

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 Aptian. 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 Crassiacollaria 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 Krons Moor sections (Poland, Germany) with new stratigraphic data published in the last years (e.g., Plasota et al. 2015, Wilmsen et al. 2019). The Gubbio section in Italy is a good reference for the Tethys and the stratigraphic record of the ODP Sites 1209 and 1210 may allow for correlation of the boundary to the tropical deep ocean. A splice of both ODP records is suited for astronomical tuning and validation of the astrochronology (Kim et al., 2022). Milestones to achieve in 2023 are the sample collection in Tercis and the site survey and data compilation for auxiliary sections.

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 (Krons Moor, 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 $\delta^{13}\text{C}_{\text{org}}$ excursion (VOICE event) in the upper part of the lower Tithonian (middle Volgian) in Boreal and South American sections. Efforts are concentrated in identifying the VOICE event in the Tethyan sections. Additionally, 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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