Compiled reports from the individual subcommissions

These reports are essentially as submitted with some light editing. Each subcommission has used the agreed template but has retained its own style; this has not been modified. These reports form the basis for the executive summary of Commission's activities during 2022.

International Commission on Stratigraphy
Subcommission on Quaternary Stratigraphy

ANNUAL REPORT 2022

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Quaternary Stratigraphy (SQS)
Reporting Officer: Jan Zalasiewicz, Chair SQS

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

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

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

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

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

3. ORGANISATION - interface with other international projects / groups

SQS works closely with the International Union for Quaternary Research (INQUA), which represents and serves the interests of Quaternarists worldwide. INQUA provides advice and crucial feedback on the stratigraphic needs of the wider Quaternary community. Prof. Thijs van Kolfschoten is both a voting member of SQS and President of INQUA, allowing direct and rapid liaison with the SQS on stratigraphic issues. An account of SQS progress and plans was published in the INQUA Newsletter, to help the exchange of information.

3a. Nominated Officers for 2020-2024 period:

Chair: Professor Jan A. Zalasiewicz
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Vice-Chair: Professor Liping Zhou
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Vice-Chair (website): Professor Martin J. Head
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Secretary: Professor Adele Bertini
Dipartimento di Scienze della Terra
Università degli Studi Firenze
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4. NATIONAL/REGIONAL/GLOBAL SUPPORT FROM SOURCES OTHER THAN IUGS

INQUA provides feedback and advice on SQS activities. INQUA's Stratigraphy and Chronology Commission (SACCOM) potentially offers modest financial support through its grants program, thereby assisting the work of SQS. Funding to assist with a field workshop intended to inaugurate new research on the Gelasian GSSP has been obtained from INQUA. The award to the Anthropocene Working Group of €800 000 from the Haus Kulturen der Welt, Berlin continues to facilitate the administration and analysis of potential candidate GSSPs. Analyses of candidate sites has made excellent progress (see below), despite the inevitable delays caused by the Covid-19 pandemic.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS

Holding of the 'Unearthing the Present' scientific forum of the Haus der Kulturen der Welt, Berlin, May 18-20, 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 of the artists Giulia Bruno and Armin Linke. 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, organized by Adele Bertini together with Colin Waters and Simon Turner of 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=nqtIlaDMBvA

Holding of the 'Where is the Planetary' multidisciplinary event of the Haus der Kulturen der Welt, Berlin, October 14-16, 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

SQS publications and conference abstracts:

Borsato, A., Fairchild, I., Frisia, S., Wynn, P. and Fohlmeister, J.. 2022, In press. The Ernesto Cave, northern Italy, as a candidate auxiliary reference section for the definition of the Anthropocene series. *The Anthropocene Review*.

DeLong, K., Palmer, K., Wagner, A., Weerabaddana, M., Slowey, N., Hermann, A., Duprey, N., Martínez-Garcia, A., Jung, J., Hajdas, I., Rose, N., Roberts, S., Roberts, L., Cundy, A., Gaca, P., Milton, A.J., Yang, H., Huang, C-Y., Shen, C-C. and Zinke, J. 2022, in press. The Flower Garden Banks *Siderastrea siderea* coral as a candidate Global boundary Stratotype Section and Point (GSSP) for the Anthropocene series. *The Anthropocene Review*.

Fiałkiewicz-Kozieł, B., Łokas, E., Smieja-Król, B., Turner, S.D., De Vleeschouwer, F., Woszczyk, M., Marcisz, K., Gałka, M., Lamentowicz, M., Kołaczek, P., Karpińska-Kołaczek, M., Kołtonik, K., Mróz, T., Roberts, S.L., Rose, N.L., Krzykawski, T., Boom, A. and Yang, H. 2022, in press. The Śnieżka peatland as a candidate for the Global boundary Stratotype Section and Point for the Anthropocene series. The *Anthropocene Review*.

Han, Y., Zhisheng, A., Lei, D., Zhou, W., Zhang, L., Zhao, X., Yan, D., Arimoto, R., Rose, N., Roberts, S., Li, L., Tang, Y., Liu, X., Fu, X., Schneider, T., Hou, X., Lan, J., Tan, L., Liu, X., Hu, J., Cao, Y., Liu, W., Wu, F., Wang, T., Qiang, X., Chen, N., Cheng, P., Hao, Y., Wang, Q., Chu, G., Guo, M., Han, M., Tan, Z., Wei, C. and Dusek, U.. 2022 In press. The Sihailongwan maar lake, northeastern China as a candidate Global boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review*.

Himson, S., Williams, M., Zalasiewicz, J., Waters, C., McGann, M., England, R., Boom, A., Holmes, R., Sampson, S., Pye, C., Berrio, J.C., Tyrrell, G., Wilkinson, I.P., Rose, R. and Cundy, A. 2022, in press. The San Francisco Estuary, USA, as a reference section for the Anthropocene series. *The Anthropocene Review*.

Kaiser, J., Ivar do Sul, J.A., Cundy, A., Hajdas, I., Rose, N., Abel, S., Arz, H.W., Dellwig, O., Gerdts, G., Labrenz, M., Moros, M., Primpke, S. and Voß, M. 2022 In press. The East Gotland Basin (Baltic Sea) as a candidate Global boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review*.

Kuwae, M., Finney, B., Shi, Z., Tsugeki, N., Omori, T., Agusa, T., Suzuki, Y., Yokoyama, Y., Hinata, H., Hatadsa, Y., Inoue, J., Matsuoka, K., Shimada, M., Takahara, H., Takahashi, S., Ueno, D., Amano, A., Tsatsumi, J., Yamamoto, M., Takemura, K., Yamada, K., Ikehara, K., Haraguchi, T., Tims, S., Froelich, M., Fifield, L.K., Aze, T., Matsumura, M., Takahashi, T., Sasa, K., Tani, Y., Leavitt, P., Doi, H., Irino, T., Moriya, K., Hayashida, A., Hirose, K., and Saito, Y. 2022, in press. Beppu Bay, Japan, as a candidate Global boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review*.

McCarthy, F.M.G. Patterson, R.T., Head, M.J., Riddick, N.L., Cumming, B.F., Hamilton, P.B., Pisaric, M.F.J., Gushulak, A.C., Leavitt, P.R., Lafond, K.M., Llew-Williams, B., Marshall, M., Heyde, A., Pilkington, P.M., Moraal,

J., Boyce, J.I., Nasser, N.A., Walsh, C., Garvie, M., Roberts, S., Rose, N.L., Cundy, A.B., Gaca, P., Milton, J.A., Hajdas, I., Crann, C.A., Boom, A., Finkelstein, S.A., McAndrews, J.H., and other members of Team Crawford. 2022, in press. The varved succession of Crawford Lake, Milton, Ontario, Canada as a candidate Global boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review*.

Stegner, A. Hadly, E., La Selle, S., Sherrod, B., Anderson, S.R., Redondo, S., Weaver, K., Viteri, M., Black, B. and Spanbauer, T.. 2022 In press. The Searsville Lake Site (California, USA) as a candidate Global boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review*.

Thomas, E., Vladimirova, D., Tetzner, D., Emanuelsson, D., Humby, J., Roberts, S., Rose, N., Gaca, P., Cundy, A. 2022, in press. The Palmer ice core as a candidate Global boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review*.

Wagreich, M., Meszar, M., Lappé, K., Wolf, J., Mosser, M., Hornek, K., Koukal, V., Litschauer, C., Piperakis, N. and Hain, K. 2022, in press. The urban sediments of Karlsplatz, Vienna (Austria), as a candidate Auxiliary boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review*.

Waters, C.N., Turner, S.D., Zalasiewicz, J. and Head, M.J. 2022, in press. Candidate sites and other reference sections for the Global boundary Stratotype Section and Point (GSSP) of the Anthropocene series. *The Anthropocene Review*.

Zinke, J., Cantin, N., DeLong, K., Palmer, K., Boom, A., Hajdas, I., Duprey, N., Martínez-Garcia, A., Rose, N., Roberts, S., Yang, H., Roberts, L., Cundy, A., Gaca, P., Milton, A.J., Grace, F., Cox, A., Sampson, S., Tyrrell, G. and Agg, M. 2022, in press. North Flinders Reef (Coral Sea, Australia) *Porites* sp. Corals as a candidate Global boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review*.

Gibbard PL, Bauer AM, Edgeworth M, Ruddiman WF, Gill JL, Merritts DJ, Finney SC, Edwards LE, Walker MJC, Maslin M, Ellis EC. 2021 online. A practical solution: the Anthropocene is a geological event, not a formal epoch. *Episodes*. https://doi.org/10.18814/epiiugs/2021/021029

Head, M.J., Zalasiewicz, J.A., Waters, C.N., Turner, S.D., Williams, M., Barnosky, A.D., Steffen, W., Wagreich, M., Haff, P.K., Syvitski, J., Leinfelder, R., McCarthy, F.M.G., Rose, N.L., Wing, S.L., An, Z., Cearreta, A., Cundy, A.B., Fairchild, I.J., Han, Y., Ivar do Sul, J.A., Jeandel, C., McNeill, J.R. and Summerhayes, C.P. 2022, online. The Anthropocene is a prospective epoch/series, not a geological event. Episodes, https://doi.org/10.18814/epiiugs/2022/022025

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Head, M.J., 2022. The Anthropocene: Earth System response to human planetary impacts [Antropocen – odpowiedz systemu ziemskiego na dzialalnosc czlowieka (simultaneous translation in Polish]. Spotkanie Klubu Mysli Ekologicznej; Kinoteatr Rialto, Katowice, Poland; 12 October, 2022 [Invited, in person].

Head, M.J., 2022. The Anthropocene: Epoch, event, current status. Faculty of Geology, University of Warsaw, Poland 10 October, 2022 [Invited, in person].

Head, M.J., 2022. Linking the Anthropocene with the Great Acceleration. AnthroFlor: SQS-sponsored International Symposium on the Anthropocene. Università degli studi Firenze, Florence, Italy, 8–10 September, 2022 [Invited, in person].

Head, M.J., 2022. Recent developments in Quaternary Stratigraphy. Delivered at: The Chibanian, its Academic Significance and Social Importance; Open Symposium of the Science Council of Japan. Science Council of Japan Auditorium, Tokyo, Japan, May 24, 2022. [Invited talk, in person, live streamed].

Head, M.J., 2022. Congratulatory speech on behalf of the International Subcommission on Quaternary Stratigraphy. Dedication ceremony at the Chiba Section, Boso Peninsula, Japan. May 21, 2022. [Invited talk, in person].

Head, M.J., and members of the Anthropocene Working Group, 2022. The Anthropocene is not a geological event, but its array of mid-20th century stratigraphic event signals marks a prospective epoch/series. Ibaraki University, Mito, Japan, May 19, 2022. [Invited talk, in person]

Head, M.J. and Zalasiewicz, J., 2022. On revealing the stratigraphic Anthropocene – An introduction. Anthropocene Working Group: A Scientific Forum. Haus der Kulturen der Welt, Berlin, May 20, 2022. [Invited talk; virtual]

Head, M.J. with contributions from the Anthropocene Working Group, 2021. The Anthropocene and Great Acceleration: the geological and humanities debate. Hevre Club, Kraków, Poland, 9 November, 2021 [Invited talk].

Head, M.J. with contributions from the Anthropocene Working Group, 2021. The Anthropocene Epoch: a proposed new unit of the Geological Time Scale underpinned by the Great Acceleration. AGH University of Science and Technology, Kraków, Poland, 8 November 2021 [Invited talk].

Williams, M., Leinfelder, R., Barnosky, A.D., Head, M.J., McCarthy, F., Cearreta, A., Himson, S., Holmes, R., Zinke, J., 2021. Planetary scale change to the biosphere recorded in the fossil record can be used to identify the Anthropocene. In: Head, M.J., McCarthy, F.M.G., Patterson, R.T. (conveners), 2021. The Anthropocene – its signature. Special Session. Geological Association of Canada / Mineralogical Association of Canada, Joint Annual Meeting, London, Ontario, Nov. 1–5 (hybrid), Nov. 1 (virtual), 2021.

Waters, C.N., Head, M.J., Turner, S., and Zalasiewicz, J., 2021. Progress on the appraisal and definition of the proposed Anthropocene Series/Epoch. In: Head, M.J., McCarthy, F.M.G., Patterson, R.T. (conveners), 2021. The Anthropocene – its signature. Special Session. Geological Association of Canada / Mineralogical Association of Canada, Joint Annual Meeting, London, Ontario, Nov. 1–5 (hybrid), Nov. 1 (virtual), 2021.

Llew-Williams, B.M., Heyde, A., Lafond, K., McCarthy, F.M.G., MacKinnon, M.D., Brand, U., Patterson, R.T., and Head, M.J., 2021. Preservation of Varved Couplets in the Oxygenated Monimolimnion of Crawford Lake: Implications for defining the Anthropocene Epoch. In: Head, M.J., McCarthy, F.M.G., Patterson, R.T. (conveners), 2021. The Anthropocene – its signature. Special Session. Geological Association of Canada / Mineralogical Association of Canada, Joint Annual Meeting, London, Ontario, Nov. 1–5 (hybrid), Nov. 1 (virtual), 2021.

Turner, S.D. 2022. Defining the stratigraphic Anthropocene. 19th Annual Meeting of the Asia Oceania Geosciences Society, Singapore (AOGS 2022 Virtual). Session SE16, 02-09-2022 (Invited speaker)

Turner, SD. 2022. The Anthropocene: A Challenge to Environmental History. European Society for Environmental History conference 2022University of Bristol, 7 July 2022. (Invited plenary)

Waters, C.N., Williams, M., Zalasiewicz, J., Turner, S.D., Barnosky, A.D., Head, M.J., Wing, S.L., Wagreich, M., Steffen, W., Summerhayes, C.P., Cundy, A.B., Zinke, J., Fiałkiewicz-Kozieł, B., Leinfelder, R., Haff, P.K., McNeill, J.R., Rose, N.L., Hajdas, I., McCarthy, F.M.G., Cearreta, A., Gałuszka, A., Syvitski, J., Han, J., An, Z., Fairchild, I.J., Ivar do Sul, J.A. and Jeandel, C. (2022, online). Epochs, events and episodes: marking the geological impact of humans. *Earth-Science Reviews*, 104171.

Waters, C.N. and Turner, S.D. 2022. Defining the onset of the Anthropocene. *Science* 378, 706-708.

Williams, M., Leinfelder, R., Barnosky, A.D., Head, M.J., McCarthy, F.M.G., Cearreta, A., Himson, S., Holmes, R., Waters, C.N., Zalasiewicz, J., Turner, S., McGann, M., Hadly, E.A., Stegner, M.A., Pilkington, P.M., Kaiser, J., Berrio, J.C., Wilkinson, I.P., Zinke, J. and DeLong, K.L. (2022). Planetary-scale change to the biosphere signalled by global species translocations can be used to identify the Anthropocene. *Palaeontology*, e12618.

Zalasiewicz, J. and Head, M.J., 2022. Recap and scope for the day. Università degli studi Firenze, Florence, Italy, 8–10 September, 2022.

Zalasiewicz, J., McCarthy, F., Waters, C., Turner, S., Head, M.J., and members of the Anthropocene Working Group, 2022. The Anthropocene as a potential unit of the Geological Time Scale: an update on progress. 36th International Geological Congress, virtual presentation; 20-22 March, New Delhi, India.

6. SUMMARY OF EXPENDITURE IN 2022

SQS-sponsored AnthroFlor meeting in Florence, 8–10 September, 2022
1. Technical assistance in the Aula Magna (Rectorate, University of Florence) = 732.00 euros (= US$ 747.75)
2. Printing of posters = 126.00 euros (= US$ 128.71)
3. Refreshments on second day = 96.70 euros (= US$ 98.78)
4. Miscellaneous = 53 euros (= US$ 54.14)
5. Colin Waters (travel and accommodation for 3 nights) = GBP 537.22 (= US$ 629.06)
6. Simon Turner (travel and accommodation for 4 nights) = GBP 602.24 (= US$ 716.78)
7. Martin Head (travel and accommodation for 4 nights) = CAN$ 1971.52 (= US$ 1479.99)
TOTAL = US$ 3138.43

7. SUMMARY OF INCOME IN 2021

Euro 800,000 over 2 years (2019, 2020) awarded to Anthropocene Working Group by the Haus Kulturen der Welt, Berlin, has continued to support ongoing analysis of candidate stratotypes throughout this year.

8. BUDGET REQUESTED FROM ICS IN 2022

This year includes significant requests, as 2022 is a year when INQU (normally every four years) and STRATI (very 3 years) meetings coincide.

Martin Head attendance at both INQUA/STRATI meetings = $3000.00.
Adele Bertini attendance at both INQUA/STRATI meetings = $2290.00
Liping Zhou attendance at INQUA meeting = $1190
Colin Waters attendance at STRATI meeting = $1000
Simon Turner attendance at INQUA meeting = $1490

(see spreadsheet for details)

Total requested $8970

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

- 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 SABSs, 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 (convenors Martin Head, Adele Bertini, Liping Zhou and Jan Zalasiewicz)
2. The Anthropocene: stratigraphical concepts and evidence (convenors Colin Waters, Simon Turner, Jan Zalasiewicz and Martin Head)
3. SQS business meeting (to be chaired by Martin Head)

INQUA XXI, 2023, Rome
Proposed SQS-led sessions
6B - GSSPs and stratotypes
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 characterization 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 characterizing recent planetary change and predicting future environmental challenges

10. KEY OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020–2024

- Develop and submit a GSSP proposal for definition of the Upper/ Late Pleistocene and its respective Stage/Age.
- Finalize analyses of candidate GSSPs for the Anthropocene, and submit a proposal for formalization to the SQS

- Continue re-investigation of 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-recognized 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).

Respectfully submitted:
Jan Zalasiewicz, Chair SQS; Adele Bertini, Secretary SQS, Liping Zhou, Vice-Chair SQS, Martin Head, Vice-Chair SQS.

20 November, 2022

APPENDIX

Names and Addresses of Current Officers and Voting Members of SQS

Officers of SQS

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List Of Working (Task) Groups and their Officers

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Working Group on the Middle/Upper Pleistocene Subseries Boundary

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Subcommission on Neogene Stratigraphy
Annual Report 2022

1. **TITLE OF CONSTITUENT BODY and NAME OF REPORTER**
Subcommission on Neogene Stratigraphy (SNS)
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Reporting: Kenneth Miller, Chair; Elena Turco, Vice Chair; Marie-Pierre Aubry, Secretary

2. **OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY**

The SNS is the primary body responsible for providing optimum clarity and stability in the Neogene Chronostratigraphic Scale by selecting and defining Global Stratotype Sections and Points (GSSPs) for Series, Subseries, and Stages and promulgating information on major events of the Neogene.

3. **ORGANIZATION - interface with other international projects / groups**

The SNS is a subcommission of the ICS, founded in 1971. Reference is made to the annual report of 1995 for a brief historical resume of the SNS. Apart from the executive bureau, the SNS has 20 voting members, in addition to 24 corresponding members (*see Appendix for full list of officers and voting and corresponding members*). In reconstituting the SNS in 2020, we strove to include ECR and ensure international balance (with 12 countries represented). The SNS has one active working group for defining the GSSPs for the Langhian and Burdigalian Stages, chaired by Frits Hilgen (University of Utrecht), with 11 members (listed in the *Appendix*). The SNS web site is used for news release and contains the following sections: Home, News, Board, Members, Newsletters, GSSP's, and Links. .

Website: http://neogene.stratigraphy.org

3a. Officers for 2020-2023:

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

In 2022, we received support for Miller's travel to Bremen to attend the 12th International Conference on Climatic and Biotic Events of the Paleogene (CBEP12) 22 - 25 August 2022 from the International Continental Scientific Drilling Program (ICDP). Though CBEP12 was a Paleogene meeting, there were numerous talks that focussed on the Miocene and the Oligocene/Miocene boundary.

5. CHIEF ACCOMPLISHMENTS

Formalization of Neogene Subseries/Subepochs

The International Commission on Stratigraphic Classification (ISSC) voted to recognize the rank of subseries as formal and to be integrated in the International Chronostratigraphic Chart (ICC) in 2021. This was approved by the ICS in 2022. The SNS vote to formalize was submitted as a paper to Episodes and will appear in 2022: *Ratification of Neogene subseries as formal units in international chronostratigraphy* by Marie-Pierre Aubry[1]*, Kenneth G. Miller[1], Elena Turco[2], José Abel Flores Villajero[3], Andrey Gladenkov[4], Patrick Grunert[5], Frits Hilgen6, Hiroshi Nishi[7], Ann Holbourn[8], Wout Krijgsman[9], Fabrizio Lirer[10], Werner E. Piller[11], Frédéric Quillévéré[12], Isabella Raffi[13], Marci Robinson[14], Lorenzo Rook[15], Jun Tian[16], Maria Triantaphyllou[17], and Felipe Vallejo[3,18]

Planned preproposal to the ICDP

Caruso, Miller, Hilgen, Herbert, and Head submitted a preproposal to ICDP)to drill the boundary stratotypes at Capo Rossello and Gela. As stated above, the moderate to heavy weathering of the outcrops inhibits high resolution (cm-scale) sampling particularly for paleomagnetics 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. Due to commitments for PETM drilling proposal to ICDP in Jan. 2023, we plan to submit a workshop proposal in Jan. 15, 2024 and run a workshop in late 2024 in Sicily.

GSSP Progress

In 2020 the Langhian and Burdigalian GSSP Working Group (chair: Frits Hilgen) 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 criterium to recognize the base of the Langhian (Turco et al., 2017). Uncertainty related to the choice of calcareous planktonic events associated with the top of Chronzone 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 criterium 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 ampliaperta*, 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 cyclostratigraphic 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. As reported by WG Chair Hilgen:

"The delay is unavoidable because although we solved the missing 100-kyr cycle in the U1337 splice just above the level that corresponds to the GSSP there is another problem with the tuned age model of this site for the interval older than 17 Ma ….The problem…[is] we wanted to include the U1337 isotope record in the final overview figure in the proposal."

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 the fall of 2022 As of Nov. 2022, we have 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 contiguity with the other GSSP sections) is available. The working group will move on to evaluating placing the Burdigalian GSSP in a Pacific IODP site.

6. **SUMMARY OF EXPENDITURE IN 2020**

Balance in Nov 2021	**USD**	$2085.95
Received in 2022:		$2480.00
Expenses in 2022: publication expenses $360 + 60 wire fees		$390.00
Balance in Nov 2022		$4175.95

7. **SUMMARY OF INCOME IN 2020**

Total receipts were $2480.00 from the ICS

Total expenditure were $390 consisting of $360 in publications expenses for color production in Episodes for *Ratification of Neogene subseries as formal units in international chronostratigraphy* by Marie-Pierre Aubry[1]*, Kenneth G. Miller[1], Elena Turco[2], José Abel Flores Villajero[3], Andrey Gladenkov[4], Patrick Grunert[5], Frits Hilgen6, Hiroshi Nishi[7], Ann Holbourn[8], Wout Krijgsman[9], Fabrizio Lirer[10], Werner E. Piller[11], Frédéric Quillévéré[12], Isabella Raffi[13], Marci Robinson[14], Lorenzo Rook[15], Jun Tian[16], Maria Triantaphyllou[17], and Felipe Vallejo[3,18] and $30 in wire fees

8. **BUDGET REQUESTED FROM ICS IN 2023**

We request support for the executive members of SNS (Chair, Vice Chair, and Secretary) of $5,000 to support travel to Strati 2023 in Lille. Full costs for a single participant (e.g., the Chair) to travel to Lille is about $3000. We conservatively ask for $5000 **as partial support for all 3 members** of the SNS Executive (air/TGV and registration) to attend the run the symposium. We propose to use the existing funds as seed money (e.g, partial airfares and ground logistics) to plan and implement a field excursion to La Vedova, Italy.

Strati 2023 cost estimate (US$)	
3 registrations	900
2 RT New York-CDG	3000
RT Milan to CDG	500
TGV CDG-Lille	600
Hotels are not budgeted fo	1800
total (no hotel costs)	5000

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

The major plan is to vote to approve the official proposal for the Langhian GSSP, that is on a reliable/reproducible guiding criterium, complemented by additional criteria useful for correlation, and reach a decision on the GSSP section and auxiliary deep-sea core. The SNS executive board will attend and run a session on Neogene Stratigraphy and Paleoceanography 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.

10. **KEY OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020-2022**

We have three action items to:

1) Vote on the final proposal for La Vedova as the Langhian boundary stratotype. The proposal has been vetted and discussed by Nov. 2022 and the vote will be completed before the end of the year.
2) Continue to evaluate possible boundary stratotypes and criteria for the definition of the base of the Burdigalian Stage; we plan to develop the proposal in 2023;
3) Submit a Workshop to ICDP to drill the Gelasian, Piacenzian, and Zanclean stages in Sicily in Jan. 2024.

APPENDIX
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1. SUBCOMMISSION ON PALEOGENE STRATIGRAPHY (ISPS)

Submitted by: Laia Alegret, Aitor Payros, Claudia Agnini

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

The ISPS is the primary body for facilitation of international communication and scientific cooperation in Paleogene Stratigraphy. In order to better understand the evolution of the Earth during the Paleogene Period, its first priority is the unambiguous definition, by means of agreed GSSPs, of a hierarchy of chronostratigraphic units, which provide the framework for global correlation. Its primary goals are:

a) to agree on an international set of stages and series for the Paleogene.
b) to formally define basal boundary stratotypes (GSSPs) of the Paleogene stages and series.
c) to encourage research into the Paleogene by setting up and supporting Working Groups and Regional Committees to study and report on specific problems.
d) to organise symposia and workshops on subjects of Paleogene stratigraphy.
e) maintain a website informing on progress in Paleogene stratigraphy (http://www.paleogene.org).

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

1) Establishment of an internationally agreed scale of chronostratigraphic units, defined by GSSPs.
2) Establishment of frameworks and mechanisms to encourage international collaboration in understanding the evolution of the Earth during the Paleogene Period.
3) Working towards an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs. This relates to, inter alia, the IUGS Geosites Programme and the UNESCO Geoparks Programme.

3. ORGANISATION - interface with other international projects / groups

Members of the Paleogene Subcommission interface with the International Ocean Discovery Program (IODP), International Subcommissions on Cretaceous and Neogene Stratigraphy, Int. Geoscience Programme (IGCP), ProGEO, Geosites and Geoparks Initiatives, UNESCO World Heritage Sites.

The ISPS consists of 20 Voting Members elected for their expertise and experience and about 100 Corresponding Members, who have a responsibility for communication in both directions between the Subcommission and researchers on Paleogene topics in their region. Voting and Corresponding Members are selected regionally to provide expertise in the Paleogene stratigraphy of each major area and according to their speciality to cover the main fields of stratigraphic tools used in the Paleogene.

Current Officers for 2020-2024 period:

Chair: **Laia Alegret**, Departamento de Ciencias de la Tierra, Universidad de Zaragoza, Calle Pedro Cerbuna, 12, E-50009 Zaragoza, Spain. Tel+34 876553465 laia@unizar.es

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

The ISPS board and the voting members get support from their own universities/institutes (facilities and staff), and have financial support for Paleogene research from their own research grants, mainly funded by national science agencies.

5. CHIEF ACCOMPLISHMENTS IN 2022 (including any publications arising from ICS WGs)

• 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 organization and presentations of the international meeting on 'Climatic and Biotic Events of the Paleogene' (CBEP 2022), held in Bremen (Germany) in August 2022.

Selection of the most relevant publications of subcommission work:

- Alegret, L., Arreguín-Rodríguez, G. J., Thomas, E. (2022). Oceanic productivity after the Cretaceous/Paleogene impact: where do we stand? The view from the deep. In: Koeberl, C., Claeys, P., Montanari, A., eds., *From the Guajira desert to the Apennines, and from Mediterranean microplates to the Mexican killer asteroid: Honoring the career of Walter Alvarez*. Geological Society of America Special Paper 557, chapter 21, https://doi.org/10.1130/2022.2557(21)
- Arreguín-Rodríguez, G. J., Thomas, E., Alegret, L. (2022). Some like it cool: Benthic foraminiferal response to Paleogene warming events. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 593, 110925, doi: 10.1016/j.palaeo.2022.110925
- Coccioni, R., Montanari, A., Boschi, S., Catanzaritti, R., Frontalini, F., Jovane, L., Kochhann, M.V.L., Pelosi, N., Sabatino, N., Savian, J.F., Sprovieri, M. (2022). Integrated stratigraphy of the Lutetian-Priabonian pelagic section at Bottacciones (Gubbio, central Italy): a proposal for defining and positioning the Global Stratotype Section and Point (GSSP) for the base of the Bartonian Stage (Paleogene System, Eocene Series). In: Koeberl, C., Claeys, P., Montanari, A., eds., *From the Guajira desert to the Apennines, and from Mediterranean microplates to the Mexican killer asteroid: Honoring the career of Walter Alvarez*. Geological Society of America Special Paper 557, chapter 16, https://doi.org/10.1130/2022.2557(16).
- Crouch, E.M., Clower, C.D., Raine, J.I., Alegret, L., Cramwinckel, M.J., Sutherland, R. (2022). Latest Cretaceous and Paleocene biostratigraphy and paleogeography of northern Zealandia, IODP Site U1509, New Caledonia Trough, southwest Pacific. *New Zealand Journal of Geology and Geophysics*, doi.org/10.1080/00288306.2022.2090386
- Dallanave, E., Sutherland, R., Dickens, G.R., Chang, L., Tema, E., Alegret, L., Agnini, C., Westerhold, T., Newsam, C., Lam, A.R., Stratford, W., Collot, J., Etienne, S., von Dobeneck, T. (2022). Absolute Paleolatitude of Northern Zealandia from the Middle Eocene to the Early Miocene. *Journal of Geophysical Research–Solid Earth*, 127, e2022JB024736
- Jones, H., Westerhold, T., Birch, H., Hull, P., Negra, M.H., Röhl, U., Sepúlveda, J., Vellekoop, J., Whiteside, J., Alegret, L., Henehan, M., Robinson L., van Dijk, J., Bralower, T. (2022). Stratigraphy of the Cretaceous/Paleogene (K/Pg) boundary at the Global Stratotype Section and Point (GSSP) in El Kef, Tunisia: New insights from the El Kef Coring Program. *GSA Bulletin*, in press.
- Kim, J-E., Westerhold, T., Alegret, L., Drury, A.J., Röhl, U., Griffith, E.M. (2022). Precessional pacing of tropical ocean carbon export during the Late Cretaceous. *Climate of the Past*, in press.
- Martínez-Braceras, N., Franceschetti, G., Payros, A., Monechi, S., Dinarès-Turell, J. (2022). High-resolution cyclochronology of the lowermost Ypresian Arnakatxa section (Basque-Cantabrian Basin, western Pyrenees). *Newsletters on Stratigraphy*, in press, https://doi.org/10.1127/nos/2022/0706
- Payros, A., Pujalte, V., Schmitz, B. (2022). Mid-latitude alluvial and hydroclimatic changes during the Paleocene-Eocene Thermal Maximum as recorded in the Tremp-Graus Basin, Spain. *Sedimentary Geology*, 435, 106155, https://doi.org/10.1016/j.sedgeo.2022.106155
- Pujalte, V., Alegret, L. (on behalf of ISPS), Hilario, A. 2022. Cretaceous-Paleogene stratigraphic section of Zumaia. In: Hilario et al., eds., *The First 100 IUGS Geological Heritage Sites*, ISBN 978-1-7923-9975-6, International Union of Geological Sciences, p. 70-71.

- Pujalte, V., Schmitz, B., Payros, A. (2022). A rapid sedimentary response to the Paleocene-Eocene Thermal Maximum hydrological change: new data from alluvial units of the Tremp-Graus Basin (Spanish Pyrenees). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 509, 110818, https://doi.org/10.1016/j.palaeo.2021.110818
-Schmitz, B., Monechi, S., Alvarez, W., Coccioni, R., Galeotti, S., Montanari, A. 2022. Cretaceous to Paleogene stratigraphic section of Bottaccione Gorge, Gubbio. In: Hilario et al., eds., *The First 100 IUGS Geological Heritage Sites*, ISBN 978-1-7923-9975-6, IUGS, p. 66-67.
- Sierra-Campos, P., Calvín, P., Bernaola, G., Larrasoaña, J.C., Payros, A., Pueyo, E.L., Montes, M., Luzón, A., Pérez, J.I., Mata, M.P., Bellido, E. (2022). Magnetobiochronology of the Nardués-Andurra section (Jaca-Pamplona basin, Pyrenees): initial results from a prospective Bartonian GSSP. Abstract book 17th Castle Meeting on palaeo, rock and environmental magnetism (Castle, Croatia), 122-123.
- Stratford, W.R., Sutherland, R., Dickens, G.R., Blum, P., Collot, J., Gurnis, M., Saito, S., Agnini, C., Alegret, L., et al. (2022). Timing of Eocene compressional plate failure during subduction initiation, northern Zealandia, southwestern Pacific. *Geophysical Journal International*, 229 (3): 1567-1585.
- Villier, L., Larrañaga, J., Payros, A., Moreno, T., Hieu, N., Zamora, S. (2022). Systematics and phylogenetic interpretation of a new bathyal spatangoid echinoid from the Eocene of Spain: *Habanaster itzae* nov. sp. *Geobios*, 72-73, 54-67, https://doi.org/10.1016/j.geobios.2022.07.005.

6. SUMMARY OF EXPENDITURE IN 2022:

1)	Support for raw data processing to construct 3D models of the sections that contain GSPPs for the bases of several stages of the Paleogene	USD 1548.6
2)	Fieldtrip (2 people) for magnetobiochronological study of a prospective section for the base of the Bartonian in Navarra, Spain	USD 228
3)	Fieldtrip (2 people) to Gorrondatxe to reassess the Lutetian GSSP	USD 248.6
4)	Registration and attendance to The First 100 IUGS Geosites (Zumaia, Spain)	USD 735.8
5)	Planned for December 2022: Acquisition of a custom-made golden spike and panel to be placed at the newly defined GSSP for the base of the Priabonian	USD 670.9
6)	Printing costs	USD 20
	TOTAL ----------	**USD 3451.9**

7. SUMMARY OF INCOME IN 2022:
3347.01 euros (3455.56 USD) were transferred to the Subcommission´s bank account

8. BUDGET REQUESTED FROM ICS FOR 2023:

1)	Support for analyses and fieldwork related to the last GSSP pending definition (the base of the Bartonian).	USD 700
2)	Official ceremony to place the golden spike of the GSSP for the Priabonian in the Alano section (Italy).	USD 1380
3)	Support for the registration and attendance to the STRATI meeting 2023 in Lille (France), 2 members of the ISPS board.	USD 1320
4)	Support for the definition of auxiliary sections of the most problematic GSSP of the Paleogene, the Ypresian (Paleocene/Eocene boundary).	USD 300
	TOTAL	**USD 3700**

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

• Full support will be given to studies related to the Bartonian 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.
• Set up a working group to study a variety of sections of the base of the Ypresian (Paleocene/Eocene boundary) from different paleogeographical 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 organized 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 done by the ISPS members is financially supported by their home countries´ research grants.

10. KEY OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020-2024

•To find a type section and agree on the criteria for the formal definition of the base of the Bartonian, and submit a GSSP proposal to the Paleogene Subcommission voting members and ICS.
•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.
•Prepare standardised regional correlation charts and paleogeographic maps by regional Committees.
•To support studies for the completion of the Paleogene astronomical time scale. This will contribute to filling the so-called "middle Eocene astronomical timescale gap" and will help to connect existing floating calibrations with the astronomically tuned standard Neogene timescale.
•Update the status of Paleogene WGs, closing those that have completed their task and/or are inactive.
•Revisit existing GSSPs and, if necessary, define new GSSPs and/or ASSPs to better characterise:
-The 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);
-The Danian/Selandian boundary: Contessa and Bottaccione, Caravaca and Sopelana;
-The Selandian/Thanetian boundary: Contessa, Italy
-The base of the Rupelian (E/O boundary): Monte Cagnero and Monte Vaccaro (Italy).

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

Current officers

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Working group leaders and corresponding members

Lutetian/Bartonian Boundary Stratotype WG. Chairman: Rick Fluegeman USA, rfluegem@bsu.edu

Bartonian/Priabonian Boundary Stratotype WG. Chair: Claudia Agnini, Italy. claudia.agnini@unipd.it

Rupelian/Chattian Boundary Stratotype WG. Chair: Rodolfo Coccioni. Rodolfo.coccioni@uniurb.it

Paleogene Deep-Water Benthic Foraminifera WG. Chair: Laia Alegret, Spain. laia@unizar.es Secretary: Gabriela J. Arreguín Rodríguez, Mexico. gjarreguin@gmail.com

Paleogene Calcareous Nannofossils WG. Chair: Simonetta Monechi, Italy. simonetta.monechi@unifi.it

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

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

Paleogene Larger Foraminifera WG, Chairman: Cesare Papazzoni, Italy. cesareandrea.papazzoni@unimore.it Secretary: Carles Ferrandez, Spain carlesferrandez@ub.edu

List of Voting Members:

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1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Cretaceous Stratigraphy (SCS)

Maria Rose Petrizzo, Chair; Michael Wagreich, Vice-chair; Francesca Falzoni, Secretary

18 November 2022

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

• To establish a standard global stratigraphic subdivision and nomenclature for the Cretaceous, as part of the ICS standard global stratigraphic scale.

• To produce a stratigraphic table displaying agreed subdivisions to stage and substage level, marking boundaries that are defined by a GSSP.

3. ORGANISATION - interface with other international projects / groups

SCS has always been linked to important international Projects such as IODP, IGCP, Mesozoic Planktonic Foraminiferal Working Group, and ICDP (International Continental Scientific Drilling Project).

3a. Nominated Officers for 2020-2024:

Chair: Maria Rose Petrizzo; Vice-Chair: Michael Wagreich; Secretary: Francesca Falzoni

Voting Members are 17, from most continents. Over 150 Cretaceous scientists from all over the world and in many different disciplines belong to one or more of the Stage Working Groups and to the Kilian Group. The Stage Working Groups of the SCS are: Berriasian, Valanginian, Barremian, Aptian, Campanian, and Maastrichtian. All WG leaders (chairs) and members are treated as Corresponding Members of the SCS.

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

The SCS has strong links with IGCP projects.

IGCP 679 Cretaceous Earth Dynamics and Climate in Asia (new in 2019, Project Leader Prof. Gang Li, China)

IGCP 710 Western Tethys meets Eastern Tethys (new in 2020, Project Leader Prof. Michał Krobicki, Poland)

IGCP 739 The Mesozoic-Palaeogene hyperthermal events (new in 2021, Project Leader Prof. Xiumian Hu, China)

5. CHIEF ACCOMPLISHMENTS IN 2022

- ### WORKING GROUPS ACTIVITIES TOWARDS THE DEFINITION OF THE GSSPs

Chairs and updated memberships of each WG are available at http://cretaceous.stratigraphy.org/working-groups/ Memberships are updated continuously by inviting active scientists who are willing to collaborate to the WG activities.

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 erected 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 voted and 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 Global Boundary Stratotype Section and Point (GSSP) of the Campanian Stage at Bottaccione (Gubbio, Italy) and its auxiliary sections (Seaford Head, U.K.), Bocieniec (Poland), Postalm (Austria), Smoky Hill, Kansas (U.S.A.) and Tepeyac (Mexico). Episodes.*

Albian GSSP

Finalization of the official steps with the local authorities for the protection and easy accessibility of the GSSP

site at Col de Pre-Guittard in the Commune of Arnayon (Département of Drôme) 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 Apian. 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 paleoenvironments. Some members prefer to keep the current informal base of the Aptian at the base of M0 for defining the GSSP and argue that it will be very confusing to shift the base of the Aptian upward by 600 kyrs 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 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 practically finished. The chairs are preparing the documentation for the discussion of the primary and secondary markers.

Berriasian (J/K boundary) GSSP

The WG keep being focused on organizing database and ideas concerning possible definitions and placing the Tithonian/Berriasian 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 J/K boundary, at least in the Tethyan domain. In 2022, the WG focused on discussion 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). Parallel with debate about the level of the J/K boundary, a search for most suitable sections has started. 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 still performed also by some members of the previous WG, we stay in contact with our colleagues trying to coordinate 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.: *Synchronization 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), Matsuoka A: *J/K boundary (JKB) in East Asia-Pacific and radiolarian evolution around the JKB*; Grabowski J.: *Pilot investigations of clay minerals at the J/K transition and correlation of VOICE isotopic event against calpionellid and magnetostratigraphy*; 10th meeting (28.02.2022), Granier B.: *J/K transition from shallow water Tethys localities*; Grabowski J.: *Coniacian GSSP – what can we learn from the Coniacian Working Group*; 11th meeting (29.03.2022); Schmitz M.: *Bringing deep time into focus – opportunities and challenges for radioisotopic dating and Cretaceous Time Scale calibration*; Grabowski J., Szives O.: *Meeting schedule for the next months*; 12th meeting (20.05.2022); Grabowski J. *New calpionellid data from Torre de Busi section (Lombardian Basin)*; Grabowski J.*: J/K boundary around the lower/middle Berriasian transition: is it a good option?*; 13th meeting, Martinez M., Aguirre-Urreta B.: *Proceedings on the integrated stratigraphy of the Vaca Muerta Formation (Neuquén Basin, Western Argentina)*; 14th Meeting (18.07.2022), Wimbledon B.: *Defining a J/K boundary: the best method (summary of the Alpina option of the J/K boundary)*; Petrova S., Reháková D.: *Revised calpionellid stratigraphy and microfacies of the Torre de' Busi section (Lombardian Basin, J/K boundary) – preliminary results*; 15th Meeting (25.10.2022), Grabowski J.: *Re-Os geochronology*; Grabowski J.: *VOICE and correlations between South America and Europe*. 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"* (chairpersons: J. Grabowski, O. Szives).

A post-Congress excursion was organized 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 Mts (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).

6. SUMMARY OF EXPENDITURE IN 2022:

Contribution attendance cost of participants to the Cretaceous Symposium (Warsaw, 22-26 August 2022) 1473.48 Euro

Contribution to the 6 stages Working Groups for fieldworks + analysis for the GSSPs 2850.00 Euro

Contribution for secretarial work and updating of the website 500.00 Euro

Bank fees for bank transfer 18.00 Euro

TOTAL expenditure in 2021 = 4841.48 Euro

7. SUMMARY OF INCOME IN 2022:

ICS Subvention for 2022 US dollars 5000.00 = 4841.48 Euro

8. BUDGET REQUESTED FROM ICS FOR 2023:

Contribution to the stages Working Groups for fieldworks, analyses, meetings 2500.00 Euro

Contribution to the new Maastrichtian WG to sampling the stratotype section at Tercis (France) 500.00 Euro

Contribution for secretarial work and updating of the website 500.00 Euro

Albian and Hauterivian GSSPs meetings with local authorities (France), GSSPs golden spike ceremonies 1000.00 Euro

Coniacian and Campanian GSSPs meetings with local authorities (Germany and Italy), GSSPs golden spike ceremonies 1500.00 Euro

TOTAL budget request from ICS in 2022= 6000.00 Euro

9. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2023):

- STUDIES, FIELD WORK TO FINALIZE THE GSSP PROPOSALS

Maastrichtian GSSP

In March 2023, WG members will examine the stratotype section in Tercis (France) for sampling and scientific discussion. 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 Kronsmoor 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.

Batenburg, S. J., et al. (2014): An astronomical time scale for the Maastrichtian based on the Zumaia and Sopelana sections (Basque country, northern Spain), J. Geol. Soc., 171, 165–180.

Kim, J.-E., et al. (accepted, 2022): Precessional pacing of tropical ocean carbon export during the Late Cretaceous. Clim. Past Discuss., https://doi.org/10.5194/cp-2022-42.

Plasota, T., et al. (2015): Magnetostratigraphy of the Campanian/Maastrichtian boundary succession from the Middle Vistula River section, central Poland. Geol. Quart., 59/4), 831–842, doi: 10.7306/gq.1262.

Wilmsen, M., et al. (2019) A Boreal reference section revisited (Kronsmoor, northern Germany): high-resolution stratigraphic calibration of the Campanian-Maastrichtian boundary interval (Upper Cretaceous). Newsl. Stratigr., 52/2, 155-172.

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 locations 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 end November 2022. If approved by SCS, ISC and IUGS, a publication will be prepared with the most relevant data concerning the Hauterivian/Barremian 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 $\delta^{13}C_{org}$ 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, astrochronologic 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 Mts, 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.

- FUTURE MEETINGS

- 2023 – 4th International Congress on Stratigraphy, Lille (France), 11-13 July 2023.

Potential funding sources external to IUGS

The SCS does not envisage being able, as an organization, to obtain significant funding from outside IUGS/ICS sources. Some additional financial support beyond what is already committed could perhaps be obtained by individual members from their host institutions and/or their personal research funds.

10. KEY OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020-2024

- November-December 2022: Vote by the SCS of the Barremian GSSP.
- Spring 2023: official ceremonies for the inauguration and placement of the golden spikes of the Albian, Hauterivian.
- March 2023: the new Maastrichtian WG start the activities with sampling the current stratotype section in Tercis (France) to establish modern criteria aimed to identify a primary marker.
- Summer 2023: official ceremonies for the inauguration and placement of the golden spikes of the Coniacian and Campanian GSSPs.
- 2023-2024: Finalization of the GSSP proposals for the base Valanginian and base Aptian and vote within the WG.
- 2023–2024: Research activities toward the preparation of the GSSP proposal for the base of the Berriasian and Maastrichtian Stages.
- 2024: Vote by the SCS of the Valanginian and Aptian GSSPs.
- 2024: Finalization of the GSSP proposal for the base Berriasian and Maastrichtian and vote within the WG.

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

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INTERNATIONAL SUBCOMMISSION ON JURASSIC STRATIGRAPHY (ISJS) ANNUAL REPORT 2022

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommission on Jurassic Stratigraphy

Reported by Angela L. Coe, Subcommission Chair, in consultation with ISJS voting members.

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

The International Subcommission on Jurassic Stratigraphy is the primary body for facilitation of international communication and scientific cooperation in Jurassic stratigraphy, defined in the broad sense of multidisciplinary activities directed towards better understanding of the evolution of the Earth during the Jurassic.

Objectives

1. The unambiguous definition, by means of agreed GSSPs, of a hierarchy of chronostratigraphical units that provide the framework for global correlation.
2. Provide an inclusive, diverse and supportive international community to facilitate global research and associated activities on Jurassic stratigraphy.
3. Advance understanding of the evolution of the Earth system during the Jurassic including palaeogeography, palaeoclimate change, evolution of life, and sea-level change.
4. Improve the resolution and correlation of the integrated stratigraphy for the Jurassic.
5. Facilitate communication on Jurassic stratigraphy for both specialist and non-specialist audiences.

Fit within IUGS Science Policy

The objectives of ISJS relate to two main science objectives of IUGS policy:

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

3. ORGANISATION including interface with other international projects / groups

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Webpersons: Angela L. Coe and David B. Kemp (see above)

3b. Interface with other international, regional and national projects

Members of the ISJS and the wider Jurassic sttratigraphy community are involved in a number of international and national projects, facilitated by contacts through activities related to the subcommission such as its Working Groups and the Jurassic congresses.

IGCP project 739 The Mesozoic-Palaeogene hyperthermal events. This project is investigating the major hyperthermal events and their associated environmental and biological responses. Episodes of Jurassic warmth (Triassic-Jurassic boundary and Toarcian Oceanic Anoxic Event) will be a focus of the project. The project involves 149 researchers from 41 countries. David Kemp and Micha Ruhl from ISJS are co-leaders. The first workshop. was held on 22nd November 2021 and there was aa session at the International Sedimentological Congress in August 2022. Website: https://es.nju.edu.cn/igcp739/44923/list.htm.

IGCP project 655 Toarcian Oceanic Anoxic Event: Impact on marine carbon cycle and ecosystems has now ended. Many of the results are summarised in Volume 514 of the *Special Publications of the Geological Society, London*. The special publication contains 16 papers dealing with the mechanisms that triggered the hyperthermal Toarcian event and its collateral effects, such as weathering, acidification, anoxia and biotic crisis.

International Continental Drilling Program (Early **J**urassic **E**arth System and **T**imescale (JET)). This project, led by Stephen Hesselbo, cored 650 m in late 2020 spanning from the Norian to Pliensbachian. Many geochemical, sedimentological and biostratigraphical analyses have been completed. A manuscript of the initial results is in preparation. ISJS members Christian Meister, Emanuela Mattioli, and Grzegorz Pieńkowski are members of the science team. Website: https://www.icdp-online.org/projects/world/europe/prees-england/details/.

UNESCO World Heritage Sites. ISJS liaises with the management group of the UNESCO East Devon and Dorset Coast (informally known as the Jurassic Coast) World Heritage Site and engages in debates and promotional activities. See https://jurassiccoast.org/.

Geoheritage. The ISJS Geoconservation Working Group (Convenor Kevin Page) has links with international and national Geoconservation bodies and advisory groups including the International Commission on Geoheritage, the Geoheritage Specialist Group of the World Commission for Protected Areas and ProGEO, and is also Editor-in-Chief of *Geoheritage*, the leading scientific journal in the field. A proposal for a special thematic issue of Geoheritage on conservation Jurassic rocks and fossils edited by Robert Weiss and Kevin Page has been accepted for Geoheritage and is in preparation.

Stratigraphy Commission of the Geological Society, London. Angela L. Coe, is chair of Stratigraphy Commission of The Geological Society, London and under her direction the Commission are currently working to raise the profile of Jurassic GSSPs in the UK.

German Subcommission for Jurassic Stratigraphy. The ISJS voting member Günter Schweigert is secretary of the German Subcommission for Jurassic Stratigraphy.

Polish-Slovakian Working Group on the Jurassic System. Scientists in these countries working on the Jurassic meet annually to exchange ideas and present work. Next September the 15th meeting will be held in Iłża, Poland.

Argentinian Jurassic group. The 8th Argentinean Jurassic Symposium that is held every three year will take place in March 2023 and all Jurassic workers are welcome.

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

We gratefully acknowledge the continued support of the Polish Geological Institute - National Research Institute and Faculty of Geology, University of Warsaw, in editing *Volumina Jurassica*, ISSN: 1731-3708, a peer-reviewed, open access journal supported by ISJS. In 2022, there will be one issue of *Volumina Jurassica*.

5. CHIEF ACCOMPLISHMENTS OF ISJS IN 2022

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 very grateful to the organisers József Palfy and István Fözy for their smooth organization 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. For photographs and the scientific programme see: https://jurassic2022.hu/

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.

***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). This includes Jurassic examples.

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 bistratigraphical correlation can be supplemented with Peltocatidae. 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 Subcommission on Cretaceous Stratigraphy (Berriasian Working Group): 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).

6/7. SUMMARY OF INCOME and EXPENDITURE FOR 2022

Item	Income ($)	Expenditure/ committed ($)
Opening balance	1500	
Transfer from ICS for 2022	5000	
Promotion of the 12th International Jurassic Congress		500 committed
Promotion and public engagement for the Kimmeridgian GSSP on the Isle of Skye (travel and graphics) 1500 from opening balance plus more to take into account inflation		2000 committed
Advancement of the Oxfordian GSSP (meeting in France to refine correlation and extra sampling in Dorset)		2600 committed
Support for attendees at the 11th Congress		1400
Closing balance		0.00

8. BUDGET REQUESTS FROM ICS FOR 2022

We request $1600 from the budget for 2023 to support attendance of Jurassic researchers at STRATI 2023. Funds are specifically requested for attendees of low means (e.g. some PhD students and early career researchers, those in countries/institutions where there are no other funds to apply for) together with those from under-represented countries or ethnic minorities.

9. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS FOR 2022

- **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 theJurassic 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.

10. KEY OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2020-2024)

- Achieve ratification of the Kimmeridgian GSSP.
- Complete or significantly advance the defining of the remaining Jurassic GSSPs (Callovian, 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 ISJS 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 International Subcommission for Cretaceous Stratigraphy 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, asses and promote their natural capital.

APPENDIX

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Villaseñor	Ana Bertha	anab@unam.mx	Departamento de Paleontología, Instituto de Geología, Primer piso, Cubículo y Laboratorio de invertebrados, C.P. 04510, Ciudad de México, México +52 (55) 56-22-42-80 Ext. 182

11b List of Task and Working Groups and their officers

The active Working Groups are as follows:

Callovian Working Group (Chair: Eckhard Mönnig, Naturkunde-Museum Coburg, Park 6, 96450 Coburg, Germany, Tel. +49 (0)9561 8081-13, e.moennig@naturkunde-museum-coburg.de)

Oxfordian Working Group (Chair: Kevin PAGE, Honorary Senior Research Fellow, Camborne School of Mines, University of Exeter, UK, Tel: +44 (0)1363 775354, kevinnpage@gmail.com; Secretary: Faculty of Geology, Department of Geology of Sedimentary Basins, University of Warsaw, Warsaw, Poland (+48 22) 55 40 429 eglownia@uw.edu.pl

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

Geoconservation Working Group (Chair: Kevin Page, Camborne School of Mines, University of Exeter, Penryn Campus, Penryn TR10 9FE; Tel: +44 (0)1363 775354, kevinnpage@gmail.com)

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

Angela L. Coe 18 November 2022

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTERS
Subcommission on Triassic Stratigraphy (STS)

SUBMITTED *BY*
Prof. Zhong-Qiang Chen, Chairman
State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences (Wuhan), 388 Lumo Road, Hongshan District, Wuhan 430074, China
Tel: 86-27-67883068; E-mail: zhong.qiang.chen@cug.edu.cn

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

- Definition of stage boundaries and selection of GSSP sections.
- Rationalization of chronostratigraphic classification for the Triassic.
- Inter-calibration of all stratigraphic tools and promoting globally data to achieve this.
- Establishment of physical, cyclostratigraphic, magento- and chemo-stratigraphic scales.
- Correlations of Triassic successions and extreme events from marine to non-marine.

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

3. ORGANISATION - interface with other international projects / groups

The STS is a Subcommission of the International Commission on Stratigraphy, with 3 executive officers and 23 voting members of the STS and about 110 corresponding members.
The editor of the online journal *Albertiana* is also appointed, and he also manages the web site and posts for STS announcements and task group discussions. The *Albertiana* editor is supported by an editorial team of ten drawn from the voting and corresponding members.

Interfaces:
IGCP 739: "The Mesozoic-Palaeogene hypothermal events: lessons for understanding Anthropogene global warming", leader Xiumian Hu, with scientists from Turkey, India, Ireland, USA. Interconnection is relevant to the joint virtual workshop of IGCP 739 on 24th of August, 2022, and joint works on the Permian-Triassic extinction and hothouse regimes.

3a. Nominated Officers for 2020-2024

Chair: Zhong-Qiang Chen, State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences (Wuhan), Wuhan, China
Vice-Chair: Wolfram M. Kürschner, UiO Department of Geosciences, Oslo, Norway
Secretary: Yadong Sun, GeoZentrum Nordbayern, University of Erlangen-Nuremberg Schlossgarten 5, Erlangen, Germany
Webperson and *Albertiana* Editor: Christopher A. McRoberts, Geology Department, SUNY, Cortland, New York, USA

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

Funding of the International Geological Summer School "Millions of years before the Silk Road" was partially supported by Tian Shan Geological Society, Kyrgystan and Bergakademie Freiberg University, Germany. All publications published by TST members were sponsored by their research grants from various funding agencies.

5. CHIEF ACCOMPLISHMENTS IN 2021

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 (Hunslow 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 (Hunslow, 2022, oral presentation). A team led by Dr. Marco Bolini 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 $\delta^{13}C_{carb}$ 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 $\delta^{13}C_{carb}$ (Henderson, 2022, oral presentationt). The same case has also been reported from the southern Qinglin region (Li et al., 2022) and the Salt Range (Han et al., 2022).

  Primary publications: Hounslow, M.W., *et al*., 2021. The case for the Global Stratotype Section and Point (GSSP) for the base of the Norian stage. *Albertiana* **46**, 25–57. Li, H.X. *et al*., 2022. Integrated conodont biostratigraphy and $\delta^{13}C_{carb}$ records from end Permian to Early Triassic at Yiwagou Section, Gansu Province, northwestern China and their implications. *Palaeogeography, Palaeoclimatology, Palaeoecology* **601**, 111079. Han, C., *et al.*, 2022 Improved taxonomic definition based on the ontogenetic series of Griesbachian-Dienerian conodonts from the Early Triassic of northwestern Pakistan. *Glob. Planet. Chang.* **208**, 103703. Chen, A.F., *et al*., 2022. A new study of Olenekian-Anisian boundary conodont biostratigraphy of the Tulong section in Himalaya Terrane, southern Tibet. *Palaeoworld* **31**, 428-442.
- **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 Coroso et al., 2022; Feng et al., 2022). Two special issues were organized in the international journal *Global and Planetary Change* (*by*

Chen, Z.Q., Harper, D.A.T., Grasby, S., Zhang, L., 2022; Chen et al., 2022; *by* Sun, Y.D., Richoz, S., Kurschner, W.M., 2022).

Primary publications: Chen, Z.Q., *et al*., 2022. Catastrophic event sequences across the Permian-Triassic boundary in the ocean and on land. *Glob. Planet. Chang.* **215**, 103890. Dal Corso, J., *et al*., 2022. Environmental crises at the Permian-Triassic mass extinction. *Nature Reviews Earth & Environment* **3**, 197-214. Feng, X.Q., *et al*., 2022. Resilience of infaunal ecosystems during the Early Triassic greenhouse Earth. *Science Advance* **8**(26), eabo0597. Sun, Y.D., *et al*., 2022. Editorial preface to special issue: Triassic at the dawn of modern world in honour of Prof. Leopold Krystyn. *Glob. Planet. Chang*. **208**, 103633.

- **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 Nov., 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) summarizing 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".

6. SUMMARY OF EXPENDITURE IN 2022

Total 1,000 USD is used to sponsor the International Summer School in southern Kyrgystan, Central Asia. Total 1,200 USD is spent in organizing STS Webinar (including hiring fee of Zoom Meeting, sponsorship for inviting speakers). Total 800 USD is allocated to cover photocopying fee for the earlier issues of STS newsletters *Albertiana* back to 1970s, 1980s, 1990s and 2000s, and these earlier issues will be stored and posted in STS website.

7. SUMMARY OF INCOME IN 2022

Total 3,000 USD was allocated for STS activities in 2022.

8. BUDGET REQUESTED FROM ICS IN 2023***

Total 3,500 USD is budgeted for organizing three major events in 2023: 1) **STS Symposium/Sessions: Triassic Integrated Stratigraphy, GSSPs, and Extreme Climatic,**

Environmental and Biotic Events, joint with STRATI 2023, 11th-13th July, 2023, Lille, France, 2) STS Field Workshop: The Olenekian-Anisian Boundary Succession in Romania, 14th -16th July, 2023, and 3) STS Field Excursion: The Olenekian-Anisian Boundary Successions in South China: from Wentou section (Guangxi) to Guandao section (Guizhou), 10th -16th October, 2023. Detailed funding application and spend budget table are attached.

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

- Organizing the **STS Symposium/Sessions: Triassic Integrated Stratigraphy, GSSPs, and Extreme Climatic, Environmental and Biotic Events**, joint with STRATI 2023, 11th-13th 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 (14th -16th July, 2023) and in South China (10th -16th 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.

10. KEY OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020-2024

Total **2** 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:

- Organizing the **International Symposium on Triassic Integrated Stratigraphy and Bio-Environmental Events** in Wuhan, China on 03-07 Nov., 2022.
- Organizing the **International Symposium and Field Workshop on Triassic Stratigraphy and Bioevents** in Alberquerque, 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.
- Organizing 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.

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

Nominated officer for 2020-2024

Chair: Zhong-Qiang Chen, State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences (Wuhan), 388 Lumo Road, Hongshan District, Wuhan 430074, China; Tel: 86-27-67883068; E-mail: zhong.qiang.chen@cug.edu.cn
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Secretary: Yadong Sun, Universität Erlangen-Nürnberg, Schlossgarten 5, 91054 Erlangen, Germany; Tel: +49 09131 85 23422; E-mail: yadong.sun@fau.de
***Albertiana* Editor:** Christopher A. McRoberts, Department of Geology, State University of New York at Cortland, P.O. Box 2000, Cortland, New York 13045, USA (mcroberts@cortland.edu).

List of Voting Members (23 members):

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yurizakh@mail.ru	Zakharov	Yuri D.	Vladivostok, Russia.
~110 STS corresponding members, not listed here			

Chairs of the Working Groups of the unresolved GSSP boundaries

Base Rhaetian Working Group, Y. Sun, yadong.sun@fau.de
Base Norian Working Group, M. W. Hounslow, m.hounslow@lancaster.ac.uk
Base Anisian Working Group (and non-marine working Group), S. G. Lucas, spencer.lucas@state.nm.us
Base Olenekian Working Group, C. M. Henderson, cmhender@ucalgary.ca

Appendix II: International Summer School Report (1), STS Symposium joint with Strati2023 (2), STS Webinar Programme (3), and Full Publication List of STS Members in 2022 (4) Available from Subcommission Chair

Appendix II-1: International Summer School Report
Appendix II-2: Call for Abstract for STS Symposium joint with STRATI 2023
Appendix II-3: Programme of STS Webinar
Appendix II-4: Full list of publications by STS Members.

SUBCOMMISSION ON PERMIAN STRATIGRAPHY

ANNUAL REPORT 2022

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommission on Permian Stratigraphy (SPS)
Submitted by: Lucia Angiolini, SPS Chair
Dipartimento di Scienze della Terra "A. Desio", Via Mangiagalli 34, 20133 Milano, Italy, E-mail: lucia.angiolini@unimi.it

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Subcommission Objectives: The Subcommission's primary objective is to define the series and stages of the Permian by means of internationally agreed GSSPs and establish a high-resolution temporal framework based on multidisciplinary (biostratigraphical, geochronologic, chemostratigraphical, magnetostratigraphical etc.) approaches, and to provide the international forum for scientific discussion and interchange on all aspects of the Permian, but specifically on refined intercontinental and regional correlations.

Fit within IUGS Science Policy: The objectives of the Subcommission involve two main aspects of IUGS policy: 1) The development of an internationally agreed chronostratigraphic scale with units defined by GSSPs where appropriate and related to a hierarchy of units to maximize relative time resolution within the Permian System; and 2) the establishment of framework and systems to encourage international collaboration in understanding the evolution of the Earth and life during the Permian Period.

3. ORGANISATION - interface with other international projects / groups

3a. Officers for 2020-2024 period:

Prof. Lucia Angiolini (SPS Chair)
Dipartimento di Scienze della Terra "A. Desio". Via Mangiagalli 34, 20133 Milano, Italy, E-mail: lucia.angiolini@unimi.it
Prof. Michael H. Stephenson (SPS Vice-chair)
British Geological Survey. Keyworth, Nottingham NG12 5GG, and Stephenson Geoscience Consulting, Keyworth, Nottingham, NG12 5HU, United Kingdom, E-mail: mikepalyno@me.com
Prof. Yichun Zhang (SPS Secretary)
State Key laboratory of Palaeobiology and Stratigraphy. Nanjing Institute of Geology and Palaeontology, 39 East Beijing Road, Nanjing, Jiangsu 210008, P.R. China, E-mail: yczhang@nigpas.ac.cn

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

Shuzhong Shen and Michael Stephenson are investigating the possibility of support for SPS through the Deep-time Digital Earth (DDE) Big Science Program of IUGS focused on informatics support for biostratigraphic data management and palaeogeographic reconstructions. Lucia Angiolini was funded by an Italian national project to perform field activity in the Kungurian base GSSP candidate at Rockland, Nevada (Fund: MURST-PRIN 2017RX9XXXY, project 'Biota resilience to global change: biomineralization of planktic and benthic calcifiers in the past, present and future')

5. CHIEF ACCOMPLISHMENTS IN 2022 (including any relevant publications arising from ICS working groups)

- 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 organized "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 organized (https://permian.stratigraphy.org/interest)

6. SUMMARY OF EXPENDITURE IN 2022

The amount received from ICS was spent for literature compilation, Dal'ny Tulkas GSSP manuscript for Episodes preparation, Standard Pro Annual ZOOM license for SPS, geochemical analyses on samples (Sr analyses) from Rockland section (Nevada), and support to the new Working Group "Gondwana to Euramerica correlations" to produce a photo-gallery of most important taxa for correlation.

Due to the Ukraine-Russian war, it was not possible to do field work in Dal'ny Tulkas and Mechetlino as scheduled. A field-trip to the Rockland section (Nevada), base Kungurian GSSP candidate, was performed by Lucia Angiolini and Charles Henderson from 14 to 23 October 2022. The expenses of Lucia Angiolini were mostly supported by an Italian National Research Fund and only subordinately by ICS funds.

7. SUMMARY OF INCOME IN 2022

An amount of Euros 4287,89 euros was allocated from ICS on July 2022.

8. BUDGET REQUESTED FROM ICS IN 2022***

We apply for 4800 US$ from ICS for SPS activities in 2023. This will be mainly for the activities to establish the base-Kungurian GSSP at Rockland, Nevada and to organize a field trip in the area, and to support the participation to the STRATI 2023 Congress in Lille.

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

· We plan to have the proposal of the base Kungurian GSSP proposal published in *Permophiles* and voted by SPS voting members.

- We plan to organize several webinars.
- We plan to support the activity of the new working group on Gondwana Correlation.

10. KEY OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020-2024

- 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.
- Organize webinars to increase the size, diversity and international coverage of the Permian Community
- Publish at least two *Permophiles* issues each year.

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

Prof. Lucia Angiolini (SPS Chair)
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Dr. Elisabeth Weldon
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Prof. Yichun Zhang (SPS Secretary)
Nanjing Institute of Geology and Palaeontology, 39 East Beijing Road, Nanjing, Jiangsu 210008, P.R China E-mail: yczhang@nigpas.ac.cn

Working group leaders

1) Artinskian-base and Kungurian-base GSSP Working Group; Chair - Valery Chernykh.
2) Correlation between marine and continental Guadalupian Working Group; Chair - Charles Henderson.
3) Correlation between marine and continental Carboniferous-Permian Transition Working Group; Chair - Joerg Schneider.
4) Gondwana to Euramerica correlations; Chair - Mike Stephenson.

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Carboniferous Stratigraphy (SCCS)

Prepared by Xiangdong Wang, Chair of SCCS

School of Earth Sciences and Engineering,
Nanjing University,
No. 163 Xianlin Avenue, Nanjing 210023, China
Tel: 086-13605184681; Email: xdwang@nju.edu.cn

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

Objective

The SCCS promotes and coordinates international cooperation among various geologic specialists for the purpose of defining standard global chronostratigraphic boundaries within the Carboniferous System and promoting regional and intercontinental stratigraphic correlation of Carboniferous. The principal SCCS goals are:

(a) to establish a standard global stratigraphic time scale and to select the best stage boundaries within the Carboniferous system,

(b) to establish high-resolution integrated stratigraphic frameworks at regional scale, and

(c) to facilitate global correlation in the system.

Fit within IUGS Science Policy

The current objectives of SCCS relate to the main aspects of IUGS policy:

(a) Establishment of a standard global stratigraphic time scale, defined by Global Stratotype Sections and Points (GSSPs).

(b) Development of internationally acknowledged chronostratigraphic units/or boundaries.

(c) Promotion of international cooperation in geological research.

3. ORGANISATION - interface with other international projects/groups

3a. SCCS Officers for 2020-2024:

Chair: Xiangdong Wang (China)
Vice-Chair: Svetlana Nikolaeva (UK/Russia)
Secretary: Markus Aretz (France)

3b. Voting members (VM) and corresponding members (CM):

For the 2020-2024 term, the SCCS currently has 21 voting members (including 3 officers) representing 11 countries: Australia (1), Belgium (2), Czech Republic (2), China (4), France (1), Germany (1), Japan (1), Russia (4), Spain (2), UK (1), USA (2). A full list of current voting members (with detailed contact information) is attached at the end of this report as an appendix. SCCS has almost 200 corresponding members at present.

3c. SCCS maintains an official website, and the URL is as follows:

http://carboniferous.stratigraphy.org/

3d. Interface with other international projects/groups

The SCCS cooperates closely with the subcommissions on Devonian (SDS) and Permian Stratigraphy (SPS) to establish common boundaries with the Carboniferous. The SCCS experts have established a closer relationship with the Deep-Time Digital Earth (DDE), the first IUGS-recognized big science program, with the primary goal of harmonizing 'deep-time' digital geological data and providing a novel glimpse into the Earth's geological past and its future.

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

5. CHIEF ACCOMPLISHMENTS IN 2022 (including any publications arising from ICS working groups)

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.

5a. 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 organized by the Subcommission on Carboniferous Stratigraphy in May 2021. This volume entitled "Ice ages, climate dynamics and biotic events: The Late Pennsylvanian World," 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. Nonmarine Biotic events. It will comprise 22 chapters: 1. About this title - Ice ages, climate dynamics and biotic events: The Late Pennsylvanian World (Lucas et al.), 2. Comparison of Late Pennsylvanian and Pleistocene climatic and biotic events (DiMichele et al.), 3. Resolving the position of the Moscovian-Kasimovian boundary and selection of the GSSP (Wang et al.), 4. The challenge of relating the Kasimovian to West European chronostratigraphy–a critical review of the Cantabrian and Barruelian substages of the Stephanian (Knight and Álvarez-Vázquez), 5. Middle - Late Pennsylvanian tectono-sedimentary, climatic and biotic records in basins of Europe, NW Turkey and North Africa–an overview (Opluštil and Schneider), 6. Dust and volcanism during the late Paleozoic (Soreghan), 7. Glaciation of Gondwana during the late Paleozoic Ice (Isbell), 8. North American Midcontinent Pennsylvanian Cyclothems and their Implications (Heckel), 9. Middle-Late Pennsylvanian atmospheric compositional changes (Isbell and Montañez), 10. Global climate models for the Late Pennsylvanian (Macarewich), 11. Climate inference from Late Pennsylvanian paleosols (Gulbranson et al.), 12. Evolutionary patterns in Late Pennsylvanian conodonts (Barrick et al.), 13. Biostratigraphy and biofacies of the Kasimovian conodonts from the Shanglong section, South China (Hu et al.), 14. Plant turnover patterns in the middle Pangean wetlands (DiMichele et al.), 15. Pennsylvanian age macro-plant biostratigraphy: Gradualism, catastrophes, and the "Cantabrian" problem (Pfefferkorn), 16. Plant turnover patterns in western Pangea during the Late Pennsylvanian (Schachat et al.), 17. Plant physiological models and plant biomes of the Late Pennsylvanian (Wilson), 18. An overview of the Pennsylvanian basins of Europe and NE Asia and their macrofloras (Opluštil), 19. Plant turnover in Gondwana (Iannuzzi),

20. Ecological and evolutionary responses of terrestrial arthropods to Middle–Late Pennsylvanian environmental change (Donovan et al.), 21. The Middle-Late Pennsylvanian record of trace fossils (Hunt et al), 22. Late Pennsylvanian tetrapod evolution (Lucas). Most of the chapters 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.

5.2 The Kasimovian-Gzhelian boundary

After a long-term international cooperation 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.

5.3 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.

5.4 The Visean-Serpukhovian, Bashkirian-Moscovian, Moscovian-Kasimovian boundaries

Coordinated 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.

6. SUMMARY OF INCOME IN 2021

Prepared by Prof. Xiangdong Wang, Chair of SCCS (Accounts maintained in U.S dollar)

Funds carried forward from 2021	$ 170
ICS Grant	$3500
TOTAL INCOME	$3670

7. SUMMARY OF EXPENDITURE IN 2022:

Prepared by Prof. Xiangdong Wang, Chair of SCCS (Accounts maintained in U.S dollar)

D/C boundary task group activity	$1700
The Kasimovian task group activity	$500
The Gzhelian task group activity	$1000
SCCS Newsletter 2021 editing	$450
TOTAL EXPENDITURE	$3650

8. BUDGET REQUEST FROM ICS IN 2023

In 2023, the pandemic restrictions will be loosened, and international travels and meetings will be possible. The 4th international Congress on Stratigraphy (Strati 2023) will be held in Lille, France, 11th-13th July 2023. The SCCS members will meet during the venue and fully discuss problems and progress on Devonian-Carboniferous, Visean-Serpukhovian, Bashkirian-Moscovian, Moscovian-Kasimovian, and Kasimovian-Gzhelian boundaries. Each working group will have the opportunity to organize a meeting and to address current issues. The attendance of some voting members and members of different task groups in these important SCCS activities is going to be partly sponsored by the Subcommission. We request 5000USD (1000USD per working group) from ICS to support attendance of SCCS members at the workshops and other activities of task groups searching for the remaining GSSPs in the Carboniferous.

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

- A special volume entitled as 'Ice Ages, Climate Dynamics and Biotic Events: The Late Pennsylvanian World' will be officially published in Geological Society, London, Special Publication 535 in 2023.
- A SCCS meeting of all voting members and five working group workshops will be organized during the Strati 2023. The DCB working group will organize 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 stages 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 to the subcommission a proposal for the boundary criterion of a revised base of the Carboniferous during the first half of the year.
- Evaluation on selecting boundary markers of Visean-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.

10. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2020-2024)

- Within the next 4 years, it should be possible to select the defining events for all stage boundaries and to make significant progress toward selecting candidate sections for the GSSPs. We intend to combine high-resolution biostratigraphy and other stratiographic methods in multi-proxy approaches to establish as many of the remaining GSSPs as possible. The proposal of the Naqing section as the official Kasimovian-Gzhelian boundary GSSP is ongoing.
- We will encourage and pay more attention to finding volcanic ash beds for radiometric dating, to establish a more precise Carboniferous time scale and facilitate the correlation of important Carboniferous events at global scale.
- Using multi-disciplinary methods including palynological studies, U-Pb dating and stable isotope studies, we will further promote marine and non-marine correlation.
- We are going to organize at least one academic activity each year, either a workshop (maybe combined with conferences) or joint workshop/field excursion.
- Integrate the Carboniferous databases from the entire world, combining the One-Stratigraphy Database at Nanjing University, the Geobiodiversity Database (GBDB, a large compilation of

data about sections) at Nanjing Institute of Geology and Palaeontology, the Paleobiology Database (a large compilation of data about fossils) at the University of Wisconsin-Madison, DDE (Deep Time Digital Earth) and other major databases, to facilitate the studies on Carboniferous biota and stratigraphy.

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

In addition to the three executive voting members, the SCCS has eighteen rank-and-file voting members.

Officers:

Chair: Dr. **Xiangdong Wang**

School of Earth Sciences and Engineering, Nanjing University, No. 163 Xianlin Avenue, Nanjing 210023, China; Tel: 086-13605184681; Email: xdwang@nju.edu.cn

Vice-Chair: Dr. Svetlana Nikolaeva

1) Department of Earth Sciences, the Natural History Museum, London, SW7 5BD UK;
2) Paleontological Institute Russian Academy of Sciences Profsoyuznaya ul., 123, Moscow, 117997 Russia; E-mail: s.nikolaeva@nhm.ac.uk

Secretary: Dr. Markus Aretz

Université Toulouse III Paul Sabatier, GET (OMP), 14, avenue Edouard Belin, 31400 Toulouse, France; Tel: +33 5 61332674; E-mail: markus.aretz@get.omp.eu

List of Regular Voting Members:

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Dr. Jitao Chen, State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, CAS, No. 39 East Beijing Rd. Nanjing, Jiangsu 210008, China; E-mail: jtchen@nigpas.ac.cn

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1. TITLE OF CONSTITUENT BODY

Subcommission on Devonian Stratigraphy

Reporting Ladislav Slavík (Chair)

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

Restrictive pandemic measures in most countries were lifted in 2022 and thus numerous activities of the SDS continued in a normal way. In spite of some difficulties, e.g., with delayed laboratory works due to their overloading atfer a long pandemic break, working groups went on with their work on revision of the GSSPs (the basal Emsian and the Devonian-Carboniferous boundary). Due to the "back to normal" several organized meetings and fieldworks enabled that SDS members started to meet face to face again. The small subprojects that have been launched in 2020 focussed on gathering data around the problematic GSSPs were partly accomplished last year. In 2022 a load of work has been done in the Prague Synform, Spanish Central Pyrenees and Morocco concerning the Basal Emsian Boundary. The major issues were discussed during the Annual business meeting of the SDS that took place in November 8th in Khon Kaen, Thailand in conjunction with the 6th International Palaeontological Congress. It was the first SDS non-virtual meeting since Milano 2019. The next, regular Annual SDS Business Meeting will take place next year in Geneseo, New York State during the Devonian oriented conference and fieldtrips. Other SDS activities included organisation of Devonian session at the IPC and future Devonian symposia, publication of the SDS Newsletter that includes all major Devonian-related topics. Also, a monographic journal volume on Rhenish Massif has been published.

The main objectives of the Subcommission on Devonian Stratigraphy fit within IUGS science policy:

- to develop of an internationally approved chronostratigraphical timescale for the Devonian with maximum time resolution, as part of the ICS standard global stratigraphic scale;
- to produce a stratigraphic table displaying agreed subdivision to stage and substage level marking boundaries that are defined by a GSSP.
- to promote of new and modern stratigraphical techniques and their integration into Devonian multidisciplinary schemes.

3. ORGANISATION - interface with other international projects/groups

Actively supporting *IGCP 652, Reading geologic time in Paleozoic sedimentary rocks: the need for an integrated stratigraphy*

3a. Current Officers for 2020-2024 period:

Chair: Ladislav (Lada) Slavík

Vice-Chair: José Ignacio (Nacho) Valenzuela-Ríos

Secretary: Ulrich (Uli) Jansen

Webperson: Carlo Corradini

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

University of Münster continue to support the staff costs of the SDS Newsletter production and the mailing. The IUGS support pays for the printing. The Newsletter has an ISSN and status as a publication. Since last year it is published and printed partly in colour, pdf version is published on the SDS web page.

We have regular annual meetings (this year face to face again). SDS members support their own attendance at these.

The major part of SDS subprojects are supported from other sources (home institutes and national funding agencies).

5. CHIEF ACCOMPLISHMENTS IN 2022 (including any publications arising from ICS working groups)

- **Annual business meeting of the SDS** took place in November 8th 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 web (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.

6. SUMMARY OF EXPENDITURE IN 2022 ($USD):

SDS Newsletter	750
International Palaeontological Congress (IPC6) and SDS meeting - travel costs:	
SDS Chair	900
SDS Vice-Chair	900
CM Ariuntogos Munkhjargal (special travel grant, Key note in Dev. session)	500
SDS Secretary (Smithsonian Museum Washington D.C. - brachiopod study)	900

7. SUMMARY OF INCOME IN 2022:

ICS $USD 4000

8. BUDGET REQUESTED FROM ICS IN 2023

The long planned SDS and IGCP 652 - Annual Meeting and field based conference in Geneseo, New York State, USA will take place from 26 July 2023 to 07 August 2023. The SDS will have a regular SDS business meeting there including Devonian focussed sessions. Our main focus will be the redefinition of the base Emsian GSSP (we expect specific proposals) and meeting to discuss the D-C boundary for redefinition of the base of the Carboniferous.

For the next year, there is also another possibility to meet: STRATI in Lille, France, 11-13 July 2023. The SDS has proposed a Devonian session: Devonian paleoenvironments and time. The convenors would be the SDS officers (Ladislav Slavík, José Ignacio Valenzuela-Ríos and Ulrich Jansen).

We request contributions to travel costs for both of these meetings.

SDS Chair travel costs	$950
SDS Vice-Chair travel costs	$950
SDS Secretary travel costs	$950

In addition we request part support for production of the SDS Newsletter $750

Total Sum requested from IUGS $3600

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

- 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 Subcommission. Progress towards selection of candidate stratotypes.
- Real SDS business meeting and Devonian symposia

10. KEY OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2020-2024)

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

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

NOMINATED OFFICERS

CHAIR
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VICE-CHAIR
JOSÉ IGNACIO VALENZUELA-RÍOS, Dpt. De Geología, Universitat de València C/. Dr. Moliner 50, E-46100, Burjassot, Spain, Tel.: 0034 96 3543412; Jose.I.Valenzuela@uv.es

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Voting members, address, country, phone, email, special fields:

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List of Working (Task) Groups and their officers

Emsian Working Group (EWG)

The Emsian Working group has been recently re-established (2021) in order to solve the problems with the correlation of the Basal Emsian boundary. The members are expected to present and evaluate proposals for the basal Emsian GSSP redefinition. The Working group is open to other specialists involved in this task.

Members

LADISLAV SLAVÍK (CZECH REPUBLIC)
JOSÉ IGNACIO-VALENZUELA-RÍOS (SPAIN)
THOMAS BECKER (GERMANY)
MAYA ERINA (UZBEKISTAN)
JINDŘICH HLADIL (CZECH REPUBLIC)
NADYA IZOKH (RUSSIA)
OLGA IZOKH (RUSSIA)
ULRICH JANSEN (GERMANY)
ALEKSEY KIM (UZBEKISTAN)
TOMÁŠ WEINER (CZECH REPUBLIC)
HEDVIKA WEINEROVÁ (CZECH REPUBLIC)

Devonian/Carboniferous Boundary Working Group (DCBWG)

The DCBWG was established in 2008, with the goal to redefine the GSSP for the Tournaisian (equivalent to base of the Carboniferous System), when problems both with the type section (La Serre E', Montagne Noire, France) and the index fossil (*Siphonodella sulcata*, conodont) arose. It includes members named by the Devonian (SDS) and Carboniferous (ISCS) subcommisions. Several meetings and workshop took place up to now, and the new GSSP is expected to be proposed in the near future.

Members
MARKUS ARETZ (FRANCE) - CHAIR
CARLO CORRADINI (ITALY) – VICE-CHAIR
ONDREJ BABEK (CZECH REPUBLIC)
R. THOMAS BECKER (GERMANY)
RAIMUND FEIST (FRANCE)
YURI GATOVSKY (RUSSIA)
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SVETLANA NIKOLAEVA (RUSSIA)
D. JEFFREY OVER (USA)
WENKUN QIE (CHINA)
EDDY POTY (BELGIUM)
CIRILLE PRESTIANNI (BELGIUM)
BARRY RICHARDS (CANADA)
CLAUDIA SPALLETTA (ITALY)

ANNUAL REPORT 2022

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

Subcommission on Silurian Stratigraphy (ISSS)

Submitted by:

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2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

Mission statement
The objectives of the Subcommission relate to three main aspects of IUGS policy:
1. The development of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs at Series and Stage levels and related to a hierarchy of units (Substages, Standard Zones, Subzones etc.) to maximize relative time resolution within the Silurian Period;
2. Establishment of frameworks and mechanisms to encourage international collaboration in understanding the evolution of the Earth during the Silurian Period;
3. Working towards an international policy concerning conservation of geologically important sites (such as GSSPs, global and regional stratotype sections, *etc*.).

Goals
- Rationalization of Global chronostratigraphical classification
- Intercalibration of fossil biostratigraphies, integrated zonations, and recognition of global datums
- Establishment of magneto- and chemo-stratigraphic scales
- Redefinition of stage boundaries and restudy of global boundary stratotype sections
- Correlation of Silurian rock successions and events, including marine and non-marine
- Application of astronomically tuned cyclostratigraphy integrated with radiometric data and biostratigraphy

3. ORGANISATION - interface with other international projects / groups

Organisation
The ISSS is a Subcommission of the International Commission on Stratigraphy. The Subcommission is organized by an Executive consisting of Chairman, Vice-Chairman and

Secretary, who are all Voting Members of the Subcommission. In the Subcommission elected for 2020-2024 there are twelve other Voting Members. One member was suspended in accord with IUGS policy about Russian aggression against Ukraine. Broad network of Corresponding Members has first of all a responsibility for communication in both directions between the Subcommission and researchers on Silurian topics in their region. Secondly, they represent a broad spectrum of specialized stratigraphical disciplines from those countries or regions where Silurian rocks are extensively studied in relation to fundamental and/or applied geological research.

Current research activities and future plans are communicated through publication of the annual ISSS newsletter, *Silurian Times*, distributed as an email attachment and a web release. Website: http://silurian.stratigraphy.org/ is currently under long time overdue reorganisation.

Interface with other international projects / groups

Collaboration will be developed with stratigraphically neighbouring subcommissions on Ordovician (ISOS) and Devonian (SDS) stratigraphy depending on subsequent revival of international meetings and conferences.

3a. Current Officers for 2020-2024 period:
Chair: **Petr Štorch** (second term)
Vice-Chair: **Carlo Corradini** (second term)
Secretary: **David Ray** (first term)
Webperson: **Huang Bing** (first term)

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

National/regional support has been provided to active members of Aeronian, Telychian and Wenlock GSSP working groups to facilitate their work.

5. CHIEF ACCOMPLISHMENTS IN 2022 (including any publications arising from ICS working groups)

- 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 print.
- 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 Weirdt, 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.*

6. SUMMARY OF EXPENDITURE IN 2022:

Expenditures	0
Total	US$ 0

7. SUMMARY OF INCOME IN 2021:

Carried forward from 2022	US$ 3,500
ICS Allocation	US$ 0
Total	US$ 3,500
Balance (carried forward from 2022)	US$ 3,500

8. BUDGET REQUESTED FROM ICS IN 2023

Requested ICS Allocation	0

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

- 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 Subcommission 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*.

Potential funding sources external to IUGS

Most of the costs of preparing Silurian Times and research activities of the working groups will be met by local support from host institutions and participation by individuals through national research grants and travel grants from their own authorities. Minor expenses may be covered from budget carried forward from 2022.

10. OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020-2024

- 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 early 2023 to be discussed by the ISSS business meeting in July 2023. New stratotypes will be chosen by means of subsequent online ballot. 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.
- ISSS bi-annual business meeting and thematic session "New stratigraphic insights into the Silurian story" is planned at 4th STRATI congress in Lille, France for July 2023.
- Homerian working group will be established and restudy of the Homerian GSSP will join the program, along with further search for sections suitable for new GSSP of the Wenlock Series. One promising section was recently found in Prague-Malá Chuchle.
- Subdivision of the Přídolí Series into two stages will be reconsidered in response to published proposal by Manda *et al.* (currently in press).
- 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.

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

Nominated officers

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Leader **Petr Štorch**

Base of Telychian GSSP Restudy Working Group
Leader **Michael J. Melchin**

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Leader **David K. Loydell**

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ANNUAL REPORT 2022 (prepared by T. Servais & B. Lefebvre)

1. TITLE OF CONSTITUENT BODY

Subcommission on Ordovician Stratigraphy (SOS)

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2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

The Subcommission promotes international cooperation on all aspects of Ordovician geology, specifically stratigraphy. Its global network involves academia, government institutions and industry.

Specific objectives are:
a. To delimit and subdivide the Ordovician System (and Period) as a part of the overall ICS mission to elaborate the standard global stratigraphic scale. This work aims to establish boundaries (GSSPs and ASSPs), correlation of major subdivisions (Stages and Series) globally and regionally, and to periodically review the effectiveness and utility of these decisions.
b. To promote regular international meetings on all aspects of Ordovician geology, especially those devoted to clarifying stratigraphic procedures, nomenclature and methods for use in establishing a unified global time scale and to prepare correlation charts with explanatory notes (the main phase of this latter task is now completed).
c. To encourage, promote, and support research on all aspects of Ordovician geology worldwide and to provide outlets, including an annual newsletter (*Ordovician News*), international meetings, and a web page, for promoting discussions and reporting results of this research.
d. To encourage, promote, and support interdisciplinary research on the Ordovician global Earth system, addressing topics that require high-resolution, global correlation.
d. The ultimate goal of the Subcommission is to provide a high-resolution geological time scale that will be a critical foundation for interdisciplinary research on the global Earth system during the Ordovician Period. The work is broadly based and must include specialists in palaeontology, all subdisciplines of stratigraphy (bio-, litho-, chemo-, and magneto-), sedimentology, geochemistry, and tectonics. With a large network including active participants from more than 25 countries, the Subcommission thus involves much of the global geological community.

3. ORGANISATION - interface with other international projects / groups

Since mid-2020, the Subcommission on Ordovician Stratigraphy (SOS) comprises an Executive (Chair, Vice-Chair and Secretary), plus 17 other Voting Members (and >300 Corresponding Members). Since 2021, the Subcommission Executive includes, for the first time, a female member, appointed by the Chair, as Internet Officer.
The Subcommission includes a broad national representation and coverage of key fossil groups as well as specialists in interdisciplinary fields such as geochemistry, sequence stratigraphy and sedimentology.

The Subcommission on Ordovician Stratigraphy closely cooperates with the IGCP 735 project "Rocks 'n' ROL (Filling knowledge gaps in the Early Palaeozoic Biodiversification" (2021–2025). The co-leaders of IGCP 735 include four Voting Members of the SOS. The second Annual Meeting of IGCP 735 was held in Marrakesh, Morocco, in coordination and collaboration with the Ordovician Subcommission.

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

Other than time allowed by employers of the Executive and Voting Members to carry out their duties and attend conferences, the Subcommission receives no support from sources other than IUGS.

5. CHIEF ACCOMPLISHMENTS IN 2022

- 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 organization of the meeting in 2023 is unlikely, and no budget has been foreseen)

- In accordance with ICS Rules, 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, online meetings are organized. The second online business meeting was organized 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" organized jointly as a videoconference congress in Lille (France) on September 13th-16th 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 (October, 21st–24th 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/).

6. SUMMARY OF EXPENDITURE IN 2022:

(all figures in USD, totals rounded due to exchange rates)

a) T. Servais' (Chair) expenses (transport by car, accommodation & food: US$ 730) in meeting B. Lefebvre (Secretary) at Lyon University, France, May 9–11, 2022, to discuss Subcommission duties and the *Geobios* special issue (organization).

b) T. Servais (Chair) expenses (transport by train, accommodation & food: US$ 750) and B. Lefebvre (Secretary) expenses (transport by train, accommodation & food: US$ 750) to participate to editorial meeting with D.A.T. Harper (former Chair) and I.G. Percival (former Secretary) at the Geological Society of London, UK, May 23–24.

c) T. Servais' (Chair) expenses (transport train, accommodation & food: US$ 750) in meeting B. Lefebvre (Secretary) at Lyon University, France, September 5–8, 2022, to discuss Subcommission duties and *Geobios* special issue (meeting editor-in-chief).

d) T. Servais (Chair) expenses (transport flight, accommodation & food: US$ 1000), B. Lefebvre (Secretary) expenses (transport flight, accommodation & food: US$ 1200) and A. Stigall's (Internet Officer) expenses (transport flight, train, accommodation & food: US$ 1200) to attend the 2nd Annual Meeting of IGCP 735 at Marrakesh University, Morocco, October 19 – 20, 2022.

7. SUMMARY OF INCOME IN 2022: same as next item (ICS was the sole source of income)

8. BUDGET RECEIVED FROM ICS IN 2022:
USD 6500

9. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2023):

- After previous meetings in Lisbon, Portugal (2013), Graz, Austria (2015), and Milan, Italy (2019), Thomas Servais (Chair) will be organizing 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 (July 11–13, 2023). The field excursion to the Ordovician of Estonia (July 15–18, 2023) is co-organized 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 (July 19–21, 2023), including field excursions to the Ordovician of Estonia (July 15–18, 2023) and Sweden (July 23–26, 2023).
- Data will be gathered for *Ordovician News* 40 (to be published in March 2023).

10. KEY OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020–2024

For further advancement and increased precision in correlation we need to focus on regional stratigraphy, regional scales and regional chronostratigraphic schemes. We recognise that many biotic, chemical and physical changes are not always synchronous, and that local and regional signals may vary from trends evident in global compilations. This is especially true for the Ordovician, where strong provincialism can mask biostratigraphic-based correlation. Ordovician regional stratigraphy and geology will therefore be the main goal for the period 2020-2024.

- To compile and publish an updated summary on Ordovician regional stratigraphy and geology: *A Global Synthesis of the Ordovician System*. Special attention is paid to precise correlation of the Ordovician depositional sequences and sea-level curves as well as stable isotope and regional biodiversity curves. This project was launched in 2021, and manuscripts were deposited in 2022. Two volumes (*Geological Society of London, Special Publications*), with ~600-800 pages, were compiled during 2022 and will be published in 2023. The realisation of this publication, originally initiated over ten years ago, considers the major objective of the Subcommission (2020-2024). The presentation of the volumes is scheduled at ISOS14 in Tallinn, July 2023.
- To better correlate Ordovician depositional sequences throughout the World.

- To design and execute a program of radiogenic dating of key Ordovician horizons (using Pb-Pb isotopes and CA-IDTIMS dating of zircons).
- The Ordovician website will be updated including development of a database for GSSPs and ASSPs.

11. Budget and ICS component requested for 2023 (all figures in USD)
1. Support for B. Lefebvre (Secretary) to attend Strati 2023 in Lille, France, July 2023: **$1200**
2. Support for A. Stigall (Internet Officer) to attend Strati 2023 in Lille, France, July 2023: **$1500**
3. Support for T. Servais (Chair) to attend ISOS14 and IGCP 735 Annual Meeting in Tallinn, Estonia, July 2023: **$1200**
4. Support for B. Lefebvre (Secretary) to attend ISOS14 and IGCP 735 Annual Meeting in Tallinn, Estonia, July 2023: **$1200**
5. Support for A. Stigall (Internet Officer) to attend ISOS14 and IGCP 735 Annual Meeting in Tallinn, Estonia, July 2023: **$1500**
6. Support for T. Servais (Chair) to SOS business meeting in Lyon, France, September 2023: **$800**

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

TOTAL 2023 BUDGET: 7400 USD
REQUESTED FROM ICS: **7400 USD**
Potential funding sources outside IUGS: None.
Subcommission officers are mainly supported by their research projects for most of their activities.

APPENDIX –Current Executive Officers and Voting Members (2020-2024) & contact details

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International Commission on Stratigraphy

Subcommission on Cambrian Stratigraphy

ANNUAL REPORT 2022

1. TITLE OF CONSTITUENT BODY

International Subcommission on Cambrian Stratigraphy

Prepared by: Prof. Per AHLBERG, Chair, per.ahlberg@geol.lu.se

Date: 27 November 2022

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY

2.a. Mission Statement

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

2.b. Goals

The two principal goals of the Subcommission are:
1) To develop a global stage-level and series-level chronostratigraphic classification of the Cambrian System.
2) To complete and publish regional and global correlation charts for the Cambrian System.

2.c. Fit within IUGS Science Policy

The objectives of the Subcommission fall within three main areas of IUGS policy:
1) The development of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs where appropriate (stages and series), and related to a hierarchy of units (zones) to maximize relative time resolution within the Cambrian Period.
2) Establishment of frameworks and systems to encourage international collaboration in understanding the evolution of the Earth during the Cambrian Period.
3) Working towards an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs and Fossil-Lagerstätten.

3. ORGANISATION

3.a. Interface with other international projects/groups

The Cambrian Subcommission is involved jointly with the Ordovician Subcommission in *IGCP Project 653: The onset of the Great Ordovician Biodiversification Event*.

The Cambrian Subcommission is working jointly with the Ediacaran Subcommission on restudy of the Cambrian base. Members of both subcommissions comprise the membership of the Terreneuvian/Fortunian Working Group. During recent years, for

instance in 2017 and 2019, joint meetings of the Ediacaran and Cambrian subcommissions have been organized.

3.b. Officers for 2020–mid 2022

Chair: Per Ahlberg (Sweden) per.ahlberg@geol.lu.se
Vice-Chair: Maoyan Zhu (China) myzhu@nigpas.ac.cn
Secretary: Anna Żylińska (Poland) anna.zylinska@uw.edu.pl
Webperson: Michael Streng (Uppsala, Sweden) michael.streng@geo.uu.se

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

N/A

5. CHIEF ACCOMPLISHMENTS AND ACTIVITIES IN 2022

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.

6. SUMMARY OF EXPENDITURE IN 2022

Since this has been yet another exceptional year because of the dissolution of the Subcommission, we had to cancel all activities, including an Annual meeting. For the same reason, and of

course because the war in Ukraine, we also had to postpone a planned Cambrian field conference in Siberia. This implies that the expenditures for 2022 is zero dollars.	$ 00.00
SUBTOTAL 2022 expenditures	$ 00.00
To be carried forward to 2023	$ 6000.00

7. SUMMARY OF INCOME IN 2022

Carried forward from 2021	$ 6000.00
ICS Allocation	$ 2000.00
SUBTOTAL 2022 income	$ 8000.00

8. BUDGET REQUESTS FROM ICS IN 2023

Since it has been an exceptional year and we had to cancel all activities, including an Annual meeting, a considerable amount of money is left from 2022, and the budget request for 2023 is therefore modest (USD 2500). The covid-19 pandemic is more or less over and we plan to hold an Annual meeting at Palaeo Down Under 3 in Perth, Australia. In addition, a Cambrian session will be held at the STRATI 2023 conference in Lille, France.

The money carried forward from 2022 will largely be saved for future Cambrian field conferences, either in China or Siberia, depending on the world situation. At these field meetings, we will have the opportunity to examine and discuss stratigraphic issues surrounding the remaining undefined stages and the base of the Cambrian GSSP.

PLANNED EXPENDITURES FOR 2023	
Annual meeting in Perth, Australia, and participation at STRATI 2023 in Lille, France	$ 2500.00
TOTAL 2023 PLANNED EXPENSES	$ 2500.00
ICS 2023 BUDGET REQUEST	$ 2500.00

9. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2023)

In 2023 the Cambrian Subcommission will continue work toward defining GSSPs for its remaining provisional stages.

- Arrival at a decision on how to define Stage 10 in 2023; then to arrive at decisions on stages 2, 3, and 4 in subsequent years.
- Continue examining issues surrounding definition of the Cambrian GSSP.

10. KEY OBJECTIVES AND WORK PLAN FOR THE NEXT FOUR YEARS (2023–2027)

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 prioritized plan for formalizing 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 2023–2024.
- Following a decision on Stage 10, provisional stages 2, 3, and 4, are expected to be defined in a fairly 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.

APPENDIX

Subcommission officers (2020–mid 2022)

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List of Voting Members (including officers) for 2020–mid 2022

Since several of the Voting Members have served for more than three terms (12 years), a number of replacements will be made by the new executive in 2023.

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7. Gerd Geyer, Bayerische Julius-Maximilians-Universität, Lehrstuhl für Geodynamik und Geomaterialforschung Am Hubland, D - 97074 Würzburg, Germany; Tel. +49-931-31-85415; gerd.geyer@uni-wuerzburg.de

8. Rodolfo Gozalo, Valencia, Dept. Botánica y Geología Universitat de Valencia, C/ Dr. Moliner 50, E-46100-Burjassot, Spain; Tel. +3) 963544398; rodolfo.gozalo@uv.es
9. Peter ('Pierre') D. Kruse, South Australian Museum, Adelaide, SA, 5000, Australia; archaeo.kruse@gmail.com
10. Malgorzata Moczydlowska-Vidal, Department of Earth Sciences, Palaeobiology, Uppsala University, Villavägen 16, SE 752 36 Uppsala, Sweden; Tel. + 46 18-471 2743; malgo.vidal@pal.uu.se
11. Elena B. Naimark, Borissiak Paleontological Institute of the Russian Academy of Sciences, Profsoyuznaya 123, Moscow 117997, Russia; naimark@paleo.ru
12. Shanchi Peng, State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road Nanjing 210008, China; scpeng@nigpas.ac.cn
13. Tae-Yoon S. Park, Division of Polar Earth-System Sciences, Korea Polar Research Institute, 26 Songdomirae-ro Yeonsu-gu, Incheon 21990, Republic of Korea; typark@kopri.re.kr
14. Pavel Yu. Parkhaev, Borissiak Paleontological Institute, Russian Academy of Sciences, Profsoyuznaya 123 Moscow 117647 Russia; Tel. +7 495 339 2055; pparkh@paleo.ru
15. John R. Paterson, School of Environmental & Rural Science, University of New England, Armidale NSW 2351, Australia; Tel. +61-2-6773 2101; jpater20@une.edu.au
16. Brian R. Pratt, Department of Geological Sciences, University of Saskatchewan, Saskatoon, SK S7N 5E2, Canada; Tel. (306) 966-5725; brian.pratt@usask.ca
17. Matthew R. Saltzman, School of Earth Sciences, 275 Mendenhall Lab, 125 South Oval Mall, Columbus, OH 43210-1398, USA; Tel. 6142920481; saltzman.11@osu.edu
18. Christian Skovsted, Swedish Museum of Natural History, Department of Palaeobiology, SE-104 05 Stockholm, Sweden; Tel. +46 8-519 551 33; christian.skovsted@nrm.se
19. Michael Steiner, Institut für Geologische Wissenschaften, FU Berlin, Malteserstraße 74-100, Haus D, 12249 Berlin, Germany; Tel. +49 30 838 70272; michael.steiner@FU-Berlin.de
20. Alexey I. Varlamov, Federal State Unitary Enterprise «All-Russian Research Geological Oil Institute», 105118, shosse Entuziastov, 36, Moscow, Russia; varlamov@vnigni.ru, info@vnigni.ru
21. Mark Webster, Department of the Geophysical Sciences, University of Chicago, 5734 South Ellis Avenue, Chicago, IL 60637, USA; mwebster@geosci.uchicago.edu
22. Xingliang Zhang, Shaanxi Key Laboratory of Early Life and Environment, State Key Laboratory of Continental Dynamics, and Department of Geology, Northwest University, Xian 710069, China; xzhang69@nwu.edu.cn
23. Maoyan Zhu, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing, 210008, China); Tel. 0086-25-83282159; myzhu@nigpas.ac.cn
24. Anna Żylińska, Department of Historical Geology, Regional Geology and Palaeontology, Faculty of Geology, University of Warsaw, Żwirki i Wigury 93, PL-02-089 Warszawa, Poland; Tel. +48 225540448, +48 5011828678 (mobile); anna.zylinska@uw.edu.pl

List of Working (Task) Groups and their officers

1. WG on Stage 10 GSSP, chaired by Per Ahlberg, Department of Geology, Sölvegatan 12, SE-223 62 Lund, Sweden; Tel. +46 46 2227870, +4679 532 92 09 (mobile); per.ahlberg@geol.lu.se
2. WG on Stage 4 GSSP, chaired by James B. Jago, School of Natural and Built Environments, University of South Australia, Mawson Lakes, SA, 5095, Australia; Jim.Jago@unisa.edu.au

3. WG on Stage 3 GSSP, chaired by Xingliang Zhang, Shaanxi Key Laboratory of Early Life and Environment, State Key Laboratory of Continental Dynamics, and Department of Geology, Northwest University, Xian 710069, China; xzhang69@nwu.edu.cn
4. WG on Stage 2 GSSP, chaired by Michael Steiner, Institut für Geologische Wissenschaften, FU Berlin, Malteserstraße 74-100, Haus D, 12249 Berlin, Germany; Tel. +49 30 838 70272; michael.steiner@FU-Berlin.de
5. Cambrian GSSP, chaired by Zhu Maoyan, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing, 210008, China); Tel. 0086-25-83282159; myzhu@nigpas.ac.cn

International Commission on Stratigraphy

Subcommission on Ediacaran Stratigraphy

ANNUAL REPORT 2022

1. TITLE OF CONSTITUENT BODY

Subcommission on Ediacaran Stratigraphy

Submitted by:

Dr. Marc Laflamme, Chairman, (Associate Professor, Department of Chemical and Physical Sciences, University of Toronto Mississauga, 3359 Mississauga Road, Mississauga, ON L5L 1C6, Canada; marc.laflamme@utoronto.ca)

Dr. James D. Schiffbauer, Vice Chairman, (Associate Professor, Department of Geological Sciences and Director, X-ray Microanalysis Core, University of Missouri, 101 Geological Sciences Building, University of Missouri, Columbia MO 65211, USA; schiffbauerj@missouri.edu)

Dr. Lucas Veríssimo Warren, Secretary, (Assistant Professor, Department of Applied Geology, São Paulo State University, Rua Quirino de Andrade 215, Sao Paulo, 01049-010, Brazil; lucas.warren@unesp.br)

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Mission statement: The Subcommission is the primary body for facilitation of international communication and scientific cooperation in Ediacaran stratigraphy, defined in the broad sense of multidisciplinary activities directed towards better understanding of the evolution of the Earth and life during the Ediacaran Period (circa 635 – 541 Ma). Its first priority is the unambiguous definition, by means of agreed GSSPs, of a hierarchy of chronostratigraphic units that provide the framework for global correlation.

Goals: The main goals of this Subcommission are: **(a)** to search for criteria useful in the subdivision and correlation of Ediacaran strata; **(b)** to define the basal boundaries of Ediacaran epochs (series) and ages (stages) through the establishment of global stratotype sections and points (GSSP's); and **(c)** to facilitate international collaboration in research on Ediacaran stratigraphy and Earth history through subcommission sponsored field trips, workshops, and meetings. In addition, the Subcommission is committed to further communication with a wider public through grassroots initiatives to conserve important Neoproterozoic geological sites, to support International Geoscience Program projects, and to encourage the wider dissemination of research findings on the internet or in popular science publications.

Fit within IUGS Science Policy: The objectives of the Subcommission relate to three main aspects of IUGS policy: **(a)** the development of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs where appropriate (Series and Stages), and related to a hierarchy of units (Standard Zones, Subzones etc.) to maximize relative time resolution within the Ediacaran Period; **(b)** the establishment of frameworks and systems to encourage international collaboration in understanding the evolution of the Earth during the late Neoproterozoic interval, in particular, cooperating with the **Cryogenian Subcommission (Graham Shields-Zhou, chair) and the Cambrian Subcommission (Per Ahlberg, chair)** to

subdivide the late Precambrian to Early Cambrian transition; and **(c)** working towards an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs and important fossil localities. These relate to, *inter alia*, the IUGS Geosites Program.

3. ORGANIZATION – Interfaces with other international project

Members of the Ediacaran Subcommission are lead investigators and officers in a number of related international projects:

- ICDP GRIND-ECT (***G**eological **R**esearch through **I**ntegrated **N**eoproterozoic **D**rilling: **E**diacaran-**C**ambrian **T**ransition;* https://www.icdp-online.org/projects/world/global-coverage/grind-ect/details/) led by Anthony R. Prave (Univ. of St. Andrews), Kristin Bergmann (MIT), Simone Antonia Kasemann (Univ. of Bremen), Francis A. MacDonald (UC Santa Barbara), Catherine Victoria Rose (Univ. of St. Andrews), Garneth Shamaila (Geological Survey Of Namibia), Ricardo Ivan Ferreira Da Trindade (Universidade De Sao Paulo), and Maoyan Zhu (Chinese Academy Of Sciences)
- Interactions with ICS Subcommission on Cambrian Stratigraphy and ICS Subcommission on Cryogenian Stratigraphy: Several members (**S. Xiao, M. Zhu, C. Zhou**, **M. Laflamme**, and others) are also active members of the ICS Subcommission on Cambrian Stratigraphy and/or ICS Subcommission on Cryogenian Stratigraphy.

3a. Current Officers for 2020-2024:

Chair: Marc Laflamme (University of Toronto Mississauga)
Vice-Chair: James D. Schiffbauer (University of Missouri)
Secretary: Lucas Warren (Universidade de Sao Paulo)

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

none.

5. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2020 (bullet point each significant achievement, limited to three maximum)

Due to the impact of the COVID19 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.
- 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 paleontology 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.

6. SUMMARY OF EXPENDITURE IN 2022:
EXPENDITURES - none

7. SUMMARY OF INCOME IN 2021:

INCOME (note previous numbers were mistakenly shown as US vs. CDN dollars)

Forwarded from 2021	CDN$ 5,725.82
Additional funds 2021	CDN$ 5,266.26
Total	CDN$ 10,992.08
Forwarding 2022	CDN$ 10,992.08*

8. BUDGET REQUESTED FROM ICS IN 2022

The Subcommission plans to have a field workshop to examine terminal Ediacaran successions in Brazil and Argentina, tentatively scheduled for July-August, 2023. The Ediacaran Subcommission plans to provide $1,500 to sponsor this field workshop and to assist early career scientists to participate in this field workshop. Additionally, we would like to request $3,000 to partially cover the travel costs of voting members who need financial assistance. We understand we have a large carry-over from the previous two years of CODVID inactivity, however the expected expenses for the trip are expected to rise significantly.

PROJECTED EXPENSES	
Brazil/Argentina field workshop sponsorship	CDN$ 1500
Brazil/Argentina field workshop (voting member travel costs)	CDN$ 3000
Website	CDN$ 150
Total	CDN$ 4650

PROJECTED INCOME:

Carried over from 2021	CDN$ 10,992.08
BUDGET REQUEST	**CDN$ 4650**

9. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (bullet point each key achievement anticipated, limited to three maximum)

1. 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 organized and led by Subcommission Secretary Lucas Warren and his colleagues in Brazil and Argentina. The field guide is attached (**Appendix**).
2. 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.
3. Construction of a database of all known end-Ediacaran sections worldwide. This includes fact-finding searches concerning the geology, geochemistry, and paleontology of each section. This is currently underway and continues as new data arises and will be instrumental to the "white paper" listed above.

9a. Potential funding sources external to IUGS:

None at the moment. We will be engaging in fundraising in the upcoming year.

10. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEAR (2020–2024)

- Subcommission annual newsletter will be distributed in January 2023. Secretary Dr. Lucas Warren will be leading the effort to compile and edit the annual 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-July, 2023 (**Appendix Attachment 2**).

- 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 finalize the discussion on TES by 2023 (previously 2020).

APPENDICES

Nominated Officers for 2020-2024:

The Subcommission is organized by an Executive consisting of Chairman, Vice-Chairman, and Secretary, who are all Voting Members of the Subcommission. These officers were nominated by the Executive of the predecessor Neoproterozoic Subcommission and appointed by ICS executives in August 2012. In 2015, they were re-elected by Subcommission voting members to serve a second term in 2016-2020. In 2020, we elected a new Executive as follows:

Dr. Marc Laflamme, Chairman, (Associate Professor, Department of Chemical and Physical Sciences, University of Toronto Mississauga, 3359 Mississauga Road, Mississauga, ON L5L 1C6, Canada; marc.laflamme@utoronto.ca)

Dr. James D. Schiffbauer, Vice Chairman, (Associate Professor, Department of Geological Sciences and Director, X-ray Microanalysis Core, University of Missouri, 101 Geological Sciences Building, University of Missouri, Columbia MO 65211, USA; schiffbauerj@missouri.edu)

Dr. Lucas Veríssimo Warren, Secretary, (Assistant Professor, Department of Applied Geology, São Paulo State University, Rua Quirino de Andrade 215, Sao Paulo, 01049-010, Brazil; lucas.warren@unesp.br)

List of Voting Members

There are currently 19 voting members and over 30 corresponding members. The Voting Members were specifically selected for their international reputations, recognized expertise in an area of geoscience relevant to the subcommission, and their willingness to take an active role in the Subcommission's activities. In October 2016, five new voting members were nominated and voted by the incumbent voting members, and were approved by the Executives to replace five incumbent voting members.

Voting members serving 2016-2020:

Name	Email	Institution
Alvaro, Jose-Javier	alvarobjj@cab.inta-csic.es	Centre of Astrobiology, Spain
Christie-Blick, Nicholas	ncb@ldeo.columbia.edu	Columbia University, New York, USA
Gehling, James G.	Jim.Gehling@samuseum.sa.gov.au	South Australian Museum, Australia
Grazhdankin, Dmitri V.	dima.grazhdankin@gmail.com	Novosibirsk, Russia
Jiang, Ganqing	ganqing.jiang@unlv.edu	University of Nevada Las Vegas, USA
Kaufman, Alan Jay	kaufman@geol.umd.edu	Maryland, USA
Laflamme, Marc	marc.laflamme@utoronto.ca	U of Toronto at Mississauga, Canada
Liu, Alexander	alex.liu@bristol.ac.uk	University of Cambridge, UK
Liu, Pengju	pengju@cags.ac.cn	Chinese Academy of Geological Sciences, Beijing, China
Moczydlowska-Vidal, Malgorzata	malgo.vidal@pal.uu.se	Uppsala, Sweden
Narbonne, Guy M.	narbonne@queensu.ca	Queens, Kingston, Canada
Schiffbauer, James D.	schiffbauerj@missouri.edu	University of Missouri, USA
Sharma, Mukund	mukund_sharma@bsip.res.in	Birbal Sahni Institute of Palaeosciences, Lucknow, India
Shields-Zhou, Graham A.	g.shields@ucl.ac.uk	University College London, UK
Wood, Rachel	Rachel.Wood@ed.ac.uk	University of Edinburgh, Edinburgh, UK
Xiao, Shuhai	xiao@vt.edu	Virginia Tech, USA
Yuan, Xunlai	xlyuan@nigpas.ac.cn	Nanjing, China
Zhou, Chuanming	cmzhou@nigpas.ac.cn	Nanjing, China
Zhu, Maoyan	zhumaoyan@gmail.com	Nanjing, China

Voting members serving 2020-2024: **New voting members**.

Name	Email	Institution
Buatois, Luis	luis.buatois@usask.ca	University of Saskatchewan
Chuanming, Zhou	cmzhou@nigpas.ac.cn	Chinese Academy of Sciences
Droser, Mary	droser@ucr.edu	University of California Riverside
Grazhdankin, Dimitry	dima.grazhdankin@gmail.com	A.A. Trofimuk Institute of Petroleum Geology and Geophysics SB RAS
Kaufman, Alan Jay	kaufman@umd.edu	University of Maryland
Laflamme, Marc	marc.laflamme@utoronto.ca	University of Toronto
Liu, Alex	agscl2@cam.ac.uk	University of Cambridge
Moczydlowska-Vidal, Malgorzata	malgo.vidal@pal.uu.se	Uppsala University
Mukund, Sharma	mukund_sharma@bsip.res.in	Birbal Sahni Institute of Palaeosciences
Narbonne, Guy	narbonne@geol.queensu.ca	Queens University
Pengju, Liu	pengjul@sina.com; pengju@cags.ac.cn	Chinese Academy of Geological Sciences
Pruss, Sara	spruss@smith.edu	Smith College
Schiffbauer, James	schiffbauerj@missouri.edu	University of Missouri
Selly, Tara	sellyt@missouri.edu	University of Missouri
Strauss, Justin	Justin.V.Strauss@dartmouth.edu	Dartmouth College

Tostevin, Rosalie	rosalie.tostevin@uct.ac.za	University of Cape Town
Warren, Lucas	lucas.warren@unesp.br	São Paulo State University
Wood, Rachel	rachel.wood@ed.ac.uk	The University of Edinburgh
Xiao, Shuhai	xiao@vt.edu	Virgina Tech
Yuan, Xunlai	xlyuan@nigpas.ac.cn	Nanging Institute of Geology and Paleontology
Zhu, Maoyan	zhumaoyan@gmail.com myzhu@nigpas.ac.cn	Nanging Institute of Geology and Paleontology

Working group leaders and corresponding members – note that these working group leaders and corresponding members will be changed this year.

- SES (Second Ediacaran Stage) working group: chaired by Chuanming Zhou (Chair) to focus on the Second Stage of the Ediacaran System.
- TES (Terminal Ediacaran Stage) working group: led by Guy Narbonne (Chair) and Malgorzata Moczydlowska-Vidal (secretary) to focus on the Terminal Stage of the Ediacaran System.
- UESr (Upper Ediacaran Series) working group: led by Alan Jay Kaufman (Chair) and James D. Schiffbauer (co-Chair) and to focus on the Upper Ediacaran Series.
- Task Group to investigate the Ediacaran-Cambrian boundary, led by voting member Dr. Maoyan Zhu.

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

• Antcliffe Jonathan	University of Lausanne, Switzerland
• Boggiani, Paulo César	São Paulo, Brazil
• Butterfield, Nicholas	Cambridge, UK
• do Carmo, Dermval	University of Brasilia, Brazil
• Chen, Xiaohong	Wuhan
• Chumakov, Nikolay	Moscow, Russia
• Dermeval Aparecido Do Carmo	Brazil
• Erwin, Douglas	Smithsonian NMNH, USA
• Dunn, Frankie	Oxford University, UK
• Erdtmann, Bernd-D.	Germany
• Evans, David A.D.	Yale University, USA
• Fedonkin, Mikhail	Moscow, Russia
• Frimmel, Hartwig	Wuerzburg, Germany
• Gaucher, Claudio	Montevideo, Uruguay
• Hoffmann, Karl-Heinz	Windhoek, Namibia
• Hofmann, Mandy	Germany
• Jenkins, Richard	Adelaide, Australia
• Kenchington, Charlotte	Oxford University, UK
• Knoll, Andrew H.	Harvard University, USA
• Kochnev, Boris	Novosibirsk, Russia
• Leme, Juliana de M.	University of San Paolo, Brazil

• Linnemann, Ulf	Dresden, Germany
• Melezhik, Victor	Norway
• Nagovitsin, Konstantin	Novosibirsk, Russia
• Patricia Vickers-Rich	Monash University, Australia
• Pokrovskii, Boris G.	Russia
• Rainbird, Robert	Ottawa, Canada
• Semikhatov, Mikhail A.	Moscow Russia
• Sergeev, Volodya	Russia
• Smith, Emily	USA
• Sun, Weiguo	Nanjing, China
• Van Kranendonk, Martin	University of New South Wales
• Walde, Detef	Universidade de Brasília
• Walter, Malcolm	Sydney, Australia
• Wang, Xiaofeng	Wuhan

Attachments:

1. 2020 Field Workshop on the Ediacaran System in Brazil and Argentina: Preliminary program and field guide: https://sites.google.com/unesp.br/south-american-ediacaran-field/home. Also see attached PDF.
2. Template for database table (Namibian example provided).

International Commission on Stratigraphy
Subcommission on Cryogenian Stratigraphy

ANNUAL REPORT 2022

1. TITLE OF CONSTITUENT BODY

Subcommission on Cryogenian Stratigraphy

Submitted by:
Maoyan Zhu, Chair
Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, China; myzhu@nigpas.ac.cn
Carol Dehler, Vice-Chair
Department of Geology, Utah State University, USA; Carol.Dehler@usu.edu
Ying Zhou, Secretary
Department of Earth Sciences, University College London, UK; y-zhou@ucl.ac.uk

2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

Mission statement

The Subcommission is the primary body for facilitation of international communication and scientific cooperation in Cryogenian stratigraphy directed at better understanding Earth system evolution during the Cryogenian Period (c.720 – c.635 Ma). Its priority is the unambiguous definition, by means of global stratotype section and points (GSSP), of a hierarchy of chronostratigraphic units that provide the framework for correlation of Cryogenian strata.

Goals

The main goals of this Subcommission are:

- To establish for the first time a rock-based GSSP for the base of the Cryogenian that will also serve as the top of the underlying Tonian.
- To identify criteria useful in the subdivision and correlation of Cryogenian (and upper Tonian) strata.
- To define the basal boundaries of Cryogenian epochs (series) and ages (stages) through the establishment of GSSPs.
- To facilitate international collaboration in research on Cryogenian stratigraphy and Earth history through subcommission sponsored field trips, workshops, and meetings.

In addition, the Subcommission is committed to expanding communication to a wider public through grassroots initiatives to conserve important Neoproterozoic geological sites, to support

International Geoscience Programme projects, and to encourage the wider dissemination of research findings on the internet, in popular science publications, and through public lectures.

Fit within IUGS Science Policy
The objectives of the Subcommission relate to three main aspects of IUGS policy:

- The development of an internationally agreed scale of chronostratigraphic units, fully defined by GSSPs where appropriate (Series and Stages), and related to a hierarchy of units (Standard Zones, Subzones etc.) to maximize relative time resolution within the Cryogenian Period;
- The establishment of frameworks and systems to encourage international collaboration in understanding the evolution of the Earth during the middle Neoproterozoic (*c.850-c.635 Ma*), in cooperation with the Precambrian and Ediacaran subcommissions.
- Working towards an international policy concerning conservation of geologically and paleontologically important sites such as GSSPs and important fossil localities. This relates to, *inter alia*, the IUGS Geosites Programme.

3. ORGANISATION - interface with other international projects / groups

Members of the Cryogenian Subcommission are lead investigators and officers in a number of related international projects, including:

- IGCP 648 (*Supercontinent Cycles and Global Dynamics*).
- ICDP project GRIND ECT (*Geological Research through Integrated Neoproterozoic Drilling (GRIND): The Ediacaran-Cambrian Transition (ECT)*).

3a. Current Officers:

- **Chair:** Maoyan Zhu, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, China
- **Vice-Chair:** Carol Dehler, Utah State University, USA
- **Secretary and webmaster:** Ying Zhou, University College London, UK

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

None

5. CHIEF ACCOMPLISHMENTS IN 2022 (including any relevant publications arising from ICS working groups)

The 2022 was a relatively quiet year. As the different covid stage and policies in different countries, and the plans will be delayed and 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.

6. SUMMARY OF EXPENDITURE IN 2022

No travel or fieldtrips were carried out during the COVID-19 pandemic. Planned activities in Scotland, IGC and elsewhere were cancelled / postponed.

7. SUMMARY OF INCOME IN 2022

$3000 from the IUGS, which was transferred from the treasurer (Durham University, UK) to Ying Zhou (Secretary of Cryogenian subcommission). The fund now is in GBP, £2490.90.

8. BUDGET REQUESTED FROM ICS IN 2022

The fund granted by IUGS previously will be carried over from 2021 and 2022. Existing funds will be used to support the postponed for field trips planned for 2023. As no fieldtrip was possible during the last three years, the subcommission plans to have three fieldtrips and one meeting during 2023 to early 2024:

- Starting with a short fieldtrip to Scotland, looking at some sections with key transitional units, possibly in May or June;
- The subcommission will be co-convene the Cryogenian session for STRATI at Lille, July;
- A fieldtrip possibly to Namibia is in planning directly following STRATI;
- A fieldtrip to the Cryogenian section in South China then is planned for later 2023 or early 2024.

Detailed plan please see the budget plan table and session 9. In total, for the 3 field trips and a meeting, we will need 3000+3000+4000+4000+200 = $14,200. The fund we can carry over is $10,500, so we apply another $3,700.

Planned Expenditures and meetings for 2023:

Purpose of expenditure	Planned time	Sum (USD)	Items	Expenditure (USD)
Scotland field meeting	~May, 2023	3000	support ($500 each) up to 6 participants/core team's travel and accommodation for the near field site meeting and the two days fieldtrip	3000
STRATI, Lille	July, 2023	3000	support ($500 each) up to 6 participants/core team's travel and accommodation to attend the meeting in Lille	3000
Namibian field trip	July, 2023	4000	support ($1000 each) up to 4 participants/core team's travel and accommodation of the field trip	4000
China field trip	Later 2023 or early 2024	4000	support ($1000 each) 4 voting members participants/core team's travel and accommodation of the fieldtrip	4000
others		200	bank transfer fees	200

9. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2023):

- Working on and voting for criteria to define **the base of the Cryogenian System** before February 2023.
- Session on **"Earth system evolution during the Tonian – Cryogenian periods"** at the fourth STRATI, at Lille. July 2023.
- Two **subcommission meetings** to discuss criteria and working plan for 2023 and 2024.
- **Field Trips and meetings**. Three field trips/meetings will be organized 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 aim to look at some key transitions on Garbh Eileach in person by at least some of the voting members of the subcommission, aim for discussion on Port Askaig Fm as a GSSP candidate; (2) Utavi, **Namibia field trip**, mid-July, 2023, 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 are proven to be a great way to introduce the up-to-date research of the Tonian/Cryogenian records worldwide, and offer good opportunities for discussion among researchers. Each time, we have up to 50 attenders. The subcommission decides to reactivate the webinar series during 2023, and aim to cover another 2-3 key Cryogenian groups. The webinar series will be organized by Ying Zhou.

10. KEY OBJECTIVES AND WORK PLAN FOR THE PERIOD 2020-2024

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

REFERENCES

Shields et al. (2021) A template for an improved rock-based subdivision of the pre-Cryogenian timescale. Journal of the Geological Society. jgs2020-222.

Lamothe, K.G., Hoffman, P.F., Greenman, J.W. and Halverson, G.P. (2019) Stratigraphy and isotope geochemistry of the pre-Sturtian Ugab Subgroup, Otavi/Swakop Group, northwestern Namibia. Precambrian Research v. 332, 105387.

Shields-Zhou, G.A, Porter, S. and Halverson, G.P. (2016) A new rock-based definition for the Cryogenian Period (circa 720 – 635 Ma). *Episodes* v. 39, no. 1, p. 3-8.

Shields, G.A., Halverson, G.P. & Porter, S.M. eds. (2018) Descent into the Cryogenian, Precambrian Research v. 319, pp. 1-220.

APPENDIX I

The Subcommission is organized by an Executive consisting of Chair, Vice-Chair and Secretary, who are all Voting Members of the Subcommission. There are currently 18 other Voting Members, making a total of 21 voting members. There are also additional corresponding members (cryogenian-subcommission@googlegroups.com).

Current Officers

1) Chair: Maoyan Zhu, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, China; myzhu@nigpas.ac.cn
2) Vice-Chair: Carol Dehler, Department of Geology, Utah State University, USA; Carol.Dehler@usu.edu
3) Secretary: Ying Zhou, Department of Earth Science, University College London, UK; y-zhou@ucl.ac.uk

List of Voting Members

4) Fabricio Caxito, Federal University of Minas Gerais, Brazil. facaxito@yahoo.com.br
5) Ian Fairchild, School of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK; i.j.fairchild@bham.ac.uk
6) Hartwig Frimmel, Institut für Geographie und Geologie, University of Würzburg, Am Hubland 97074 Würzburg, Germany; hartwig.frimmel@uni-wuerzburg.de
7) Galen Halverson, Dept. of Earth & Planetary Sciences, McGill University, 3450 University Street, Montreal, Quebec, H3A 2A7 Canada; galen.halverson@mcgill.ca
8) Karl-Heinz Hoffmann, Geological Survey, Private Bag 13297, Windhoek, Namibia; mkh.hoffmann@iway.na
9) Anton Kuznetsov, Institute of Precambrian Geology and Geochronology, Russian Academy of Sciences (RAS), nab. Makarova, 2, St. Petersburg, 199034 Russia; antonbor9@mail.ru
10) Marc Laflamme, University of Toronto Mississauga, 3359 Mississauga Road, Mississauga, ON, L5L 1C6, Canada. marc.laflamme@utoronto.ca
11) Konstantin Nagovitsin, TIPGG, Russian Academy of Sciences, Novosibirsk, Russia; nagovicinKE@ipgg.sbras.ru
12) Susannah Porter, Department of Earth Science, University of California at Santa Barbara, CA 93106, USA; porter@geol.ucsb.edu
13) Tony Prave, School of Earth & Enviro Sciences, University of St Andrews, Irvine Building, St Andrews, UK; ap13@st-andrews.ac.uk
14) Leigh Anne Riedman, University of California, Santa Barbara, USA; lriedman@ucsb.edu
15) Mukund Sharma, Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow-226 007, Uttar Pradesh, INDIA; sharmamukund1@rediffmail.com
16) Bing Shen, School of Earth and Space Science, Peking University, Beijing 100871, China; bingshen@pku.edu.cn
17) Graham Shields, Department of Earth Sciences, University College London, Gower Street, London WC1E 6BT, United Kingdom; g.shields@ucl.ac.uk
18) Nicholas L. Swanson-Hysell, Earth and Planetary Science Department, University of California, Berkeley, California 94720, USA; swanson-hysell@berkeley.edu
19) Malcolm Wallace, School of Earth Sciences, University of Melbourne, Parkville Vic 3010, Australia; mww@unimelb.edu.au
20) Shihong Zhang, State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Beijing 100083, China; shzhang@cugb.edu.cn
21) Chuanming Zhou, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, No.39 East Beijing Road, Nanjing 210008, China; cmzhou@nigpas.ac.cn

APPENDIX II

Publication lists related to Cryogenian and Tonian stratigraphy and Earth system evolution (will be updated on the website).

Braun C, A Voigt, C Hoose et al., Controls on subtropical cloud reflectivity during a waterbelt scenario for the Cryogenian glaciations. - Journal of Climate, 2022

da Silva MF, EL Dantas, M Matteini, RIF Trindade, Late Tonian explosive volcanism and hyaloclastites in northern Paraguay Belt, Central Brazil: A record of Rodinia break-up in western Gondwana. - Precambrian Research, 2022

Dey S, P Dasgupta, K Das et al, Krol Sandstone-black shale association of the Lesser Himalayan Neoproterozoic succession, Himachal Pradesh, India: An unexplored record of the hothouse aftermath. - Marine and Petroleum Geology, 2022

Fairchild IJ, H Bao, R Windmill, I Boomer, The Marinoan cap carbonate of Svalbard: Syngenetic marine dolomite with 17O- anomalous carbonate‐associated sulphate.- The Depositional Record, 2022

Flowers RM, RA Ketcham et al., Existing thermochronologic data do not constrain Snowball glacial erosion below the Great Unconformities. - PNAS, 2022

Ga T n, G Zhou, T Luo et al., Earliest Ediacaran speleothems and their implications for terrestrial life after the Marinoan snowball Earth. - Precambrian Research, 2022

Griffith HJ s, RJ Whittle, EG Mitchell, Animal survival strategies in Neoproterozoic ice worlds. - Global Change Biology, 2022

Hoffman PF, Glacial erosion on snowball Earth: testing for bias in flux balance, geographic setting, and tectonic regime. - Canadian Journal of Earth Sciences, 2022

Hohl SV, AS Rodler, S Viehmann et al., C, Sr, Nd isotope chemostratigraphy and zircon provenance of the Witvlei Group (Namibia): Neoproterozoic glaciations and seawater evolution. - Precambrian Research, 2022

Hood AS, DE Penman, MA Lechte et al., Neoproterozoic syn‐glacial carbonate precipitation and implications for a snowball Earth. –Geobiology, 2022

Isakson VH, MD Schmitz, CM Dehler et al., A robust age model for the Cryogenian Pocatello Formation of southeastern Idaho (northwestern USA) from tandem in situ and isotope dilution U-Pb dating of volcanic tuffs and epiclastic detrital zircons. Geosphere, 2022

Khan MMSS, M Umar, B Pan et al., A newly discovered Neoproterozoic diamictite-cap carbonate couplet from the Western Himalaya: The expansion of the Marinoan snowball Earth glaciation to the northwestern margin of the Indian Plate in North Pakistan. - Precambrian Research, 2022 - Elsevier

Lan Z, MH Huyskens, G Le Hir et al., Massive volcanism may have foreshortened the Marinoan snowball Earth. - Geophysical Research Letter, 2022

Li T, G Zhu, K Zhao, Z Chen, Geochemical characteristics of organic-rich intervals within the Cryogenian non-glacial Datangpo Formation in southeastern Yangtze Block-implications for paleoenvironment and its control on organic matter accumulation.- Precambrian Research, 2022

Ma H, B Shen, X Lang et al., Active biogeochemical cycles during the Marinoan global glaciation. - Geochemica et Cosmochimica Acta, 2022

McDannell KT, CB Keller et al., Reply to Flowers et al.: Existing thermochronologic data constrain Snowball glacial erosion below the Great Unconformity. - PNAS, 2022

McDannell KT, CB Keller, Cryogenian glacial erosion of the central Canadian Shield: The “late” Great Unconformity on thin ice. - Geology, 2022

Millikin AEG, JV Strauss, GP Halverson et al., Calibrating the Russøya excursion in Svalbard, Norway, and implications for Neoproterozoic chronology. –Geology, 2022

Nolan M, S Xiao, B Gill, R Reid, M Schwid, Enigmatic provenance of carbonate clasts in Cryogenian glacial diamictite of the Nantuo Formation in South China.- Precambrian Research, 2022

O'Connell B, MW Wallace, AS Hood et al., Deep water cuspate stromatolites of the Cryogenian Trezona Formation. Geobiology, 2022
O'Sullivan EM, TF Nägler, EC Turner et al., Mo isotope composition of the 0.85 Ga ocean from coupled carbonate and shale archives: Some implications for pre-Cryogenian oxygenation. - Precambrian Research, 2022
Shen W, X Zhu, H Xie, X Wang, Y He, Tectonic–sedimentary evolution during initiation of the Tarim Basin: Insights from late Neoproterozoic sedimentary records in the NW basin.- Precambrian Research, 2022
Shen W, X Zhu, J Li, B Yan et al., Mechanism of organic matter accumulation in black shale of the Datangpo Formation: Insights from paleo-environmental variation during the Cryogenian non-glaciation.- Precambrian Research, 2022
Shen W, X Zhu, B Yan et al., Secular variation in seawater redox state during the Marinoan Snowball Earth event and implications for eukaryotic evolution. - Geology, 2022
Shields GA, RA Strachan, SM Porter et al., A template for an improved rock-based subdivision of the pre-Cryogenian timescale. - Journal of the Geological Society, 2022
Sun R, J Shen, SE Grasby et al., CO2 buildup drove global warming, the Marinoan deglaciation, and the genesis of the Ediacaran cap carbonates. - Precambrian Research, 2022
Sun R, SE Grasby, J Shen, J Xiao, R Yin, Climate/ocean dynamics and possible atmospheric mercury depletion events during the Late Sturtian deglaciation. - Chemical Geology, 2022
Uhlein GJ, A Uhlein, Late Cryogenian and late Paleozoic ice ages on the São Francisco craton, east Brazil. - Frontiers in Earth Science, 2022
Uhlein GJ, A Uhlein, Late Cryogenian and late Paleozoic ice ages on the São Francisco craton, east Brazil. - Frontiers in Earth Science, 2022
Wang X, PA Cawood, SE Grasby et al., Mercury anomalies across the Cryogenian-Ediacaran boundary in South China. - Precambrian Research, 2022
Wu CZ, FF Zhao, T Yang et al, Genesis of the Fulu Cryogenian iron formation in South China: Synglacial or interglacial? – Precambrian Research, 2022
Yan B, X Zhu, Z Li, J Li, Origin of the Cryogenian iron formations: Climatic fluctuation coupling with local hydrothermal iron input.- Precambrian Research, 2022
Yu W, TJ Algeo, Q Zhou et al., Evaluation of alkalinity sources to Cryogenian cap carbonates, and implications for cap carbonate formation models. - Global and Planetary Change, 2022
Zhao K, X Lang, G Zhu et al., Low marine sulfate levels during the initiation of the Cryogenian Marinoan glaciation. - Precambrian Research 2022
Zhu G, T Li, Z Zhang, K Zhao et al., Nitrogen isotope evidence for oxygenated upper ocean during the Cryogenian interglacial period- Chemical Geology, 2022

International Commission on Stratigraphy

Subcommission on Pre-Cryogenian Stratigraphy

Report 2022

1. Title of constituent body and name of reporter

International Subcommission on Pre-Cryogenian Stratigraphy

Respectfully submitted by Nora Noffke, Acting Chair; Martin Whitehouse, Chair

2. Overall Objectives and fit within IUGS Science Policy

The International Subcommission on Pre-Cryogenian Stratigraphy coordinates the study of selected stratigraphic sections worldwide that represent the Precambrian Earth ages before the Cryogenian. It organizes its presentation through the ICS website. The Subcommission's priority is to enable the international geoscience community to have stratigraphic information on the first ¾ of the geological record.

3. Organization

The Subcommission includes nineteen members. The membership is representative of almost all continents (see appendix). All members conduct active research and education on Hadean, Archean and Proterozoic Earth history.

Current Officers for 2020-2024 period (together with any changes in personnel):

Chair: Martin Whitehouse
Vice-Chair(s): Nora Noffke (Acting Chair); Douglas Galante (Vice Chair)
Secretary: Evelyn Sanchez
Web person: ICS

4. Interfaces with other international projects and/or extent of support other than IUGS

The subcommission's work in 2022 has been supported in part by the funding agency FAPES in Brazil to collaborate on our project on Earth's oldest sedimentary successions in the Pilbara region, West Australia (Lead-PI FAPES: Douglas Galante). A new collaboration is in place with the Geological Survey of Western Australia, Perth. The Geological Survey will provide logistics and transport for the duration of the 6th Int. Archean Symposium 2023 and of the follow-up field trip to Meso- and Neo-Proterozoic sites.

5. Chief accomplishments for 2022

- A field workshop 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 Paleoarchean boundary.
- Douglas Galante has received funding from FAPES Brazil that helped defray expenses for the workshop in Australia.
- One 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.

6. Summary of expenditures in 2022

Travel to Denver, CO (flight only):	$ 508.00
Taxi:	$ 60.00
Travel to Australia (flight, 1 person):	$ 3,406.07

Total spent: $ 3,974.07

7. Summary of Income 2022

We gratefully have received for 2022 the amount of 4,000 USD from IUGS. Douglas Galante was able to provide $ 6,700 towards activities of the subcommission.

8. Budget requested from ICS for 2023

We request $5,250 for representative members of our subcommission to attend the symposium and field visits in Australia (flight and registration), and the STRATI 2023 in Lille, France (registration and logistics).

Flight Australia	ca. 3,400.00 USD
Registration 6th International Archean Symposium	650.00 USD
STRATI Meeting (registration and logistics, est.)	ca. 1,200.00 USD
Total budget estimate:	**ca. 5,250.00 USD**

9. Work plan, anticipated results, milestones, and communications to be achieved in 2023

- 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).
- Finalizing 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

10. Key objectives and work plan for the next 4 years (2020 to 2024):

- Subdividing the Hadean and Archean stratigraphy; to be finalized 2023
- Collaboration Geological Survey of Western Australia regarding geoheritage status for the Paleoarchean boundary.
- Cont. publication of scientific papers and abstracts

- Proposal 2023 to the funding agency in Brazil to extend funds for another year.
- Starting 2023, focus shift to the Mesoproterozoic and Neoproterozoic.

Appendix – Member of the Pre-Cryogenian Subcommission

Member Name	Institution	Country
Axel Hofmann	Department of Geology, University of Johannesburg	South Africa
Barry Reno	Northern Territory Geological Survey	Australia
Chris Fedo	University of Tennessee	USA
David Huston	Geoscience Australia	Australia
Donald Lowe	Stanford University	USA
Douglas Galante	Brazilian Synchrotron Light Laboratory	Brazil
Evelyn Sanchez	Universidade Federal dos Vales do Jequitin e Mucuri	Brazil
Flavia Callefo	Universidade Estadual de Campinas	Brazil
Frances Westall	CNRS Orleans Campus · Centre de Biophysique Moléculaire (CBM)	France
Humberto Reis	Universidade Federal de Ouro Preto	Brazil
Jaana Halla	Finnish Museum of Natural History	Finland
Juha Köykkä	Geological Survey of Finland	Finland
Linda Hinnov	George Manson University	USA
Linda Kah	University of Tennessee	USA
Mark van Zuilen	Institut de Physique du Globe de Paris	France
Martin Whitehouse	Swedish Museum of Natural History	Sweden
Matheus Kuchenbecker	Universidade Federal dos Vales do Jequitin e Mucuri	Brazil
Nik Beukes	University of Johannesburg	South Africa
Noah Nhekho	Geological Survey and Mines Dept of Swaziland	Swaziland
Nora Noffke	Old Dominion University	USA
Peter Haines	Geological Survey of Western Australia	Australia
Simon Johnson	Geological Survey of Western Australia	Australia
Stan Awramik	University of California	USA
Yogmaya Shukla	Birbal Sahni Institute of Palaeobotany	Índia

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER
Subcommission on Stratigraphic Classification (ISSC)
Werner E. Piller, Chair; Jochen Erbacher, Secretary
28. 11. 2022

2. OVERALL OBJECTIVES AND FIT WITHIN IUGS SCIENCE POLICY
The Subcommission represents a core business for the International Commission on Stratigraphy, the primary body for creating, discussing, publishing and disseminating an internationally agreed-upon guide to stratigraphic terminology and classification. Its immediate priorities are to advertise new developments in stratigraphic methods, check that the procedures are carefully followed, monitor the application of the accepted rules, and encourage the teaching of basic stratigraphic principles and concepts to new generations of students and professionals. Its future goal is a revision of the International Stratigraphic Guide in order to keep it current but also open to new approaches.

3. ORGANISATION - interface with other international projects / groups
ISSC has always been directly or indirectly linked to big international projects such as deep-sea drilling and deep continental drilling as well as IGCP. It has close ties to national stratigraphic commissions, which increasingly look beyond the borders of the parent countries. This is especially true with the North American Commission on Stratigraphic Nomenclature which embraces the USA, Canada and Mexico, and tacitly much of the Caribbean area. ISSC encourages other national bodies to harmonize their codes with each other and the International Stratigraphic Guide.

3a. Nominated Officers for 2020-2024:

The terms of the nominated officers listed below ended December 2019. As this was their first term, a formal vote to confirm their continuation was not necessary, in case all voting members agreed. No reactions opposing the continuation were received.

Chair: Werner E. Piller
Vice-Chairs: Brian Pratt and Richard Fluegeman
Secretary: Jochen Erbacher

The Working Groups of the ISSC currently active are: Biostratigraphy and Chronostratigraphy. All WG leaders (chairs) and members are treated as Corresponding Members of the Subcommission. Moreover, Corresponding Members are also all the Chairs of the ICS Subcommissions.

4. EXTENT OF NATIONAL/REGIONAL/GLOBAL SUPPORT FROM SOURCES OTHER THAN IUGS
Most ISSC activities are linked to various programs and projects, such as IGCP, IODP, ICDP and a variety of national projects. Out of these international programs and affiliated national projects ISSC activities are supported directly or indirectly.

5. CHIEF ACCOMPLISHMENTS IN 2022

- 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 organized during the 32nd IGC in Florence, entitled "Post-Hedberg Developments in Stratigraphic Classification". Background and motivation of this ambitious project "New Developments on Stratigraphic Classification" are clearly expressed in the introductory article (Cita, 2007) 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.

STATE OF THE ART (as of November 2022)

Papers published:

Cita, M. B., 2007. New developments in stratigraphic classification. A project of the International Subcommission on Stratigraphic Classification ISSC: Newsletters on Stratigraphy, v. 42(2), p. 69–74.

Strasser, A., Hilgen, F. and Heckel, P., 2007. Cyclostratigraphy – concepts, definitions, and applications: Newsletters on Stratigraphy, v. 42(2), p. 75–114.

Weissert, H., Joachimski, M. and Sarthein, M., 2008. Chemostratigraphy: Newsletters on Stratigraphy, v. 42(3), p. 145–179.

Langereis, C., Krijgsman, W., Muttoni, G., and Menning, M., 2010. Magnetostratigraphy – concepts, definitions, and applications: Newsletters on Stratigraphy, v. 43(2), p. 207–233.

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

New achievement!

Pratt, B.R., Finney, S.C., Easton, R.M., Piller, W.E., 2022. Lithostratigraphy: Formation of the Formation. – Newsletters on Stratigraphy, 1-24. DOI: 10.1127/nos/2022/0732

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 (Petrizzo 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 finalized in 2023.

PUBLICATIONS

PRATT, B.R., FINNEY, S.C., EASTON, R.M., PILLER, W.E., 2022. Lithostratigraphy: Formation of the Formation. – Newsletters on Stratigraphy, 1-24. DOI: 10.1127/nos/2022/0732

HEAD, M.J., AUBRY, M.-P., PILLER, W.E., WALKER, M., 2022. The Standard Auxiliary Boundary Stratotype: a proposed replacement for the Auxiliary Stratotype Point in supporting a Global boundary Stratotype Section and Point (GSSP). – Episodes, 1-12 https://doi.org/10.18814/epiiugs/2022/022012

HEAD, M.J., AUBRY, M.-P., PILLER, W.E., WALKER, M., 2022. Standard Auxiliary Boundary Stratotype (SABS) approved to support the Global boundary Stratotype Section and Point (GSSP). – Episodes, 1-2. https://doi.org/10.18814/epiiugs/2022/022044

- ISSC BUSINESS MEETING

A brief business meeting was held during the in Vienna on May 23rd during EGU 22.

- PROPOSALS – the subcommission voted on a proposal for the formalization 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 October 27, 2022.

- CONFERENCE PARTICIPATION - ISSC co-organized the technical session (on-site

presentations) SSP2.1 “Phanerozoic stratigraphy, paleoceanography, and paleoclimate” 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.

6. SUMMARY OF EXPENDITURE IN 2022:

Expenditures in 2022: USD 1,932.23 (USD 1,998,12)
For the Biostratigraphy Workshop in Schaumburg, Rinteln, Germany

7. SUMMARY OF INCOME IN 2022:

3948,00 US$ (3315.60 Euro)

8. BUDGET REQUEST FOR 2023

ISSC chair will attend EGU 2023 in Vienna, STRAT2023 in Lille, France and GSA 2023, Pittsburgh, USA. At EGU a session co-sponsered by ISSC will be held, STRATI2023 requires business meeting of ICCS and ICS, during GSA 2023 a workshop on Chronostratigraphy will be held and the chair will attend the annual meeting of NACSC.
Since Werner Piller is Professor emeritus no institutional financial support is available anymore and here requests financial support for his attendance.
A number of meetings of the subcommission’s working groups are planned to be held around EGU in Vienna (see list of working groups below), STRATI 2023 and GSA 2023 in order to proceed with the overview articles planned. The requested budget will be used to support the participation of working group members and potential guests to these meetings.

PROJECTED EXPENSES

Participation in EGU 2023, Vienna	650.- Euro
Travel expenses support for the 4th Strati2023, Lille, France	900.- Euro
Travel expenses editorial work for Biostratigraphy volume NOS	1200.- Euro
Travel expenses for workshop on Chronostratigraphy (3 persons)	4500.- Euro
Available (out of 2021, 2022)	2000.- Euro

TOTAL estimated expenditure **5,250.- Euro**

9. WORK PLAN, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2023):

- For the chapter Biostratigraphy next steps (define potential reviewers for special volume and finalize publication) have to be done.

- The session "Phanerozoic stratigraphy, paleoceanography, and paleoclimate" will be held at the EGU General Assembly 2023 (EGU 2023), 23-28 April 2023, Vienna, Austria.

- A business meeting will be held during Strati23 in Lille, France.

- All the remaining review papers on the various branches of Stratigraphy will be submitted 2023.

Potential funding sources external to IUGS
The Subcommission does not envisage being able, as an organization, to obtain significant funding from outside IUGS/ICS sources. Some financial support could be obtained by individual members from their host institutions and/or their personal research funds. There is, however, a considerable amount of in-kind funds supporting the activities of all ISSC members, such as covering of travel costs to our workshops etc.

10. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2020-2023)

- ISSC will take the initiative to suggest special sessions and symposia at conferences that advance stratigraphic principles, in collaboration with other ICS subcommissions.
- ISSC will continue to participate in GSSP discussions with ICS subcommissions.
- ISSC continues to interface with national stratigraphic commissions although only in an advisory capacity.
- The ULTIMATE GOAL of ISSC is the publication of a new, multi-authored, really multinational International Stratigraphic Guide—a guide not a code, simple, clear, concise, user-friendly, for worldwide distribution and acceptance (post-2023).

APPENDIX

Nominated officers

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Vice-Chair: Richard H. Fluegeman, rfluegem@bsu.edu, Department of Geological Sciences, Ball State University, 4130 West University Ave., Muncie, Indiana 47304, USA, Phone: (765)285-8267
Secretary: Jochen Erbacher, erbacher@bgr.de – Stratigraphy and Collections, Federal Institute for Geosciences and Natural Ressources, Stilleweg 2, 30655 Hannover, Phone: +49-511 643-2795

List of further Voting Members

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List of Working group leaders and corresponding members

BIOSTRATIGRAPHY WG

Chair: Jochen Erbacher, Germany
Werner Piller, Austria
Jörg Pross, Germany
Claudia Agnini, Italy
Maria Rose Petrizzo, Italy
Carlo Coradini, Italy
Petr Storch, Czech Republic
Dieter Korn, Germany

CHRONOSTRATIGRAPHY WG

Chair: Marie-Pierre Aubry, USA
Martin Head, Canada
Werner E. Piller, Austria
Brian McGowran, Australia

List of corresponding members

- Harper David A. T., david.harper@durham.ac.uk, ICS chair
- Brian Huber, huberb@si.edu, ICS vice-chair
- Bruce Eglington, bruce.eglington@usask.ca, Subcommission Precambrian Stratigraphy
- Graham Shields-Zhou, g.shields@ucl.ac.uk, Subcommission Cryogenian Stratigraphy
- Shuhai Xiao, xiao@vt.edu, Subcommission Ediacarian Stratigraphy
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INTERNATIONAL SUBCOMMISSION ON TIMESCALE CALIBRATION (ISTC)
ANNUAL REPORT FOR 2022

1. International Subcommission on Timescale Calibration (ISTC)

REPORTING
Brad Cramer – Chair
Mark Schmitz – Vice-Chair
Anne-Christine DaSilva – Secretary

2. Overall Objectives and Fit within IUGS Science Policy

In response to a growing movement of geoscientists who increasingly work at the intersection of time and stratigraphy, and in an effort to provide a platform for promoting integration between the traditionally stratigraphic communities of the ICS with the radioisotopic communities that historically have not been a central component of the ICS enterprise, we have created a new International Subcommission on Timescale Calibration (ISTC). The objective of this subcommission is not to 'certify' or 'approve' any particular numerical calibration of the International Chronostratigraphic Chart, but rather, to provide advice and counsel to existing ICS Subcommissions on geochronological issues, to delineate best practices and the role of inter-laboratory calibrations to chronostratigraphic and timescale problems, and to provide a venue for increasing collaboration between chronostratigraphic and geochronologic research.

3. Organization – Interface with other international project / groups

This subcommission became officially operational in 2020. The website is nearly completed and will include an interactive database of all radioisotopic dates utilized during the creation of the GTS2020 timescale. This will be a primary interface for the DDE to access the calibration data utilized in construction of the GTS2020.

3a. Current Officers and Nominated Officers for 2020-2024 period

Chair: Bradley D. Cramer – University of Iowa

Vice Chair: Mark Schmitz – Boise State University

Secretary: Anne-Christine DaSilva - Université de Liège
Webperson: Bradley D. Cramer – University of Iowa

4. Extent of National/Regional/Global Support from Sources other than IUGS

There has, as yet, been no additional support from sources other than IUGS.

5. Chief Accomplishments in 2022

The creation of additional teaching materials for the Cyclostratigraphy Intercomparison Project (CIP) and the organization of the website database have been the chief accomplishments of 2022. We are also organizing 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 utilized in calibration of the GTS2020 timescale that will be available online at the ISTC website.

6. Summary of Expenditures in 2022
There were no expenditures in 2022.

7. Summary of Income in 2022
There was no income in 2022.

8. Budget Requested from ICS in 2023
We are not requesting funds from ICS in 2023.

9. Work Plan, Critical Milestones, Anticipated Results & Communications to be Achieved Next Year
- First in-person meeting of the ISTC to be held at STRATI 2023 in Lille.
- Planning and organization for the first ISTC digital subcommission meeting to be held online in early 2023.
- Acquisition of funding at the national/international level to support community building globally for the ISTC

10. Key Objectives and Work Plan for the Period 2020-2024
- Create the full subcommission with both voting members and corresponding members. We have completed the list of voting members and are now in the process of filling out the list of corresponding members.
- Organizing the first subcommission meeting to physically bring the ISTC together for the first time
- Organizing 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 subcommission 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 Paleontological Association, The Paleontological Society, etc.

APPENDIX
The current officers and voting membership has been completed. We are now in the process of completing the list of corresponding members.

International Subcommission on Timescale Calibration

Voting Members and Executive Committee 2020

Executive Committee

Chair: Brad Cramer – University of Iowa, USA (Integrated Stratigraphy)
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Vice Chair: Mark Schmitz – Boise State University, USA (U-Pb)
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Secretary: Anne-Christine da Silva – Université de Liège, Belgium (Integrated Stratigraphy)
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