



International Commission on Stratigraphy

ANNUAL REPORT 2022

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 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 of three voting and three non-voting members, and 17 Subcommissions that deal with the major chronostratigraphic units and aspects of stratigraphic classification. The ICS Executive has initiated a new Executive ex-officio position of Treasurer and appointed a new webmaster. The webmaster is revising the ICS website and transferring the webpages of the subcommissions to the main ICS site.

Subcommissions:

Quaternary
 Neogene
 Paleogene
 Cretaceous
 Jurassic
 Triassic
 Permian
 Carboniferous
 Devonian
 Silurian
 Ordovician
 Cambrian
 Ediacaran
 Cryogenian
 Pre-Cryogenian
 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 organising 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 ICS subcommittees together include 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 60-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 and 3 non-voting members of the Executive, and the chairs of the 17 Subcommittees) represent 12 countries: United Kingdom (5 members), Canada (1), Italy (2), USA (3), China (4), Sweden (1), France (1), Netherlands (1), Spain (1), Austria (1), Australia (1) and Czechia (2). Among all subcommittee officers and the ICS executive, 18 countries are represented: United Kingdom (7 members), Canada (3), USA (7), China (11), Italy (7), Australia (1), Spain (3), Poland (2), Russia (1), Czech Republic (2), France (3), Belgium (1), Germany (3), Brazil (3), Sweden (2), 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 42 countries: USA (71), China (38), United Kingdom (25), Ireland (1), Russia (29), Canada (15), Germany (24), Italy (25), Australia (12), Spain (8), France (11), Japan (9), New Zealand (4), Argentina (3), Belgium (8), Netherlands (7), Brazil (10), Poland (10), Czech Republic (5), Denmark (3), Sweden (8), Switzerland (5), United Arab Emirates (1), Hungary (2), India (4), South Africa (3), Austria (4), Slovenia (1), Tunisia (1), Swaziland (1), Estonia (2), Finland (3), Iran (2), Jordan (1), Korea (1), Mexico (1), Croatia (1), Algeria (1), Namibia (1), Greece (1), Turkey (1) and Columbia (1). The ICS subcommittees are continuing in the process of reinstalling their websites on the main ICS site (noted last year), and some continue to maintain their own 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/
Timescale calibration	being established

3a. ICS Executive Officers for 2020-2024:

Chair: David Harper (Durham, England)

Vice-Chair: Shuzhong Shen (Nanjing, China)

Secretary General: Philip Gibbard (Cambridge, England)

Non-voting officers:

Information Officer: Nicholas Car (Brisbane, Australia)

Graphics Officer: Kim Cohen (Utrecht, Netherlands)

Treasurer: Stuart Jones (Durham, England)

ICS Subcommittee officers:

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

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

Few of the subcommittees 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 organisations. Informally, every officer and member of ICS donates their own time, office space, institutional facilities, and other components to the activities of the organisation. 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 palaeontological 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 palaeo-climate models. The designation of GSSPs necessitates close interaction with local and international groups concerned with conservation, such as UNESCO (Geoparks Programme), IUGS (Geosites Programme) and ProGEO (Geosites and Geoparks initiatives).

As the founding member of the Deep-time Digital Earth (DDE), an innovative and international Big Science Program of IUGS, ICS representatives (Dave Harper and Junxuan Fan together with Shuzhong Shen) have participated in all the DDE Governing Council and WTG meetings in 2022, and the open science forum organized by DDE at the UNESCO headquarter in Paris in November 2022 (Junxuan Fan). The DDE and ICS co-sponsored Stratigraphy Working Group has organized a team to build a so-far most comprehensive domain ontology for stratigraphic knowledge, which contains ontologies for seven stratigraphic subdisciplines and over 1200 knowledge nodes (Xu et al., in press, <https://doi.org/10.1016/j.gsf.2022.101461>). All the data are freely accessible through the DDE platform. This work forms the foundation for the interoperability of stratigraphic data in a computer-readable way in the future.

6. CHRONOSTRATIGRAPHIC STAGE AND SERIES NAMES AND DEFINITIONS ESTABLISHED BY 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 of Lower and Upper Pleistocene Subseries
- Base Chibanian Stage (= base Middle Pleistocene Subseries)
- 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 Priabonian Stage
 - 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 Campanian Stage
 - Base Santonian Stage
 - Base Coniacian Stage
 - Base Turonian Stage
 - Base Cenomanian Stage (= Base Upper Cretaceous Series and Base Cretaceous System)
 - Base Hauterivian Stage
- Jurassic:
- Base Kimmeridgian Stage
 - 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 Artinskian Stage
 - 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

Hadean:

Base Hadean Eon (GSSA)

7. CHIEF ACCOMPLISHMENTS IN 2022

Full commission

- The 2022 version of ICS Chronostratigraphic Chart, which includes revised numerical ages, was posted on the ICS website (there were 10 versions of the chart in 2022). An interactive chart is also available on the website.
- Several authors, university teachers and other educators and professional societies were granted permission to use and reproduce the ICS International Chronostratigraphic Chart in their productions.
- Auxilliary stratotype sections. The proposal was published in *Episodes*, and the scheme was approved unanimously by the ICS in October 2022.
- The impact of the COVID19 Pandemic is still partially impacting ICS activities, the potential accomplishments (e.g. dedication ceremonies for GSSPs) have again been postponed.
- A new executive with a new generation of energetic and qualified colleagues, is establishing a new Subcommittee on the Cambrian System, without links to the past.
- *Deciphering Earth's History: the Practice of Stratigraphy*: Members of ISJS

as well as members of other subcommissions and the Executive of ICS contributed to book on stratigraphical techniques. (<https://www.geolsoc.org.uk/GIP001>).

- Celebration of GSSPs. These are currently on hold.
- IUGS 60th Anniversary. The ICS was active in supporting the celebrations. The ICS led on a virtual event about Extinction and the Stratigraphic Record, led by David Harper and Mike Benton with four other keynote speakers; some 175 participated. The ICS had a leading role in celebrating Earth Day with a virtual presentation on Geodiversity in the Earth Sciences. Harper presented Geodiversity in the chronostratigraphic record during October 2023.
- Launch of the First 100 IUGS geological sites. Harper presented on stratigraphy and the stratigraphic record together with the sites at Sirius Pass Greenland), Everest (China and Nepal) and Meishan (China). He was also a member of the panel of judges.
- Harper presented the IPA special lecture at the 6th International Palaeontological Congress in Khon Kaen, Thailand and presented on ‘chronostratigraphy and fossils’ in the History of the Geological Sciences symposium.

Quaternary Subcommission.

- Holding of the ‘Unearthing the Present’ scientific forum of the Haus der Kulturen der Welt, Berlin, 18-20 May, 2022, for presentation of the analytical results of stratigraphic proxy data for the 12 Anthropocene GSSP candidate stratotypes, together with discussions, in tandem, with the HKW ‘Earth Indices: Processing the Anthropocene’ exhibition. Records of the proceedings may be seen at: <https://www.anthropocene-curriculum.org/project/evidence-experiment/unearthing-the-present> And, at: <https://www.youtube.com/watch?v=Qtj8YqsUjFg>
- Holding of the SQS AnthroFlor meeting in Florence, Italy, 8-10 September 2022, organised by the Anthropocene Working Group (AWG). This was designed to introduce SQS members to the various issues surrounding the Anthropocene, including the stratigraphy of the 12 candidate GSSP sites, in readiness for SQS analysis of the forthcoming formal proposal on the Anthropocene by the AWG. It comprised two days of presentations, posters and discussions followed by a field excursion in the environs of Florence. Records of the proceedings may be seen at: <https://www.youtube.com/watch?v=Qtj8YqsUjFg> and <https://www.youtube.com/watch?v=nqtllaDMBvA>
- Holding of the ‘Where is the Planetary’ multidisciplinary event of the Haus der Kulturen der Welt, Berlin, 14-16 October, 2022, in which members of the Anthropocene Working Group participated. Records from the proceedings may be seen at: https://www.hkw.de/en/programm/projekte/2022/where_is_the_planetary/start.php

Neogene Subcommission

- Formalization of Neogene Subseries/Subepochs. The International Commission on Stratigraphic Classification (ISSC) recognition of the rank of subseries as formal was approved by the ICS in 2022. The SNS vote to formalise the subseries/subepochs was submitted to *Episodes* and will appear

in 2022.

- Planned preproposal to the ICDP. Caruso, Miller, Hilgen, Herbert & Head submitted a preproposal to ICDP to drill the boundary stratotypes at Capo Rossello and Gela. The moderate to heavy weathering of the outcrops inhibits high resolution (cm-scale) sampling particularly for palaeomagnetism and stable isotopes. ICDP responded positively by inviting a workshop proposal for developing details for proposed drilling, including evaluation of previous cores taken in this area. Following commitments for PETM drilling proposal to ICDP in Jan. 2023, we plan to submit a workshop proposal in 15 January, 2024 and run a workshop in late 2024 in Sicily.
- GSSP Progress. In 2020 the Langhian and Burdigalian GSSP Working Group succeeded in finding a consensus on a proposal to place the Langhian GSSP in the La Vedova section in Italy close to the top of C5Cn, the selected guiding criterion to recognise the base of the Langhian (Turco et al., 2017). Uncertainty related to the choice of calcareous planktonic events associated with the top of Chronozone 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 Last Common Occurrence (LCO) of *Helicosphaera ampliapertura*, an event proposed for the best approximation of the top of C5Cn in the Mediterranean.
- Potential problems in correlation to the pending La Vedova GSSP requires an Standard Auxiliary Boundary Stratotype (SABS) in a Pacific IODP core, at the corresponding stratigraphic level, providing direct correlation to the open ocean benthic isotope record and low-latitude calcareous plankton events. Site U1337 will be designated as auxiliary open ocean boundary stratotype, as its continuous succession across the Burdigalian-Langhian boundary provides a good-quality benthic isotope record that has been astronomically tuned (Holbourn et al., 2015). The lack of magnetostratigraphy for Site 1337 can be overcome by through detailed cyclostratigraphical correlations (stable isotopes, CaCO₃) to Site U1336 that has a reliable magnetostratigraphy across the boundary interval and is in good agreement with La Vedova section. However, these detailed correlations highlighted a missing 100-kyr cycle in the splice of Site U1337 just above the level that corresponds to the GSSP. The revision of the splice and the age model of Site U1337 has delayed the completion of a GSSP proposal and its formal submission.
- The proposal for the Langhian GSSP was submitted in May 2022. Access issues and discussion of the placement of the GSSP, whether it be astronomical criteria or at the magnetochron boundary delayed voting until autumn 2022. As of November 2022, we have received written confirmation of access to the La Vedova section and have agreed in principle on the placement of the GSSP at the level based on astronomical criteria (following the tradition of other Neogene and Quaternary GSSPs) and are currently scheduling a vote.
- The discussion on the definition Burdigalian GSSP is still wide open since no good candidate section (astronomically tuned deep marine section, possibly in the Mediterranean, that would guarantee the stratigraphic continuity with the other GSSP sections) is available. The working group will move on to evaluating placing the Burdigalian GSSP in a Pacific IODP site.

Paleogene Subcommission

- Using images and videos of the most significant outcrops of the Paleogene GSSPs, filmed in 2021 in Zumaia, Gorrondatxe, Massignano, Bottaccione and Monte Cagnero, 3D models of some of the outcrops have been constructed in 2022 and are now available at the ISPS website. Raw data are being processed to construct the remaining 3D models, and relevant links and information will be included.
- In 2021, the WG on the Bartonian, the only stage of the Paleogene pending formal definition, submitted to ISPS a proposal for the Bartonian GSSP. Although the board of ISPS raised some fundamental issues related to the completeness, continuity and exposure of the section, magneto- and cyclostratigraphy, the proposal was published as a chapter in a GSA special paper (Coccioni *et al.*, 2022). In order to address the questions raised, the WG decided to proceed with further stratigraphic analyses through the optimal interval of the Bottaccione section. In early 2022, they informed the board of ISPS that they had carried out a further magnetostratigraphic sampling through the interval C20n-C18r. The WG is expected to submit an improved proposal in the near future.
- In order to find the best option for the GSSP of the Bartonian, further studies are being carried out in Navarra (Spain; Sierra-Campos *et al.*, 2022), in the Italian Torrente Caravello section (by Dinarés-Turell and colleagues), and in a new section in Iran (Mahanipour, Monechi, Galeotti, Lanci).
- In order to address some questions raised on the reliability of the GSSP for the base of the Lutetian Stage at Gorrondatxe, the calcareous nannofossil biostratigraphy and magnetostratigraphy were revisited and new cyclostratigraphic and astrochronological studies were carried out.
- Contribution to the organisation and presentations of the international meeting on ‘Climatic and Biotic Events of the Paleogene’ (CBEP 2022), held in Bremen (Germany) in August 2022.

Cretaceous Subcommission

- Maastrichtian GSSP. The need to revise the current definition of the base Maastrichtian was discussed during the Business Meeting of the SCS held in Warsaw (11th Cretaceous Symposium, Aug. 2022). The current GSSP was ratified in 2001 and the stage boundary is defined at Tercis les Bains, Landes (France) by the mean of 12 biostratigraphic criteria of equal importance falling closely above the FAD of the ammonite *Pachydiscus neubergicus*. The Boreal proxy is the FAD of belemnite *Belemnella lanceolata*. Given the taxonomic problems related to the identification of *P. neubergicus*, its diachronous occurrence in several localities, and the difficult applicability of several biostratigraphic criteria listed in the GSSP definition, a new WG was established in October 2022. The major aim of the new WG is the definition of the primary marker for the base of the Stage.
- Campanian GSSP. The GSSP proposal for the base of the Campanian Stage in the Bottaccione Gorge section at Gubbio, Umbria-Marche Basin (Italy) was approved by SCS in June 2022, by ICS in August 2022, and was ratified by IUGS in October 2022. The primary criterion is the point indicated by the magnetic polarity reversal from Chron 34n to Chron C33r, which falls at 221.53 m in the Bottaccione section. The proposal includes 5 auxiliary

sections: 1) Seaford Head, UK (Thibault *et al.* 2016); 2) Postalm, Austria (Wolfgring *et al.* 2018); 3) Bocieniec, Poland (Dubicka *et al.* 2017); 4) Smoky Hill, Kansas, USA (Kita *et al.* 2017); and 5) Tepeyac, Mexico (Ifrim and Stinnesbeck 2021). Further information are included in the paper: Gale, A.S., *et al.*, in press. The Campanian Stage GSSP and its auxiliary sections in *Episodes*.

- Albian GSSP. Finalising of the official steps with the local authorities for the protection and accessibility of the GSSP site at Col de Pre-Guittard in the Commune of Arnayon (Département of Drôme, France) and planning of the official GSSP ceremony for the placement of the golden spike.
- Aptian GSSP. Two rounds of e-mail discussions on the selection of an Aptian GSSP were completed in 2022. The first discussion in Spring 2022 focused on the selection of a marker for the definition of the base of the Aptian Stage. The negative spike in the C-isotope record is seen by many as an optimal marker, since it is identified in sections covering a broad variety of palaeoenvironments. Some members favour keeping the current informal base of the Aptian at the base of M0 for defining the GSSP and argue that it will be confusing to shift the base of the Aptian upwards by 600 kyr from the top of the *M. sarasini* ammonite zone. In a second discussion in Summer 2022, the members were asked for most recent data on sections covering the time interval around the negative C-isotope spike, including, if possible, the current Barremian-Aptian transition. The discussion was not entirely successful (limited number of contributions) but it showed that the selection process can move forward.
- Barremian GSSP. The drafting of the formal proposal of the Río Argos section (Caravaca, SE Spain) as GSSP of the Barremian Stage has been completed. The primary marker discussed and approved by the working group is the first appearance of the ammonite *Taveraidiscus hugii*. Secondary candidate criteria include: bioevents (foraminifera, calcareous nannofossils), C isotope stratigraphy, sequence stratigraphy and astrochronology. Correlations are discussed and a new calibration of the Hauterivian/Barremian boundary against the magnetostratigraphic scale is proposed. The protection of the Río Argos section is ensured by the current urban planning regulations of the municipality of Caravaca, and its recognition at the regional and national level is also being processed. The proposal was sent to SCS for discussion in May 2022, it is currently in the final phase of internal review, and will be sent to SCS for voting by the end of November 2022.
- Valanginian GSSP. The recommended primary event to define the base of the Valanginian Stage is the first appearance of the calpionellid *Calpionellites darderi*. The alternative event is the FAD of the ammonite “*Thurmanniceras*” *pertransiensis*. Cañada Luenga (Cehegín, SE Spain) and Vergol (Montbrun-les-Bains, SE France) are considered as possible candidates for the GSSP. The preliminary studies on the two candidate sections are nearing completion. The chairs are preparing the documentation for the discussion of the primary and secondary markers.
- Berriasian (Jurassic-Cretaceous J/K boundary) GSSP. The WG continue to focus on organising a database and ideas concerning possible definitions and placing the Tithonian/Berriasian Stage boundary, as well as its global and regional palaeoenvironmental context. It was confirmed that the Tethys-domain provides the best quality, continuous stratigraphical dataset, based on

integrated calpionellid, calcareous nannofossil and magnetic stratigraphy, from the base of the upper Tithonian to the Berriasian/Valanginian boundary. The Tethyan ammonite stratigraphy in the J/K boundary interval has recently been largely modified, and we support the opinion of the former WG that ammonites should be regarded as useful, but not as first-order markers in defining the boundary, at least in the Tethyan domain. In 2022, the WG concentrated discussion on which level (not yet the primary marker) should be the best choice for the global J/K boundary definition. The 3 levels under considerations are: 1) the lower/middle Berriasian boundary (base M17r/base zone *Calpionella elliptica*/base zone *Subthurmannia occitanica*); 2) present day Tithonian/Berriasian boundary (base *Calpionella alpina* Subzone); 3) a boundary in the upper Tithonian (between magnetozones M20n1r and M19r)/base *Crassicollaria* Zone or base *Intermedia* Subzone. The first two options were already discussed during WG meetings in May and July 2022. The third option will be presented and discussed in the next meeting (November 2022). Synchronously with debate about the level of the J/K boundary, a search for most suitable sections has begun. At present, the most advanced option is Torre de Busi (Lombardy Basin, Italy), however sections are considered also in the Vocontian Basin. The revised calpionellid stratigraphy of Torre de Busi was completed and presented during Warsaw and Budapest meetings. J. Grabowski performed a high-resolution magnetic susceptibility and gamma-ray spectrometric logging of the section during field work in November 2022. It was suggested that the future proposal for the J/K boundary should include not only the main GSSP section but also auxiliary (or regional) stratotypes in different palaeogeographic realms (NW Europe, Southern America). The works on specific sections are also still performed by some members of the previous WG, we stay in contact with our colleagues trying to co-ordinate and exchange information on our efforts. As in 2021, the WG meets online once a month, usually with 1-2 keynote talks and discussion. Up to now 15 meetings were organized (the 16th meeting is scheduled for November 2022) with the following presentations: 7th meeting (22.11.2021), Grabowski J.: Current activities; Martinez M.: Synchronisation of the timing of carbon cycle, volcanism and the pacing of the Earth orbit in the Early Cretaceous; 8th meeting (7.12.2021), Mutterlose J., Schneider C.: The Jurassic/Cretaceous boundary in the Boreal Realm; 9th meeting (25.01.2022). The presentations and short reports of the meetings are archived and accessible only to WG members on a dedicated web page. WG members presented 2 contributions during the Cretaceous Symposium in Warsaw 2022 and 7 contributions during the Jurassic Congress in Budapest in the session “The Jurassic-Cretaceous Boundary” (chair-persons: J. Grabowski, O. Szives). A post-Congress excursion was organised by J. Grabowski and colleagues: The Jurassic-Cretaceous transition in the Western Carpathians, exploring the J/K boundary sections in the Pieniny Klippen Belt (Slovakia) and Transdanubian Mountains (Hungary). Additionally, the meetings of the

WG were organized during both Cretaceous and Jurassic Congresses, with participation of SCS and JCS officers and some invited guests.

- Kilian Group. The WG met during the 11th International Cretaceous Symposium in Warsaw, Poland (22-26 August 2022).

Jurassic Subcommittee

- 11th Jurassic Congress: The main focus this year was the Jurassic Congress in Budapest, Hungary over five days from the 29 August to 2 September 2022. The conference was hugely successful with lively scientific discussion and collegiate atmosphere. As most delegates had not seen their colleagues for several years due to the pandemic, this was a very special meeting. There were 110 delegates from 31 countries this was a lower than usual but given world circumstances this was not surprising. There were twelve thematic sessions with two sessions running in parallel throughout. The most popular topic at the conference was the Toarcian Oceanic Anoxic Event. There was a mid-conference fieldtrip on the Wednesday to the geological garden of Tata where remarkably the full succession from the top of the Triassic to the base of the Cretaceous could be seen. There were constructive discussions on the Jurassic GSSPs that are not yet formally defined (see below). Additionally, based on discussion at the meeting we will be setting up a new working group on high-resolution subdivision and correlation of the Jurassic. The conference dinner on a boat on the Danube from which the evening lights of Budapest could be enjoyed was well attended.
- We are grateful to the organisers József Palfy and István Fözy for their smooth organisation that provided a relaxed and constructive atmosphere. This was aided by the fact that for the first time all the talks and the accommodation was at one venue so that conversation could happen over breakfast and dinner as well as throughout the day.
- 12th Jurassic Congress: Voting has taken place by both the delegates of the 11th Jurassic Congress and the voting members on three proposals for the next congress. It was decided by a >60% majority that the 12th Jurassic Congress will be held in Exeter, UK in 2026.
- Submission of the Kimmeridgian GSSP proposal to Episodes: The paper for the accepted definition of the Kimmeridgian GSSP has been accepted by Episodes. In partnership with Scottish Natural Heritage (<https://www.nature.scot/>) and other local bodies work has begun on promoting the GSSP to the scientific community and general public, though there has been some delay due to the pandemic.
- The Oxfordian Working Group: Data from 60 sections have been studied and from this two candidate sites (Redcliff Point, Weymouth, England; Thuoux with Saint-Pierre d'Argençon and Lazer, Serres, SE France) are being synthesised and considered. A further section Dubki, Saratov Region, Russia was previously proposed but is currently on hold because of the war. *Cardioceratidae* ammonites provide widespread markers and rapidly evolved during this interval global biostratigraphical correlation can be supplemented with *Peltoctidae*. Carbon isotopes and magnetostratigraphy are also likely to be very informative.
- The Callovian and Tithonian Working group: In the Callovian Working Group, work has continued on the remarkable ammonite faunas from Albstadt-Pfeffingen, Germany but it is agreed that this section presents a

number of issues in terms of using it to define the GSSP. The Tithonian Working Group have focussed on correlating the European and American sections. Work on the neighbouring base Berrasian GSSP is proving helpful. After much fruitful discussion around different data sets and sections it was agreed at the 11th Congress that the working group for the Callovian and the Tithonian would be renewed and revitalised following new work in non-European sections and interest from other researchers.

- Research with the International Subcommittee on Cretaceous Stratigraphy (Berriasian Working Group; *cf.* above): A short meeting was held at the 11th Jurassic Congress with all members of the Berriasian Working Group and the executive of ISJS present to discuss current proposals. A boundary within what has historically been the Tithonian was favoured and this will be the focus of further studies
(See <https://cretaceous.stratigraphy.org/news/berriasian-wg-meetings>).

Triassic Subcommittee.

- A total of 140 papers that are closely related to stratigraphy and extreme biotic, environmental and climatic events within the Triassic have been published by STS members in 2022.
- New achievements in I-O, O-A and C-N boundaries: Through a two-stage process of option elimination in voting, conforming with ICS guidelines, the working group decided by 60% majority to propose that the first occurrence datum of bivalve *Halobia austriaca* in the Pizzo Mondello section, Italy at the base of bed FNP135A should become the ‘golden spike’ for the base of the Norian (Hounslow *et al.*, 2021). Thus, after a formal voting procedure within the working group, the Pizzo Mondello section was selected as the global stratotype section and point for the base of the Norian in the end of 2021 (Hounslow, 2022, oral presentation). A team led by Dr. Marco Balini is preparing a formal proposal for the GSSP of CNB for the ratification within voting members of STS in 2022-2023. The FO of conodont *Chiosella timorensis sensu stricto*, together with the base of normal-polarity subzone MT1n and near the end of the positive $\delta^{13}\text{C}_{\text{carb}}$ excursion was suggested as the primary marker defining the GSSP for the O-A boundary, and the Wentou section of Guangxi, South China was recommended as the most suitable candidate for this GSSP (Chen *et al.*, 2019; Lucas, 2022, oral presentation). A new study from Tibet also strengthens that the conodont *C. timorensis* is the best marker defining the OAB (Chen *et al.*, 2022). The signal and sections of the GSSP for the IOB have long been hotly debated in the past three decades. The updated studies show that the I-O boundary can be best defined by the first occurrence of conodont *Novispathodus waggeni waggeni* or *Eurygnathodus costatus*, coinciding with the upper part of the positive shifting excursion of $\delta^{13}\text{C}_{\text{carb}}$ (Henderson, 2022, oral presentation). The same case has also been reported from the southern Qinglin region (Li *et al.*, 2022) and the Salt Range (Han *et al.*, 2022).
- Permian-Triassic mass extinction and recovery, and Triassic extreme events and correlations: Great advancements have been achieved on the correlations of catastrophic event sequences in terrestrial and marine ecosystems as well as ecosystem recovery processes after the PTB mass extinction (Chen *et al.*, 2022; Dal Corso *et al.*, 2022; Feng *et al.*, 2022). Two special issues were organised

in *Global and Planetary Change* (Chen, Z.Q., Harper, D.A.T., Grasby, S., Zhang, L., 2022; Chen et al., 2022; Sun, Y.D., Richoz, S., Kürschner, W.M., 2022).

- One international summer school and two indoor workshops: 1) STS sponsored the International Geological Summer School “Millions of years before the Silk Road”, 15-28 August 2022 in Madygen, Kyrgyzstan, Central Asia, organized under the auspices of UNESCO by the Tian Shan Geological Society with the support of the German university TU Bergakademie Freiberg. Participants were twelve graduate and PhD students from Germany, United Kingdom, Russia, Uzbekistan and Kyrgyzstan. The summer school report is attached. 2) The STS Webinar: Triassic GSSPs—Progresses, Problems and Perspectives (11-12 November, 2022, Webinar), with online participants up to 105. This webinar provided a great platform for STS members to communicate each other. Chairs of the IOB, OAB and CNB working groups were invited to report the progresses, problems and perspectives on their GSSP studies. The voting members of the working groups of these GSSPs have been updated, and the IOB task group has selected a new secretary (Dr. Zhengyi Lyu) to organize activities within this task group (led by Prof. Charles Henderson). The new working/voting members were also selected or nominated for the OAB task group led by Dr. Spencer Lucas. The CNB working group pushed Dr Marco Bolini’s team to complete the formal proposal of the GSSP for the CNB so that it can be ratified within STS before the end of 2023. 3) STS business meeting (12 Nov, 2022, Webinar): 1) summarising STS works in 2022; 2) updating voting members for all task groups; 3) nominating Dr. Yadong Sun to be the chair for the working group of the GSSP of the N-R Boundary, and Dr. Sun will invite new voting members for this task group; and launching serial books ‘*The Triassic of the World*’.

Permian Subcommission

- The proposal for the Global Stratotype Section and Point (GSSP) for the base Artinskian Stage (Lower Permian) was ratified by the IUGS Executive Committee on 2 February 2022.
- The manuscript "Proposal for the Global Stratotype Section and Point (GSSP) for the base Artinskian Stage (Lower Permian)" was sent to *Episodes* on 22 February 2022 (EPISODES-D-22-00018) and received a positive review.
- Five new voting members were selected based on their extensive experience in Permian stratigraphy (Annette Goetz, Germany; Sam Lee, School of Earth, Australia; Ana Karina Scomazzon, Brazil; Elisabeth Weldon, Australia; Dongxun Yuan, China).
- A new Working Group was organised “Gondwana to Euramerica correlations” with the aim of solving the difficulty of correlating between Gondwana and Euramerica.
- The Permian Time Scale was kept updated: <https://permian.stratigraphy.org/gssps> and two issues of *Permophiles* were published (SPS Newsletters *Permophiles* 72 and 73).
- Two webinars have been organised (<https://permian.stratigraphy.org/interest>).

Carboniferous Subcommission

- The work of SCCS has been strongly impacted by the current political and sanitary situation. Almost half of the SCCS voting members and officers are directly impacted, and the search for GSSPs has been slowed down due to temporary inaccessible of key sections in several countries.
- *Ice ages, climate dynamics and biotic events: The Late Pennsylvanian World: Geological Society, London, Special Publications 535.* The Geological Society, London, approved the publication of an edited volume in their Special Publications series based on the results from the “the Kasimovian Workshop”, a 4-day online meeting organised by the Subcommission on Carboniferous Stratigraphy in May 2021. This volume is edited by Spencer G. Lucas (VM of SCCS), William A. DiMichele (CM of SCCS), Joerg W. Schneider (CM), Stanislav Opluštil (SCCS), and Xiangdong Wang (Chair of SCCS).
- The volume is divided into five sections: I. Introduction, II. Timescale, III. Physical Parameters, IV. Marine Biotic events, and V. Non-marine Biotic events. It will comprise 22 chapters, most of which have been reviewed, and some of them have been accepted after revision and are already available online. The complete volume of the book will be published in 2023.
- The Kasimovian-Gzhelian boundary. After a long-term international co-operation of multidisciplinary studies on the Naqing section, South China, the Kasimovian-Gzhelian boundary Work Group is now preparing a formal proposal for the Naqing section to become the GSSP for the Global Gzhelian Stage. The proposal will present detailed descriptions and data on sedimentary evolution, conodont and fusulinid biostratigraphy, conodont lineage of the index taxon, carbon, oxygen, strontium and uranium isotopic stratigraphy, and cyclostratigraphy of the Naqing section. The proposal will be submitted to be voted hopefully at the end of this year or latest in the first months of 2023.
- The Devonian-Carboniferous boundary. The Devonian-Carboniferous Working Group has made significant progress during a series of online meetings during the last month. A calendar listing a succession of important stratigraphical dates has been established for the latest Devonian and earliest Carboniferous. The data used for it result from various methods, and derive from very different facies realms. The work on a proposal how a revised boundary for the base of the Carboniferous could be defined, has started and should be finished by the working group in the first half of 2023.
- The Viséan-Serpukhovian, Bashkirian-Moscovian, Moscovian-Kasimovian boundaries. Co-ordinated progress of the working groups for those three boundaries has not been possible due to the current political and sanitary situation. Hence, activities have been reduced to mostly individual work of working group members..

Devonian Subcommission

- Annual business meeting of the SDS took place in 8 November in Khon Kaen, Thailand in conjunction with the 6th International Palaeontological Congress. It was the first SDS non-virtual meeting since Milano 2019, and, in spite of a long break in personal meetings it was relatively well attended. The Chair and Vice-Chair informed about major points in the business meeting agenda and the current situation in our Devonian community, on-

going Devonian projects (reports on biostratigraphical, petrophysical and geochemical data from the key areas and progress in the Basal Emsian boundary redefinition), Devonian publications and forthcoming meetings. We had 17 participants, including guests from 9 countries. The meeting was successful, we recruited three new Corresponding Members from Thailand, Mongolia and Algeria. These countries are thus newly represented within the SDS community.

- Update of the new SDS webpage – housed on the ICS website (stratigraphy.org).
- Publications: SDS Newsletter No. 37 and a special volume of *Palaeobiodiversity and Palaeoenvironments* “*The Rhenish Massif: More than 150 years of research in a Variscan mountain chain*” (Guest-editors: S. Hartenfels, C. Hartkopf-Fröder & P. Königshof) with 11 contributions on 336 pages.

Silurian Subcommission

- Silurian Times No 29 was edited by the secretary, David Ray, and distributed in April, 2022, 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 planned meetings, the latest news and recent publications on Silurian research.
- The restudy of the Rheidol Gorge section submitted for publication in *Lethaia* by Melchin *et al.* is currently in press (see below).
- The Chinese working group conducted extensive geochemical studies on samples from the Aeronian GSSP candidate section at Yuxian section, Sichuan Province.
- Melchin, M.J., Davies, J.R., Boom, A., De Weirtdt, J., McIntyre, A.J., Russell, C., Vandenbroucke, T.R.A., Zalasiewicz, J.A. (in press). Integrated stratigraphic study of the Rhuddanian-Aeronian (Llandovery, Silurian) boundary succession at Rheidol Gorge, Wales: A proposed Global Stratotype for the base of the Aeronian Stage. *Lethaia*.

Ordovician Subcommission

- The official inauguration of the second Auxiliary Boundary Stratigraphic Section and Point (ASSP) for the base of the Ordovician System in the Dayangcha section (Northern China), originally scheduled for May 2020, was postponed first to May 2021, and is currently postponed again to a later date, possibly in 2023 (as the sanitary situation did not evolve so far, the organisation of the meeting in 2023 is unlikely, and no budget has been foreseen).
- In accordance with ICS Statutes, the Voting Members of SOS were replaced in 2020, and the voting membership voted to select a new Executive and Voting Members for the term 2020–2024. The voting membership was increased to 20. During the Covid pandemic, on-line meetings are organised. The second on-line business meeting was organised in late March 2022 attending most voting members.
- Following the final meeting of the International Geoscience Programme (IGCP) 653 ‘The onset of the Great Ordovician Biodiversification Event’ and kickoff meeting of the IGCP 735 ‘Rocks n’ ROL (Filling knowledge gaps in the Early Palaeozoic Biodiversification’ organised jointly as a video conference congress

in Lille (France) on 13-16 September 2021, two thematic volumes were scheduled in *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology* and in *Geobios*. Both special issues are focused on the Ordovician radiations, and are co-guest-edited by current and former executive officers of the Subcommission. During 2022, numerous contributions were submitted to these two volumes, which will be published in 2023.

- A major accomplishment during 2022 is the production of the publication in two volumes of the *Geological Society Special Publication* series on a global Ordovician synthesis. Launched by the Ordovician Subcommission in 2021, all manuscripts for chapters have been deposited between January and November 2022. The publication is scheduled for Summer 2023.
- The second Annual Meeting of the International Geoscience Programme (IGCP) 735 ‘Rocks ‘n’ ROL (Filling knowledge gaps in the Early Palaeozoic Biodiversification)’ took place as a successful in person congress, October 19th–20th 2022, with about 50 participants, with the Ordovician subcommission being a co-organising body. The excursion to the Central Anti-Atlas (21–24 October, 2022) was coinciding with the 3rd National Conference on Moroccan Geological Heritage, in Zagora.
- Ordovician News 39 (for 2021) was published in March 2022 and is available from the SOS webpage (<http://ordovician.stratigraphy.org/>).
- The SOS webpage changed its host, and is now managed as a separate page of the webpage of the ICS (<http://stratigraphy.org/>).

Cambrian Subcommission

- Two options are being considered for defining the base of Stage 10: 1) at the lowest occurrence (LO or evolutionary appearance, FAD) of *Lotagnostus americanus*, or 2) at the LO (or FAD) of *Eoconodontus notchpeakensis* just below the onset of the HERB/TOCE excursion. The two options have been extensively discussed during four periods in 2021–2022. The results of a balloting among the Voting Members conducted in June–July 2021 were inconclusive. 55% voted for *L. americanus* as the primary marker and 45% preferred that we should proceed with two candidates for the level. For approval all decisions require 60% of the delivered votes. Since the level with *L. americanus* was the winner of a relative majority of less than 60%, a second round of voting was planned, asking the Voting Members if they accept or reject *L. americanus* as the primary marker. A period for discussion was allotted in October–November 2021, but opinions were circulated within the Subcommission well into 2022.
- Unfortunately, the discussions concerning Stage 10 frequently invoked bad behaviour, sometimes with bullying and harassment, by a couple of members of the Cambrian community. The behaviour evidently also intimidated several, mainly younger, members who neither do not wish to engage in discussion nor wish to be part of the Cambrian Subcommission. The protagonists have been asked to cease and desist from this behaviour a number of times, but generally without success. Therefore, the Cambrian Subcommission has become dysfunctional and in March 2022 it was decided to dissolve the current Subcommission. During the remainder of 2022, efforts have been made to rebuild the Cambrian Subcommission from scratch and a new executive (with new officers) was ratified at the IUGS EC meeting in early October 2022.

Ediacaran Subcommission

- Due to the impact of the Covid-19 Pandemic, many of our expected accomplishments were postponed to 2022. Our leadership transition took longer than expected, and the disruptions to activities as mundane as opening a bank account significantly affected our progress. Online/virtual teaching has also strained our members.
- The Subcommission continues to work on a field workshop to examine Ediacaran successions in Brazil and Argentina in July 2023. All logistical work is completed, but prices have gone through the roof following the COVID delay. We may need to reduce the extent of the trip. Prices will be confirmed in December 2022.
- The new website continues to grow: as part of the Executive transition, we wished to transfer the website to new ownership. We also solicited our colleague Dr. Tara Selly to act as web-developer.
- A database of known late-Ediacaran sections is currently being constructed, with input from all voting members. Construction of a database of all known end-Ediacaran sections worldwide. This includes fact-finding searches concerning the geology, geochemistry, and palaeontology of each section. This is currently underway and will continue into the new year.
- A special issue of the *Journal of Paleontology* with the executive members (Laflamme, Schiffbauer, Warren, Selly) and voting member (Liu) as guest editors is nearing completion. Two drafts remain to be resubmitted post reviews, but the remainder of the manuscripts have successfully gone through the entire peer review process.

Cryogenian Subcommission

- The 2022 was a relatively quiet year. As a result of the different Covid -19 restrictions and policies in different countries, and the plans have been delayed. They will be carried out in 2023.
- The first draft of the criteria to define the base of the Cryogenian System. During this summer and autumn, at least three working groups on different criteria have come up with a document. These documents will be discussed and voted later 2022 to early 2023.
- We have set up a Teams working group for the subcommission, working on the criteria documents and discussing on other subcommission related topics.

Precryogenian Subcommission

- A field workshop led by Nora Noffke, Flavia Callefo and Evelyn Sanchez in the Earth's oldest sedimentary succession, the Dresser Formation, located in the highly protected Buick Geoheritage Reserve in Western Australia, determined a top candidate section for the Paleoproterozoic boundary.
- Douglas Galante has received funding from FAPES Brazil that helped defray expenses for the workshop in Australia.
- A manuscript is in preparation with the lead by Jaana Halla and Humberto Reis.
- The subcommission has successfully submitted a proposal for the base of the Hadean. The proposal was voted on by ICS and ratified.
- At the GSA Meeting in Denver, Colorado, USA, the current work of the Subcommission was discussed and the upcoming proposal regarding the

Hadean/Archean boundary prepared.

- A new collaboration has been established with the Geological Survey of Western Australia..

Stratigraphic Classification Subcommission

- Subseries/subepoch project. On 19 January 2021 ISSC submitted a proposal to the ICS for Subseries/Subepochs to be accorded the status of formal chronostratigraphic units in a new/revised version of the International Stratigraphic Guide. The voting result on 23 March 2021 was: 17 yes, 2 no, 1 abstention (20 votes) representing a supermajority with 89.47% (with abstention) and 85% yes. On 1 May 2021 the IUGS Executive Committee ratified this proposal and Subseries can now be defined as chronostratigraphic units in a formal rank intermediate between stage and series. Following this ratification, Aubry and Piller revised the online version of the “*International Stratigraphic Guide – an abridged version*” (<https://stratigraphy.org/guide/>; online: 17 November 2021). This outcome was also the starting point for ISNS to discuss and vote positively on this topic.
- Auxiliary boundary stratotype project. A small working group (Leader: M. Head; M.-P Aubry, W. E. Piller, M.J.C. Walker) deals with the topic of Auxiliary Boundary Stratotypes. More and more auxiliary stratotypes are currently published to support GSSPs but representing different approaches. To standardise auxiliary stratotypes the authors work on a proposal to introduce Standard Auxiliary Boundary Stratotypes to support GSSPs with reference sections which represent, e.g., different facies or palaeogeographic context. The manuscript will be finished early 2022 and submitted to *Episodes*.
- New developments in stratigraphic classification project. The final goal of ISSC is to update, upgrade and implement the *International Stratigraphic Guide* (Hedberg, 1976 [1st edition]; Salvador, 1994 [2nd edition]; Murphy and Salvador, 1999 [abridged edition]). The ISG is a most important official document with a large distribution, which requires revisiting because of the fundamental advances of stratigraphy in the last 30 years. A project was developed by ISSC under the Chairmanship of Maria Bianca Cita following a workshop organised 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) printed in *Newsletters on Stratigraphy* where the various review articles are being published. 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.
- Lithostratigraphy. The working group is making good progress. It is expected, that the manuscript will be submitted in spring 2022.
- Biostratigraphy. In 2021 new working group members have been approached and invited to work on this topic. As the concepts and approaches of biostratigraphy vary between fossil groups and stratigraphic systems, this turns out to be rather difficult. The core team of authors will held a video-conference to define a thematic skeleton of the manuscript. The manuscript, however, will not be finalised before end of 2022.

- Chronostratigraphy. A new working group has been established. The manuscript should be finalised in summer/spring 2022.
- A business meeting was planned to be held during EGU (Vienna, Austria) or/and GSA Annual Meeting (Portland, Oregon). Due to the COVID 19 pandemic no meeting took place in person. We plan a meeting for EGU 2022 (Vienna).
- North American Commission on Stratigraphic Nomenclature (NACSN). The chair of ISSC, Werner Piller, was again invited and attended the 76th annual meeting of the NACSN on 5 October 2021 which has been a digital meeting in conjunction with the GSA Annual Meeting in Portland (Oregon, USA). The major general topics of this meeting were: Subseries have been formalised in the North American Stratigraphic Code as already published by
- Aubry, M.-P., Fluegeman, R., Edwards, L., Pratt, B.R., and Carlton E. Brett, 2020: *North American Commission on Stratigraphic Nomenclature Report 14 – Revision of Articles 73, 81, 82 and Table 2 of the North American Stratigraphic Code to Formalise Subseries and Subepochs. Stratigraphy*, 17 (4), 315-316. A proposal on formalisation of chemostratigraphy has again been discussed. Although it is still in a very immature state some proponents urge for submitting the proposal to the NACSN. It is, however, still unclear how formal chemostratigraphic units could be defined. Some members of the NACSN want also that Chemostratigraphy will formally be included in the upcoming new version of *International Stratigraphic Guide*. In this respect many questions have to be addressed before.
- The session SSP2.3 “Integrated Stratigraphy - Recent advances in stratigraphic systems and geochronology” was digitally held at the EGU General Assembly 2021 (EGU 2021), 19-30 April 2021, Vienna, Austria.

Timescale Calibration

- The creation of additional teaching materials for the Cyclostratigraphy Intercomparison Project (CIP) and the organisation of the website database have been the chief accomplishments of 2022. We are also organising our first digital subcommission meeting and will have our first in-person meeting at STRATI 2023.
- Continued collaboration and support for the Cyclostratigraphy Intercomparison Project (CIP) in their creation of online learning resources and tools for researchers and teachers of cyclostratigraphy
- Creation of an online dataset for radioisotopic data utilised in calibration of the GTS2020 timescale that will be available online at the ISTC website.

Graphics Officer (Cohen) and Web Officer (Car) contributions

- The ICS Chronostratigraphic Chart, which included newly ratified GSSPs and subseries division and revised numerical ages, was kept actual on www.stratigraphy.org (versions released: 2022/02, 2022/10), as was a changelog (LINK).
- The ICS website since 2020 also features digitally generated web chart representations, based on its Semantic Web representation, which was kept up to date to the 2020 chart.

- Eight out of seventeen Subcommissions are operating their own websites within the new website system. The status of Subcommissions' website standardisations can be seen online (LINK).
- The following translated versions of the ICS chart were updated to the 2021/2022 versions: Iberian Portuguese; Catalan; Spanish; American Spanish; Chinese; Japanese; Finnish; Hungarian; French; Belgium Dutch; Netherlands Dutch; Norwegian. Slovak; Czech and Korean translations were newly translated in 2022.
- A presentation by the Informatics officer is scheduled for 07-Dec-2022, reviewing unofficial digital-form versions of the ICS chart data (names, numeric ages, hierarchy, status, standard color, ...), in particular that in so-called Semantic Web or Knowledge Graph form. The progress on creating an ICS-authorized digital 'point of truth', kept actual by ICS officers will be outlined too, including liaison with the Commission for Geoscience Information (CGI). The one-off tasks in the last year have been: vocabulary submissions to CGI
- The Webmaster has submitted a simplified version of the timescale as a Knowledge Graph vocabulary to the Commission for Geoscience Information's Geoscience Terminology Working Group this is based on the existing, detailed, Knowledge Graph version of the Chart (<http://resource.geosciml.org/vocabulary/timescale/gts2020>) which, while powerful, is hard to use this simple version is under review and expected to be published soon at <https://cgi.vocabs.ga.gov.au/> alongside the detailed version of the Chart
- Chart data presentation, the Webmaster delivered a presentation entitled "The Internetian Age" describing data publications of the Chart.

8. SUMMARY OF EXPENDITURE IN 2022

The IUGS Executive Committee awarded ICS a budget of **\$71,650** for 2022. However there was a clawback of \$28,261 carryovers from the previous year (due to suspended programmes due to Covid) Thus, **\$43,389** new money was available for ICS activities in 2022 and spent accordingly. Expenditure is detailed in the appended financial spreadsheet (Expenditure_Budgets).

9. SUMMARY OF INCOME IN 2022

The IUGS Executive Committee awarded the ICS a budget of \$43,389 for 2022, No additional income to the ICS is declared.

10. BUDGET PROPOSALS FROM ICS IN 2022

These have been itemised in detail in the attached spreadsheet (Expenditure_Budgets). A request for \$68,340 new money has made on behalf of the executive and subcommissions for activities during 2023 (Including estimates for attendance at the IUGS EC meeting in Nairobi, 2024. Many of the requests are for attendance at STRATI 2023 in Lille, a number of GSSPS

are close to completion, others under investigation and a number of book projects are near publication or far advanced. The carryover of funds have been minimised and those subcommissions with monies from the previous year have made strong cases for their use (mainly for work suspended during the pandemic) in addition to new funds for conference attendance and new projects.

10. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED IN 2023

Quaternary Subcommission

- Given the rapid progress being made in the analysis of candidate stratotypes for the Anthropocene, this will be the next major GSSP decision for the SQS. Following voting to select a single candidate GSSP by the Anthropocene Working Group in late 2022/early 2023, and accompanying SABSSs, a proposal will be submitted to SQS in the first half of 2023. Extensive discussion/consultation within and beyond SQS will take place during 2023 prior to SQS voting. STRATI 2023 and INQUA XXI (below) will be part of this required discussion/consultation process.
- 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 developed for these potential candidates as soon as possible. The Upper Pleistocene Working Group is being reformed under the co-convenership of Martin Head.
- Planned conference involvement:
STRATI 2023, Lille: Proposed SQS-led sessions and business meeting:
 1. Developments in Quaternary chronostratigraphy.
 2. The Anthropocene: stratigraphical concepts and evidence.
 3. SQS business meeting.INQUA XXI, 2023, Rome: Proposed SQS-led sessions
Session 8: A second stage for the Middle Pleistocene Subseries?
Session 17: Fine-scale subdivision of the Quaternary: a land-sea perspective
Session 19: Global characterisation of the Neogene–Quaternary (Pliocene–Pleistocene) transition: to presentations describing SQS-sponsored reanalysis of Monte San Nicola stratotype.
Session 40: The Anthropocene as a tool for characterising recent planetary change and predicting future environmental challenges.

Neogene Subcommission

- The major plan is to vote to approve the official proposal for the Langhian Stage GSSP, that is on a reliable/reproducible guiding criterion, complemented by additional criteria useful for correlation, and to reach a decision on the GSSP section and auxiliary deep-sea core. The SNS executive will attend and run a session on Neogene Stratigraphy and Paleooceanography at STRATI 2023. We hope to run a field trip to the La Vedova section Conero Riviera, Italy after Sept. 2023 to formally designate the boundary stratotype for the Langhian Stage.

Paleogene Subcommission

- Full support will be given to studies related to the Bartonian Stage GSSP, the only Paleogene Stage pending definition. Fieldwork is planned in several Italian and Spanish sections, and on-going studies of the Bartonian WG will likely lead to the resubmission of an improved proposal in 2023.
- Establish a working group to study a variety of sections of the base of the Ypresian (Paleocene/Eocene boundary) from different palaeogeographical areas and depositional settings with the aim of defining potential auxiliary sections. Eventually, a manuscript will be submitted to the journal *Episodes* to present the auxiliary sections defined.
- Contribute to the ICS STRATI-2023 meeting, to be held in Lille (France), in July 2023. A business meeting of the Subcommission and a specific session on the Paleogene will be organised by the ISPS.
- Publish the results of the re-study of the GSSP for the base of the Lutetian Stage.
- Potential funding sources external to IUGS: most of the research that is currently being undertaken by the ISPS members is financially supported by their home countries' research grants.

Cretaceous Subcommission

- Maastrichtian GSSP. In March 2023, WG members will examine the stratotype section in Tercis (France). Resampling of the section is necessary to establish modern biozonations for calcareous nannofossils, planktonic foraminifers and palynomorphs. Further, the cyclicity of the Tercis section will be investigated to achieve an astrochronology for the succession. This approach has the potential to develop an astronomically tuned timescale for the Maastrichtian Stage in context with the records of Zumaia/Sopelana in Spain (Batenburg *et al.* 2014). In addition, the working group plans to develop auxiliary boundary sections for correlation. Potential candidate sections in the Boreal realm are the Vistula and Krons Moor sections (Poland, Germany) with new stratigraphic data published in the last years (e.g., Plasota *et al.* 2015, Wilmsen *et al.* 2019). The Gubbio section in Italy is a good reference for the Tethys and the stratigraphic record of the ODP Sites 1209 and 1210 may allow for correlation of the boundary to the tropical deep ocean. A splice of both ODP records is suited for astronomical tuning and validation of the astrochronology (Kim *et al.*, 2022). Milestones to achieve in 2023 are the sample collection in Tercis and the site survey and data compilation for auxiliary sections.
- Aptian GSSP. Several possible locations for a GSSP based primarily on C-isotope stratigraphy will be proposed in a third online discussion in winter 2022/23. These sites will include Cismon and Gorgo a Cerbara (core and outcrop data), La Bedoule (core and outcrop data), Cau (core data). The WG members will be asked to argue for one or the other locality, accepting the fact that the negative C-isotope spike will define the future base of the Aptian. In 2023, the WG plans to define a GSSP and several Standard Auxiliary Boundary Stratotypes and only in a follow-up step, the formal descriptions of the chosen sites will be made. Potential WG meeting during the STRATI 2023 congress (Lille, France).
- Barremian GSSP. The GSSP proposal will be sent to SCS by the end of November 2022. If approved by SCS, ISC and IUGS, a publication will be

prepared with the most relevant data concerning the Hauterivian/Barremian stage boundary and the Río Argos section. Official contacts with the local authorities will also continue to increase protection and facilitate accessibility of the GSSP site.

Valanginian GSSP. The documentation for the discussion of the primary and secondary markers will be circulated among the WG members in mid-December 2022, and the discussion will take place in January-February 2023. At the end of February, the informal vote will be held to decide the primary marker. The reports on each of the two candidate sections will be completed on March and will be sent to WG members in mid-April, for discussion on May-June. The informal vote to decide the candidate section for GSSP for the Valanginian Stage and the possibility of designating the other section as ASSP will take place by the end of June. The formal proposal for the section chosen for the Valanginian GSSP will be prepared during the second half of 2023. The proposal will be formally discussed and voted by the members of the WG by the end of 2023 or the beginning of 2024 and, once approved, will be submitted to SCS.

- **Berriasian (J/K boundary) GSSP.** The WG is planning to integrate the bio- and magnetostratigraphy with chemostratigraphy, climatostratigraphy (arid/humid cycles), eurybathic sea-level changes, astrochronology and radiometric dating with the aim to overcome the faunal provincialism, which has prevented a consensus on the definition of the J/K boundary. Preliminary data indicate that humid/arid cycles well documented in NW Europe might be correlated with Tethyan sequences, where palaeoclimatic variations are not well studied. The strategy is to supply more palaeoenvironmental data from the Tethyan sections with excellent chronostratigraphy (bio+magneto) and to date more precisely the NW European sections. We started integrating clay mineral and stratigraphic study in sections of the Vocontian Basin (Taulanne) and Balkans (Bulgaria, Kopamitsa – Berende). The first data obtained are very promising. Some hopes are related to the recently discovered $\delta^{13}\text{C}_{\text{org}}$ excursion (VOICE event) in the upper part of the lower Tithonian (middle Volgian) in Boreal and South American sections. Efforts are concentrated in identifying the VOICE event in the Tethyan sections. Additionally, astrochronological and radiometric studies, quite advanced in South American sections (Neuquen basin) are planned also in the Tethyan successions. The first data were obtained by M. Martinez on the hemipelagic Tithonian section in the Carpathians (Tatra Mountains, Poland). Launching a special project application to the ICS is considered, devoted to these topics, after some pilot investigations (see above).
- **Kilian Group.** The upper Aptian, lower-middle Albian zonal schemes will be in focus at the forthcoming Kilian meeting.

Jurassic Subcommittee

- **Oxfordian GSSP:** Finalising of data from the sections in UK and France including field discussion to sort out different approaches and agree correlations. Preparation of proposals for the working group to vote on.
- **Callovian and Tithonian GSSP:** Formation of refreshed working groups following constructive discussion at the 11th Jurassic congress followed by the search for other possible sections and primary markers.

- Kimmeridgian GSSP: Celebration and promotion of the Kimmeridgian GSSP on the Isle of Skye, Scotland.
- High resolution subdivision and correlation of the Jurassic: Formation of a new working group to consider a variety and a system of markers for high-resolution correlation of the Jurassic including suggested nomenclature.
- STRATI 2023: Successful Jurassic session and business meeting at STRATI 2023. Support of wider members of the Jurassic community leading a workshop on radio-isotopic dating.

Triassic Subcommittee

- Organisation of the STS Symposium/Sessions: Triassic Integrated Stratigraphy, GSSPs, and Extreme Climatic, Environmental and Biotic Events, joint with STRATI 2023, 11-13 July, 2023, Lille, France, in which STS business meeting is held, progresses on GSSPs for IOB, OAB, CNB, and NRB are reported.
- Organizing the STS Field Workshops: The Olenekian-Anisian Boundary Successions in Romania (14-16 July, 2023) and in South China (10 -16 October, 2023).
- GSSPs: The plan is to move towards a vote on the GSSP for CNB in late 2023 within STS. The IOB, OAB and NRB GSSPs move towards preparing a discussion document among the working group members at the Lille meeting in 2023, as a prelude to moving towards a vote on the candidate markers and sections.
- Promoting Books Series of “The Triassic of the World”: A total of 6-7 volumes are planned to summarize integrated stratigraphy, palaeontology, as well as environmental and biotic evolutions and global correlations, and this book series cover Europe (except for Russia), Russia, China, Asia (outside China), northern high-latitude region, Oceania-Africa-Antarctic, North America, and Middle-South America. Detailed allocation of book volumes and chapters will be carried out in 2023.

Permian Subcommittee

- We plan to have the proposal of the base Kungurian GSSP proposal published in *Permophiles* and voted by SPS voting members.
- We plan to organise several webinars.
- We plan to support the activity of the new working group on Gondwana Correlation.

Carboniferous Subcommittee

- The special volume entitled: ‘*Ice Ages, Climate Dynamics and Biotic Events: The Late Pennsylvanian World*’ will be officially published as Geological Society, London, Special Publication 535 in 2023.
- A SCCS meeting of all voting members and five working group workshops will be organised during the Strati 2023. The DCB working group will organise a field and indoor meeting prior to Strati 2023 in order to study and review important sections in Germany and Belgium.
- A detailed proposal for the GSSP defining the base of the Gzhelian Stage will be provided and be voted by the task groups and SCCS, and the result should be submitted to the ICS.

- The DCB working group will submit a proposal to the Subcommittee for the boundary criterion of a revised base of the Carboniferous during the first half of the coming year.
- Evaluation on selecting boundary markers of Viséan-Serpukhovian, Bashkirian-Moscovian and Moscovian-Kasimovian boundaries will be discussed among voting members. The marker of one out of the three boundaries will be officially selected in 2023.

Devonian Subcommittee

- Work on formal proposals or progress reports submitted from key areas for the revision of the basal Emsian GSSP.
- Revision of the D/C boundary with the D/C Boundary Task Group in close collaboration with the Carboniferous Subcommittee. Progress towards selection of candidate stratotypes.
- Real SDS business meeting and Devonian symposia.

Silurian Subcommittee

- Two ISSS groups working on restudy of the base of the Aeronian GSSP and base of the Telychian GSSP will be hopefully able to complete their work by submission of the formal proposals of the candidate sections (Štorch *et al.*, Hlasna Treban, Czech Republic and Melchin *et al.*, Rheidol Gorge, UK for Aeronian GSSP and David Loydell *et al.*, El Pintado Reservoir, Spain, for Telychian GSSP).
- Planning of the ISSS bi-annual business meeting and thematic session “New stratigraphic insights into the Silurian story” to be held at the 4th STRATI congress in Lille, France (July 2023). ISSS discussion will be followed by online formal voting on the Aeronian and Telychian GSSP replacement candidate sections. Potential subdivision of the Přídolí Series into two stages will be discussed in response to submitted proposal by Manda *et al.* (in press).
- Update of the website for Silurian Subcommittee by webmaster Huang Bing. We gratefully acknowledge this work and the support provided by the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences.
- Manda, Š., Slavík, L., Štorch, P., Tasáryová, Z., Čáp, P. (in press): Division of Přídolí Series in Central Bohemia: graptolite and conodont biostratigraphy, faunal changes, and geochemical record. *Newsletters in Stratigraphy*.

Ordovician Subcommittee

- After previous meetings in Lisbon, Portugal (2013), Graz, Austria (2015), and Milan, Italy (2019), Thomas Servais (Chair) will be organising the fourth International Congress on Stratigraphy (STRATI 2023) under the auspices of the International Commission on Stratigraphy (ICS). STRATI 2023 will take place in Lille, France (11–13 July, 2023). The field excursion to the Ordovician of Estonia (15–18 July, 2023) is co-organised with ISOS 14 (see below). The Ordovician Subcommittees schedules both a business meeting and a scientific session.

- Support of the joint ISOS 14 and 3rd Annual Meeting of IGCP 735 to be held in Tallinn, Estonia (19–21 July, 2023), including field excursions to the Ordovician of Estonia (15–18 July, 2023) and Sweden (23–26 July, 2023).
- Data will be gathered for *Ordovician News* 40 (to be published in March 2023).

Cambrian Subcommission

- In 2023 the Cambrian Subcommission will continue work towards defining GSSPs for its remaining provisional stages.
- Arrival at a decision on how to define Stage 10 in 2023; 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

- Field workshop to examine Ediacaran successions in Brazil and Argentina. This trip will hopefully be run in the summer of 2023 (Previously 2020). Focus will be on the Corumba and Bambui groups in Brazil, 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 organised and led by Subcommission Secretary Lucas Warren and his colleagues in Brazil and Argentina. The field guide is attached (Appendix).
- Developing and managing a special issue (most likely in *Episodes*) that brings our membership up to speed on the progress made over the past 5 years (since Xiao *et al.*, 2016. Towards an Ediacaran time scale: problems, protocols, and prospects. *Episodes*, 39(4), pp.540-555). This special issue will also summarize regional Ediacaran stratigraphy and potential criteria for the definition of the terminal Ediacaran stage (TES). Each manuscript will be formatted identically and designed as a facts-only short format where all proposed defining characters of the Series and Stages are identified and compared across sections. Importantly, recent recalibration and dating of the global Shuram negative excursion (Rooney *et al.*, 2020, Calibrating the coevolution of Ediacaran life and environment. *Proceedings of the National Academy of Sciences*. 2020 Jul 21;117(29):16824-30) may finally provide a strong correlative character for the base of the Series and Stage. We believe we are close to a final vote and wish to have all the facts in one place before voting. With the change in leadership, we also require a change in our subcommittees. These committees will be tasked with setting realistic boundaries within both proposed Series. This work is ongoing from last report.
- Construction of a database of all known end-Ediacaran sections worldwide. This includes fact-finding searches concerning the geology, geochemistry and palaeontology of each section. This is currently underway and continues as new data arises and will be instrumental to the ‘white paper’ listed above.

Cryogenian Subcommission

- Working on and voting for criteria to define the base of the Cryogenian System before February 2023.
- A session on “Earth system evolution during the Tonian – Cryogenian periods” has been proposed at the fourth STRATI, at Lille. July 2023.
- Two subcommission meetings will take place this year to discuss the criteria and working plan for 2023 and 2024.
- Field Trips and meetings. Three field trips/meetings will be organised if the pandemic situation permits, including (1) Scotland field trip, followed the virtual meeting in May 2021, the field trip, possibly 4 days, will be led by Tony Spencer, is aimed to look at some key transitions on Garbh Eileach in person by at least some of the voting members of the subcommission, aimed for discussion on the Port Askaig Fm as a GSSP candidate; (2) Utavi, Namibia field trip, mid-July, 2023, to be organised by Karl-Heinz Hoffman and Galen Halverson. The field trip is planned as a 5-day physical trip plus two days of travel. (3) South China field trip, led by Maoyan Zhu and a 7-8 days physical trip, to look at some sections covers critical intervals during the Tonian and Cryogenian period in South China.
- Cryogenian Webinar Series. During 2020 and 2021, the webinar series have proved to be a great way to introduce the up-to-date research on the Tonian/Cryogenian records worldwide, and offer good opportunities for discussion among researchers. Each time, we have up to 50 attendees. The Subcommission will reactivate the webinar series during 2023, and aim to cover another 2-3 key Cryogenian groups. The webinar series will be organised by Ying Zhou.

Precryogenian Subcommission

- Proceed with the ICS vote on the Archean and Hadean subdivisions, including the Hadean/Archean boundary.
- Establish the GSSP Eo-/Paleoarchean in the Buick Geoheritage Reserve, Western Australia.
- Start of exploring younger Precambrian successions of the Meso- and Neo-Proterozoic age in collaboration with the Geological Survey of Western Australia.
- The Subcommission plans to present the results at the meeting 6th International Archean Symposium in Perth, West Australia, where also a trip with scientific staff from the Geological Survey of Western Australia to different Precambrian sites including Meso- and Neo-Proterozoic successions is planned. The subcommission will also be actively participating at the STRATI 2022 in Lille, France. Here, a session on the Precambrian Earth is suggested (chairs: Noffke and Westall).
- Finalising a manuscript lead by Halla and Reis on the problematic and resolution on Hadean and Archean stratigraphy.
- Potential funding sources 2023: FAPES, Geological Survey of Western Australia.

Stratigraphic classification

- Project: new developments in stratigraphic classification
The final goal of ISSC is to update, upgrade and implement the International Stratigraphic Guide (Hedberg, 1976 [1st edition]; Salvador, 1994 [2nd edition]; Murphy and Salvador, 1999 [abridged edition]). The ISG is a most important official document with a large distribution, which requires revisiting

because of the fundamental advances of stratigraphy in the last 30 years. A project was developed by ISSC under the Chairmanship of Maria Bianca Cita following a workshop organised 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) printed in Newsletters on Stratigraphy where the various review articles are being published. 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.

- Status Quo of issues to be published
 Biostratigraphy: New working group members have been approached and have been invited to attend a workshop on Schaumburg castle close to Rinteln, Germany. On September 19-22, an international group of experts, each specialists in a biostratigraphically important fossil group, met to discuss the focus, direction, and structure of another special volume in Newsletters on Stratigraphy. This volume will comprise chapters on Ammonites (Korn *et al.*), Graptolites (Storch *et al.*), Conodonts (Corradini, *et al.*), Planktonic foraminifera (Petruzzo *et al.*), Calcareous nannoplankton (Agnini *et al.*), Pollen (Stojakovits *et al.*), Dinoflagellate cysts (Pross *et al.*), Small mammals (Agusti *et al.*) and a general chapter on biostratigraphic methodology by Piller & Erbacher. The aim of the volume is to show how different fossil groups can support biostratigraphy, how valuable the different groups (“strengths”) are in biostratigraphy and what their weaknesses are. The focus will be the major achievements made over the past 30 years (i.e., since publication of the last stratigraphic guide, which was published in 1994). Manuscripts for this volume will be submitted to the editors of this special volume (Erbacher & Piller) by end of June 2023.
- Chronostratigraphy: A working group has been established end of 2020 (core: Marie-Pierre Aubry, Martin Head, Werner Piller). The manuscript should be finalised in 2023.
- A brief business meeting was held during the in Vienna on May 23rd during EGU 22. The subcommission voted on a proposal for the formalisation of Standard Auxiliary Boundary Stratotypes (SABS), submitted by Martin Head *et al.* and finally accepted and submitted it to the ICS for approval. The proposal was approved by ICS on 27 October, 2022.
- Conference participation - ISSC co-organised the technical session (on-site presentations) SSP2.1 “Phanerozoic stratigraphy, palaeoceanography, and palaeoclimate” at EGU 2022 in Vienna (Wednesday, 25 May, 8:30 – 16:40).
- North American Commission on Stratigraphic Nomenclature (NACSN). The chair of ISSC, Werner Piller, was again invited and attended the 77th annual meeting of the NACSN on 10 October 2022 which has been a hybrid meeting in conjunction with the GSA Annual Meeting in Denver (Colorado, USA).
- One major point of discussion was again the inclusion of Chemostratigraphy in the NACS and a report on the translation of the NACS into Spanish and French.

Timescale Calibration

- First in-person meeting of the ISTC to be held at STRATI 2023 in Lille.

- Planning and organisation for the first ISTC digital subcommission meeting to be held on line in early 2023.
- Acquisition of funding at the national/international level to support community building globally for the ISTC.

Graphics Officer and Webmaster

- For the upcoming year, points of attention and plans of the officers are:
- Keeping the ICS chart up to date with GSSP status and numeric age developments.
- This may include a formal cross-check between GTS-2020 and the ICS Chart. This was last formally performed against the GTS-2012 (in 2012 and 2013) and it has since been left to ICS Subcommission chairs to call updates to numeric ages on the ICS chart.
- For the Jurassic ages, the GTS-2020 ages have replaced the GTS-2012 ones (2022/10).
- Keeping the ICS website up to date with chart status and downloads, ICS activities and news items, ICS output, ICS subcommission activities and content, stratigraphic guide text and downloads, statutes and annual report archives and so on.
- Further integrating the workflows that follow each IUGS ratification, ICS Executive and ICS subcommission chair approved requests to change chart content, namely cross-check if with a new GSSP also the numeric age is wished to be amended. The updating of the chart pdf/jpeg (editing and exports from graphics software). The updating of the chart in Semantic Web representation (pushing edits on GitHub). The uploading of the chart on the websites (emailing and web-admin). Updating the interactive chart connection to the latest GitHub-stored version.
- Release of updated translations of the ICS chart.
- Improved digital representation (structuring and accessibility of the chart.
- Continued data remodelling work on the Semantic Web representation of the Chart (LINK) to represent better stratigraphic and temporal typologies has begun with a new Knowledge Graph of Chart and related information being built at LINK. Co-authoring this remodelling with Nicholas Car is Steve Richard, one of the two main contributors of the Semantic Web form of the Chart.
- Remodelling work was completed in Q1, 2022. Data display will occur after remodelling (Q4, 2022). After data display (e.g. interactive chart on the ICS website), we shall generate a like-for-like version of the pdf chart from the Semantic Web form of the Chart (2023).
- Preparation of an *Episodes* paper on developments on the ICS chart last 10 years, to succeed the 2013 paper (i.e. a paper at meta-level: formal administrative, distribution-technical, digital-era representation-diversity and diversity-of-usage orientated).
- Expected work for the next year includes: continued updates to the stratigraphy.org website. A major style update to all ICS websites.
- Implementation of a point-of-truth data version of the Chart from which pdf Charts may be derived.
- Continued update of and creation of new Subcommission websites.

11. OBJECTIVES AND WORK PLAN FOR THE CURRENT 4 YEAR TERM (2020-2024)

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.
- Continue coordinating 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 continue 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 a GSSP proposal for definition of the Upper/ Late Pleistocene and its respective Stage/Age.
- Analyse candidate GSSPs for the Anthropocene, and submit a proposal for formalisation to the SQS
- Re-investigate the GSSP for the Gelasian Stage (and Lower Pleistocene

Subseries, Pleistocene Series, Quaternary System) at Monte San Nicola, Sicily.

- Explore the possibility of a second stage for the Middle Pleistocene, based around the increasingly well-recognised Mid-Brunhes Transition.
- Continue to examine the fine-scale subdivision of the Quaternary.
- Continue to develop/update detailed correlation charts for the Quaternary (Cohen & Gibbard, 2019, *Quaternary International*, is the latest version).

Neogene Subcommission

- We will hold a virtual meeting with members in spring 2022 and a tentative field trip to La Vedova section Conero Riviera, Italy after Sept. 2022. As noted above, we have three action items to:
- submit the final proposal for La Vedova as the Langhian boundary stratotype and to subsequently vet and vote on the proposal;
- evaluate possible boundary stratotypes and criteria for the definition of the base of the Burdigalian Stage;
- submit a preproposal to ICDP to drill the Gelasian, Piacenzian, and Zanclean stages in Sicily.

Paleogene Subcommission

- To advance 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 celebrate the official ceremony to place the Golden Spike at the GSSP for the base of the Priabonian in Alano di Piave section, Italy.
- 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 time scale.
- Update the status of Paleogene working groups, creating new working groups 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 to characterise better the following boundaries:
 - Thanetian/Ypresian (P/E) 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
 - Base of the Rupelian (E/O boundary): Monte Cagnero and Monte Vaccaro sections in Italy.

Cretaceous Subcommission

- Spring 2022: official ceremonies for the inauguration and placement of the golden spikes of the Albian and Hauterivian GSSPs.
- 2022: Finalisation of the GSSP proposals for the base Barremian and base Campanian and vote within the WG.
- 2023: Finalisation of the GSSP proposals for the base Valanginian and base Aptian and vote within the WG.
- 2022–2024: Research activities toward the preparation of the GSSP proposal for the base of the Berriasian Stage by the new Berriasian WG.
- 2022-2024: Continue preparation of proposals for the definition of substages for discussions at the forthcoming meeting: 11th International Symposium on the Cretaceous (Poland, 2022).
- 2022-2023. Vote by the SCS of the Barremian and Campanian GSSPs.
- 2023-2024. Finalisation of the GSSP proposal for the base Berriasian and vote within the WG.
- 2023-2024. Vote by the SCS of the Valanginian and Aptian GSSPs.

Jurassic Subcommittee

- Achieve ratification of the Kimmeridgian GSSP.
- Complete or significantly advance the defining of the remaining Jurassic GSSPs (Calloviaian, Oxfordian, and Tithonian) through revitalizing the working groups and facilitating progress by encouraging constructive collaboration and raising funds.
- Increase diversity and facilitate research aspirations at all career stages by championing representation through the new official positions, providing a diversity of opportunities, role models and subject specialist champions.
- Facilitate communication on the Jurassic for both specialist and non-specialist audiences. including promoting the Jurassic GSSPs. This will be achieved through meetings, workshops, *Volumina Jurassica*, outreach activities and maintaining an up-to-date and informative subcommittee website.
- Facilitate a successful and inclusive Jurassic congress in Budapest, Hungary in 2022.
- Improve resolution and correlation of the integrated stratigraphy for the Jurassic.
- Further our understanding of the Earth system during the Jurassic especially palaeoclimate change.
- Provide support to IGCP 655 (Toarcian) and future IGCP projects related to the Jurassic.
- Work with the Cretaceous Subcommittee to help them define the base of the Berriasian and the Jurassic/Cretaceous boundary.
- Work with national and international bodies to protect Jurassic geological sites, assess and promote their natural capital.

Triassic Subcommittee

- A total of two international symposia, 2-3 STS sessions, 1-2 thematic issues, significant progresses on 4 GSSPs (2 of them can be ratified) are anticipated to be achieved:
- Organisation of the International Symposium on Triassic Integrated Stratigraphy and Bio-Environmental Events in Wuhan, China on 03-07 November, 2022.

- Organisation of the International Symposium and Field Workshop on Triassic Stratigraphy and Bioevents in Albuquerque, New Mexico, USA in June-August, 2024.
- Launching global Triassic book series: *Triassic of the World*, and inviting the Triassic workers from around the world to write various volumes and chapters in 2022-2024.
- Organisation of the STS sessions in major conferences, and journal special issues in 2022-24.
- Norian GSSP: This GSSP is anticipated to move towards a vote in late 2022.
- Olenekian GSSP: Completing the GSSP proposal and submitting to STS for ratification in 2023.
- Anisian GSSP: The GSSP of OAB is to be voted in 2023-2024.
- Rhaetian GSSP: A long-time stasis in this group has seen no significant prospects of change. If this continues into early 2022, a new chair of this working group will be sought to move forward at a faster pace.

Permian Subcommission

- Establish the Artinskian and Kungurian GSSPs.
- Revise the Permian timescale where it needs to be improved (Guadalupian stages, replacement GSSP section of the base-Lopingian).
- Establish a robust palaeogeographic frameworks for the Permian and focus on N-S correlations.
- Propose DDE-sponsored informatics support for biostratigraphic data management and palaeogeographic reconstructions.
- Organise webinars to increase the size, diversity and international coverage of the Permian Community
- Publish at least two *Permophiles* issues each year

Carboniferous Subcommission

- 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 remaining GSSPs ratified in the next four years and redefine the Devonian-Carboniferous boundary.
- 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 are going to organise at least one academic activity each year, either a workshop (maybe combined with conferences) or joint workshop/field excursion. However, this plan might be delayed or cancelled due to the COVID-19 situation, and we will probably have more video meetings and try to make progresses through internet.
- To establish working groups on dividing the Tournaisian and Viséan stages

because both of them represent too long time interval.

- 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 Palaeobiology Database (a large compilation of data about fossils) at the University of Wisconsin-Madison, DDE (Deep Time Digital Earth) 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

- Principal work will be devoted to GSSP-related research activities – restudy of some previously ratified but currently inadequate basal stratotypes. Delayed formal proposals of the Aeronian and Telychian GSSP replacement candidates will be completed in 2021 and new stratotypes will be chosen. We aimed to vote on these candidate sections in 2019 in Milano, but the deadline had to be postponed due to delayed work on some of the candidate sections and subsequent Covid-related restrictions.
- Homerician working group will be established and restudy of the Homerician GSSP will join the programme, together with never ending search for potential sections suitable for 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 take part in 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) is the official database of the ICS.
- ISSS bi-annual field-meeting and business meeting organised in Sofia, Bulgaria in August 2021 in collaboration with Geological Institute of Bulgarian Academy of Sciences may be postponed until the end of international travel restrictions, most likely until 2022.

Ordovician Subcommission

- After previous meetings in Lisbon, Portugal (2013), Graz, Austria (2015) and Milan, Italy (2019), Thomas Servais (Chair) will be organising the fourth international congress on stratigraphy (STRATI 2023) under the auspices of the International Commission on Stratigraphy (ICS). STRATI 2023 will take place in Lille, France (11–13 July, 2023). The field excursion to the

Ordovician of Estonia (15–18 July, 2023) is co-organised with ISOS 14 (see below). The Ordovician Subcommissions schedules both a business meeting and a scientific session.

- Support of the joint ISOS 14 and 3rd Annual Meeting of IGCP 735 to be held in Tallinn, Estonia (19–21 July, 2023), including field excursions to the Ordovician of Estonia (15–18 July, 2023) and Sweden (23–26 July, 2023).
- Data will be gathered for Ordovician News 40 (to be published in March 2023).

Cambrian Subcommission

- The principal objective of the Subcommission 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 prioritised plan for formalising definition of the remaining undefined GSSPs. The plan is:
 - Provisional Stage 10 is expected to be defined next, and a decision on a GSSP will likely be made in 2021.
 - 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 (Babcock, L.E. *et al.* 2014: Proposed reassessment of the Cambrian GSSP. *J. of African Earth Sci.* 98, 3–10). A decision on how to proceed with the Cambrian GSSP is expected to be made following ratification of GSSPs for stages 2, 3, and 4.

Ediacaran Subcommission

- Subcommission annual newsletter will be distributed in December 2021 or January 2022. Secretary Dr. Lucas Warren will be leading the effort to compile and edit the newsletter.
- Building on several previous trips in Brazil sponsored by members of the Ediacaran Subcommission, the Subcommission will sponsor an extended field trip to examine Ediacaran successions in Brazil and Argentina. The field trip will be led by TES-WG voting member Dr. Lucas Warren and his colleagues, and it is tentatively scheduled on June or July 2022.
- A field workshop is being planned to visit and examine Ediacaran successions in Siberia.
- A vote will be called to decide what criterion or criteria will be the most useful in dividing the Ediacaran System into series and stages (particularly the second and terminal stages of the Ediacaran System). Our goal is to finalise the discussion on TES by 2022 (previously 2020).

Cryogenian Subcommission

- Voting for criteria to define the base of the Cryogenian System (2021)

- Call for proposals for basal Cryogenian GSSP candidates (2022).
- Voting and ratification of basal Cryogenian GSSP (2023).
- Establishment of working groups on Cryogenian subdivision (2022)
- Voting and ratification of Cryogenian series (2023-2024).
- Interface with other international projects / groups.
- Field trips planned: (1) Utavi, Namibia field trip, mid-July, 2021 (organised by Karl-Henz Hoffman and Galen Halverson); Scotland field trip, May 2021 (virtual and already in planning, organised by Ian Fairchild and Tony Spencer); Tonian Urals field trip, 2022 (organised by Anton Kuznetsov); South China field trip, 2023 (organised by Maoyan Zhu).

Precryogenian Subcommittee

- The Subcommittee has made significant progress in evaluating the possible venues of subdividing the Hadean and Archean stratigraphy. The subcommittee is finalising a manuscript that will discuss the problematic and present possible solutions. Submission is geared towards the beginning of 2022. The commission will submit also a proposal to fund a virtual field trip programme to a major funding agency in the USA and in Brazil. After final voting on the Hadean and Archean on the ICS level, the Subcommittee will re-organise to focus specifically onto the Mesoproterozoic. Several colleagues, including Linda Kah, University of Tennessee, have expressed interest in leadership roles.

Stratigraphic Classification

- For the Biostratigraphy chapter the next steps (define potential reviewers for special volume and finalise publication) have to be done.
- The session “Phanerozoic stratigraphy, palaeoceanography, and palaeoclimate” will be held at the EGU General Assembly 2023 (EGU 2023), 23-28 April 2023, Vienna, Austria.
- A business meeting will be held during STRATI 23 in Lille, France.
- All the remaining review papers on the various branches of stratigraphy will be submitted 2023.

Timescale Calibration

- Organising a major position volume to be focused on current best practices in timescale calibration as well as where we see the future of timescale calibration. This is to be a printed volume following on from the first subcommittee meeting.
- Integrate the ISTC with other international as well as national and regional organizations. For example EARTHTIME, EARTHTIME EU, EARTHTIME China, Geochronology Division of the GSA, SEPM, The Palaeontological Association, The Paleontological Society, etc.

APPENDIX 1: ICS DIRECTORY OF OFFICERS 2020-2024

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P.L. Gibbard
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D.A.T. Harper
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APPENDICES: REPORTS OF INDIVIDUAL SUBCOMMISSIONS

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