GSSP proposal to be submitted to the ICS and the IUGS.
- To support the organization of field workshop in Turkey to sample the Lutetian/Bartonian transition in the Baskil section (eastern Turkey).
- To support the attendance of ISPS members to the IGC36 in New Delhi.
- To produce an updated version of an integrated Paleogene Time Scale.
- Preparation of standardised regional correlation charts and paleogeographic maps by the regional Committees.
- To support studies for the completion of the Paleogene astronomical time scale. This will contribute to filling the so-called “middle Eocene astronomical timescale gap” and will help to connect existing floating calibrations with the astronomically tuned standard Neogene timescale.
- Update the status of Paleogene WGs, creating new WGs as necessary and closing those which have completed their task and/or are inactive.
- Revisit existing GSSPs and, if necessary, define new GSSPs and/or ASSPs in order better to characterise the following boundaries: Thanetian/Ypresian (Paleocene/Eocene) boundary (i.e., Alamedilla, Caravaca and Zumaia sections in Spain; Forada and Contessa Highway sections in Italy; Polecat Bench in Wyoming); Danian/Selandian boundary: Contessa and Bottaccione sections in Italy; Caravaca and Sopelana sections in Spain; Selandian/Thanetian boundary: Contessa, Italy, the Base of the Rupelian (Eocene/Oligocene boundary): Monte Cagnero and Monte Vaccaro sections in Italy.

Cretaceous Subcommission

- 2020: Submission of the Berriasian GSSP to SCS for vote and if approved to ICS for vote and then to IUGS for ratification.
- 2020-2021. Inauguration of the Albian GSSP, and of the Hauterivian GSSP if approved by ICS and ratified by IUGS.
- 2020-2021: Finalization of the proposals by the Working Groups for the base Barremian, base Aptian, base Coniacian, base Campanian. Voting by members of the Working Groups to select a single GSSP candidate section.

- 2020-2021: Continue preparation of proposals for the definition of substages for discussions at the forthcoming meeting: 11th International Symposium on the Cretaceous (Poland, 2021).
- 2020-2022: Finalization of the proposals by the Working Groups for the base Valanginian.
- 2020-2024: Submission of the proposals for the GSSP candidate sections approved by the Working Groups to the Cretaceous Subcommittee Voting Members

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

- Olenekian, Norian and Rhaetian GSSP's: All should complete the voting process, and move towards preparing documents, to be submitted to the STS for approval.
- Anisian GSSP: Completion of the on-going work at the 3 possible GSSP candidates, and move towards a formal vote on selection of the primary marker and the GSSP section.

Permian Subcommittee

- Establish the Artinskian and Kungurian GSSPs.
- Completing the research into the replacement GSSP section of the base-Lopingian.
- Propose and assist the ICS Chair to organise the working group under the Deep-time Digital Earth Big Science Programme to establish the numerical multidisciplinary timeline. Try to get financial support from DDE programme.

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 Subcommission

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

Silurian Subcommission

- Two ISSS groups working on restudy of the base of the Aeronian GSSP and base of the Telychian GSSP will complete their work by submission of the formal proposals of remaining candidate sections (Junxuan Fan *et al.*, Yuxian, China, Aeronian GSSP and David Loydell *et al.*, El Pintado Reservoir, Spain, Telychian GSSP).
- ISSS discussion and formal voting on the Aeronian and Telychian GSSP replacement candidate sections is anticipated for 2020.
- Further update of the website for Silurian Subcommission by Hou Xudong. We gratefully acknowledge the support of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences for this work.

Ordovician Subcommission

- For further advancement and increased precision in correlation we need to focus on regional stratigraphy, regional scales and regional chronostratigraphic schemes. We recognise that many biotic, chemical and physical changes are not always synchronous, and that local and regional signals may vary from trends evident in global compilations. This is especially true for the Ordovician, where strong provincialism can mask biostratigraphic-based correlation. Ordovician regional stratigraphy will therefore be the main goal for the period 2020-2024.
- Compilation and publication of an updated summary on Ordovician regional stratigraphy and geology: 'A Global Synthesis of the Ordovician System'. The focus will be on precise correlation of Ordovician depositional sequences and sea-level curves as well as stable isotope and regional biodiversity curves. Though work has been proceeding on this task, regrettably it is at a glacial pace. The incoming Subcommission will ensure the project is finalised.
- This will enable better correlation of Ordovician depositional sequences globally.

- The Subcommittee will identify key Ordovician horizons for radiogenic dating (using Pb-Pb isotopes and CA-IDTIMS dating of zircons) and will seek to focus research in this area.
- The Ordovician website will be updated to include development of a database for GSSPs and ASSPs throughout the System. The ASSP concept will be the subject of informed discussion.
- Ordovician News will continue to be compiled and distributed annually to provide a network for dissemination of current Ordovician-focused research activities.

Cambrian Subcommittee

- In 2020 the Cambrian Subcommittee will continue work toward defining GSSPs for its remaining provisional stages.
- Arrival at a decision on how to define Stage 10 in 2020 (two options: at the FAD of the agnostoid *Lotagnostus americanus* or at the FAD of the conodont *Eoconodontus notchpeakensis*); then to arrive at decisions on stages 2, 3, and 4 in subsequent years.
- Continue examining issues surrounding definition of the basal Cambrian GSSP.

Ediacaran Subcommittee

- The Subcommittee annual newsletter will be distributed in February 2019. Secretary Marc Laflamme will be leading the effort to compile and edit the annual newsletter.
- In 2019, the Subcommittee 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. 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 Subcommittee 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 Centre 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 Subcommittee members interested in interpreting the geochemical signals that accentuate the Proterozoic.
- Building on two previous trips in Brazil sponsored by the Ediacaran Subcommittee, 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 discussions in 2019 raised questions on the establishment of subdivisions for the Hadean.
- The Archean subdivisions “Paleo-, Meso-, and Neoarchean” will be revisited. One field conference in South Africa, especially in the Barberton Greenstone Belt and the Witwatersrand and Pongola Supergroups is planned. There are several possible boundaries for the Archean that need inspection. They are easy accessible and logistics is easy as well. Air travel to South Africa is still very cheap. This conference could be one of three (or more) that could be financed by the 3-year grant suggested by IUGS.
- A series of conference sessions will aid the engagement of the scientific community in our endeavour.
- The Subcommission is currently establishing collaboration with Dr. Brian Zimmer, Appalachian State University, USA, to develop a plan to travel to Australia and to digitalise the oldest fossils preserved in the Pilbara region. It is planned to set up a PanCam database that can be used by students of the geosciences to ‘visit’ key locations for the Precambrian stratigraphy..

Stratigraphic Classification

- All the remaining review papers on the various branches of Stratigraphy will be published in 2020.
- 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.
- The subcommission will take the initiative to encourage special sessions and symposia at conferences that advance stratigraphic principles, in collaboration with other ICS subcommissions.
- The subcommission will continue to participate in GSSP discussions with ICS subcommissions.
- The subcommission continues to interface with national stratigraphic commissions although only in an advisory capacity.
- The ultimate goal 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 (post-2020)..

Subcommission on Timescale Calibration (ISTC)

- First sessions organised by ISTC at GSA. Planning and organisation for the first ISTC subcommission meeting to be held in 2021.

- Acquisition of funding at the national/international level to support community building globally for the ISTC.
- The primary funding source that will be sought during 2020 will be the US-NSF through the RCN proposal.

APPENDIX 1: ICS DIRECTORY OF OFFICERS 2016-2020

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DAT Harper
Durham University
14.01.2019

APPENDICES: REPORTS OF INDIVIDUAL SUBCOMMISSIONS

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