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JK2018

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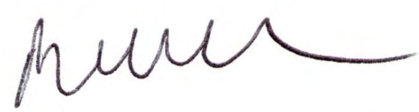
FOREWORD

The **JK2018** International Symposium focuses on a ca. 20 My interval of time spanning the Tithonian – Berriasian / Volgian – Ryazanian / – Valanginian interval (eventually overlapping slightly its lower and upper boundaries) in the Tethys area, as well as in the Panthalassa, Boreal and Austral regions.

This meeting is intended to bring together people with interests in the transition period spanning the latest Jurassic to the earliest Cretaceous times and to feature disciplines covering the many aspects of stratigraphy (litho-, bio-, magneto-, chemo-, cyclo-, sequence), as well as sedimentology, paleontology, paleogeography and global tectonics, at all scales, from the SEM – Scanning Electron Microscopy – to basin analyses.

The meeting is hosted by the **Muséum d'Histoire naturelle de Genève** and I take this opportunity to acknowledge the support provided by Jacques AYER (Director of the Museum), Dr Nadir ALVAREZ (Head of the ‘Research and Collections' Unit), Dr Lionel CAVIN (Curator, Editor-in-Chief of *Revue de Paléobiologie*), their staff and colleagues, among whom are Dr Christian MEISTER, Dr André PIUZ, and Dr Éric MONTEIL. The organizing committee, which also includes Prof. Rossana MARTINI, Prof. Jean J. CHAROLLAIS, and Prof. Andreas STRASSER, thanks the 15 national and international organizations that agreed to be our scientific partners.

This abstract volume comprises 59 contributions, which is already an achievement. More than 70 participants representing at least 25 nationalities are attending and we wish you will all enjoy contributing to this stimulating meeting and to the debates.



Bruno GRANIER
President of JK2018

Note: In order to have fair, unbiased, and open discussions on the system boundary during the **JK2018** meeting and to give all sides the possibility to defend their views, it was suggested that, in both abstracts and figures, the author(s) should refrain as much as possible from using “JK system boundary”, and should preferably refer to stage boundaries instead. We did not censor any abstract. Accordingly, you will find some abstracts stating that the system boundary equates to the Tithonian-Berriasian boundary (more specifically the base of the acme /abundance/ zone of *Calpionella alpina*), which was not the conclusion of the meeting.

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Dursun ACAR[1,2], M. Namik CAGATAY[1], K. Kadir ERIS[1], S. Can GENC[3], Erol SARI[4], Sefer ÖRÇEN[5], Ozlem MAKAROGLU[7], Sena AKCER[7], Demet BILTEKIN[8]

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2. Integrated stratigraphy of the Agrio Formation (Neuquén Basin, Argentine Andes): Towards an intercalibration with the Tethys during late Valanginian-Hauterivian times

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The Valanginian and Hauterivian stages were periods of transition between the relatively cold late Jurassic and a greenhouse world which continued in the rest of the Cretaceous. During this intervening time the world seemed to have distinct climate zones, which are reflected in distinct Boreal, Tethysian and Austral marine biotas. However, the duration of these stages is presently under debate, and their numerical ages are also poorly constrained. These uncertainties have hindered efforts to correlate and calibrate different ammonoid zonations of the Boreal and Austral realms with the «standard» Tethysian Mediterranean region zonation as well as the bioevents of nannofossil markers.

To tackle these and other early Cretaceous topics we are studying the Agrio Formation of the Neuquén Basin in west-central Argentina. This basin is a retro-arc basin developed in a normal subduction segment at the foothills of the Andes. Extensive and laterally continuous outcrops and a rich fossil record, combined with ash fall tuffs interbedded in thick, expanded sedimentary successions make the basin an excellent site for stratigraphical, paleontological, and radio-isotopic studies. The infill of the basin during the late early Valanginian to the late Hauterivian is represented by the Agrio Formation. We have studied this unit for more than 20 years with bed-by-bed collection of macrofossils and samples for microfossils. More recently we started sampling the tuff layers. Presently, there are four high precision CA-ID TIMS U-Pb radio-isotopic ages which are well constrained biostratigraphically by ammonoids and calcareous nannofossils. The oldest one is 130.39 ± 0.16 Ma (early Hauterivian), the second is 129.09 ± 0.16 Ma (base of late Hauterivian), the third one is 127.42 ± 0.15 Ma (late Hauterivian) and the forth is 126.97 ± 0.15 Ma (late Hauterivian). We selected a stratigraphic section at the locality of El Portón where this formation is nearly 700 metres thick and represented by its three members. The lower Pilmatué Member and the upper Agua de la Mula Member are both marine and composed of marl-limestone alternations, likely forced by orbital cycles. The non-marine Avilé Member in between is represented by lutites and sandstones deposited in an ephemeral lacustrine and fluvial environment and is connected to a short episode of shallowing related to a forced regression.

We performed magnetic susceptibility measurements in both the Pilmatué and Agua de la Mula members, having obtained the first orbital time scale of the Agrio Formation.

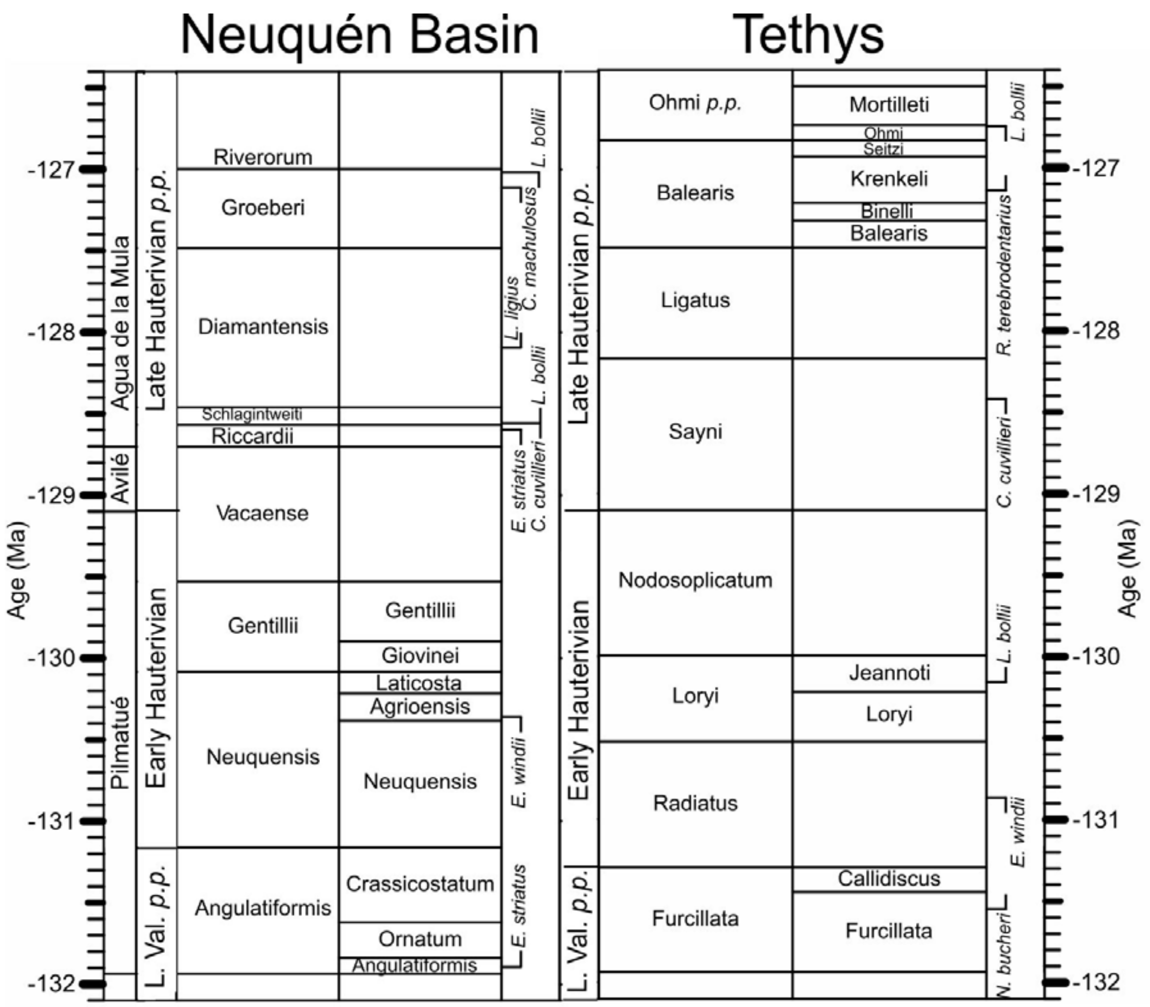

Figure 1 : Correlation chart of the late Valanginian-Hauterivian ammonoid zones and calcareous nannofossil bioevents of the Neuquén Basin and the Tethysian Mediterranean area.

Thus, we achieved a robust combination of biostratigraphy, cyclostratigraphy and high-precision radio-isotopic ages for the Agrio Formation and these data were correlated with those of classic sections of the Tethys, including the candidates for the base of the Hauterivian (La Charce, France) and the base of the Barremian (Río Argos, Spain).

The astrochronological framework provided here gives an opportunity to independently assess the calibration of the ammonoid zones and the nannofossils bioevents in the Neuquén Basin with the «standard» chronostratigraphy in the Tethysian Mediterranean area.

3. Basin evolution model for the late Jurassic-Early Cretaceous interval in the NE Arabian Plate, Kurdistan region - NE Iraq

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The studied area is located in the southwestern part of Zagros fold and thrust belt, specifically in Kurdistan region-NE Iraq. Our research intended to constrain the basin evolution in the western segment of Neo-Tethys (Kermanshah basin) during the late Jurassic-early Cretaceous interval, as well as the characteristics of both the Tithonian-Berriasian and the Berriasian-Valanginian boundaries. With the use of stratigraphy (age determination and fundamental tectonostratigraphic methods), we have tried to constrain the basin models during this period. Nannofossil analyses were used for the biostratigraphic approach.

4. On the correlation possibilities in the Berriasian - Hauterivian interval of the Boreal / Tethysian successions

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The problem of correlation of Tethysian and Boreal biostratigraphic scales is one of the most difficult for the early Cretaceous, especially in the Jurassic - Cretaceous boundary interval. It is still unsolved because of the absence of, or poor, marine connections between Peri-Tethysian and high-Boreal basins. By the term «high-Boreal» I mean Arctic regions of Russia, Canada, Greenland, and some other countries. It generally coincides with the «Arctic Realm/Subrealm» of SAKS *et al.* (1964) adopted by WESTERMANN (2000) to paleogeographic terminology.

One of the most important seaways connecting Peri-Tethys and high-Boreal basins was the Russian Platform sea, which allowed Tethysian-Boreal marine fauna migrations, including ammonites and belemnites (BARABOSHKIN *et al.*, 2007). Meridional fauna distribution and adaptation to changing conditions took some hundred thousand years, even in case of rapidly evolved ammonites (GUZHIKOV & BARABOSHKIN, 2006). The diachronism of the fauna makes any inter-realm biostratigraphic correlation also diachronous, even with the existence of a migration path. The use of integrated biostratigraphic, paleomagnetic and stable-isotope correlation helps to make an isochronous inter-realm correlation. This way we significantly increase the precision of a Tethysian / Boreal correlation in the Berriasian - Hauterivian interval, based on an integrated study of reference sections in the Boreal Realm (BARABOSHKIN & GUZHIKOV, 2018). A number of highly-traceable levels were recognized:

● Base of M18r Chron corresponds to the ± base *P. grandis* Zone (Tethysian, T) and ± *Ch. chetae* Zone (Boreal, B) and to $\delta^{13}C$ excursion (DZYUBA *et al.*, 2013). It is near the base of the recently-used Jurassic / Cretaceous (Volgian / Ryazanian) boundary.

● Base of M11r Chron corresponds to the ± base *S. verrucosum* T-Zone, and the base of ± *P. polyptychus* B-Zone and to $\delta^{13}C$ excursion («WEISSERT event»). It is near the base of the lower / upper Valanginian boundary.

● «Faraoni event» above the base of M5n Chron is in the mid-*P. ohmi* T-Zone, and the base of ± *C. discofalcatus* B-Zone.

● Base of M3r Chron is in the mid-*T. hughi* T-Zone, corresponds to the ± base *C. discofalcatus* B-Zone. It is near the base of the Hauterivian / Barremian boundary.

Other levels which could be potentially very traceable are the bases and tops of the largest magnetic Chrons in this interval - M19n, M17r and M16n.

We believe that the best boundary between Stages and especially between Systems is a highly correlatable isochronous level based on non-paleontological methods (paleomagnetic and / or stable isotope). It will be facies- and latitude-independent and has therefore the highest potential for correlation all over the World.

To follow this idea, one should recognize such non-paleontological markers first, and then look at the supporting paleontological markers.

BARABOSHKIN E.J. & GUZHIKOV A.Yu. (2018).- The Boreal Lower Cretaceous of Russia: Revision of the Stage boundaries on the base of non-paleontological data. *In*: BARABOSHKIN E.Yu., LIPNITSKAYA T.A. & GUZHIKOV A.Yu. (Eds.). Cretaceous system in Russia and the near abroad: The problems of stratigraphy and paleogeography.- Proceedings of IX All-Russian Meeting on September 17-21, 2018, Belgorod, State National Research University, Belgorod, Polyterra, p. 47-53 (in Russian).

BARABOSHKIN E.J., NAJDIN D.P., BENJAMOVSKI V.N., HERMAN A.B. & AKHMETIEV M.A. (2007).- Northern Hemisphere Seaways in Cretaceous and Paleogene.- Geological Faculty of Moscow State University, Moscow, 182 p (in Russian).

DZYUBA O.S., IZOKH O.P. & SHURYGIN B.N. 2013.- Carbon isotope excursions in Boreal Jurassic-Cretaceous boundary sections and their correlation potential.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 381-382, p. 33-46.

GUZHIKOV A.Yu. & BARABOSHKIN E.J. (2006).- Assessment of Diachronism of Biostratigraphic Boundaries by Magnetochronological Calibration of Zonal Scales for the Lower Cretaceous of the Tethyan and Boreal Belts.- *Doklady Earth Sciences*, vol. 409A, No. 6, p. 843-846.

SAKS V.N., MESEZHNIKOV M.S. & SHULGINA N.I. (1964).- About the connection of the Jurassic and Cretaceous marine basins in the North and South of Eurasia. *In*: D.L. STEPANOV (ed.), Stratigraphy of the Upper Paleozoic and Mesozoic of the southern biogeographical provinces. International Geological Congress, XXII Session.- Reports of Soviet Geologists, Problem 16a, Nedra Publishing House, Moscow, p. 163-174 (in Russian with English abstract).

WESTERMANN G.E.G. (2000).- Marine faunal realms of the Mesozoic: Review and revision under the new guidelines for biogeographic classification and nomenclature.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 163, p. 49-68.

5. Ethology and paleoenvironmental significance of *Chondrites*: Revising the fossil icon of the Jurassic-Cretaceous boundary

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The iconic trace fossil *Chondrites* is broadly plant-root shaped and is one of the most common fossils of the Jurassic-Cretaceous boundary in terms of abundance and geographical distribution. *Chondrites* is widely documented from several Jurassic-Cretaceous boundary sections including those of Puerto Escaño in Spain (PRUNER *et al.*, 2010), Nordvik in north Siberia (Russia) (ZAKHAROV *et al.*, 2014), Kashpir and Gorodische in the Volga Basin (Russia) (KESSELS *et al.*, 2003) and southern Mendoza in the Neuquén Basin (Argentina) (KIETZMANN *et al.*, 2015). *Chondrites* is also reported from classical units of the Jurassic-Cretaceous transition such as Maiolica (WIECZOREK, 1988), Puez Formation (LUKENEDER, 2010), Kostel Formation (TCHOUMACHENCO & UCHMAN, 2001).

Despite its abundance, the first modern revision of *Chondrites* was published by FU (1991) and, since then, virtually no studies have comprehensively focused on its ethology. The behaviour of *Chondrites* remains unclear, limiting its application as a paleoenvironmental and paleoceanographic tool.

Here, we address this gap by review of existing literature and analysis of novel data, including (1) macroscopic and thin section observations, with specific emphasis on specimens preserved in Jurassic-Cretaceous units (*e.g.*, Biancone, Puez Formation); (2) Environmental Scanning Electron Microscopy observations and X-Ray microanalyses (ESEM-EDX); (3) CT-scans and resin peels of modern analogues of *Chondrites*, *i.e.*, burrows of thyasirid bivalves and vermiform animals (FU, 1991; HERTWECK *et al.*, 2007; SEILACHER, 1990; DUFOUR & FELBECK, 2003); (4) computer-controlled serial grinding (BEDNARZ & MCILROY, 2015); (5) morphometric analysis of 88 specimens of *Chondrites* (6) theoretical morphology, following the principles established in previous works (NIKLAS, 1994, 2004; MCGHEE, 1999).

Results show that the tracemakers of *Chondrites* built their burrows to obtain food: chemosymbiotic bivalves produced *Chondrites* to provision sulfur-oxidizing symbionts with the chemical reductants they required for metabolism; asymbiotic bivalves built *Chondrites* to cultivate bacteria and directly ingesting them; subsurface deposit feeding annelids produced *Chondrites*-like traces to search for food in the sediment.

The burrowing mechanism by which *Chondrites* was produced depend on the physiology of the tracemaker. Bivalves produced *Chondrites* by pushing their extensile foot into the sediment. In the case of sulfur-pumping symbiotic bivalves, inactive burrows were actively backfilled to ensure pumping efficiency in the new tunnel. In analogy with modern annelids it is likely that the burrowing cycle of worm-like tracemakers consisted of extending the proboscis and intruding into the sediment or by ingesting the sediment particles in front of them. In the case of vermiform animals, fill of *Chondrites* may have been produced by selective deposit feeding with authigenic alteration of ingested clay minerals or by the withdrawal of the proboscis sucking sediment from the surface (FERGUSON, 1965). Alternatively, some examples of *Chondrites* may represent a passively filled open burrow system. Available evidence shows that *Chondrites* was continuously modified or represented a part of the producer lifespan. Morphometric data show that branch width increases through time, suggesting that the *Chondrites* tracemaker(s) became larger and larger over the Phanerozoic.

Chondrites, as well as their modern tracemakers, are associated with a vast range of marine settings, typically including dysoxic ones. This explains the abundance of *Chondrites* at the Jurassic-Cretaceous boundary. In fact, the Jurassic/Cretaceous boundary interval is characterized by the widespread occurrence of black shales, often linked to anoxic events (*e.g.*, Valanginian WEISSERT event, Hauterivian Faraoni Oceanic Anoxic Event) (KESSELS *et al.*, 2003; BODIN *et al.*, 2009). However, in line with previous works (BROMLEY & EKDALE, 1984; EKDALE & MASON, 1988), caution should be exercised in using *Chondrites* as a proxy for dysoxia because it is also characteristically associated with well-oxygenated and space-limited environments.

BEDNARZ M. & MCILROY D. (2015).- Organism-sediment interactions in shale-hydrocarbon reservoir facies - Three-dimensional reconstruction of complex ichnofabric geometries and pore-networks.- *International Journal of Coal Geology*, vol. 150-151, p. 238-251.

BODIN S., FIET N., GODET A., MATERA V., WESTERMANN S., CLÉMENT A., JANSSEN N.M.M., STILLE P. & FÖLLMI K.B. (2009).- Early Cretaceous (late Berriasian to early Aptian) palaeoceanographic change along the northwestern Tethyan margin (Vocontian Trough, southeastern France): δ13C, δ18O and Sr-isotope belemnite and whole-rock records.- *Cretaceous Research*, vol. 30, p. 1247-1262.

BROMLEY R.G. & EKDALE A.A. (1984).- *Chondrites*: A trace fossil indicator of anoxia in sediments.- *Science* (New York, N.Y.), vol. 224, p. 872-874.

DUFOUR S.C. & FELBECK H. (2003).- Sulphide mining by the superextensile foot of symbiotic thyasirid bivalves.- *Nature*, vol. 101, p. 65-67.

EKDALE A.A. & MASON T.R. (1988).- Characteristic trace-fossil associations in oxygen-poor sedimentary environments.- *Geology*, vol. 16, p. 720-723.

FERGUSON L. (1965).- A note on the emplacement of sediment in the trace fossil *Chondrites*.- *Proc. Geol. Soc. London*, vol. 1622, p. 79-82.

FU S. (1991).- Funktion, Verhalten und Einteilung fucoider und lophocteniider Lebensspuren.- *Courier Forschungsinstitut Senckenberg*, vol. 135, p. 1-79.

HERTWECK G., WEHRMANN A. & LIEBEZEIT G. (2007).- Bioturbation structures of polychaetes in modern shallow marine environments and their analogues to *Chondrites* group traces.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 245, p. 382-389.

KESSELS K., MUTTERLOSE J. & RUFFELL A. (2003).- Calcareous nannofossils from late Jurassic sediments of the Volga Basin (Russian Platform): evidence for productivity-controlled black shale deposition.- *International Journal of Earth Sciences*, vol. 92, p. 743-757.

KIETZMANN D.A., PALMA R.M. & LLANOS M.P.I. (2015).- Cyclostratigraphy of an orbitally-driven Tithonian--Valanginian carbonate ramp succession, Southern Mendoza, Argentina: implications for the Jurassic--Cretaceous boundary in the Neuquén Basin.- *Sedimentary Geology*, vol. 315, p. 29-46.

LUKENEDER A. (2010).- Lithostratigraphic definition and stratotype for the Puez Formation: formalisation of the Lower Cretaceous in the Dolomites (S. Tyrol, Italy).- *Austrian Journal of Earth Sciences*, vol. 103, p. 138-158.

MCGHEE G.R. (1999).- Theoretical morphology: The concept and its applications.- Columbia University Press, 378 p.

NIKLAS K.J. (2004).- Computer Models of Early Land Plant Evolution.- *Annual Review of Earth and Planetary Sciences*, vol. 32, p. 47-66.

NIKLAS K.J. (1994).- Morphological evolution through complex domains of fitness.- *Proceedings of the National Academy of Sciences*, vol. 91, p. 6772-6779.

PRUNER P., HOUŠA V., OLÓRIZ F., KOŠT'ÁK M., KRS M., MAN O., SCHNABL P., VENHODOVÁ D., TAVERA J.M. & MAZUCH M. (2010).- High-resolution magnetostratigraphy and biostratigraphic zonation of the Jurassic/Cretaceous boundary strata in the Puerto Escaño section (southern Spain).- *Cretaceous Research*, vol. 31, p. 192-206.

SEILACHER A. (1990).- Aberrations in bivalve evolution related to photo-and chemosymbiosis.- *Historical Biology*, vol. 3, p. 289-311.

TCHOUMATCHENCO P. & UCHMAN A. (2001).- The oldest deep-sea Ophiomorpha and Scolicia and associated trace fossils from the Upper Jurassic-Lower Cretaceous deep-water turbidite deposits of SW Bulgaria.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 169, p. 85-99.

WIECZOREK J. (1988).- Maiolica-a unique facies of the Western Tethys.- *Annales Societatis Geologorum Poloniae*, vol. 58, p. 255-276.

ZAKHAROV V.A., ROGOV M.A., DZYUBA O.S., ŽÁK K., KOŠT'ÁK M., PRUNER P., SKUPIEN P., CHADIMA M., MAZUCH M. & NIKITENKO B.L. (2014).- Palaeoenvironments and palaeoceanography changes across the Jurassic/Cretaceous boundary in the Arctic realm: case study of the Nordvik section (north Siberia, Russia).- *Polar research*, vol. 33, p. 19714.

6. Panthalassan radiolarite versus pelagic carbonate in Intra-Pangaean basins during the late Jurassic - early Cretaceous transition – paleofertility and ocean circulation

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The transition between the Jurassic and Cretaceous systems is gradual without any distinct change in stable isotope values, typical of other system boundaries. Accordingly, continuous radiolarite sections observed throughout Eastern Tethys and Panthalassa (>80% of the world ocean) do not show any marked change suggestive of a "natural" Jurassic/Cretaceous boundary.

Intra-Pangaean, *i.e.*, Proto-Caribbean, Central Atlantic and Western Tethysian sedimentary records across the Jurassic-Cretaceous transition differ from the radiolarite-dominated series known from Panthalassa: 1. During the Jurassic, radiolarite did not form in the Proto-Caribbean, Gulf of Mexico and the Central Atlantic. The first sediment in these basins is pelagic, often C_{org}-rich, claystone (DSDP Site 534) or pelagic cherty limestone since the Oxfordian (Guaniguanico

Terrane, NW-Cuba, Taman Formation, E-Mexico). 2. In Western Tethys, middle to lower upper Jurassic ribbon bedded radiolarite progressively grades during the Oxfordian-Kimmeridgian (depending on paleogeography) into cherty pelagic limestone and passes during the middle-late Tithonian into pure nannofossil limestone with occasional radiolarian-rich chert layers (Maiolica or Biancone Formation).

During the late Jurassic, calcareous nannofossils became for the first time an important component of the Intra-Pangaean sediments. *Watznaueria* spp. appear first, while *Nannoconus* spp. became dominant during the late Tithonian-early Valanginian and declined again in favor of *Watznaueria* during the late Valanginian-early Hauterivian (ERBA & TREMOLADA, 2004), Nannoconids came back during late Hauterivian and finally declined during late Barremian. When nannoconids thrived, *Watznaueria* declined in numbers and size (BORNEMANN *et al.*, 2003). While nannoconids became rock forming in Intra-Pangaean basins and epicontinental seas, this genus has been reported from Panthalassa only in small abundances, mainly from shallow DSDP/ODP sites (*e.g.*, Ongtong-Java, Mid-Pacific Mountains, ERBA, 1994).

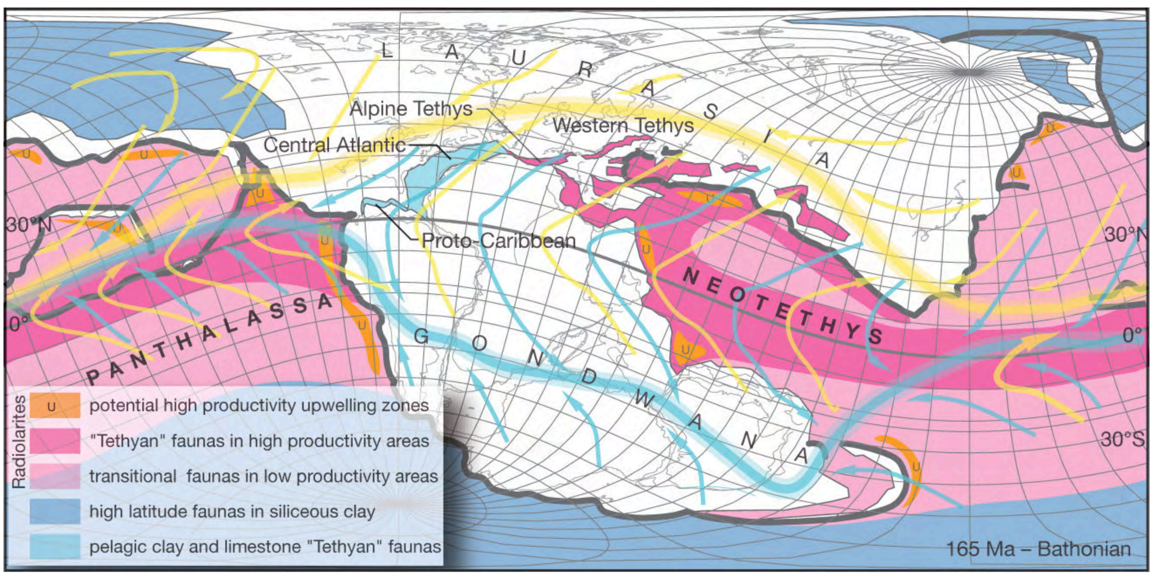

Figure 1: Paleogeographic map for 165 Ma (Bathonian) adapted from BAUMGARTNER (2013), showing major oceanic radiolarian bio-provinces and low/high accumulation radiolarites. Neotethys and Panthalassa oceans were well-connected with each other. The Intra-Pangaean basins, *i.e.*, Central Atlantic and the initial Proto-Caribbean, formed a low-fertility 'Mediterranean' sea with restricted connections to the world ocean. Jurassic radiolarian faunas of that sea are very similar to those of the Tethys-Panthalassan low latitude belt, but accumulation rates were much smaller and episodic, not allowing for radiolarite formation. Northern summer (yellow) and Southern summer (blue) Intertropical Convergence Zones and associated (hypothetical) trade winds are shown, suggesting a "Mega-monsoon" situation in Neotethys (IKEDA *et al.*, 2017).

Hyaline calpionellids (*Crassicollaria*, *Calpionella*, *Tintinnopsella*, etc.) have a very similar paleogeographic and stratigraphic distribution, in that they appeared and became common in Intra-Pangaean basins during the late Tithonian, evolved quickly and disappeared with the first nannoconid crisis at the end of the early Valanginian. Isolated calpionellid occurrences have been reported form E-Tethys (Kiogar Nappes of Tibet, HEIM & GANSSER, 1939), but this group is unknown from Panthalassa.

In the UAZ95 zonation (BAUMGARTNER *et al.*, 1995, now in revision) we recognized an important radiolarian faunal turnover within UAZ13, which is defined by 39 species appearances at its base and 9 disappearances at its top (see also BARTOLINI *et al.*, 1999). UAZ 13 approximately corresponds with the *Crassicollaria* Zone, the first occurrence of hyaline calpionellids, and includes the first occurrence of *Nannoconus.* If the radiolarian faunal turnover, largely defined in Intra-Pangaean sections, can be confirmed in Panthalassan sections, it may serve as a global correlation of the rather local first occurrences of hyaline calpionellids and nannoconids. Currently, the *Crassicollaria* Zone is placed in the late Tithonian. Its base, in the upper part of Magnetic Anomaly M20n, coincides with the FAD of *Nannoconus infans* and as mentioned above, with the FAD of many radiolarian species and genera. This event may be the only chance for a global correlation. A slight change of redox conditions, materialized by the change from pink to grey chert, may be suspected near this event in many Tethysian sections, such as Bosso and Torre di Busi, but is absent in Panthalassan sections.

The paleo-ecological affinities of nannoconids have been discussed controversially, including the following interpretations: warm waters; low nutrients; low CO2 concentrations, low terrigenous input and high carbonate productivity. J. MUTTERLOSE (written communication) currently interprets nannoconid blooms as indicating clear waters, barren of mud, reflecting relative warm, arid and low nutrient conditions.

These conditions clearly contrast with conditions generally advocated for the formation of radiolarite, namely increased surface fertility and/or bottom water conditions that favored carbonate dissolution and silica preservation (BAUMGARTNER, 2013). On the other hand, the high radiolarian diversity observed during the Berriasian-early Valanginian, before the extinction event related to the WEISSERT-Event (E1 of O'DOGHERTY & GUEX, 2002) may reflect the well-known inverse correlation of trophic level and plankton diversity. The distribution of pelagic carbonate vs. radiolarite is critical to the paleo-oceanographic interpretation of the Trans-Pangaean Seaway.

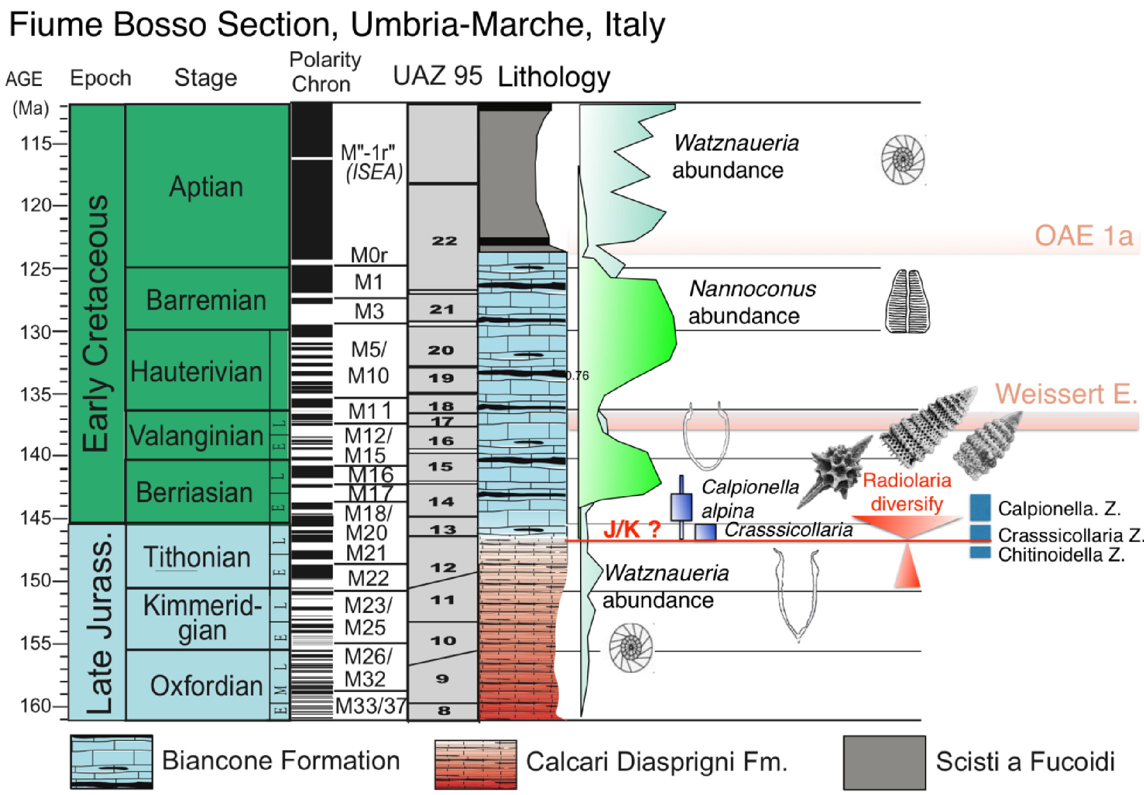

Figure 2: Schematic chronostratigraphic view of the Bosso section (Umbria-Marche, Italy), with polarity chrons, radiolarian UAZ95-zones and cartoons of nannofossil, calpionellid and radiolarian distributions across the Jurassic-Cretaceous transition. Sources cited in the text.

It does *not* support an east-west directed current (often conceived as a circum-global equatorial system) across this seaway, whether it is open or intermittently closed during the middle Jurassic-early Cretaceous (Brunetti *et al.*, 2015). The Intra-Pangaean basins were "Mediterranean" seas, characterized by a sluggish, lagoonal circulation, with stratified water masses and relatively low surface fertility, only poorly connected to the world ocean. In the jaw-like opening of Western Tethys during the middle-late Jurassic, the boundaries between silica and carbonate realms depended on local and regional paleogeography. Radiolarite facies reached nevertheless to the W into Subbetic and the Rif realms adjacent to the Central Atlantic, while the nannoconid carbonate facies reached eastwards to the drowned Arabian Platform, but not to the deep water Hawasina Realm.

Bartolini A., Baumgartner P.O. & Guex, J. (1999).- Middle and Late Jurassic radiolarian paleoecology versus carbon-isotope stratigraphy. Palaeogeography, Palaeoclimatology, Palaeoecology, 145, 43-60.

Baumgartner P.O. (2013).- Mesozoic radiolarites - Accumulation as a function of sea surface fertility on Tethyan margins and in ocean basins. Sedimentology, 60 (1), 292-318.

Baumgartner P.O., Bartolini A., Carter E.S., Conti M., Cortese G., Danelian T., De Wever P., Dumitrica P., Dumitrica-Jud R., Goričan Š., Guex J., Hull D.M., Kito N., Marcucci M., Matsuoka A., Murchey B., O'Dogherty L., Savary J., Vishnevskaya V., Widz D. & Yao A. (1995).- Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys based on Unitary Associations. *In*: Baumgartner P.O., O'Dogherty L., Goričan Š., Urquhart E., Pillevuit A. & De Wever P. (Eds.), Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, systematics, biochronology.- *Mémoires de Géologie (Lausanne)* 23, p. 1013-1048.

Bornemann A., Aschwer U. & Mutterlose J. (2003).- The impact of calcareous nannofossils on the pelagic carbonate accumulation across the Jurassic-Cretaceous boundary.- *Palæogeography, Palæoclimatology, Palæoecology*, 199, p. 187-228.

BRUNETTI M., BAUMGARTNER P.O., VÉRARD C. & HOCHARD C. (2015).- Ocean circulation during the Middle Jurassic in the presence/absence of a circum global current system.- *Journal of Palaeogeography* 4, p. 371-383.

ERBA E. (1994).- Nannofossils and superplumes: The early Aptian 'nannoconid crisis'.- *Paleoceanography* 9, 483-501

ERBA E. & TREMOLADA F. (2000).- Volume calculation of coccoliths and estimates of carbonate fluxes during the Cretaceous.- *J. Nannoplankton Res.* 22, p. 96.

HEIM A.A. & GANSSER A. (1939).- Central Himalaya: Geological Observations of the Swiss Expedition, 1936.- Gebruder Fretz, Delhi, Hindustan Publishing Corporation (India), 245 p.

IKEDA M., TADA R. & OZAKI K. (2017).- Astronomical pacing of the global silica cycle recorded in Mesozoic bedded cherts.- *Nature Communications*, 8: 15532, DOI: 10.1038/ncomms15532

O' DOGHERTY L. & GUEX J. (2002).- Rates and pattern of evolution among Cretaceous radiolarians: relations with global paleoceanographic events.- *Micropaleontology*, 48 (1), p. 1-22.

7. Discussion on the calpionellid biozones and proposal of a homogeneous calpionellid scheme for the Tethysian Realm

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Calpionellids constitute a group of planktonic microfossils usually occurring in large numbers in pelagic deposits from the late early Tithonian to Valanginian times, and showing a fairly uniform stratigraphic distribution all over the Tethysian Realm, from Argentina and Mexico to, at least, eastern Iran. REMANE (1963, 1971) proposed a preliminary calpionellid scheme consisting of five zones and six subzones informally named: A (A1, A2, A3), B, C, D (D1, D2, D3), and E. This biozonal scheme based on specific associations, acme, and partial and/or total ranges, has represented so far a valid zonal framework towards a homogeneous and universal calpionellid scheme, only requiring changes at the level of subzones and lower subdivisions. Subsequently several works established new calpionellid frameworks that are often inconsistent and differing from one region to another. Such discrepancies noticeably hamper the purpose of calpionellids for biostratigraphy and long-distance correlations. These discrepancies between local schemes originated from the misguided choice of zonal indices: actually quite a number of subzones are grounded on either rare species with short ranges and sporadic appearances (*e.g.*, Bermudezi, Andrusovi, Remanei, Praetintinnopsella,…), or rare and atypical forms (*e.g.*, Catalanoi, Colomi, Doliphormis,…), or abundant long-ranged taxa (*e.g.*, Longa, Remaniella, Cadischiana, Ferasini) in some stratigraphic levels that also yield species with more reliable stratigraphic value. Consequently, further consistent stratigraphical use of this fossil group requires a homogeneous framework with unambiguous definition of zones and subzones, preferably based on sound associations of two or more taxons (except for species with a typical form and a short range). The retained subzones should correspond to stratigraphic intervals wide enough to be identifiable in the widest possible geographical area. Their boundaries must correspond to major events or noteworthy changes in the composition of calpionellid assemblages. Short-duration events should be restricted to lower subdivisions. Consequently, it makes then sense to propose a coherent framework of 7 biozones, 15 subzones, and more than 5 intervals, all based upon the analysis of several dozens of sections from North Africa, France, and Iran, and the critical insights of former published works.

8. Detailed lithostratigraphy and radiolarian occurrences around the Jurassic-Cretaceous boundary in the Bosso Valley section, Central Italy

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The Bosso Valley section is located in the Umbria-Marche area of the Northern Apennines (Central Italy). The stratigraphic succession which outcrops in this area is made of several lithological units, spanning from late Triassic to Miocene, and is referred mainly to pelagic environments (except for the late Triassic-earliest Jurassic units, related to a shallow water environment). Since the Jurassic, the Umbria-Marche area was characterized mainly by carbonate sediments, with scarce terrigenous influx, deposited in a basin with topographic differences of the sea floor, due to tectonic activity. Different Jurassic stratigraphic sequences were deposited, and from the late Jurassic (Tithonian) the basinal deposits remain uniform throughout the Northern Apennines. The Maiolica Formation (Tithonian to Barremian-early Aptian) is the first pelagic and quite uniform unit, consisting of white to light gray well bedded limestones, with gray to black thin shale interbeds. Light gray to black nodules and layers of diagenetic chert are abundant. The Maiolica Formation has an average thickness of about 300 meters in the Umbria-Marche area, nevertheless there are considerable variations in thickness and facies into the basinal Maiolica sequences (ALVAREZ, 1989; CRESTA *et al.*, 1989). The bioclastic content is composed mainly of calpionellids, calcareous nannofossils, radiolarians, siliceous sponge spicules and rare ammonites. The stratigraphic transition of the Maiolica Formation with the underlying Calcari a Saccocoma ed Aptici (if present) or Calcari Diasprigni formations coincides with a major change in the pelagic environment during the late Tithonian, that caused a synchronous change in sedimentation from siliceous, or clay-rich, to calcareous, confirmed by a drastic radiolarian faunal change (BAUMGARTNER, 1984). The Jurassic-Cretaceous boundary (JKB) is recorded in the lower part of the Maiolica Formation. Radiolarians are good candidates for defining the JKB because they are widespread and can be found as both shallow and deep sedimentary facies. Evolutionary lineages of several radiolarian taxa across the JKB are reviewed and discussed by MATSUOKA *et al.* (2018).

The Bosso Valley section outcrops along the Cagli-Pianello road, following the Bosso River. This section is a potential candidate for the GGSP for the base of the Berriasian Stage (JKB) and it was studied for calpionellid biostratigraphy and magnetostratigraphy by HOUSA *et al.* (2004). The marked increase in abundance of *Calpionella alpina* at the base of the *Calpionella alpina* Subzone was accepted as the JKB primary marker in the Bosso Valley section.

In this section the Maiolica Formation yields interesting radiolarian assemblages, previously studied by KOCHER (1981), BAUMGARTNER (1984) and JUD (1994), as reported in CHIARI *et al.* (2018). Radiolarians from the Maiolica Formation are often poorly preserved, calcified in the limestone and recrystallized in the chert, but very recent detailed field observations and careful sampling revealed well-preserved radiolarians inside the limestone around the cherty layers or nodules. Three samples below and two samples above the JKB of the Bosso Valley section (according HOUSA *et al.*, 2004) were processed and new radiolarian biostratigraphic studies were carried out by LI *et al.* (2018).

ALVAREZ W. (1989).- Evolution of the Monte Nerone Seamount in the Umbria-Marche Apennines: I. Jurassic-Tertiary stratigraphy.- *Boll. Soc. geol. ital.* 108, p. 3-21.

BAUMGARTNER P.O. (1984).- A Middle Jurassic-Early Cretaceous low latitude radiolarian zonation based on the unitary associations and age of Tethyan radiolarites.- *Eclogae Geologicae Helvetiae* 77 (3), p. 729-837.

CHIARI M., BERTINELLI A., LI X. & MATSUOKA A. (2018).- Stratigraphy around the Jurassic-Cretaceous boundary in the Bosso Valley Section (Umbria-Marche Apennines, Central Italy): Geological setting, historical review and current situation.- International Meeting around the Jurassic-Cretaceous Boundary, Genève 5-7 December, abstract volume.

CRESTA S., MONECHI S., PARISI G., BALDANZA A. & REALE V. (1989).- Mesozoic-Cenozoic stratigraphy in the Umbria-Marche area. Geological field trips in the Umbria-Marche Apennines (Italy).- *Mem. descr. Carta geol. Italia* 39, 185 p.

HOUSA V., KRS M., MAN O., PRUNER P., VENHODOVA D., CECCA F., NARDI G. & PISCITELLO M. (2004).- Combined magnetostratigraphic, paleomagnetic and calpionellid investigations across Jurassic/Cretaceous boundary strata in the Bosso Valley, Umbria, central Italy.- *Cretaceous Research* 25, p. 771–785.

JUD R. (1994).- Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys.- *Mémoires de Géologie (Lausanne)* 19, 147 p.

KOCHER R.N. (1981).- Biochronostratigraphiche Unterschungen Ober jurassicher radiolarienführender Gesteine insbesondere der Südalpen.- *Mittelungen Geologisch Instut ETH und Zuric*h (N.F.) 234, 184 p.

LI_X., MATSUOKA A., BERTINELLI A. & CHIARI M. (2018).- Well preserved radiolarians across the Jurassic-Cretaceous (J/K) boundary in the Bosso Valley section, Central Italy.- International Meeting around the Jurassic-Cretaceous Boundary, Genève 5-7 December, abstract volume.

MATSUOKA A., O'DOGHERTY L., GORIČAN S., BAUMGARTNER P.O., LI X., CHIARI M. & BERTINELLI A. (2018).- Radiolarian phylogeny around the Jurassic-Cretaceous boundary and radiolarian occurrences in the Bosso Valley section, central Italy.- International Meeting around the Jurassic-Cretaceous Boundary, Genève 5-7 December, abstract volume.

9. Stratigraphy around the Jurassic-Cretaceous boundary in the Bosso Valley Section (Umbria-Marche Apennines, Central Italy): Geological setting, historical review and current situation

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The Umbria-Marche Apennines, located in the southern part of the Northern Apennines, resulted from the movement between Africa and the European plate. The Umbria Marche stratigraphic successions include Triassic-Messinian units deposited in the southern margin of Western Tethys. This basin was implicated in three different tectonic phases: extensional in the Mesozoic, compressional in the

Neogene and extensional again starting in late Miocene (MENICHETTI & PIALLI, 1986; MENICHETTI, 2016).

In this work we present a historical review and the current situation of the Bosso section (Umbria-Marche Apennines), which is located near the town of Pianello along the Bosso valley. This section is particularly important because it is one of the candidates for the GGSP for the J/K boundary and it was studied for calpionellid biostratigraphy and magnetostratigraphy by HOUSA *et al.* (2004).

The J/K boundary was recorded in the lower part of the Maiolica Formation, which started in the Tithonian and is characterized by whitish, beige and gray pelagic limestones with black and gray cherts. The contact with the underlying Calcari ad Aptici Formation is transitional and represents an important environmental change.

In particular, we present a historical review of the radiolarian biostratigraphy of the Bosso Valley section published in the last 37 years. The first paper describing radiolarians was published by KOCHER (1981) and the data were re-examined by BAUMGARTNER (1984). Successively, JUD (1994) sampled the Tithonian-Barremian interval in the Bosso valley. These data were included in the database utilized for the radiolarian zonation proposed by BAUMGARTNER *et al.* (1995). Recently a detailed radiolarian biostratigraphic study was carried out by LI *et al.* (2018).

BAUMGARTNER P.O. (1984).- A Middle Jurassic-Early Cretaceous low latitude radiolarian zonation based on the unitary associations and age of Tethyan radiolarites.- *Eclogae Geologicae Helvetiae* 77 (3), p. 729-837.

BAUMGARTNER P.O., BARTOLINI A., CARTER E.S., CONTI M., CORTESE G., DANELIAN T., DE WEVER P., DUMITRICA P., DUMITRICA-JUD R., GORIČAN Š., GUEX J., HULL D.M., KITO N., MARCUCCI M., MATSUOKA A., MURCHEY B., O'DOGHERTY L., SAVARY J., VISHNEVSKAYA V., WIDZ D. & YAO A. (1995).- Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys based on Unitary Associations. *In*: BAUMGARTNER P.O., O'DOGHERTY L., GORIČAN Š., URQUHART E., PILLEVUIT A. & DE WEVER P. (Eds.), Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, systematics, biochronology.- *Mémoires de Géologie (Lausanne*) 23, p. 1013-1048.

HOUSA V., KRS M., MAN O., PRUNER P., VENHODOVA D., CECCA F., NARDI G. & PISCITELLO M. (2004).- Combined magnetostratigraphic, paleomagnetic and calpionellid investigations across Jurassic/Cretaceous boundary strata in the Bosso Valley, Umbria, central Italy.- *Cretaceous Research*, vol. 25, p. 771-785.

LI X., MATSUOKA A., BERTINELLI A. & CHIARI M. (2018).- Well preserved radiolarians across the Jurassic-Cretaceous (J/K) boundary in the Bosso Valley section, Central Italy.- International Meeting around the Jurassic-Cretaceous Boundary, Genève 5-7 December, abstract.

KOCHER R.N. (1981).- Biochronostratigraphiche Unterschungen Ober jurassicher radiolarienführender Gesteine insbesondere der Südalpen.- *Mittelungen Geologisch Instut ETH und Zuric*h (N. F.) 234, 184 p.

JUD R. (1994).- Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys.- *Mémoires de Géologie* (Lausanne), vol. 19, 147 p.

MENICHETTI M. & PIALLI G. (1986).- Geologia strutturale del preappennino umbro tra i Monti di Gubbio e la catena del M. Petrano-M. Cucco (Appennino Umbro-marchigiano).- *Memorie della Società Geologica Italiana* 35, p. 371-388.

MENICHETTI M. (2016).- Early Cretaceous tectonic event in the Adria: Insight from Umbria-Marche pelagic basin (Italy). *In*: MENICHETTI M., COCCIONI R. & MONTANARI A. (eds.), The Stratigraphic Record of Gubbio: Integrated Stratigraphy of the Late Cretaceous-Paleogene Umbria-Marche Pelagic Basin.- *Geological Society of America Special Paper* 524, p. 35-55.

10. Stratigraphic and geodynamic characterization of the Jurassic-Cretaceous «red beds» of Errachidia-Msmrir transverse (central High Atlas, Morocco)

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The Moroccan central High Atlas is characterized by a special structural form characterized by many large syncline bowls separated by a set of narrow anticlines. The middle Jurassic-lower Cretaceous «red beds» are deposited in the center of these synclines, with unconformable contact on the underlying carbonate formations of the lower and middle Jurassic. Formed by three superposed units (JENNY *et al.*, 1981), the Guettioua Formation, the Iouaridène Formation and the Jbel Sidal Formation, these « red beds »had been attributed to different ages from the middle Jurassic to the early Cretaceous (infra-Cenomanian). This paper is interested in the description and interpretation of these beds in order to correlate sections of different locations of these red sediments, from Errachidia in the east to Msmrir in the west, going through Imilchil. Five sections have been logged at different locations, following the following E-W transverse: Zaabel, Errachidia, Tadighoust, Msmrir and Imilchil. From east to west, some differences are highlighted. The western sections are thicker. In the west the facies are more clayey, with many sandstone beds. The sandstone deposits in the Msmrir and Imilchil sections show some dinosaur bones and plant remains, as well as trace-fossils, such as dinosaur footsteps.

JENNY J., LE MARREC A. & MONBARON M. (1981).- Les couches rouges du Jurassique moyen du Haut Atlas central (Maroc) : Corrélation lithostratigraphiques, éléments de datation et cadre tectono-sédimentaire.- *Géobios*, 14, 427-631.

11. The Jurassic-Cretaceous is at an impasse: Why not go back to OPPEL's original and historic definition of the Tithonian (1865)?

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The questions of the highest Jurassic stage and that of the Jurassic-Cretaceous boundary were first discussed during two Jurassic Colloquia, Luxembourg 1 (1962) and Luxembourg 2 (1967) and again in the Cretaceous Colloquium in Lyon (1963). The Lyon-Neuchâtel (1973) Colloquium was devoted to the second item. Following these discussions, according to ICS (International Commission on Stratigraphy) regulations, is the objective was to fix a boundary at a point in a section providing a well-defined standard. Such GSSP (Global Stratotype Sections and Points) are most commonly defined at a biostratigraphical marker point. Thus, only the International Subcommission of

Cretaceous Stratigraphy (ISCS) and within this the Berriasian Working Group are permitted to define the lowest stage of the Cretaceous and the Jurassic-Cretaceous boundary. In 2007 the Group initiated a new phase of activity.

The Tithonian Stage defined by OPPEL (1865) was accepted as the highest stage of the Standard Jurassic Time Scale at the International Congress of the ISJS in Poitiers (1991) and subsequently confirmed by the ICS. Although no GSSP has been selected as yet, the lower boundary was accepted as the base of the Lithographicum / Hybonotum Zone of the Tethysian Zonal scheme and equivalents in other provincial zonal schemes. The upper boundary will be at the base of the overlying unit. But what precisely is this unit and what is its position according to the Jurassic-Cretaceous boundary?

On the other hand the Jurassic-Cretaceous problem has been pending and awaiting a proposal likely to obtain a large acceptance. This issue persists in spite of new global data from multiple disciplines other than ammonite biostratigraphy: micropaleontology, magnetostratigraphy, sequence stratigraphy (WIMBLEDON, 2008, 2017; WIMBLEDON *et al.*, 2011).The reason for this impasse is the deep provincialism of the ammonite faunas and other groups between the Boreal and Tethysian Realms (also within them), which developed beginning in the late Oxfordian onwards. This was also a time of connection of large expanses of non-marine environments (*e.g.*, Purbeck, Wealden).

KILIAN scheme: Tithonian-Berriasian boundary is the Jurassic-Cretaceous boundary

For many decades the definition of the Jurassic-Cretaceous boundary has been an age-old correlation enigma (WIMBLEDON, 2008). Perhaps the reason is that it was defined loosely. Other criteria were possible (discussed later), but the issue dates back to the time when the stages were first defined. Only a few years separate the definitions of the Tithonian (OPPEL, 1865) and Berriasian (COQUAND, 1871) stages. In contrast to the other stages around the Jurassic-Cretaceous boundary (*e.g.*, Portlandian, Volgian, Ryazanian, Purbeck, and Wealden), the Tithonian was not defined from a stratotype, but instead OPPEL listed numerous localities in Central and Southern Europe, S Germany and SE France, with original ammonite faunas and other biota, which were published after OPPEL's death by his pupil, K. von ZITTEL (1868, 1870).

However, rock sequences in SE France were well-studied and as early as 1846 the Berrias Limestones were known by MALBOS & DUMAS and already classified as the earliest stage of the «Neocomian». By 1868 COQUAND noted the «Berriasian (ammonite) fauna», which would be described by PICTET by 1867. Thus, in spite of TOUCAS (1888, 1889, 1890), HAUG (1898) and LAPPARENT (1892), the prevailing scheme would be the KILIAN one (1890, 1891, 1907, 1910), in which the Jurassic-Cretaceous boundary was identified as the Tithonian-Berriasian boundary. That scheme would be amplified by the MAZENOT's monograph (1939) on the Tithonian and Berriasian ammonites, REMANE's studies (1963, 1968) on calpionellids, and LE HÉGARAT's (1968, 1973) exhaustive study of the Berriasian of SE France. But a quite different interpretation of the Jurassic-Cretaceous boundary and the age of the Berriasian stage is possible if the original definition of the Tithonian by OPPEL (1865) is considered.

Original Tithonian definition and two schemes of the Jurassic-Cretaceous boundary

OPPEL defined the Tithonian (1865, p. 535) as «… a particular formation group located between the stage of Kimmeridge and the deepest Neocomian layers, which I call this Tithonian Stage, in order to indicate the relationship of this group of layers to the Cretaceous formations that begin immediately above». This definition of the lower boundary of the Tithonian is ambiguous because of two later meanings of the Kimmeridgian Stage (sensu anglico vs sensu gallico). However the quoted faunas are undoubtedly those of the highest zone of the Kimmeridgian Stage. However, definition of the upper boundary, which is the overlying marls with pyritic fossils of Valanginian age in SE France, is not ambiguous.

COQUAND's Berriasian (1871) is not defined any better. The Berriasian name was derived from a locality at Berrias, and it is based on the «Calcaires de Berrias» Formation, which already was assumed to be part of the Neocomian Stage (MALBOS & DUMAS, 1846). Its fauna was described by PICTET (1867) and was named the «Berriasian Fauna» by COQUAND (1869). Thus the question of the position of the Berriasian was posed early.

On one side are those who considered the Berriasian to be part of the Jurassic (HAUG, 1898; LAPPARENT, 1892a, b; and particularly TOUCAS, 1889, 1890, 1908), and divided the Tithonian into three substages, lower, middle (= Ardescian TOUCAS, 1890) and upper Tithonian or Berriasian.

On the other side, according to MALBOS & DUMAS (1846) and COQUAND (1869, 1871), are those who accepted the Berriasian as the first Cretaceous stage (or substage within the Valanginian Stage), particularly KILIAN (1890-1891, 1907, 1910) the scheme of which was confirmed by MAZENOT (1939, 1957), BUSNARDO *et al.* (1963), BARBIER & THIEULOY (1963, REMANE (1963, 1968), LE HÉGARAT & REMANE (1968), LE HÉGARAT (1965, 1973), DONZE & LE HÉGARAT (1965, 1966, 1972), and BARTHEL *et al.* (1973).

Brief review of the TOUCAS scheme and the Lyon-Neuchâtel Colloquium (1973)

The TOUCAS proposal re-appeared in 1967 (WIEDMANN, 1967, 1968, 1971) and at the Lyon-Neuchâtel Colloquium (1973) on the Jurassic-Cretaceous boundary (WIEDMANN, 1974, 1980; DRUSCHICHTS, 1969, 1975; Geyer, 1983). At the same time the Ardescian Stage was resurrected, but WIEDMANN and DRUSCHICHTS did not agree on the original meaning. A modern revision of the Ardescian stratotype was presented later (ÉNAY, 1980; CECCA, 1986; CECCA *et al.*, 1988; ÉNAY *et al.*, 1989a, b; JAN DU CHÊNE *et al.*, 1993), but the Ardescian was considered only as part of the Tithonian *s.l.,* the Berriasian being included as well.

However, this return to the TOUCAS scheme had little impact, save the motions submitted during the Lyon-Neuchâtel Symposium on the Jurassic-Cretaceous boundary, which included Motion III by J. FLANDRIN, R. ÉNAY, J.-P. THIEULOY, G. LE HÉGARAT and V. DRUSCHICHTS and motion XII by A. ZEISS (Mémoire du B.R.G.M., 86, p. 388-389).

Motion III, with three proposals: (i) the Tithonian-Berriasian boundary at the base of the Jacobi / Grandis Zone and the Calpionellids B Zone; (ii) Berriasian-Valanginian boundary at the base of the Pertransiens Zone; (iii) The Jurassic-Cretaceous boundary situated at the base of the Valanginian.

Motion XII: Tithonian is the upper stage of the Jurassic system and is divided into four substages: *Danubian* (Hybonotum-Palatinum zones), *Neuburgian* (Bavaricum zone s.*l.* = Semiforme-Ponti zones), *Ardescian* (Microcanthum-Durangites zones*= Transitorius zone *s.l.*; Calpionellid A zone) and *Berriasian* (Jacobi-Boissieri zones; B-D Calpionellids zones» (*Presently: Andreaei zone).

Long discussion at the end of the Symposium resulted in the submission of 12 motions, which were too numerous to be discussed during the session. Thus an inquiry was decided and organized after the meeting on (i) the motions and (ii) on the Jurassic-Cretaceous boundary.

Of the 120 questionnaires sent around, the Jurassic-Cretaceous boundary gathered 84 votes, but only 70 concerned the motions. The results concerning motion III were:

Motion III itself: 22 favorable votes;

- Proposal 1 (Tithonian-Berriasian boundary): 52 favorable votes;
- Proposal 2 (Berriasian-Valanginian boundary): 73 favorable votes;
- Proposal 3 (Jurassic-Cretaceous boundary): 18 favorable votes (as opposed to 33 favorable to the boundary at the base of the Jacobi / Grandis Zone).

Since the 1973 Lyon-Neuchâtel Symposium progress has been made but until now no decision has been taken and no GSSP has been fixed. Thus it is time to review the evidence for and advantages of placing the Jurassic-Cretaceous boundary at the bottom of the Valanginian Stage (*i.e.*, the Pertransiens zone).

Why the Jurassic-Cretaceous should not be at the base of the Valanginian Stage?

First, when concluding his monograph and about the Berriasian and the Jurassic-Cretaceous boundaries, Le Hégarat himself (1973, p. 297) stated emphatically that *« aucun renouvellement important de faune ne se produit à la limite Tithonique-Berriasien. Seules s'observent des fluctuations au sein des genres et des espèces ».* Likewise the calpionellids are only impoverished, without any major change across the boundary, which is placed in the middle of the Calpionella Zone (Zone B). So, concerning both the ammonites and the calpionellids, *« Le passage Tithonique-Berriasien est mal caractérisé paléontologiquement car aucun changement fondamental ne se produit à son niveau »* and further *« il est cependant certain que les faunes du Tithonien terminal et les faunes du Berriasien sont intimement liées* »

In revising the Ardescian type-section Cecca (1986) and Cecca *et al.* (1988, 1989a, b) proposed that a new definition of its stratigraphic range should correspond to the Microcanthum and Durangites (recte Andreaei) zones, *i.e.*, upper Tithonian, based on recent studies of the Le Chouët section in the Vocontian basin (Wimbledon *et al.*, 2013; Bulot *et al.*, 2014). These authors agree that the change between highest Tithonian Andreaei Zone and the lowest Berriasian Jacobi / Grandis Zone is of a usual level for consecutive zones, *i.e.*, without a sharp break.

In contrast, Le Hégarat (1973, p. 297) wrote that «*contradistinction is strikingly with what it is noted at the Berriasian-Valanginian boundary*». According to Le Hégarat (1973, p. 295), the boundary between the highest Berriasian zone and subzone (Boissieri Zone, Callisto Subzone) and the lowest Valanginian zone and subzone (Roubaudi Zone, Pertransiens Subzone) is «*a well-marked discontinuity between Berriasian and Valanginian*», and further «*the changes in the faunas are rude*». He suggested that external events would have strengthened the efficiency of that change, but it is asserted that «*these are added to deep and irreversible* *biological changes: nearly all the Tithonian and Berriasian ammonite genera have disappeared above the Berriasian-Valanginian boundary».* As noted by BLANC *et al.* (1994), many authors (*e.g.*, LE HÉGARAT & REMANE, 1968; HOEDEMAEKER, 1982; BUSNARDO & THIEULOY, 1979) have underlined that the Berriasian-Valanginian boundary is disturbed by sedimentological events (gap, slumps), but they did not use the same zonal scheme. The proposal by BULOT *et al.* (1993) to place the Berriasian-Valanginian boundary at the base of the Pertransiens Zone would be strengthened by the first occurrence at about the same level of *Calpionellites darderi* (= base of the *Calpionellites* Zone).

To conclude, a decision to use the Berriasian-Valanginian boundary as the Jurassic-Cretaceous boundary (i) would end decades of as yet unsuccessful discussions, (ii) would provide easier and larger possibilities for world-wide correlation and (iii) would be in better agreement with the original and historic definition of OPPEL's definition of the Tithonian Stage, while the concept of a Berriasian Stage as a normal integral part of the Tithonian of OPPEL is preserved.

BARBIER R. & THIEULOY J.-P. (1963. Rapport sur l'étage Berriasien.- *Mémoires du Bureau de Recherches* Géologiques et Minières, 34, p. 69-77.

BARTHEL K.W., REMANE J. & ZEISS A. 1973. Das Jura/Kreide-Grenzproblem: Empfehlungen der stratigraphischen Subkomissionen für die Jura- und Kreide-System der Bundesrepublik Deutschland.- *Newsletters on Stratigraphy*, Leiden, 2 (3), p. 163-168.

BLANC É., BULOT L.G. & PAICHELER J.-C. *et al.* (1994).- La coupe de référence de Montbrun-les-Bains (Drôme, SE France) : Un stratotype potentiel pour la limite Berriasien-Valanginien.- *Comptes-Rendus de l'Académie des Sciences*, Paris, 318 (2), p. 101-108

BULOT L.G., BLANC É., THIEULOY J.-P. & REMANE J. (1993). - La limite Berriasien-Valanginien du Sud-Est de la France, données biostratigraphiques nouvelles.- *Comptes-Rendus de l'Académie des Sciences*, Paris, (2), 316, p. 1771-1778.

BULOT L.G., FRAU C. & WIMBLEDON W.A.P. (2014).- New and poorly known Perisphinctoidea (Ammonitina) from the Upper Tithonian of Le Chouet (Drôme, SE France).- *Volumina Jurassica*, vol. 12 (1), p. 113-128.

BUSNARDO R. & THIEULOY J.-P. (1979).- Les zones d'ammonites du Valanginien.- *Les stratotypes français*, 7, p. 58-68.

BUSNARDO R., LE HÉGARAT G. & MAGNÉ J. (1963).- Le stratotype du Berriasien.- *Mémoires du Bureau de Recherches Géologiques et Minières*, 34, p. 5-33, 3 fig., 6 tab.

CECCA F. (1986).- Le Tithonique de la bordure ardéchoise dans la région du stratotype de l'Ardescien : Étude stratigraphique et paléontologique.- *Documents du Laboratoire de Géologie*, Lyon, 272 p. (24 Pls.).

CECCA F., ÉNAY R. & LE HÉGARAT G. (1988).- The Tithonian of Ardèche (South-East France): New stratigraphical data and significance of the Ardescian Stage (or Substage). *In*: 2nd International Symposium on Jurassic Stratigraphy, Lisboa 1985.- Geological Survey of Denmark, Copenhagen, vol. I, p. 585-607.

CECCA F., ÉNAY R. & LE HÉGARAT G. (1989a).- The Tithonian of Ardèche (South-East France): New stratigraphical data and revision of the type-section of the « Ardescian » (TOUCAS, 1890).- *Newsletters on Stratigraphy*, Berlin-Stuttgart, 20(3), p. 115-129.

CECCA F., ÉNAY R. & LE HÉGARAT G. (1989b).- L'Ardescien (Tithonique supérieur) de la région stratotypique : Séries de référence et faunes (ammonites, calpionelles) de la bordure ardéchoise.- *Documents du Laboratoire de Géologie*, Lyon, 107, 115 p. (6 Pls.).

COQUAND H. (1869).- Nouvelles considérations sur les calcaires jurassiques à Diceras du Midi de la France, en réponse à la note de Hébert du 9 novembre 1868.- *Bulletin de la Société géologique de France* (2), 27, p. 73.

COQUAND H. (1871).- Sur le Klippenkalk du département du Var et des Alpes maritimes.- *Bulletin de la Société géologique de France*, 28, p. 232.

DRUSCHICHTS V.V. (1974).- The Berriasian of the Crimea and its stratigraphical relations. Colloque sur la limite Jurassique-Crétacé, Lyon-Neuchâtel, 1973.- *Mémoires du Bureau de Recherches Géologiques et Minières*, Orléans, 86, p. 337-341.

ÉNAY R. (1980).- Ardescien. *In*: CAVELIER C. & ROGER J. (eds.), Les étages Français et leurs stratotypes.- *Mémoires du Bureau de Recherches Géologiques et Minières*, 190, p. 92-95.

HAUG E. (1898).- Portlandien, Tithonique et Volgien.- *Bulletin de la Société géologique de France*, 26, p. 197-228.

HOEDEMAEKER P.J. (1982).- Ammonite biostratigraphy of the upppermost Tithonian, Berriasian and lower Valanginian along the Rio Argos (Caravaca, SE Spain).- *Scripta Geologica*, 65, p. 1-81.

JAN DU CHÊNE R., BUSNARDO R., CHAROLLAIS J., CLAVEL B., DECONINCK J.-F., EMMANUEL L., GARDIN S., GORIN G., MANIVIT H., MONTEIL E., RAYNAUD J.-F., RENARD M., STEFFEN D., STEINHAUSER N., STRASSER A., STROH-

MENGER C. & VAIL P.R. (1993).- Sequence-stratigraphic interpretation of Upper Tithonian-Berriasian reference sections in South-East France: A multidisciplinary approach.- *Bulletin du Centre de Recherche Exploration-Production elf Aquitaine*, 17(1), p. 151-181 (4 Pls.).

KILIAN W. (1890-1891).- Notes sur les couches les plus élevées du terrain jurassique et de la base du Crétacé inférieur dans la région delphino-provençale.- *Travaux du laboratoire de Géologie de Grenoble*, 1, p. 161-180.

KILIAN W. (1896).- Notice stratigraphique sur les environs de Sisteron.- *Bull. Soc. geol. France*, Paris (3) 23 (1895), p. 659-803,

KILIAN W. (1907-1913).- Unterkreide (Palaeocretacicum). Lethaea geognostica, II. Mesozoicum, 3 (Kreide), 1. Abt., 398 p.

KILIAN W. (1910).- La faune des couches à *Hoplites boissieri* (PICTET) (Berriasien *p. p.* = Valanginien inférieur) du Sud-Est de la France.- Association française pour l'avancement des Sciences, Congrès de Lille, p. 476-496.

LAPPARENT A. de. (1892).- Traité de Géologie, 2ème édit.- Savy Ed. Paris, 280 p.

LAPPARENT A. de. (1892).- Traité de Géologie, 3ème édit.- Masson Ed. Paris, 2 vols, p. 1-567 + 579-1645.

LE HÉGARAT G. (1973).- Le Berriasien du Sud-Est de la France.- *Documents du Laboratoire de Géologie, Lyon*, 43, fasc. 1 : p. 1-138 (Pls. 1-53); fasc. 2: p. 309-576 (Pls. 54-55).

LE HÉGARAT G. (1980).- Berriasien. In : CAVELIER C. & ROGER J. (eds.), Les étages Français et leurs stratotypes.- *Mémoires du Bureau de Recherches Géologiques et Minières*, 190, p. 96-105.

LE HÉGARAT G. & REMANE J. (1968).- Tithonique supérieur et Berriasien de l'Ardèche et de l'Hérault. Corrélation des ammonites et des calpionnelles.- *Geobios*, Lyon, 1, p. 7-70.

MAZENOT G. (1939).- Les Palaeohoplitidae tithoniques et berriasiens du Sud-Est de la France.- *Mémoires de la Société géologique de France*, 18 (41), 303 p. (40 Pls.).

MAZENOT G. (1957).- Berriasien.- *Lexique stratigraphique international*, I, 4a VI, p. 56-58.

PICTET F. J. (1867).- Études paléontologiques sur la faune à Terebratula dyphioides de Berrias (Ardèche). Mélanges paléontologiques. Bâle, 2, p. 43-130.

REMANE J. (1963).- Les calpionelles dans les couches de passage du Jurassique au Crétacé en « fosse vocontienne ».- *Travaux du Laboratoire de Géologie de Grenoble*, 39, p. 26-82 (6 Pls.).

TOUCAS A. (1888).- Note sur le Jurassique supérieur et le Crétacé inférieur de la vallée du Rhône.- *Bulletin de la Société géologique de France*, (3), 16, p. 903-930.

TOUCAS A. (1889).- Nouvelles observations sur le Jurassique supérieur de l'Ardèche.- *Bulletin de la Société géologique de France*, (3), 17, p. 729-742.

TOUCAS A. (1890).- Étude de la faune des couches tithoniques de l'Ardèche.- *Bulletin de la Société géologique de France*, (3), 18, p. 560-630 (Pls. 13-18).

TOUCAS A. (1908).- Sur le Tithonique et le Berriasien et réponse à une observation de W. KILIAN.- *Bulletin de la Société géologique de France*, (4), 8, p. 25-27.

WIEDMANN J. (1967).- Die Jura/Kreide-Grenze und Fragen stratigraphische Nomenklatur.- *Neues Jahrbuch für Geologie und Palaeontologie Mittheilungen*, Stuttgart, 12, p. 736-746.

WIEDMANN J. (1968).- Das Problem stratigraphischer Grenzbiehung und die Jura Kreide Grenze.- *Eclogae geologicae Helvetiae*, Basel, 61, p. 321-386.

WIEDMANN J. (1971).- Zur Frage der Jura/Kreide-Grenze. *In*: Colloque sur le Jurassique méditerranéen, Budapest, 1969.- *Annales Institut Geologici Hungarici*, Budapest, 54(2), p. 149-154.

WIEDMANN J. (1980).- El limite Jurasico-Cretacico: Problemas y soluciones.- Actas II Congreso Argentino de Paleontologia y Bioestratigrafia y I Congreso Latinoamericano de Paleontologia. Buenos Aires, 1978. 5, p. 103-120.

WIMBLEDON W.A.P. (2008).- The Jurassic-Cretaceous boundary: An Age-old correlative enigma.- *Episodes*, 31 (4), p. 423-428.

WIMBLEDON W.A.P. (2017).- Developments with fixing a Tithonian/Berriasian (J/K).- *Volumina Jurassica*, vol. XV, p. 181-186.

WIMBLEDON W.A.P., CASELLATO C.E., REHÁKOVÁ D., BULOT L.G., ERBA E., GARDIN S., VERREUSSEL R.M.C.H., MUNSTERMAN D.K. & HUNT C.O. (2011).- Fixing a basal Berriasian and Jurassic-Cretaceous (J/K) boundary - Is there perhaps some light at the end of the tunnel? *Rivista Italiana di Paleontologia e Stratigrafia*, 117 (2), p. 295-307.

WIMBLEDON W.A.P., REHAKOVA D., PSZCZÓŁKOWSKI A., CASELLATO C.E., HALÁSOVÁ E., FRAU C., BULOT L.G., GRABOWSKI J., SOBIEŃ K., PRUNER P., SCHNABL P. & ČÍŽKOVÁ K. (2013).- An account of the bio- and magnetostratigraphy of the Upper Tithonian-Lower Berriasian interval at Le Chouet, Drôme (SE France).- *Geologica Carpathica*, 64 (6), p. 437-460.

ZITTEL K.A. von (1868).- Palaeontologische Studien über die Grenz-schichten der Jura und Kreide-Formation im Gebiete der Karpathen, Alpen und Apenninnen. 1, Die Cephalopoden der Stramberger Schichten.- *Palaeontologische Mittheilungen der Bayerische Staatsamlung* 2, vii + 118 p. (Pls. 1-24).

ZITTEL K.A. von (1870).- Palaeontologische Studien über die Grenz-schichten der Jura und Kreide-Formation im Gebiete der Karpathen, Alpen und Apenninnen. 2, Die Fauna der älteren Cephalopoden fuehrenden Tithonbildungen.- *Palaeontologische Mittheilungen der Bayerische Staatsamlung* 2, p. 119-311 (Pls. 25-39).

12. Looking for the Jurassic-Cretaceous system boundary in the Vocontian Trough (S-E France): Sedimentological problems

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Resedimented conglomerates and slump deposits coming from the slopes of the Vocontian Trough are widespread in the corresponding basinal successions (FERRY & GROSHENY, 2013; FERRY, 2017). The maximum stratigraphic extent of a first pulse of redeposited sediments in this basin spans the uppermost Oxfordian to the lower Berriasian. This prevents the identification of a continuous succession spanning the Tithonian-Berriasian transition in most of the basinal sections. Recently, several sections of the upper Drôme River valley have been studied by several authors to improve the ammonite biostratigraphy. It should be remembered that all these sections are located on the left side of a breccia lobe about 50 km long and 20 km wide, running approximately along the present-day Drôme River valley (COURJAULT *et al.*, 2011). The thickest breccia accumulation is within the lower Tithonian. The degree of reworking diminishes in size and frequency during the deposition of the basinal equivalent of the upper Tithonian-lower Berriasian «Calcaires Blancs», originally defined on the western border of the basin. It should also be remembered that hiatuses which cannot be identified in the field are frequent, like the one in the middle of a limestone bed which imperceptibly superimposes Berriasian limestone over upper Kimmeridgian limestone (FERRY *et al.*, 2015, Fig. 8). This is true even in successions devoid of resedimented bodies like in the Angles section (LE HEGARAT & FERRY, 1990), better known for hosting the Barremian hypostratotypic section. The best basinal area for finding an adequately exposed and continuous stratigraphic succession in this basin is probably in the vicinity of the Veynes village (FERRY *et al.*, 2015, Fig. 3). According to COURJAULT *et al.* (2011), this location corresponds to the tail of the Drôme River lobe, in an area overhanging a deeper submarine terrace where the gully-connected breccia lobe of Céüse (FERRY *et al.*, 2015) is located.

COURJAULT T., GROSHENY D., FERRY S. & SAUSSE J. (2011).- Detailed anatomy of a deep-water carbonate breccia lobe (Upper Jurassic, French subalpine basin).- *Sedimentary Geology*, vol. 238, no. 1-2, p. 156-171.

FERRY S. (2017).- Summary on Mesozoic carbonate deposits of the Vocontian Trough (Subalpine Chains, SE France). *In*: GRANIER B. (ed.), Some key Lower Cretaceous sites in Drôme (SE France).- *Carnets de Géologie*, Madrid, CG2017_B01, p. 9-42.

FERRY S. & GROSHENY D. (2013).- Turbidites et brèches carbonatées (Jurassique et Crétacé du bassin subalpin).- Livret-Guide Excursion ASF-GFC, 20-23 septembre 2013, 101 p. URL: http://hal.archivesouvertes.fr/docs/00/90/81/77/PDF/2013_Turbidites_SE_ExcuGFC.pdf

FERRY S., GROSHENY D., ATROPS F. & BACKERT N. (2015).- The base-of-slope carbonate breccia system of Céüse (Tithonian, S-E France): Occurrence of progradational stratification in the head plug of coarse granular flow deposits.- *Sedimentary Geology*, vol. 317, p. 71-86.

LE HÉGARAT G. & FERRY S. (1990).- Le Berriasien d'Angles (Alpes-de-Haute-Provence).- *Geobios*, vol. 23, no. 3, p. 369-373.

13. Berriasian ammonites from the type «Ryazanian» (Central Russia) of supposed Tethysian origin: A systematic re-interpretation

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In the past fifteen years, a number of ammonite taxa of supposed Tethysian origin or affinity were reported from the Berriasian condensed deposits of Central Russia (regionally referred to as "Ryazanian"). These occurrences have been used to constrain long-distance correlation and paleobiogeographic interpretation of the Russian Platform during the earliest Cretaceous. We revise these taxa herein. We provide re-assessment for the genera *Riasanella*, *Riasanites* (= *Subriasanites*), *Prorjasanites* and *Karasyazites*. To accommodate the systematic issues, we introduce a new ammonite genus: *Mittaites* gen. nov. (type species *Mazenoticeras ceccai*). Considering the strong affinities between these genera (except with *Karasyazites*), their restricted paleobiogeographic distribution and a potential phyletic origin from the *Gechiceras*-*Tauricoceras* lineage, we propose the introduction of the new family Riasanitidae fam. nov. Our re-examination suggests that the occurrence of Tethysian migrants in Central Russia should be ruled out. Pending new investigation, correlation of the Ryazanian-type beds with the Standard Mediterranean Ammonite Scale (SMAS) for the Berriasian Stage should be regarded with caution.

14. Correlation of low-latitude radiolarian-bearing pelagic lithofacies around the Jurassic-Cretaceous boundary

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Calpionellids have been considered as the stratigraphically most important fossils to define the Jurassic-Cretaceous boundary and, after the formal vote in 2016, the base of the Calpionella Zone (Alpina Subzone) was accepted as the primary marker for the Berriasian Stage. The occurrence of calpionellids is restricted to micritic cherty limestone known as the Maiolica (or Biancone) limestone from classical localities in the Southern Alps. The first appearance of true calpionellids in the upper Tithonian Crassicollaria Zone coincides with the base of the Maiolica limestone which is located below but close to the Jurassic-Cretaceous boundary. Radiolarians allow us to study a longer continuous interval around the boundary since they are common in the Maiolica-type limestone and also in the underlying lime-poor to lime-free siliceous deposits.

A distinct facies change in Tithonian pelagic successions is best known from the Alpine-Mediterranean region but is not limited to this region and is not everywhere manifested in a change from chert- to carbonate-dominated lithologies. Starting from the western North Atlantic (DSDP Site 534), greyish red calcareous claystone is replaced by nannofossil-radiolarian limestone and chalk at this level. In the western Tethys including the Alps, Carpathians, Apennines and Dinarides-Hellenides, bedded radiolarian chert (or highly siliceous Rosso ad Aptici limestone) is overlain by the Maiolica-type limestone. Eastwards in the Neotethys, the proportion of silica in the upper Tithonian to lower Cretaceous deposits increases significantly. From the Koçali Complex in eastern Turkey to the Yarlung-Zangbo Suture Zone in southern Tibet, the deep-water Jurassic and Cretaceous successions are lime-free radiolarites. Where the Jurassic-Cretaceous transition is well exposed and tectonically undisturbed, *e.g.* in the Zagros Mountains in Iran, siliceous claystone prevails in upper Jurassic radiolarites but only pure bedded chert characterizes the upper Tithonian-lower Cretaceous interval. An identical upper Tithonian-lower Cretaceous radiolarite facies with no clay and no carbonate admixture occurs in the distal sections of the Hawasina Nappes in Oman; coeval sections of topographically higher areas of the same depositional basin are characterized by Maiolica-type micritic limestone. The sections in Oman are important for the comparison of different upper Tithonian-lower Cretaceous facies within a single basin but are less suitable to study vertical facies changes because a tectonically-induced stratigraphic gap occurs just below the upper Tithonian deposits. If we continue further east from the Neotethys to the western Pacific (ODP Leg 129, Site 801) the Jurassic-Cretaceous sediments are also fully siliceous and the proportion of clay varies; the lower Tithonian radiolarite contains a considerable amount of clay whereas in the upper Tithonian the amount of clay is reduced.

A clearly marked intra-Tithonian facies change is globally synchronous and can be traced from the Atlantic across the Alps and the Himalayas to the Pacific. It is reflected in a drastic increase of pelagic carbonate and in decrease of clay content. In deeper-water successions that are devoid of carbonate, the decrease of clay content is considerable and easy to recognize. Higher in the successions, no obvious facies change is recorded at the Jurassic-Cretaceous boundary. According to the so far established radiolarian zones (for a review on Mesozoic zonations see GORIČAN *et al.*, in press), the transition between the different facies corresponds to the boundary between two radiolarian zones, namely between the Unitary Association zones 12 and 13 of BAUMGARTNER *et al.* (1995), and between the *Pseudodictyomitra primitiva* Zone and the *Pseudodictyomitra carpatica* Zone of MATSUOKA (1995). The Jurassic-Cretaceous boundary is indistinct and lies within the Unitary Association Zone 13 and within the *Pseudodictyomitra carpatica* Zone. The intra-Tithonian boundary is thus more pronounced in facies change and in faunal break than the Jurassic-Cretaceous boundary as it is currently defined.

BAUMGARTNER P.O., BARTOLINI A., CARTER E.S., CONTI M., CORTESE G., DANELIAN T., DE WEVER P., DUMITRICA P., DUMITRICA-JUD R., GORIČAN Š., GUEX J., HULL D.M., KITO N., MARCUCCI M., MATSUOKA A., MURCHEY B., O'DOGHERTY L., SAVARY J., VISHNEVSKAYA V., WIDZ D. & YAO A. (1995).- Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys based on Unitary Associations. *In*: BAUMGARTNER P.O., O'DOGHERTY L., GORIČAN Š., URQUHART E., PILLEVUIT A. & DE WEVER P. (Eds.), Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, systematics, biochronology.- *Mémoires de Géologie (Lausanne)* 23, p. 1013-1048.

GORIČAN Š., O'DOGHERTY L., BAUMGARTNER P.O., CARTER E.S. & MATSUOKA A. (in press) - Mesozoic radiolarian biochronology - current status and future directions. - *Revue de micropaléontologie*.

MATSUOKA A. (1995).- Jurassic and Lower Cretaceous radiolarian zonation in Japan and in the western Pacific.- *The Island Arc* 4, 140-153.

15. A continuous stratigraphical record of the upper Kimmeridgian to lower Berriasian paleoenvironmental changes in a pelagic setting: The Veliky Kamenets section (Pieniny Klippen Belt, Ukraine)

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Integration of magnetic stratigraphy with bio- and chemostratigraphy gives a good opportunity to create a high resolution chronostratigraphic framework with a potential for global correlation of sedimentary and biotic events. Pelagic and hemipelagic sediments are especially suitable for tracing long term paleoenvironmental changes. The upper Jurassic and lower Cretaceous deep marine sediments of the Pieniny Klippen Belt (PKB, Carpathians) originated in the eastern prolongation of the Alpine Tethys, in the Penninic - Vahic ocean (*e.g.* STAMPFLI & HOCHARD, 2009).

The Veliky Kamenets section (PKB, Ukraine) (Fig. 1) is a unique locality which shows excellently exposed lower Jurassic to lowermost Cretaceous sedimentary succession. The Toarcian - Berriasian part is precisely dated with calcareous dinoflagellates, calpionellids and ammonites (REHÁKOVÁ *et al.*, 2011). Our new study is complemented by nannofossil biostratigraphy as well. The rocks were especially suitable for paleomagnetic studies (LEWANDOWSKI *et al.*, 2005). We present results of an integrated bio-, magneto- and chemostratigraphic study of the upper Kimmeridgian to lower Berriasian interval of the section, spanning ca. 10 My. The interval studied extends from the upper Kimmeridgian (Parvula Acme Zone) to lower Berriasian (the standard Calpionella Zone, Elliptica Subzone). Succession of magnetozones from M23r to M18n has been identified. The Kimmeridgian/Tithonian boundary (Borzai/Pulla zonal boundary) is correlated for the first time with the transition between M22r and M22n polarity zones. It is close to the FO of the nannofossil *Conusphaera mexicana minor* and closely corresponds to the position of Kimmeridgian/Tithonian boundary in the recently studied S'Adde section (Sardinia, MUTTONI *et al.*, 2018). In the upper Tithonian, the occurrence of the characteristic nannofossil genus *Acadialithus* is registered. The Tithonian/Berriasian boundary, defined as Colomi/Alpina Subzonal boundary, occurs in the middle of the M19n2n polarity zone. It coincides with the first occurrences of the two stratigraphically important nannofossil species: *Nannoconus steinmannii minor* and *N. kamptneri minor.* The position of Tithonian/Berriasian boundary against magnetostratigraphy is consistent in all Western Tethysian sections (*e.g.*, GRABOWSKI, 2011).

Magnetic susceptibility reveals a long term decrease which is interpreted as an effect of intensifying carbonate sedimentation and dilution of detrital particles in carbonate matrix. The interpretation is supported by lowering content of K and Th which accounts for decreasing amount of terrigenous material. The increasing carbonate productivity resulted in acceleration of sedimentation rate and step-wise demise of *Saccocoma* microfacies since polarity chron M19r. The same decreasing trend is observed in stable isotope stratigraphy. The major fall of $\delta^{13}C$ values from 2.5 ‰ to 1.6 ‰ occurs between the upper Kimmeridgian and the middle Tithonian (polarity zone M20r). Throughout the upper Tithonian and lower Berriasian the carbon isotopic ratio is relatively stable fluctuating between $\delta^{13}C$ values of 1.4 to 1.7 ‰.

Figure 1: General view of the Veliky Kamenets active quarry (present state) with Tithonian/Berriasian boundary indicated.

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GRABOWSKI J. (2011).- Magnetostratigraphy of the Jurassic/Cretaceous boundary interval in the Western Tethys and its correlations with other regions: a review.- *Volumina Jurassica*, 9, p. 105-128.

LEWANDOWSKI M., KROBICKI M., MATYJA B.A. & WIERZBOWSKI A. (2005).- Palaeogeographic evolution of the Pieniny Klippen basin using stratigraphic and palaeomagnetic data from the Veliky Kamenets section (Carpathians, Ukraine).- *Palæogeography, Palæoclimatology, Palæoecology*, 216, p. 53-72.

MUTTONI G., VISCONTI A., CHANNELL J.E.T., CASELLATO C.E., MARON M. & JADOUl F. (2018).- An expanded Tethyan Kimmeridgian magneto-biostratigraphy from the S'Adde section (Sardinia): Implications for the Jurassic timescale.- *Palæogeography, Palæoclimatology, Palæoecology*, 503, p. 90-101.

REHÁKOVÁ D., MATYJA B.A., WIERZBOWSKI A., SCHLÖGL J., KROBICKI M. & BARSKI M. (2011).- Stratigraphy and microfacies of the Jurassic and lowermost Cretaceous of the Veliky Kamenets section (Pieniny Klippen Belt, Carpathians, Western Ukraine).- *Volumina Jurassica*, 9, p. 61-104.

STAMPFLI G. & HOCHARD C. (2009).- Plate tectonics of the Alpine realm. *In*: MURPHY J.B., KEPPIE J.D. & HYNES A.J. (eds.), Ancient orogens and modern analogues.- *Geological Society London, Special Publications*, 327, p. 89-111.

16. Kimmeridgian - Tithonian of the pelagic Fatric succession in the Western Tatra (Central West Carpathians, Poland): Integrated bio-, magneto- and chemostratigraphy of the Dolina Lejowa section

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A Kimmeridgian - Tithonian pelagic succession in the Fatric (Krizna) unit of Western Tatra Mts, ca. 47 m in thickness is comprised of the uppermost part of radiolarian limestones (Czajakowa Radiolarite Formation), red platy and nodular limestones of *Ammonitico rosso* type (Czorsztyn Limestone Formation) and grey marly limestones of the Jasenina Formation. Integrated dating of the Lejowa section (in progress) is based on calcareous dinocysts, calpionellids and magnetic stratigraphy. The interval studied spreads from the upper Kimmeridgian (Moluccana Zone) to upper Tithonian (Crassicollaria Zone). According to preliminary magnetostratigraphic interpretation it corresponds to polarity zones from M24r to lower part of M19n. The Kimmeridgian/Tithonian boundary (Borzai/Pulla zonal boundary) falls in the lower part of the Czorsztyn Limestone Formation. The sedimentation of red nodular limestone terminates in the Malmica or Semiradiata Zone of lower Tithonian.

Bositra, radiolarian-*Bositra* and *Bositra*-radiolarian-spiculite microfacies dominate in the radiolarian limestones of Czajakowa Formation. Variegated microfacies with *Saccoccoma* (*Saccoccoma*-radiolarian, *Saccoccoma-Globochaete,* radiolarian-*Saccoccoma-Globochaete* and *Saccoccoma* wackestone/packstone) appear as the most important component of microfacies in the Czorsztyn Formation. *Saccocoma* microfacies continue higher up into the lower part of Jasenina Formation. In the upper part of this formation the calpionellids start to occur and they stepwise dominate over the saccocomids. The *Saccocoma* microfacies finally disappear in the polarity chron M19r and combinations of calpionellid - Globochaete - radiolarian microfacies is the most common. The described succession of microfacies is typical for the Tethys ocean and was described from the Carpathian - Balkan area by numerous authors (*e.g.*, PSZCZÓŁKOWSKI, 1996; LAKOVA & PETROVA, 2013; REHÁKOVÁ *et al.*, 2011). Minor differences are the result of paleogeography.

The carbon isotopic ratio ($\delta^{13}C$) reveals a smooth decrease from ca. 2.5 ‰ in the upper Kimmeridgian to ca. 1 ‰ in the upper Tithonian. The major decrease between 2.5 ‰ and 1.5 ‰ occurs just in the Kimmeridgian/Tithonian boundary interval. Magnetic susceptibility (MS) in the grey colored Jasenina Formation correlates very well with lithogenic elements and might be regarded as reliable proxy of terrigenous input. The correlation is not as evident in reddish Czajakowa and Czorsztyn formations due to more complex rock magnetic properties and the mineralogical source of MS (co-occurrence of magnetite and hematite). The detailed chemostratigraphic survey has been performed with a handheld Olympus XRF device. The data were verified by data obtained in a geochemical laboratory. The amount of terrigenous elements is apparently lower in the upper Kimmeridgian/lower Tithonian than in the upper Tithonian. A large increase of terrigenous input is observed in the polarity zone M20n (Chitinoidella Zone, Jasenina Fm), which might be compared with so called Hlboč event (REHÁKOVÁ, 2000; GRABOWSKI *et al.*, 2013).

GRABOWSKI J., SCHNYDER J., SOBIEŃ K., KOPTIKOVÁ L., KRZEMIŃSKI L., PSZCZÓŁKOWSKI A., HEJNAR J. & SCHNABL P. (2013).- Magnetic susceptibility and spectra gamma logs in the Tithonian-Berriasian pelagic carbonates in the Tatra Mts (Western Carpathians, Poland): Palaeoenvironmental changes at the Jurassic/Cretaceous boundary.-*Cretaceous Research*, vol. 27, p. 398-417.

LAKOVA I. & PETROVA S. (2013).- Towards a standard Tithonian to Valanginian calpionellid zonation of the Tethyan Realm.- *Acta Geologica Polonica*, vol. 63, no. 2, 201-221.

PSZCZÓŁKOWSKI A. (1996).- Calpionellid stratigraphy of the Tithonian - Berriasian pelagic limestones in the Tatra Mts. (Western Carpathians).- *Stud. geol. polonica*, vol. 109, p. 103-130.

REHÁKOVÁ D. (2000).- Calcareous dinoflagellate and calpionellid bioevents versus sea-level fluctuations recorded in the West-Carpathian (Late Jurassic/Early Cretaceous) pelagic environments.- *Geologica Carpathica*, vol. 51, no. 4, p. 229-243

REHÁKOVÁ D., MATYJA B.A., WIERZBOWSKI A., SCHLÖGL J., KROBICKI M. & BARSKI M. (2011).- Stratigraphy and microfacies of the Jurassic and lowermost Cretaceous of the Veliky Kamenets section (Pieniny Klippen Belt, Carpathians, Western Ukraine.- *Volumina Jurassica*, vol. 9, no. 1, p. 61-104.

17. Magnetic stratigraphy, stable isotopes and chemostratigraphy in the upper Berriasian of Rówienka section (Western Tatra Mts., Fatric succession, Poland): Towards a consistent model of late Berriasian paleoenvironmental changes in the Western Tethys

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The results of new paleoenvironmental research in the Carpathians (Rówienka, Fatric succession, Poland) are presented. Magneto- and biostratigraphy, magnetic susceptibility (MS), inorganic geochemistry, gamma ray spectrometry (GRS) and stable isotopes were studied. Indications of terrigenous input and redox proxies are discussed and compared with other Western Tethysian sections, especially those from the Balkan area (GRABOWSKI *et al.*, 2016) and Vocontian Basin (MORALES *et al.*, 2013; EMMANUEL & RENARD, 1993). The implications of results are referred to paleogeographic and paleotectonic reconstructions (*e.g.*, HAAS & PÉRÓ, 2004; SCHMID *et al.*, 2008; PLAŠIENKA, 2018).

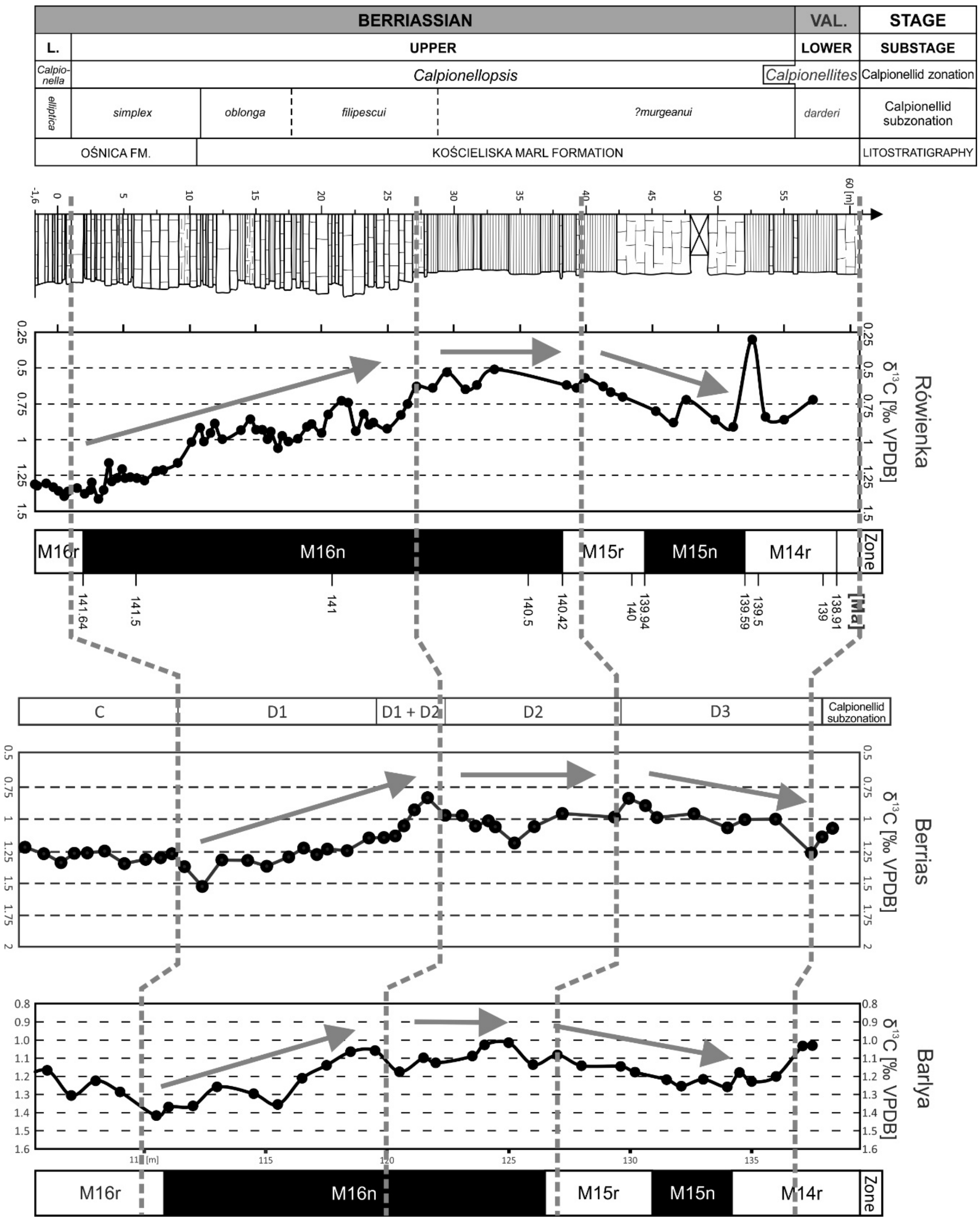

Figure 1: Carbon isotopes ($\delta^{13}C$), magneto- and biostratigraphic correlation between Rówienka (Western Tatra, Poland), Barlya (Western Balkan, Bulgaria; Grabowski *et al.*, 2016) and Berrias (Vocontian Basin, SE France; Emmanuel & Renard, 1993). Dotted line shows $\delta^{13}C$ correlation, trends of concordance are marked by arrows. L. - lower Berriasian; VAL. - Valanginian.

Integration of magneto- and biostratigraphic data (Grabowski & Pszczółkowski, 2006) allows precise correlation of even very distant sections from different tectonic units. Additionally, rock magnetism and geochemical data, gamma spectroscopy and carbon isotope analysis give useful information about the environmental conditions in a basin during sedimentation time. During the

Berriasian, the Fatric basin was situated at the southern shelf of the Penninic-Vahic (Alpine Tethys) ocean. The Rówienka section covers the stratigraphic interval from the upper part of M16r polarity chron up to the M14r chron (Berriasian/Valanginian boundary). MS shows a increasing trend in M16n magnetozone and then a slight decrease in magnetozones M15r and M15n. GRS data and content of lithogenic elements (K, Al, Th, and others) show a long term increasing contribution of terrigenous material throughout the upper Berriasian, which is in concordance with MS data. It is interpreted as evidence of an approaching collision at the southern margin of the Central Western Carpathians (CWC) (*e.g.*, SCHMID *et al.*, 2008; PLAŠIENKA, 2018). The same orogenic events controlled terrigenous supply in the late Berriasian of the Western Balkan section (Barlya, Grabowski *et al.*, 2016) situated at the southern margin of Moesian platform. Tectonically induced continental runoff was most probably intensified by humid climate.

Carbon isotope data ($\delta^{13}C$) from Rówienka (Fig. 1) correlate very well with those from Barlya (GRABOWSKI *et al.*, 2016) and the Vocontian sections (EMMANUEL & RENARD, 1993). $\delta^{13}C$ decreases towards minimal values in the upper part of magnetozone M16n and then increases in magnetozones M15r and M15n in the uppermost Berriasian. A similar pattern may be seen in other magnetostratigraphically dated upper Berriasian sections from the Alpine - Carpathian area as well as those without magnetostratigraphic calibration (MORALES *et al.*, 2013). This led to a conclusion that $\delta^{13}C$ variations might be a good proxy for regional scale correlations. The paleoenvironmental implications of this conclusion are discussed.

Trace elements, such as Ba and Ni are interpreted as paleoproductivity proxies (TRIBOVILLARD *et al.*, 2006). Evidence of temporal increase of the basin productivity was found in Rówienka, in the upper part of M16r magnetic zone (lower part of the upper Berriasian). Furthermore, total organic carbon (TOC) content in Rówienka is increasing along with the terrigenous input, which is likely evidence of land provenance of the organic matter.

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EMMANUEL L. & RENARD M. (1993).- Carbonate geochemistry (Mn, $\delta^{13}C$, $\delta^{18}O$) of the Late Tithonian - Berriasian pelagic limestones of the Vocontian trough (SE France).- *Bulletin des Centres de Recherches Exploration - Production elf Aquitaine*, vol. 17 (1), p. 206-221.

GRABOWSKI J. & PSZCZÓŁKOWSKI A. (2006).- Magneto- and biostratigraphy of the Tithonian-Berriasian pelagic sediments in the Tatra Mountains (central Western Carpathians, Poland): sedimentary and rock magnetic changes at the Jurassic/Cretaceous boundary.- *Cretaceous Research*, vol. 27, p. 398-417.

GRABOWSKI J., LAKOVA I., PETROVA S., STOYKOVA K., IVANOVA D., WÓJCIK-TABOL P., SOBIEŃ K. & SCHNABL P. (2016).- Paleomagnetism and integrated stratigraphy of the Upper Berriasian hemipelagic succession in the Barlya section Western Balkan, Bulgaria: Implications for lithogenic input and paleoredox variations.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 461, p. 156-177.

HAAS J. & PÉRÓ C. (2004).- Mesozoic evolution of the Tisza mega-unit.- *International Journal of Earth Sciences*, vol. 93, p. 297-313.

MORALES C., GARDIN S., SCHNYDE J., SPANGENBERG J., ARNAUD-VANNEAU A., ARNAUD H., ADATT T. & FÖLLMI K.B. (2013).- Paleoclimatic and paleoenvironmental change across the Berriasian-Valanginian boundary along a transect from the Jura platform to the Vocontian Basin.- *Sedimentology,* vol. 60 (1), p. 36-63.

PLAŠIENKA D. (2018).- Continuity and episodicity in the early Alpine tectonic evolution of the western Carpathians: How large-scale processes are expressed by the orogenic architecture and rock record data.- *Tectonics*, vol. 37, p. 2029-2079.

SCHMID S.M., BERNOULLI D., FUGENSCHUH B., MATENCO L., SCHEFER S., SCHUSTER R., TISCHLER M. & USTASZEWSKI K. (2008).- The Alpine-Carpathian-Dinaridic orogenic system: correlation and evolution of tectonic units.- Swiss *Journal of Geosciences*, vol. 101, p. 139-183.

TRIBOVILLARD N., ALGEO T. J., LYONS T. & RIBOULLEAU A. (2006).- Trace metals as a paleoredox and paleoproductivity proxies: An update.- *Chemical Geology*, vol. 232, p. 12-32.

18. Dual biozonation scheme (benthic foraminifera and "calcareous" green algae) over the Jurassic - Cretaceous transition: Another plea to revert the system boundary to its historical ORBIGNY's and OPPEL's definition

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The Tithonian-Valanginian interval is subdivided into 5 biozones (zones and subzones) combining mostly large benthic foraminifera and "calcareous" green algae, which are typical of photozoan assemblages. This dual zonation is calibrated on a sequence stratigraphic framework for the Jura Mountains where all occurrences of ammonites and calpionellids are plotted. The microfossil diversity was low in the Tithonian-early Berriasian times. It then significantly increased over middle-late Berriasian times before a first extinction event at the Berriasian/Valanginian boundary, followed by a second extinction event in the early Valanginian times. The lower/middle Berriasian and the Berriasian/Valanginian boundaries can be traced consistently from West to East through the whole Tethysian realm. By contrast, the upper Tithonian and the lower Berriasian cannot be distinguished. Because the location of the Jurassic/Cretaceous system boundary has been pending a decision of the International Commission on Stratigraphy since 1975, this survey provides one more argument to abandon the early 20th century KILIAN's view which placed it at the Tithonian/Berriasian stage boundary, and to return it to the original 19th century ORBIGNY's and OPPEL's view, *i.e.*, back at the Berriasian/Valanginian stage boundary.

anonymous (1975a).- VII. Discussion sur la position de la limite Jurassique-Crétacé. *In*: Colloque sur la limite Jurassique-Crétacé (Lyon, Neuchâtel, septembre 1973).- *Mémoires du B.R.G.M.*, vol. 86, p. 385-383.

anonymous (1975b).- VIII. Discussion générale préliminaire au dépôt des motions. *In*: Colloque sur la limite Jurassique-Crétacé (Lyon, Neuchâtel, septembre 1973).- *Mémoires du B.R.G.M.*, vol. 86, p. 385-393.

GRANIER B. (2019).- Dual biozonation scheme (benthic foraminifera and "calcareous" green algae) over the Jurassic - Cretaceous transition. Another plea to revert the system boundary to its historical ORBIGNY's and OPPEL's definition.- *Cretaceous Research*., vol. 93, p. 245-274.

19. Late versus early leachings of ooid cortices: Facts, findings and conclusions

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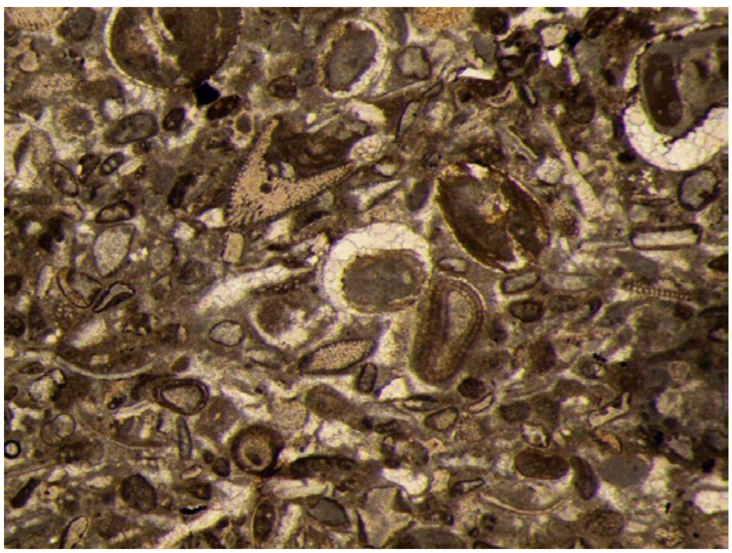
According to most authors (*e.g.*, see references in Granier *et al.*, 2014), fossil calcitic radial and radial-concentric ooids have retained their fibrous fabric. They also state that fossil aragonitic ooids have lost their original fabric, either via the replacement of aragonite by a calcitic mosaic, or via the leaching of aragonite. Thus, occurrence of a drusy calcitic cement in lieu of some cortical layers or of the whole cortex is commonly interpreted as "two-phase"/"bimineralic" or aragonitic ooids.

Several authors (*e.g.*, see references in Granier *et al.*, 2014) reported the finding of ooids with partly leached cortices from the lower Cretaceous strata of the French and Swiss Jura Mountains. They commonly interpreted "these features" (...) "as evidence for subaerial exposure".



Ooids with partly leached cortices from both the Grand Essert Fm (ex "Pierre jaune de Neuchâtel", early Hauterivian: Charollais *et al.*, 2008; Comité Suisse de Stratigraphie, 2014) and the Gorges de l'Orbe Fm (ex "Urgonien jaune", late Hauterivian in age: Charollais *et al.*, 2008; Comité Suisse de Stratigraphie, 2014) have been studied by Granier *et al.* (2014). According to these authors, it is not the mark of an early leaching of "two-phase"/"bimineralic" ooids but rather the mark of late leaching of calcitic ooids "probably related to tectonics and/or karstification that favored the seepage of acidic waters".

The same phenomena affected calcitic ooids from the lowermost Cretaceous Vuache Fm (ex "Calcaires roux", early Valanginian in age: Charollais *et al.*, 2008; Comité Suisse de Stratigraphie, 2014) at Crozet, Ain, France (Granier, 2019). There, besides the late leaching, there are also locally few evidences of early leaching of some aragonitic allochems, hence rare evidences for genuine "subaerial exposure".

CHAROLLAIS J., CLAVEL B. & BUSNARDO R. (2008).- Biostratigraphie et découpage séquentiel des formations du Crétacé Inférieur de la plateforme Jurassienne (France, Suisse). *In* : A Terra. O Conflitos e Ordem. Homenagem ao Professor Ferreira SOARES.- Museu Mineralógico e Geológico da Universidade de Coimbra, p. 197-207.

Comité Suisse de Stratigraphie (2014).- Jura. *In*: Lexique lithostratigraphique de la Suisse.- swisstopo, Service géologique national. Online at http://www.strati.ch/index.php/fr/cms/downloads

GRANIER B. (2019).- Dual biozonation scheme (benthic foraminifera and "calcareous" green algae) over the Jurassic - Cretaceous transition. Another plea to revert the system boundary to its historical ORBIGNY's and OPPEL's definition.- *Cretaceous Research*., vol. 93, p. 245-274.

GRANIER B., BARBIN V. & CHAROLLAIS J. (2014).- Significance of partial leaching in calcareous ooids: The case study of Hauterivian oolites in Switzerland.- Carnets Geol., Madrid, vol. 14, no. 22, p. 471-481.

20. Early Cretaceous events in southern Spain

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In southern Spain, the upper Jurassic carbonate platform did not end with the Tithonian, but with the Berriasian (GRANIER, 2019). The sections studied in the Alicante comprise Sierra de Fontcalent (RASPLUS & FOURCADE, 1987), *i.e.*, a basinal section, Busot (GRANIER *et al.*, 1995), *i.e.*, a slope section, and three platform sections: Cabezon de Oro, Puig Campana and Sierra Helada (GRANIER, 1987, 2007, 2019; GRANIER & PERTHUISOT, 2009).

A forced regression at the start of the Valanginian was followed by a healing phase (*sensu* POSAMENTIER & ALLEN, 1993). It marks the abrupt change from a rimmed carbonate shelf to a mixed siliciclastic-carbonate non-rimmed shelf passing to a ramp system. The associated deposits form a thick sigmoidal sedimentary wedge, hence the 175-meter-thick lower Valanginian section at Sierra de Fontcalent (RASPLUS & FOURCADE, 1987), with basinal onlaps against the slope beyond the shelf break. On the platform itself, transgressive facies, known as the «Calcarénites à Pseudocyclammines» (GRANIER, 1987, 2007, 2019; GRANIER & PERTHUISOT, 2009) or the upper member of the Sierra del Pozo Formation, are characterized by swaley and hummocky (SCS and HCS) cross-stratifications. The microfacies is commonly represented by a «lithoclastic floatstone with a grainstone matrix, a mixture of carbonate allochems and terrigenous sand or silt» (*e.g.*, GRANIER, 2007, Fig. 2). The siliciclastic material, which is free of clay, is derived from material stored for millions of years on the southern shore of the Iberian Meseta. Consequently, it did not impede the working of the carbonate factory and the growth of small coral patches.. In conclusion, in southern Spain, this first major Valanginian transgression did not lead to a genuine drowning.

At Sierra de Fontcalent, *i.e.*, the basinal section, most lower Cretaceous units above the lower Valanginian are condensed: 8 m for the upper Valanginian, 7 m for the Hauterivian (glauconitic), and 21 m for the lower Barremian (glauconitic). At Cabezon de Oro, Puig Campana and Sierra Helada, *i.e.*, the platform sections, the whole upper Valanginian to Barremian interval is reduced to a 0.5 to 2 m thick interval with ferruginous oolite and glauconite (GRANIER, 1987, 2007, 2019; GRANIER & PERTHUISOT, 2009) due to hiatuses and extreme condensation. The hiatuses and condensation are the mark of sedimentary starvation. All these sites were then located within the aphotic zone (with limited carbonate production) and the potential siliciclastic supply from the Iberian Meseta was not reaching these distal areas. On one hill of the Busot village, below the castle ruins ("Castillo árabe"), the ferruginous oolite, which is a few meters thick, contains mostly Hauterivian and Barremian ammonites. By contrast, on another hill, below a chapel ("Ermita del Calvario") and less than 200 meters away, a 65 meter section consisting only of Hauterivian strata - dated by ammonites - was measured. This anomaly corresponds to the infill of a scar resulting either from a slope collapse or most probably from the growth a synsedimentary fault. The sediments are bioclastic wackestones with benthic foraminifers and calcareous algae, mostly reworked material from the shallower and slightly older sediments. There is no evidence for turbidity current (as it is the case in most Tithonian - Berriasian Vocontian sections in France) but rather for traction currents (with rolling, creeping and saltating grains). In their muddy matrix GRANIER *et al.* (1995) reported the striking occurrence of numerous free Calpionellids. The sedimentary features listed above exclude a reworking of these fragile tiny amphoras.

In addition to the Busot paleofault, there are other arguments for distensive tectonic activity and the related block-faulting that are responsible for basinal starvation. For instance, GRANIER (1987) documented microscopic sedimentary dikes and sills in the ferruginous oolite at Cabezon de Oro. However, the most striking evidence comes from Sierra Helada with a local hiatus corresponding to the Berriasian-Barremian interval. Additionally, spectacular macroscopic sedimentary sills and breccias affect the Tithonian limestones. They are post-early Valanginian in age, a dating that is inferred because few lithoclasts derived from the «Calcarénites à Pseudocyclammines» are found in the sedimentary infills.

To summarize, the three-fold geological story comprises:

1) a pre-Valanginian episode marked by the ending of the Jurassic carbonate platform (first event),

2) an early Valanginian episode marked by significant sea level falls and rises, *i.e.*, forced regressions and major transgressions or drownings,

3) a late Valanginian to early Barremian episode marked by significant distensive tectonic activity (last events) in the whole area.

GRANIER B. (1987).- Le Crétacé inférieur de la Costa Blanca entre Busot et Altea, Alicante (Espagne) : Biostratigraphie, sédimentologie, évolution tectono-sédimentaire.- Ph.D. thesis, Université Paris VI; *Mémoires des Sciences de la Terre*, Université Pierre et Marie Curie, Paris, no. 87-49, vol. I (texte): 281 p.; vol. II (54 Pls.).

GRANIER B. (2007).- On the trail of a major trans-Tethyan discontinuity. *In*: BULOT L.G., FERRY S. & GROSHENY D. (eds.), Relations entre les marges septentrionale et méridionale de la Téthys au Crétacé [Relations between the northern and southern margins of the Tethys ocean during the Cretaceous period].- Carnets Geol., Madrid, vol. 7, no. M02/07 (CG2007_M02/07), p. 32-37.

GRANIER B. (2019).- Dual biozonation scheme (benthic foraminifera and "calcareous" green algae) over the Jurassic - Cretaceous transition. Another plea to revert the system boundary to its historical ORBIGNY's and OPPEL's definition.- *Cretaceous Research*, vol. 93, p. 245-274.

GRANIER B., VIRGONE A., BUSNARDO R. & BULOT L. G. (1995).- Des calpionelles dans l'Hauterivien supérieur. Découverte exceptionnelle à Busot (Alicante, Espagne).- *Comptes-Rendus de l'Académie des Sciences* (Série II a), Paris, vol. 321, p. 1179-1186.

GRANIER B. & PERTHUISOT V. (2009).- Discussion of: Development of carbonate platforms on an extensional (rifted) margin: the Valanginian-Albian record of the Prebetic of Alicante (SE Spain), by J.M. CASTRO *et al.*, Cretaceous Research 29 (2008), 848-860.- *Cretaceous Research*, vol. 30, no. 4, p. 1019-1026.

POSAMENTIER H.W. & ALLEN G.P. (1993).- Variability of the sequence stratigraphic model: Effects of local basin factors.- *Sedimentary Geology*, vol. 86, p. 91-109.

RASPLUS L. & FOURCADE É. (Coords.) *et al.* (1987).- Stratigraphie intégrée du sillon citrabétique (Sierra de Foncalent, Province d'Alicante, Espagne).- *Géobios*, Lyon, vol. 20, no. 3, p. 337-387.

21. Revised dating of the major earliest Cretaceous transgression in S Aquitaine (SW France)

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[2] deceased on October 30th, 2018

The oldest dating of the earliest Cretaceous transgression in S Aquitaine (SW France) was long considered Aptian. In 1954, CUVILLIER and DEBOURLE report from the subsurface the find of a microfossil assemblage that they ascribe to the Valanginian. In 1968, SCHROEDER and POIGNANT cast some doubts on the identifications and state that this assemblage is characteristic of the Barremian, not of the Valanginian. Revision of the benthic foraminifers and Dasycladales from the bottom section of the Cretaceous at Lacq 104 borehole demonstrates that the oldest records of the transgression, per definition diachronous, are probably at least late Hauterivian in age. Due to the lack of any evidence for the occurrence of Berriasian or Valanginian strata, the hiatus related to erosion and non-deposition is there assumed to span the ? lower part of the Hauterivian, the Valanginian, most if not all of the Berriasian and possibly the uppermost part of the Tithonian.

CUVILLIER J. (1955).- Coupe stratigraphique dans le Néocomien et le Jurassique supérieur de Lacq (forage 104).- Revue de l'Institut Français du Pétrole, vol. X, no. 5, p. 316-318.

CUVILLIER J. & DEBOURLE A. (1954).- Découverte du Jurassique terminal et du Néocomien en Aquitaine occidentale et méridionale.- *Compte Rendu sommaire des Séances de la Société géologique de France*, année 1954, no. 3, p. 75-76.

SCHROEDER R. & POIGNANT A. (1967).- *Paleodictyoconus* im Valanginian SW-Frankreichs (Studien über primitive Orbitolinidae IV).- *Neues Jahrbuch für Geologie und Paläontologie*, *Monatshefte* 1967, Heft 2, p. 73-85.

SCHROEDER R. & POIGNANT A. (1968).- Sur la position stratigraphique des «calcaires à Dictyoconus» rapportés au Valanginien en Aquitaine.- *Comptes Rendus de l'Académie des Sciences Paris* (Série D), t. 266, no. 10, p. 992-993.

22. Revision of the fossil genus *Clypeina* (MICHELIN, 1845), Chlorophyta, Dasycladales, Polyphysaceae: Systematic position of *Clypeina sulcata* (ALTH, 1882), *C. jurassica* (FAVRE & RICHARD, 1927), and *C. inopinata* FAVRE, 1932

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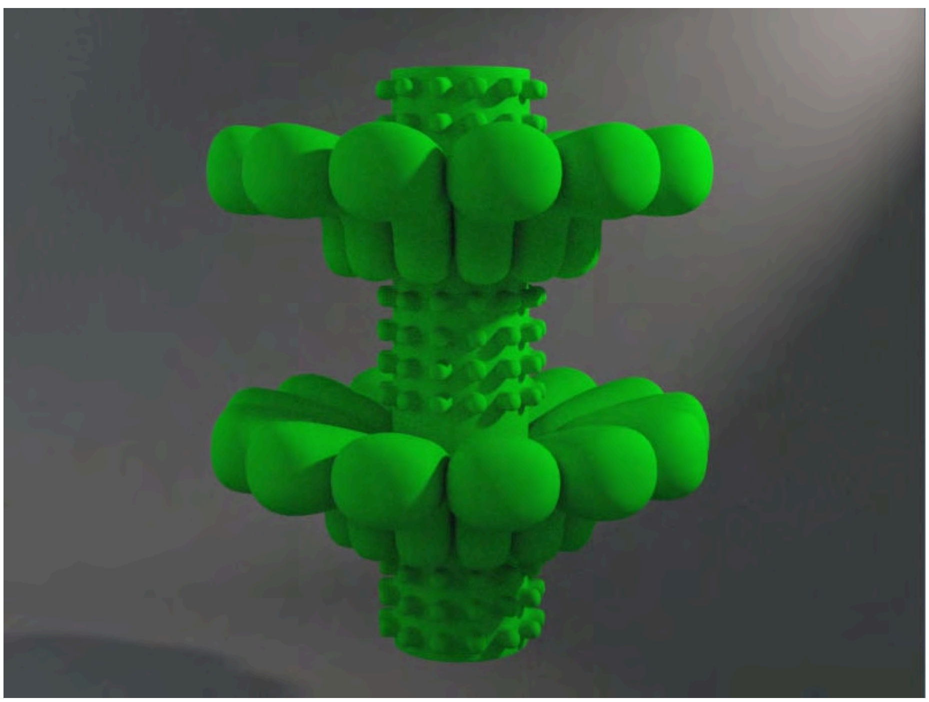
Following a preliminary historical survey of the Cenozoic *Clypeina marginoporella* MICHELIN, 1845, which is the type of the genus, and of the Mesozoic *Clypeina sulcata* (ALTH, 1882), the point was made that both species may not be ascribed to the same genus. Accordingly, a new genus is introduced with *C. sulcata* as type-species. In addition, the generic diagnosis of *Clypeina* is amended (*i.e.*, shortened) in order to exclude all features that are not present in its type. A rather large collection of algae was used to illustrate some key characteristics of these algal taxa as well as few features rarely observed in *C. sulcata*.



ALTH A. von (1882).- Die Versteinerungen des Niźniower Kalksteines.- *Beiträge zur Paläontologie Österreich-Ungarns un des Orients*, Band I, Heft 3-4, p. 183-332 (Pls. XVIII-XXIX).

FAVRE J. (1932).- Présence d'une nouvelle espèce d'algue calcaire siphonée dans le Valanginien du Jura central, *Clypeina inopinata* n. sp.- *Eclogæ geologicæ Helvetiæ*, vol. 25, no. 1, p. 11-16.

FAVRE J. & RICHARD A. (1927).- Étude du Jurassique supérieur de Pierre-Châtel et de la cluse de la Balme (Jura méridional).- *Mémoires de la Société paléontologique suisse*, t. XLVI, p. 1-39 (3 Pls.).

PFENDER J. (1927a).- Sur la présence de *Clypeina* MICHELIN dans les couches de passage du Jurassique au Crétacé, en Basse-Provence calcaire; de son identité avec l'organisme A du Purbeckien marin au Salève (JOUKOWSKY et FAVRE).- *Compte Rendu sommaire des Séances de la Société géologique de France*, 1927, no. 4, p. 28.

PFENDER J. (1927b).- Sur la présence de *Clypeina* MICHELIN dans les couches de passage du Jurassique au Crétacé, en Basse-Provence calcaire; de son identité avec l'Organisme A du Purbeckien marin au Salève (JOUKOWSKY et FAVRE).- *Bulletin de la Société géologique de France* (4e série), t. XXVII, nos. 1-2, p. 89-94 (Pl. V).

23. Perisphinctes Ravine - a key Jurassic-Cretaceous boundary succession in Kuhn Ø, NE Greenland

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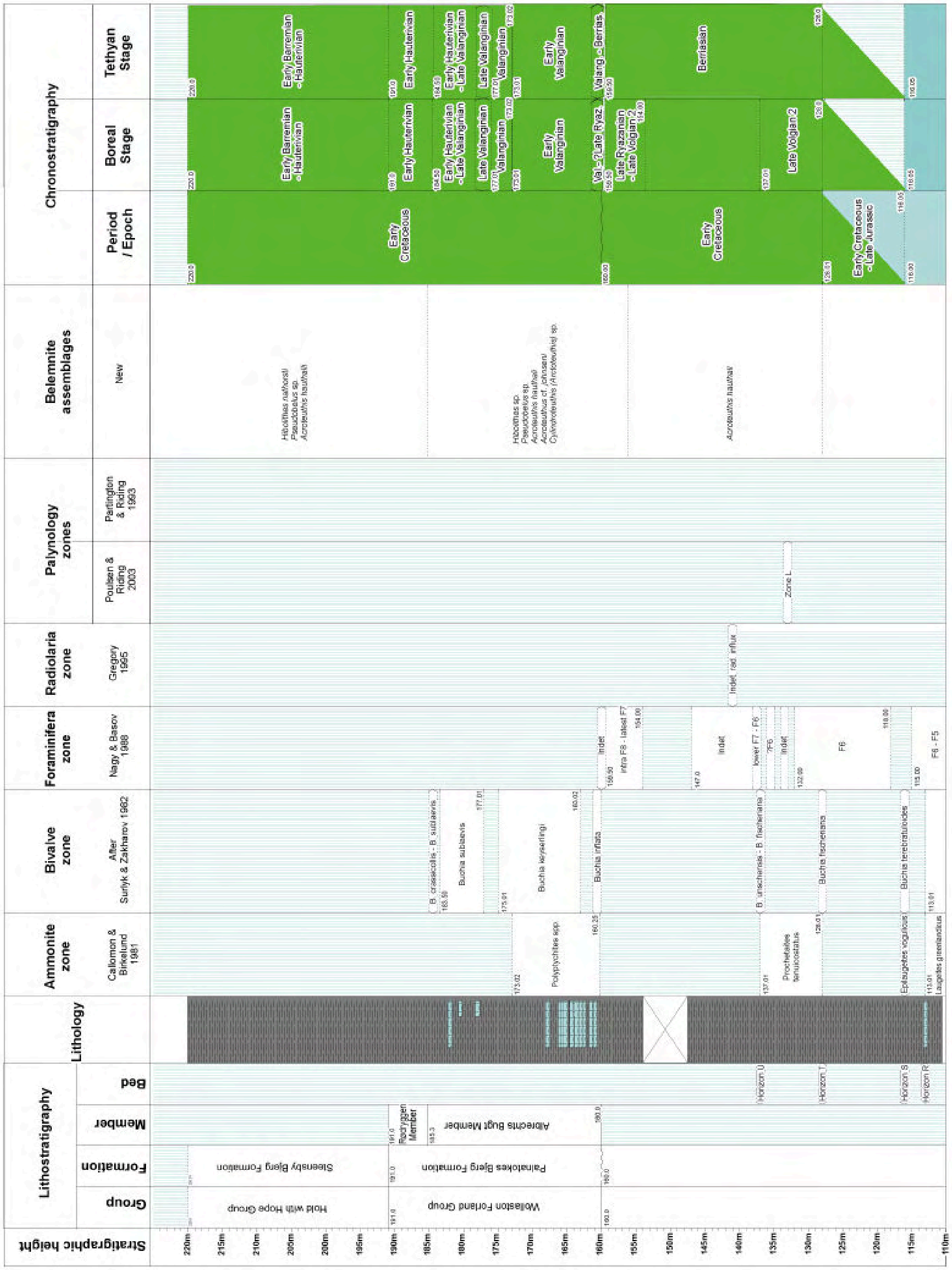
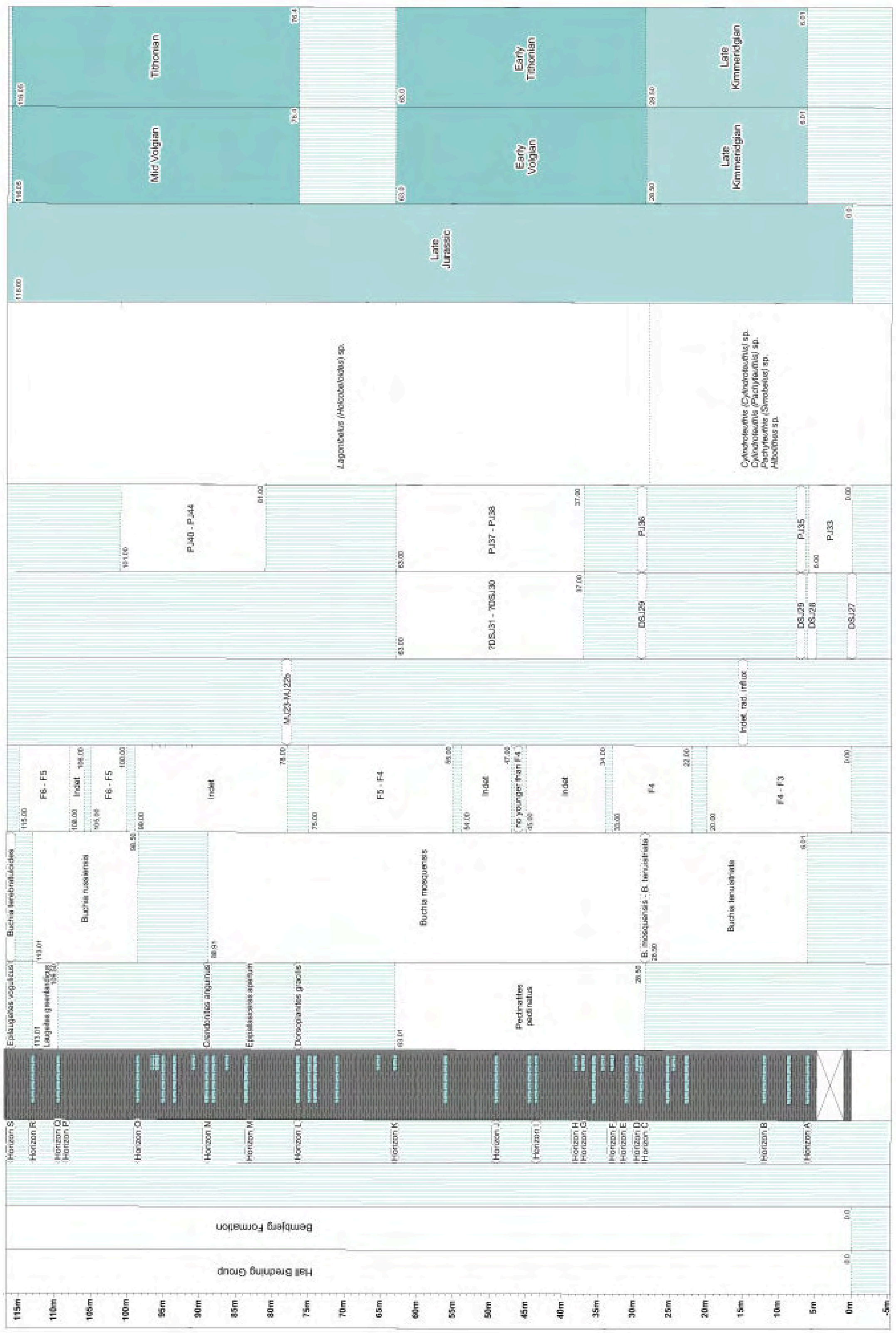
[2] Deceased
[3] Petrostrat, Tan-y-Graig, Parc Caer Seion, Conwy, LL32 8FA (UK)
[4] Acting Director of Research, London South Bank University, 6, St George's Circus, London SE1 6FE (UK)
[5] Institute of Geological and Nuclear Sciences, 1 Fairway Drive, Avalon 5010, PO Box 30-368, Lower Hutt 5040 (New Zealand)

An important biostratigraphical reference section across the Jurassic-Cretaceous boundary is documented from Perisphinctes Ravine, eastern Kuhn Ø, Northeast Greenland. A continuous section extends for some 220m from the Bernbjerg Formation (early Volgian-Ryazanian) up into the Cretaceous Sandy Shales (Valanginian-Hauterivian). The mudstone-dominated succession contains 21 concretionary beds in the late Kimmeridgian to Ryazanian interval, which contain well-preserved macrofauna, It was also sampled for micropaleontology and palynology. Integrated biostratigraphic data are here displayed in table form.

The latest Kimmeridgian is characterized by the bivalve *Buchia tenuistriata*. The earliest Volgian is characterized by the appearance of ammonites, *Pectinatites groenlandicus* with the last *B. tenuistriata* and first *B. mosquensis*. The latest early Volgian is marked by the last *Pectinatites*. The earlier part of the Mid Volgian is marked by the successive *Dorsoplanites gracilis, Epipallasiceras apertum* and *Crendonites anguinus* zones, the latter containing the last *B. mosquensis*. The latest part of the Mid Volgian is characterized by *B. russiensis* with *Laugeites greenlandicus* at the top. The earliest late Volgian is marked by the appearance of *Epilaugeites vogulicus* with *B. terebratuloides*, and followed by *Prochetaites tenuicostatus* with *B. fisheriana* and *B. unschensis*. The latest Ryazanian/earliest Valanginian is characterized by *B. inflata* with *Tollia* sp. The early Valanginian is characterized by *Buchia keyserlingi* with polyptychitid ammonites. The later Valanginian to earliest Hauterivian is marked by *B. sublaevis*. The later part of the early Hauterivian is marked by *B. sublaevis* with *B. crassicollis*. In the Kimmeridgian to late Ryazanian interval foraminiferal zones from F3 to F8 were recognized of the Svalbard succession. In addition Radiolarian events were identified in the late Kimmeridgian, earliest Mid Volgian and late Volgian. The microfossil successions are correlated with the palynological zonations for northwest Europe and the North Sea (see next 2 pages).


Chronostratigraphy
Tethyan Stage
Boreal Stage
Period / Epoch
Belemnite assemblages
Palynology zones
Radiolaria zone
Foraminifera zone
Bivalve zone
Ammonite zone
Lithology
Lithostratigraphy
Group
Formation
Member
Bed
Stratigraphic height



Summary log of Section S3404, eastern Kuhn Ø, showing lithostratigraphy, biostratigraphy, chronostratigraphy and sampling levels.

24. Berriasian peperites in the Ukrainian Carpathians - their biostratigraphical control and sedimentological significance

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Peperites are a special kind of volcaniclastic rocks where volcanic pieces (usually basaltic) with sharp-boundaries occur within sedimentary deposits. These are formed on the sea-floor as a result of submarine eruption and disintegration of magma/lavas intruding and mingling with unconsolidated, or at least poorly consolidated, wet sediment (*e.g.*, BUSBY-SPERA & WHITE, 1987; SKILLING *et al.*, 2002; CHEN *et al.*, 2016). Volcaniclastic sequences, which occur in several tectonostratigraphic units in the Transcarpathian Ukraine (Pieniny Klippen Belt, Kamyanyi Potik, Porkulets units) (LOMIZE, 1968) sometimes have peperites.

In the first case, in the Veliky Kamenets active quarry (Pieniny Klippen Belt - PKB) a continuous section occurs with a lower Jurassic (since Hettangian?) to lowermost Cretaceous (Berriasian) sedimentary succession (Fig. 1). The biostratigraphy of the Toarcian-Berriasian part of this section is very precisely based on ammonites, dinoflagellates and calpionellids (REHÁKOVÁ *et al.*, 2011). Basaltic rocks occur in the uppermost part and overlie creamy-white *Calpionella* Limestones. They are directly covered by biodetritic limestones and synsedimentary breccias. The latter are the so-called Walentowa Breccia Member of the Łysa Limestone Formation, according to the Polish and Slovakian parts of the PKB (after BIRKENMAJER, 1977), which are dated by calpionellids as middle and/or upper Berriasian and upper Berriasian, respectively. Importantly, in this breccia some clasts of basaltic rocks occur (Fig. 1) which implies they are middle and/or upper Berriasian in age as well. Additionally, on the contact between *Calpionella* Limestones and basalts (sometimes developed as pillow basaltic lavas with interstitial limestones), peperites have been discovered recently. According to magnetostratigraphic study (GRABOWSKI *et al.*, this volume) magnetozones from M23r to M18n have been identified in the studied section. The Jurassic/Cretaceous boundary (Colomi/Alpina boundary) occurs in the middle of the M19n2n polarity zone. Our latest investigations are concentrating now on radiometric dating of these basaltic rocks, which geochemically have previously been determined to be caused by intra-plate volcanism (KROBICKI *et al.*, 2008; OSZCZYPKO *et al.*, 2012). Integrated litho-, bio-, chemo- and magneto-stratigraphic studies carried out in this section can be here supplemented by absolute age determination of a submarine volcanic event. This is a unique chance to calibrate the age of the J/K boundary.

In the second case, the Kamyanyi Potik Unit (Nappe) is the most internal and structurally highest unit of the Fore-Marmarosh units (KROBICKI *et al.*, 2014; HNYLKO *et al.*, 2015 with literature). It forms a separate nappe and consists of the earliest Cretaceous Chyvchyn Formation (up to 1000 m in thickness), composed mainly of basic igneous extrusions, and the Kamyanyi Potik Formation (200 m in thickness) represented by dark, thin-bedded limestones, black shales, sandstones and conglomerates with volcanic material. The best places to study this unit occur both on Chyvchyn Mount (1766.1m a.s.l.) - the highest peak of the Chyvchyn Mountains, and in the vicinity of the city of Rakhiv. The geological structure of the Chyvchyn Mountains was first shown on a geological map published by ZAPAŁOWICZ (1886) and PAZDRO (1934), where volcano-sedimentary deposits were attributed to the Triassic. Our recent geological mapping work showed that this complex forms a tectonic klippe/cap which consists of four small thrust slices (HNYLKO *et al.*, 2015). Biostratigraphical investigations using calpionellids indicate their age as Berriasian. The structurally lowermost slice (100-200 m thick) consists of thin-bedded micritic *Maiolica*-type limestones with cherts which are intercalated by calcareous pyroclastic turbidites (similar to stratotype in the Kamyanyi Potik stream near Rakhiv). The second slice, the next highest structurally (250-300 m thick), is formed by hyaloclastic breccias/conglomerates (gravelstones) with a volcano-tuffitic matrix and blocks of different sizes containing pebbles and olistoliths of limestones (often with corals and other benthic fauna, occasionally in blocks 5 m in diameter), which represent submarine debris flow deposits. The third slice, the next structurally highest (up to 30-40 m thick), is entirely comprised of classical peperites deposits (limestones with irregular pieces of basaltic rocks). The fourth and structurally highest slice (200-250 m thick) crops out on the Chyvchyn peak and is represented by massive basaltic pillow lavas. In our interpretation, the primary volcano-sedimentary sequence began with basaltic pillow lava flows, then peperites, then great debris flows with olistoliths and distal pyroclastic turbidities which were finally intercalated by micritic, pelagic limestones (*Maiolica*-type). In this case, peperites were a transitional event between main submarine basaltic flooding and mingling of debris flows with carbonate mud on the sea-floor.

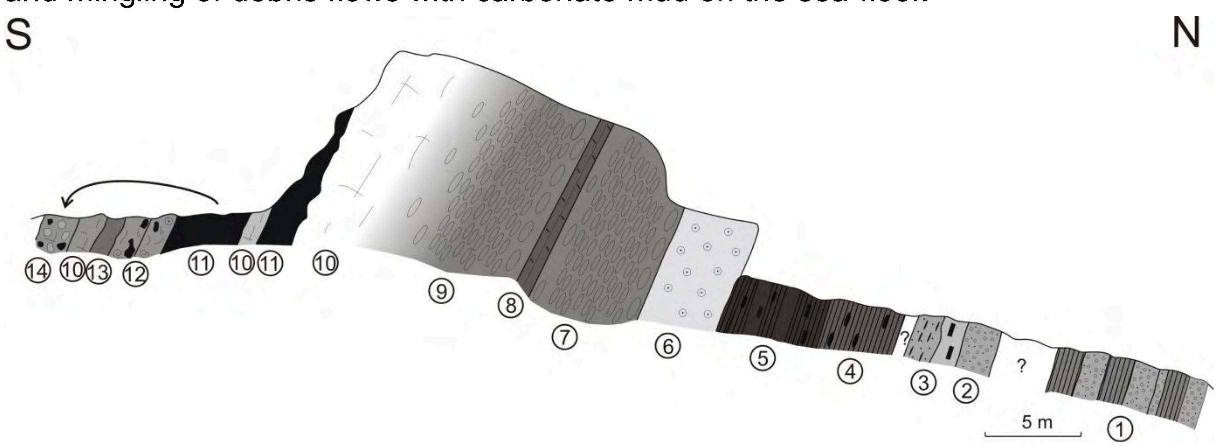

Figure 1: Schematic cross-section of the Veliky Kamenets quarry with a sequence of Jurassic and lowermost Cretaceous rocks (after KROBICKI *et al.*, 2012; modified; lithostratigraphical names adopted from BIRKENMAJER, 1977). Explanations: 1-5 - Hettangian(?)-lowermost Bajocian: 1 - white-yellowish conglomerate and cherry red shales; 2 - yellow sandstones; 3 - fine-grained sandstones and mudstones with coal; 4 - black shales with spherosiderites; 5 - mudstones with bivalve coquina; Bajocian: 6 - pink crinoidal limestones (Smolegowa and/or Krupianka Limestone Formation); uppermost Bajocian-Oxfordian: 7 - red nodular limestones of the *Ammonitico Rosso*-type facies (Niedzica Limestone Formation); Kimmeridgian: 8 - red thin-bedded radiolarites (Czajakowa Radiolarite Formation); upper Kimmeridgian-upper Tithonian: 9 - red nodular limestones of the *Ammonitico Rosso*-type facies (Czorsztyn Limestone Formation); 10-14 - upper Tithonian-Berriasian: 10 - creamy and white *Calpionella* limestones (Dursztyn Limestone Formation); 11 - black basalts (including peperites); 12 - creamy biodetritic limestones (Harbatowa Limestone Member of the Łysa Limestone Formation); 13 - green tuffites; 14 - yellowish carbonate breccia (Walentowa Breccia Member of the Łysa Limestone Formation). Arrow indicates origin of basaltic clasts within Walentowa Breccia Member.

In conclusion, in two analyzed cases (Veliky Kamenets quarry and Chyvchyn Mt) we have very unique associations of volcanogenic rocks and limestones which occur together as sedimentary episodes of submarine eruptions of basaltic lavas on unconsolidated sea floor carbonate mud. Such volcano-sedimentary deposits are perfect additional setting for age dating of volcanic activity by dating of limestones, which are sometimes full of both macrofossils (*e.g.*, corals of the Štramberk-type limestones - shallow-water carbonates known as olistoliths and exotic pebbles in flysch deposits of the Outer Carpathians; *e.g.*, ELIÁŠOVÁ, 2008; KOŁODZIEJ, 2015, with literature cited therein) and microfossils (calpionellids) which are Berriasian in age (IWAŃCZUK *et al.*, 2015).

BIRKENMAJER K. (1977).- Jurassic and Cretaceous lithostratigraphic units of the Pieniny Klippen Belt, Carpathians, Poland.- *Studia Geologica Polonica*, t. 45, 2, p. 1-159.

BUSBY-SPERA C.J. & WHITE J.D.L. (1987).- Variation in peperites textures associated with differing host-sediment properties.- *Bulletin of Volcanology*, 49, p. 765-775.

CHEN S., GUO Z., QI J., ZHANG Y., PE-PIPER G. & PIPER D.J.W. (2016).- Early Permian volcano-sedimentary successions, Beishan, NWChina: Peperites demonstrate an evolving rift basin.- *Journal of Volcanology and Geothermal Research*, 309, p. 31-44.

ELIÁŠOVÁ H. (2008).- Corals from the Štramberk limestone (Silesian Unit, Outer Western Carpathians, Czech Republic).- *Geologia, Kwartalnik AGH*, 34, p. 151-160.

GRABOWSKI J., BAKHMUTOV V., KDÝR Š., KROBICKI M., PRUNER P., REHÁKOVÁ D., SCHNABL P., STOYKOVA K. & WIERZBOWSKI H. (2018).- A continuous stratigraphical record of the Upper Kimmeridgian to Lower Berriasian palaeoenvironmental changes in a pelagic setting: the Veliky Kamenets section (Pieniny Klippen Belt, Ukraine) (this volume).

HNYLKO O., KROBICKI M., FELDMAN-OLSZEWSKA A. & IWAŃCZUK J. (2015).- Geology of the volcano-sedimentary complex of the Kamyanyi Potik Unit on Chyvchyn Mount (Ukrainian Carpathians): preliminary results.- *Geological Quarterly*, 59, 1, p. 145-156.

IWAŃCZUK J., KROBICKI M., FELDMAN-OLSZEWSKA A. & HNYLKO O. (2015).- Calpionellid biostratigraphy of the lowermost Cretaceous volcanogenic beds of the Kaminnyi Potik Unit (Ukrainian Carpathians).- *Berichte des Institutes für Erdwissenschaften Karl-Franzens-Universität Graz*, 21, p. 179.

KOŁODZIEJ B. (2015).- Corals of the Štramberk-type limestones from Poland: Taxonomic and palaeoecological aspects.- *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen*, 276, p. 181-199.

KROBICKI M. (2012).- Wycieczka terenowa. In: JURASSICA X:, Abstrakty i przewodnik wycieczki terenowej, Rakhiv-Beňatina 25-30.06.2012, p. 31-56.

KROBICKI M., OSZCZYPKO N., SALATA D. & GOLONKA J. (2008).- Intra-plate alkaline volcanism in the Pieniny Klippen Belt (Eastern Carpathians, Ukraine). *In*: NÉMETH Z. & PLAŠIENKA D. (eds) SlovTec 08, 6th CETeG, 23-26 April 2008, Upohlav, Pieniny Klippen Belt, Slovakia.- Proceedings and Excursion Guide, p. 73-74.

KROBICKI M., HNYLKO O., FELDMAN-OLSZEWSKA A. & IWAŃCZUK J. (2014). Tectono-stratigraphic position of the Kaminnyi Potik Unit in the Ukrainian Carpathians and volcanogenic rocks of Mt Chyvchyn. *In*: ROCH R. *et al.* (eds) STRATI 2013.- Springer, p. 533-537.

LOMIZE M.G. (1968). Late-Jurassic volcanism of the Eastern Carpathians.- *Vestnik Moskovskovo Universiteta*, 6, p. 42-58 (in Russian only).

OSZCZYPKO N., SALATA D. & KROBICKI M. (2012).- Early Cretaceous intra-plate volcanism in the Pieniny Klippen Belt - a case study of the Velykyi Kamenets'/Vilkhivchyk (Ukraine) and the Biała Woda (Poland) sections.- *Geological Quarterly*, 56, 4, p. 629-648.

PAZDRO Z.T. (1934).- Les Montagnes de Czywczyn.- *Rocznik Polskiego Towarzystwa Geologicznego*, 10, p. 3-149 (in Polish with French summary).

REHÁKOVÁ D., MATYJA B.A., WIERZBOWSKI A., SCHLÖGL J., KROBICKI M. & BARSKI M. (2011).- Stratigraphy and microfacies of the Jurassic and lowermost Cretaceous of the Veliky Kamenets section (Pieniny Klippen Belt, Carpathians, Western Ukraine).- *Volumina Jurassica*, 9, p.61-104.

SKILLING I.P., WHITE J.D.L. & MCPHIE J. (2002).- Peperites: a review of magma-sediment mingling.- *Journal of Volcanology and Geothermal Research*, 114, p. 1-17.

ZAPAŁOWICZ H. (1886).- Geologische Skizze des östlichen Theiles des Pokutisch-Marmaroscher Grenz-Karpathen.- *Jahrbuch der k. k. Geologischen Reichsanstalt*, 36, p. 361-591.

25. Records of the global Valanginian events in the Getic Carbonate Platform (Southern Carpathians, Romania)

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Carbonate sequences of the Getic Carbonate Platform crop out in large surfaces on the eastern part of the Southern Carpathians (in Dâmbovicioara zone, Braşov-Codlea zone, Bucegi Mountains, Piatra Craiului Mountains).

The aim of the present study is to reveal the effects of the global Valanginian events recorded in different depositional settings of the eastern part of the Getic Carbonate Platform. In the shallowest setting of the platform the late Tithonian - lower Valanginian deposits (almost 400 m thick) are represented by reef limestones that pass gradationally into intraclastic/bioclastic-dominated shoals and peritidal carbonate deposits (Cheile Dâmbovicioarei Formation). The lower part of the succession is dominated by bioconstructions and contains corals and diverse microencrusters (*e.g.*, *Pseudorothpletzella* sp. and *Crescentiella morronensis*). The rudstones and grainstones following the bioconstructions contain a foraminiferal assemblage represented by *Coscinoconus alpinus* and *Bramkampella arabica* and calcareous algae (*Clypeina sulcata*), suggesting a late Tithonian age.

Toward the upper part of the Cheile Dâmbovicioarei Formation, two ammonite specimens have been found and identified as *Berriasella* (*Picteticeras*) cf. *picteti* and *B*. (*P*.) aff. *elmi*. Both are indicative for the Boissieri Zone of the upper Berriasian. The microfossil assemblage from the upper part of the Cheile Dâmbovicioarei Formation is represented by abundant foraminifera and rivulariacean-type cyanobacteria. Among foraminifera present, *Pfenderina neocomiensis, Haplophragmoides joukowskyi, Montsalevia salevensis, Pseudotextulariella courtionensis, Protopeneroplis ultragranulata and Meandrospira favrei* are indicative of the Berriasian-lower Valanginian. Consequently, based on ammonite and microfossil assemblages, at least a late Berriasian-early Valanginian age for the upper part of Cheile Dâmbovicioarei Formation can be assumed.

During the latest Berriasian-early Valanginian time interval, extensional tectonic events and a coeval sea-level low-stand determined the emergence and possibly subaerial exposure of the structural highs of the Getic Carbonate Platform.

In the shallowest settings of the carbonate platform (Braşov-Codlea and Dâmbovicioara zones) the corresponding stratigraphic gap is well constrained to the early Valanginian. Considering the existing biostratigraphic data, we assume a gap of almost 1.5 Ma in the Braşov-Codlea zone and one of almost 2.5 Ma in the Dâmbovicioara zone.

The drowning event following the emergence of the platform is documented by the intra-Valanginian discontinuity surface associated with an interval of stratigraphic and taphonomic condensation, phosphatisation, glauconitisation and encrustation with iron oxyhydroxides. This drowning event is also associated with glauconite-rich and pyrite-bearing wackestone infilling of the irregular surface of the discontinuity, as well as forming the matrix of *in situ* fracture breccias and chaotic collapse breccias.

The onset of the drowning event was highly diachronous (based on ammonites species identified on the sediment above the discontinuity surface). In the Braşov-Codlea zone it started in the middle early Valanginian (Neocomiensiformis Zone), in the Dâmbovicioara zone in the earliest late Valanginian (Verrucosum zone), and in the Bucegi Mountains in the late Valanginian (upper Verrucosum Zone).

The deepest settings of the carbonate platform from Bucegi Mountains reveal a tectonic model of half-graben tilted blocks. The limestones forming the tilted blocks belong to the Lespezi Formation and are interpreted as successions deposited at the base of the slope. The occurrence of the abundant encrusting *Crescentiella morronensis* in close association with microbe-sponge carbonates with strong biogenic encrustation, *Terebella lapilloides* and oncoidic carbonates is interpreted as a process of allochthonous carbonate grains being exported from the protected areas of deep outer shelf and/or of upper-middle slope settings. The allochthonous shallow-water skeletal debris is represented by *Spirillina, Patellina, Lenticulina, Epistomina, Ophtalmidium, Coscinoconus, Neotrocholina, Meandrospira,* miliolids; *Crescentiella morronensis*, quite frequent; *Koskinobulina socialis,* and *Radiomura cautica*. The autochthonous background pelagic sediment consists of bioclastic-lithoclastic packstone-wackestone containing abundant calpionellids (*Calpionella alpina, Lorenziella hungarica, Remaniella cadischiana, Calpionellopsis simplex, C. oblonga, Tintinnopsella carpathica*, and *T. longa*). This assemblage belongs to the Calpionellopsis standard zone. No specimen of *Calpionella elliptica* or specimens of *Calpionellites* have been found, so we suppose that the Elliptica subzone, as well as the Calpionellites zone is missing in the analyzed material. The existing calpionellid assemblages indicate a late Tithonian-Berriasian age, from the upper part of the standard zone A to the standard zone D.

During the late Berriasian, the slope of the carbonate platform started to be affected by extensional tectonics, generating normal faulting and tilting of blocks, with their foot-wall uplifts forming escarpments and their hanging-wall dip-slopes developing as small ramps. The top of the Lespezi Formation was affected by tectonic fracturing, producing *in situ* breccia and neptunian dykes. After the faulting, the highest-lying parts of the tilted blocks were probably emergent and preferentially karstified. Relative sea-level lowstands (during the latest Berriasian-early Valanginian) and, locally, emersion of the tilted blocks of the carbonate platform, were followed in the late Valanginian (starting with late Verrucossum Zone) by a sea-level rise that led to the final drowning of the platform. The general deepening of the platform is documented by the overlying post-drowning pelagic sediments onlapping the discontinuity surface.

The negative - positive carbon isotope excursions recorded in the studied sections are correlated with an increase of the total organic content. These excursions correspond to the global paleoenvironmental perturbations of the carbon cycle related to the Valanginian «Weissert» episode, which is reflected both in shallow-water (the Dâmbovicioara and Codlea zones) as well in deep-water settings (Bucegi Mountains) of the Getic Carbonate Platform.

26. Facies, stratigraphy and magnetic susceptibility of lower Cretaceous (Aptian-Albian) strata from Djebel Felten Formation, central rim of the Constantine shelf, NE Algeria

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The sedimentological analysis of an Aptian-Albian carbonate succession, well dated by benthic and planktonic foraminifers, which crops out at Djebel Felten, has allowed the recognition of 25 lithofacies grouped into 12 microfacies associations that imply carbonate platform environments. The succession is repeatedly interrupted by emersions, suggesting high-frequency relative sea-level oscillations.

Stacking pattern of the limestone-marl alternations and facies evolution allow the identification of sequence boundaries, transgressive surfaces, and maximum-flooding events or condensed sections of at least two hierarchical levels.

The magnetic susceptibility (MS) signal appears to be influenced by facies and platform geometry. The evolution of MS seems to be mainly related to changes in carbonate productivity, water agitation and unconformities. Algal facies and biomicrites (rudist floatstones) corresponding to high carbonate production show the lowest signal, whereas black pebbles, paleokarsts, and storm deposits are characterized by higher values. In addition, the MS signals from proximal microfacies have higher values than the distal ones. MS appears to be a useful complementary proxy for paleoenvironmental interpretations, correlations and sequence stratigraphy. For example, sea level rise led to a decrease in the content of the detrital materials, and therefore to a decrease in the susceptibility values. On the top of a HST, the uplift and exposure events may lead to elevated magnetic susceptibility values. Carbonate susceptibilities can therefore be considered as one of the environmental proxy data for sequence stratigraphic investigation.

27. The numerical age of the Jurassic/Cretaceous system boundary

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The age of the Jurassic/Cretaceous boundary has remained elusive for the past decades. Here we examine the numerical age of the boundary by cross calibrating the numerical age of two distinct stratigraphic sections that contain well-established early Berriasian boundary markers. We present high-precision U-Pb zircon age determinations of single grains of volcanic zircon of two sections that span the Jurassic/Cretaceous: the Las Loicas section, Argentina, and the Mazatepec section in Mexico. We evaluate how well the determined boundary ages of these two distinct sections agree and whether we can constrain a globally valid Jurassic/Cretaceous boundary age. In Argentina the age of the boundary was determined at 140.22 ± 0.13 Ma and in Mexico at 140.9 Ma. Additionally, we also present the first age determinations in the early Tithonian in the *Virgatosphinctes andesensis* Zone at 147.112 ± 0.078 Ma and tentatively propose a minimum duration of ~7 Ma for the Tithonian stage. These results allows us to challenge the age for the boundary currently accepted by the International Commission on Stratigraphy, which calibrates the age of the boundary at ~145 Ma.

28. Well preserved radiolarians across the Jurassic-Cretaceous (J/K) boundary in the Bosso Valley section, Central Italy

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The Bosso Valley section is located near the Pianello-Cagli road and follows the Bosso River in the Umbria-Marche area of the Central Italy. The pronounced increase in abundance of *Calpionella alpina* documented at the base of *Calpionella* zone is accepted as the Jurassic-Cretaceous boundary (JKB) indicator in the Bosso Valley section. The magnetostratigraphical record of the JKB has been correlated with the *Calpionella* zone. The JKB is placed between Beds 77 and 78 (HOUSA *et al.*, 2004). The Maiolica Formation, which crosses the JKB, is characterized by whitish, beige to gray colored, well-bedded limestones with abundant black to gray chert layers and chert nodules and marly intervals. Certain horizons in the Bosso Valley section yield well-preserved radiolarians, significant for the correlation of deep marine sediments. In order to establish radiolarian biostratigraphy across the JKB, a detailed study was conducted to elucidate the relationship between lithology and preservation of radiolarians in the Bosso Valley section. Three samples of micritic limestone below the JKB (Beds 73, 75, and 77) and two samples above the JKB (Beds 86 and 87) were collected for analysis. The limestone samples were immersed in 10% hydrochloric acid for 30 to 60 minutes, then washed, dried and examined under a binocular microscope and a scanning electron microscope. Radiolarians are abundant both in the chert bands or nodules and in the limestone. Preservation of radiolarians varies in different parts because of variations in diagenesis. Surfaces of etched limestone are observed and divided into different parts, based on the preservation of radiolarians. Radiolarians are generally calcified in the pure lime beds. Radiolarians are generally badly preserved in the chert bands or nodules. Well-preserved radiolarians are located inside the limestone near the chert bands or nodules. Primary results of radiolarian assemblages near the JKB are proposed. Limestones near chert layers or nodules in the Bosso Valley section enable radiolarian biostratigraphic study across the JKB.

HOUSA V., KRS M., MAN O., PRUNER P., VENHODOVA D., CECCA F., NARDI G. & PISCITELLO M. (2004) .- Combined magnetostratigraphic, paleomagnetic and calpionellid investigations across Jurassic/Cretaceous boundary strata in the Bosso Valley, Umbria, central Italy. - *Cretaceous Research*, vol. 25, p. 771-785.

29. Facies changes along the Jurassic-Cretaceous boundary in Jordan

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The Jurassic-Cretaceous boundary in Jordan is defined at the base of the overlying lower Cretaceous, *i.e.*, the Kurnub Sandstone Group, which is marked by the regional 'Lower Cretaceous Unconformity' (LCU). The upper part of the Jurassic strata is comprised of carbonate dominated facies, *i.e.*, the Mughanniyya Formation, beneath the sandstones of the overlying Kurnub Sandstone Group. The topmost of the Jurassic succession is marked by a thin argillaceous sandy paleosol horizon containing plant remains, and is underlain by fossiliferous strata (limestones, marlstone, clay and dolomite) assigned a latest Bathonian to Callovian age. The peritidal setting of the uppermost Jurassic is indicated by the variable lithofacies, including dolomitic limestone, mudcracked mudstones with burrow mottling, and shallow scours with granular and pebbly sandstone infillings. A regressive event during the deposition of the Kurnub Group is indicated, when progressive shoaling of the sea floor and further retreat of the shoreline occurred.

The lowermost Cretaceous Kurnub sequence consists of sandstone with shale and mudstone interbeds that formed under braided and meandering fluvial systems. These terrestrial facies pass upward into tidal and shallow marine carbonate facies. The boundary separating the Cretaceous strata from the underlying Jurassic strata is marked by the LCU that truncates all rock formations below. It represents a time when the land emerged and the Neotethys Sea retreated northwards due to a major eustatic sea-level fall. Northward flowing streams accompanied a regional uplift of the Arabian-Nubian Shield.

30. The Jurassic-Cretaceous boundary in Lebanon

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Louis DUBERTRET is considered the father of the modern stratigraphy in the Levantine area. His work remains the basis of any geological or paleontological contribution in Lebanon. However, the stratigraphical units he introduced when mapping the region, *i.e.*, J6 = Kimmeridgian, J7 = uppermost Jurassic, C1 = Neocomian [The "Néocomien" *sensu* DUBERTRET comprised all the Cretaceous strata below the Aptian, *i.e.*, including the Barremian], C2a = lower Aptian, and C2b = upper Aptian" (DUBERTRET, 1955), and later renamed by WALLEY (1997, 2001) respectively as "Bikfaya, Salima, Chouf, Abeih, and Mdairej formations") are all facies-driven. Because this concept is nowadays considered outdated, the Lebanese stratigraphy was in need for a full revision.

In 2013, our team initiated a full revision of the lower Cretaceous in Lebanon based on a holistic approach of stratigraphy (micropaleontological, biostratigraphical, and lithostratigraphical studies). We were able to identify regional stratigraphical discontinuities and related bounded units, document their typical paleontological assemblages with both micro- and macrofossils, ascribe them more accurate ages, and better understand both vertical and, consequently (WALTHER's law), lateral facies changes.

DUBERTRET considered the Bikfaya Cliff, symbolized as J6, to be Kimmeridgian in age. However, the occurrence of *Campbelliella striata* (CAROZZI, 1954) gave better resolution, permitting a late Kimmeridgian - Tithonian date.

The Salima Formation *auct.*, above the J6, was considered Jurassic in age. Its microfossil contents (GRANIER *et al.*, 2016) suggested it should be divided into two different units: 1) an unnamed unit with *Longicollaria insueta* (ŘEHÁNEK, 1986) as a marker for the middle Tithonian, and 2) the oolitic limestones of the Salima that could be early Valanginian in age. According to S. FERRY (personal communication), the macrofossil contents of this oolitic unit (*e.g.*, brachiopods, identified by Y. ALMÉRAS) validates the age ascription.

The "Grès du Liban" of HEYBROEK (1942), "Grès de base" or "C1" of DUBERTRET (1955), or "Chouf Formation" of WALLEY (2001) was considered an interval comprising continental strata only. However, GRANIER *et al.* (2016) reported marine occurrences at its base that are dated as early Barremian. The "Grès du Liban" *sensu* GRANIER *et al.* (2015) comprises the "C1" and the base of the "C2a" of DUBERTRET (1955). In its upper part, there are locally lacustrine and palustrine facies corresponding to a series of Lagerstätten (including fishes, turtles, ostracods, *etc.*), as well as amber sites with arthropod inclusions (AZAR, 1997; 2007; AZAR *et al.*, 2003).

The Salima Formation *emend.*, which corresponds to an overall transgressive oolitic unit, is an unconformity-bounded unit. Based on our investigations: 1) the lower unconformity corresponds to a hiatus that encompasses at least the duration of the Berriasian; 2) the upper discontinuity corresponds to a hiatus that encompasses at least the upper Valanginian and the Hauterivian. Regardless of the selected option for the Jurassic-Cretaceous boundary (Tithonian/Berriasian or Berriasian/Valanginian), it unambiguously fits into the discontinuity at the base of the Salima Formation in Lebanon.

AZAR D. (1997).- Lebanese Amber.- *Meganeura*, Strasbourg, vol. 1, p. 26-27.

AZAR D. (2007).- Preservation and accumulation of biological inclusions in Lebanese amber and their significance.- *Comptes rendus Palevol*, Paris, vol. 6, no. 1-2, p. 151-156.

AZAR D., NEL A. & GÈZE R. (2003).- Use of amber fossil inclusions in palaeoenvironmental reconstruction, dating and palaeobiogeography. *In*: Fossil insects.- *Acta Zoologica Cracoviensa*, vol. 46, supplement, p. 393-398.

DUBERTRET L. (1955).- Notice explicative de la Carte géologique du Liban au 200.000e.- Ministère des Travaux Publics, Beyrouth, 74 p. (30 Pls.).

GRANIER B., AZAR D., MAKSOUD S., GÈZE R. & HABCHI R. (2015).- New fossiliferous sites with Barremian Charophyta in the "Grès du Liban " *auct.* (Lebanon), with a critical perspective regarding the nature of *Munieria* DEECKE, 1883.- *Carnets Geol.*, Madrid, vol. 15, no. 15, p. 199-229.

GRANIER B., TOLAND C., GÈZE R., AZAR D. & MAKSOUD S. (2016).- Some steps toward a new story for the Jurassic - Cretaceous transition in Mount Lebanon.- *Carnets Geol.*, Madrid, vol. 16, no. 8, p. 247-269.

HEYBROEK F. (1942).- La géologie d'une partie du Liban Sud.- Thesis, Dr in de Wis- en Natuurkunde aan de Rijksuniversiteit Groningen; *Leidsche Geologische Meddedeelingen*, vol. XII, fasc. 2, p. 251-470.

WALLEY C. (1997).- The Lithostratigraphy of Lebanon.- *Lebanese Science Bulletin*, vol. 10, no. 1, p. 81-108.

WALLEY C. (2001).- The Lebanon passive margin and the evolution of the Levantine Neo-Tethys. *In*: ZIEGLER P.A., CVAZZA W., ROBERTSON A.H.F. & CRASQUIN-SOLEAU S. (eds.), Peri-Tethyan rift/wrench basins and passive margins.- *Mémoire du Muséum national d'Histoire naturelle*, vol. 186, p. 407-439.

31. New magnetostratigraphic data from the upper Volgian of the Moscow region

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Strong biogeographical segregation near to the Jurassic/Cretaceous boundary leads to the impossibility of direct Boreal-Tethysian correlation by biostratigraphy, thus identifying magnetostratigraphy as a key approach. However, magnetostratigraphic data from the Boreal section are very scarce. So far the only Nordvik section (northern Siberia) is characterized by a succession which permits direct correlation with Tethysian regions (*cf.* HOUŠA *et al.*, 2007; SCHNABL *et al.*, 2015), but ammonite findings in the upper Volgian of this section are uncommon and the position of zonal boundaries remains tentative (ROGOV *et al.*, 2015). Here we are describing the first preliminary results of a magnetostratigraphic study of the condensed upper Volgian succession in the Eganovo sand pit near Moscow (N55°32'0.16"; E38° 3'28.28"). This section is well-characterized by ammonites (ROGOV, 2017), and contains a nearly full succession of ammonite biohorizons except the uppermost middle Volgian Nikitini Zone, with a gap corresponding to its upper subzone. The uppermost part of the Volgian here is lacking any macrofossils and cannot be correlated to any ammonite zone. A total of 12 paleomagnetic samples were collected from the ~3.8 m interval. Each sample was prepared as several cubic specimens. The magnetic susceptibility (K) and

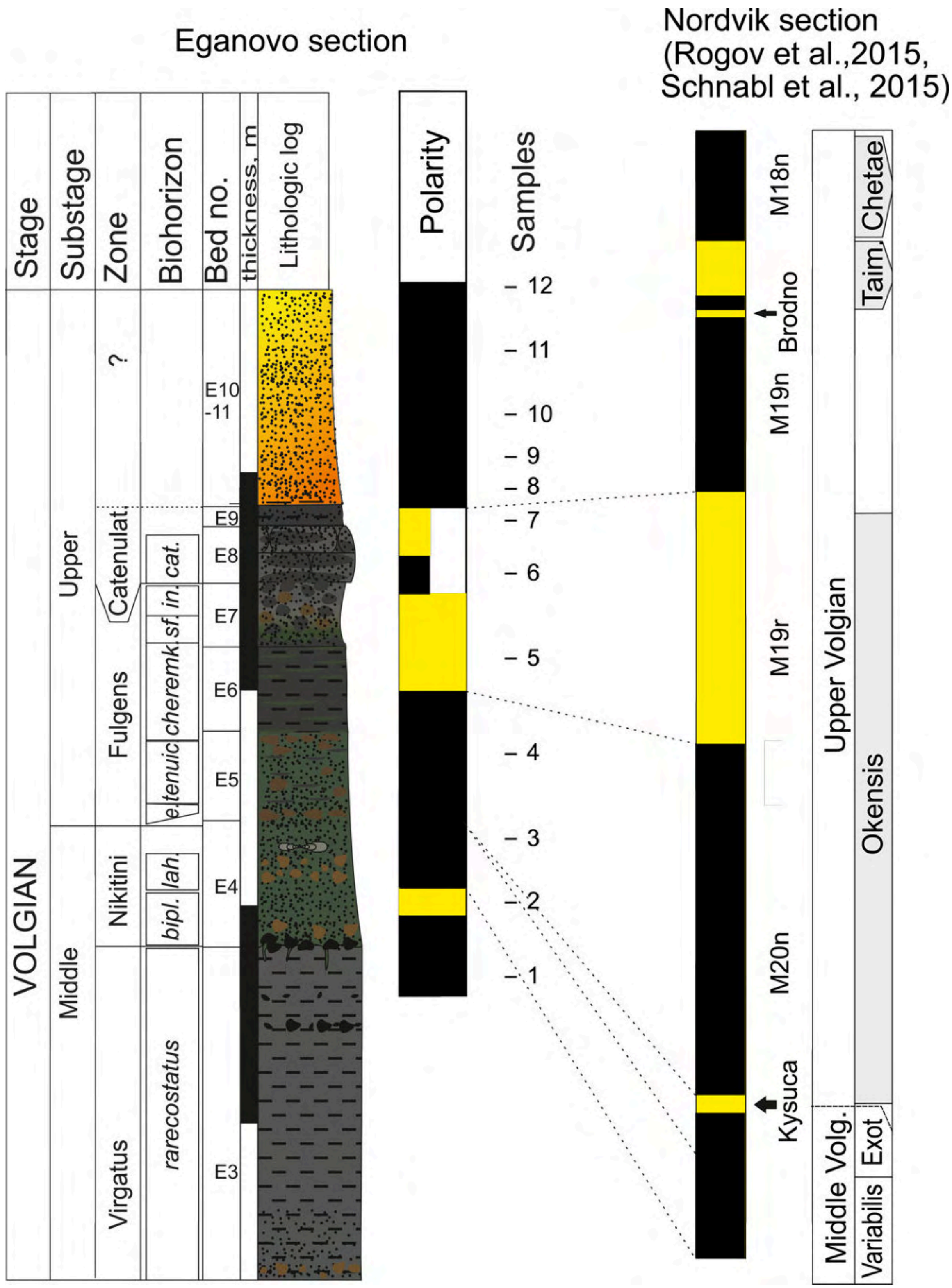

Figure 1: Lithostratigraphy and ammonite biostratigraphy of the Eganovo section plotted together with the polarity zones detected and their comparison with polarity zones recognized in Nordvik (Northern Siberia).

anisotropy of magnetic susceptibility (AMS) were measured using MFK1-FB kappabridge, while the natural remanent magnetization (NRM) was measured using a 2G Enterprises. Alternating field demagnetization was carried out from 3 to 80 mT with 3 mT steps. As revealed by magneto-mineralogical study, the main sources of natural remanent were magnetite and closely related minerals, but some samples from member 2 are characterized by the presence of iron hydroxydes. In the studied section, different lithologies are characterized by different NRM and K values. AMS of samples from the Member 2 (beds E2-E9) is characterized by a nearly equal distribution of K1 axes suggesting weak hydrodynamics with only a little influence of bottom currents from NW to SE, but some samples show an anomalous distribution of axes suggesting active hydrodynamics. Paleomagnetic data are relatively poor, as in other strongly condensed successions. As follow from Zijderveld diagrams, nearly all samples are characterized by the presence of low coercitivity remanent magnetization and characteristic remanent magnetization (ChRM). The latter was used for determination of magnetic polarity. ChRM was recognized in 7 samples only, but even such preliminary data permits recognition of a succession of magnetic polarity zones which could be correlated with both the Nordvik succession and the Standard succession. Two reverse polarity zones, which correspond to the lower part of the middle Volgian Nikitini Zone and the upper Fulgens to Catenulatum upper Volgian zones could be ascribed to M20r and M19r respectively. These results fit well with biostratigraphic correlation of Eganovo and Nodrvik successions.

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Houša V ., Pruner P., Zakharov V.A., Kostak M., Chadima M., Rogov M.A., Šlechta S. & Mazuch M. (2007). - Boreal-Tethyan correlation of the Jurassic-Cretaceous boundary interval by magneto- and biostratigraphy.- *Stratigraphy and Geological Correlation*, vol. 15, p. 297-309.

Rogov M.A. (2017). - Ammonites and infrazonal stratigraphy of the Kimmeridgian and Volgian stages of southern part of the Moscow syneclise.- *Transactions of the Geological Institute*, v. 615, p. 7-160.

Rogov M.A., Alifirov A.S. & Igolnikov A.E. (2015). - Revised ammonite succession of the Upper Volgian of Nordvik section: zonal boundaries and uncertainties.- The International Scientific Conference on the Jurassic/Cretaceous boundary. September 7-13, 2015, Samara (Russia). Kassandra, Togliatti, p. 70-76.

Schnabl P., Pruner P. & Wimbledon W.A.P. (2015). - A review of magnetostratigraphic results from the Tithonian-Berriasian of Nordvik (Siberia) and possible biostratigraphic constraints. - *Geologica Carpathica*, vol. 66, p. 489-498.

32. Interhemispheric time scale for the Hauterivian and its implications for the carbon cycle in the Berriasian-Barremian times

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Discrepancies in the ages and durations of the Berriasian to Barremian stages still exist between geological data and the proposed geological time scale of 2016 (OGG *et al.*, 2016; LENA *et al.*, 2018). The Hauterivian Stage suffers from these discrepancies, as its duration is proposed at 3.92 myr (OGG *et al.*, 2016), while astrochronology in the Tethysian area (SE France and SE Spain) led to a duration of 5.9 ± 0.4 myr (MARTINEZ *et al.*, 2015). In order to reconcile these durations, we investigated the Agrio Formation in the Neuquén Basin (Argentina). A total of 2,200 samples were collected every 0.25 cm and measured for magnetic susceptibility with a Kappabridge KLY-2. From spectral analyses carried out on these MS signals, it appears that the 100-kyr eccentricity is continuously recorded throughout the Agrio Formation, allowing duration calculations. In addition, a new U-Pb age measured on zircons was derived in the upper part of the Agrio Formation using the CA-ID-TIMS method. Thus, four U-Pb ages are now available in the Agrio Formation measured with the U-Pb CA-ID-TIMS (AGUIRRE-URRETA *et al.*, 2015, 2017). Notably, the astrochronological durations fit with three of the U-Pb ages. A fourth age appears 300 kyr older than what is suggested by astrochronology, which may be due to protracted crystallization of zircons in the magmatic chamber. These new data in the Agrio Formation, together with correlations to the Tethysian area, suggest a revision to the duration of the Hauterivian Stage of 5.22 ± 0.11 myr starting at 131.29 ± 0.25 Ma and ending at 126.07 ± 0.25 Ma. The previous overestimate of the duration of the Hauterivian Stage was likely due to distortion of the 405-kyr eccentricity in the sedimentary record, as recent studies document (LAURIN *et al.*, 2017; MARTINEZ, 2018). Thanks to these revised ages and previous astrochronological frameworks, we were able to revise the ages and durations of stages from the late Berriasian to the Barremian-Aptian boundary. A synthesis of $\delta^{13}C$ measured on belemnites (MARTINEZ & DERA, 2015) indicate a clear 2.4-myr cycle in the carbon cycle record which fits with the main paleoceanographic events. Higher amplitudes of this cycle are notably observed during major volcanic episodes, suggesting that acceleration of the hydrolic cycle lead to a reinforcement of the long-MILANKOVITCH cycles.

AGUIRRE-URRETA B., LESCANO M., SCHMITZ M.D., TUNIK M., CONCHEYRO A., RAWSON P.F. & RAMOS V.A. (2015).- Filling the gap: new precise Early Cretaceous radioisotopic ages from the Andes.- *Geological Magazine*, vol. 152, p. 557-564.

AGUIRRE-URRETA B., SCHMITZ M., LESCANO M., TUNIK M., RAWSON P.F., CONCHEYRO A., BUHLER M. & RAMOS V.A. (2017).- A high precision U-Pb radioisotopic age for the Agrio Formation, Neuquén Basin, Argentina: implications for the chronology of the Hauterivian Stage.- *Cretaceous Research*, vol. 75, p. 193-204.

LAURIN J., RŮŽEK B. & GIORGIONI M. (2017).- Orbital signals in carbon isotopes: Phase distortion as a signature of the carbon cycle.- *Paleoceanography*, vol. 32, p. 1236-1255.

LENA L., LÓPEZ-MARTÍNEZ R., LESCANO M., AGUIRRE-URRETA B., CONCHEYRO A., VENNARI V., NAIPAUER M., SAMANKASSOU E., PIMENTEL M., RAMOS V. & SCHALTEGGER U. (2018).- Cross-continental age calibration of the Jurassic/Cretaceous boundary.- *Solid Earth Discussions*, https://doi.org/10.5194/se-2018-57.

MARTINEZ M., DECONINCK J.-F., PELLENARD P., RIQUIER L., COMPANY M., REBOULET S. & MOIROUD M. (2015).- Astrochronology of the Valanginian - Hauterivian stages (Early Cretaceous): Chronological relationships between the Parana-Etendeka large igneous province and the WEISSERT and the Faraoni events.- *Global and Planetary Change*, vol. 131, p. 158-173.

MARTINEZ M. (2018).- Mechanisms of preservation of the long MILANKOVITCH cycles in detrital supply and carbonate production in hemipelagic marl-limestone alternations.- *Timescale and Stratigraphy*, vol. 3, p. 189-218.

OGG J.G., OGG G. & GRADSTEIN F.M. (2016).- A concise geologic time scale.- Elsevier, 234 p.

33. Early Cretaceous neritic carbonate community and facies response to paleonvironmental and sea-level changes: New evidences from the Apennine carbonate platform of southern Italy

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The early Cretaceous marine sedimentary record is punctuated by several crises of carbonate production and perturbations of the global carbon cycle (WEISSERT & ERBA, 2004; FÖLLMI & GODET, 2013). The earliest of these crises occurred during the Valanginian period. In the northern Tethysian domain, this crisis entailed the demise of carbonate platforms and major changes in carbonate producer communities. High trophic conditions are mirrored by the shift to a heterozoan neritic community that started close to the Berriasian/Valanginian boundary and persisted up to the early Barremian. Fossil assemblages, combined with lithofacies characteristics, are here used to reconstruct the Valanginian-Barremian paleoenvironmental history of the San Lorenzello section, which belongs to the Apennine Carbonate Platform (APC) of southern Italy. Unlike coeval northern Tethysian carbonate platforms, this platform did not record any drowning event during the Valanginian-Barremian. However, it responded to paleoenvironmental perturbations by biofacies changes that are here investigated.

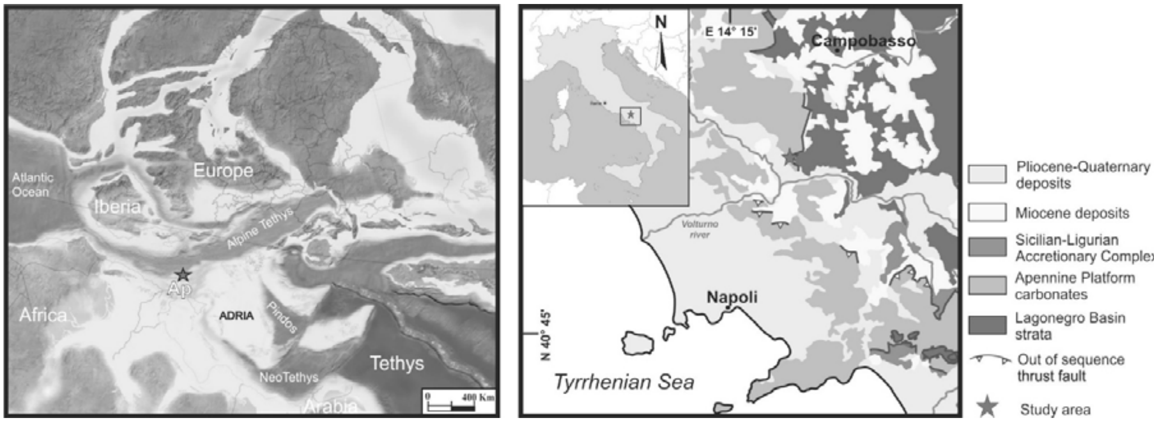

Figure 1: On the left, the paleogeography of the western-central Tethys in the Early Cretaceous (Ap: Apennine carbonate platform; red star: San Lorenzello section) (http://cpgeosystems.com/125_Cret_EurMAp_sm.jpg modified). On the right, a simplified geological map of the southern Apennines (Italy) with location of the studied section.

The San Lorenzello section (233 m thick) is well exposed on the southern slope of the Monte Monaco di Gioia ridge (Matese Mountains), about 70 km North of Naples (Fig. 1). The first 86 m were previously investigated by sedimentology, cyclostratigraphy, sequence stratigraphy and isotope stratigraphy (D'ARGENIO *et al.*, 1997; FERRERI *et al.*, 2004; AMODIO, 2006; AMODIO *et al.*, 2008; AMODIO *et al.*, 2018). We have revisited this older interval using high-resolution biostratigraphy and present a work in progress on biota and facies evolution throughout the whole Valanginian-Barremian interval.

Based on lithofacies changes and related early diagenetic features, we propose a sedimentary model for the carbonates of the San Lorenzello section. According to our model this section was part of a wide and shallow carbonate platform that was influenced by waves and/or storms. A narrow, high-energy zone of migrating sandy shoals separated a more open from a more restricted lagoon. The sporadic occurrence of laminated and charophyte-bearing limestones suggests ephemeral tidal-supratidal settings with brackish ponds. The sea-level oscillations induced frequent and cyclic emersions of the platform, witnessed by karstification and pedogenesis of marine carbonates. Previous works also showed an eustatic control on the depositional sequences (superbundles in D'ARGENIO *et al.*, 1997; FERRERI *et al.*, 2004).

Taking into account the CHIOCCHINI *et al.* (2008) and DE CASTRO (1991) biozonal schemes, based on calcareous algae and benthic foraminifera, and supplementing these schemes with the data on biostratigraphic distribution of *Salpingoporella* species (CARRAS *et al.*, 2006), the first results of our study leads to a considerable refinement of the biostratigraphy of the studied section. Our new investigations confirm that the lower part of this section is late Valanginian in age, as already indicated by AMODIO *et al.* (2008). The first *Vercorsella* and *Cuneolina* species occur at 10-15 m from the base of the section. The next interval (between 20 and 60 m from the base of the section) is characterized by *Actinoporella podolica*, *Salpingoporella annulata* and *Selliporella johnsoni*, associated with *Vercorsella camposauri*, *V. scarsellai*, *Cuneolina laurentii* and *Praechrysalidina infracretacea.* This association points to a late Valanginian-early Hauterivian age. Within this interval, the occurrence of typical specimens of *C. laurentii* (between 40 and 50 m from the base of the section), the LO of *S. johnsoni* (at about 55 m) and the FO of *P. danilovae* (at about 58 m) allow identification of the Valanginian-Hauterivian boundary as occurring in the *C. laurentii* biozone sensu DE CASTRO, 1991. The FO of *Salpingoporella piriniae*, preceded by the FO of *S. melitae* and *S. muehlbergii*, allows identification of the Hauterivian-Barremian boundary between 100 and 110 m from the base of the section, based on the review of the distribution of *Salpingoporella* species by CARRAS *et al.* (2006). The LO of *Campanellula capuensis* and *Clypeina solkani,* between 150 and 160 m from the base of the section, indicates the lower/upper Barremian boundary (CHIOCCHINI *et al.*, 2008; DE CASTRO, 1991). The LO of *S. annulata*, found at about 145 m from the base, points to the late Barremian (CARRAS *et al.*, 2006).

These new biostratigraphic data indicate that the Valanginian-Hauterivian boundary is about ten meters below the position indicated by FERRERI *et al.* (2004). The mismatch between the biostratigraphic position of the Valanginian-Hauterivian boundary of FERRERI *et al.* (2004) and the chemostratigraphic position of the same boundary, based on correlation with reference deep water sections by carbon isotope stratigraphy, was already underlined by AMODIO *et al.* (2008). Our new biostratigraphy of the San Lorenzello section eliminates this mismatch and produces a close agreement between the biostratigraphic and C-isotope position of the Valanginian-Hauterivian boundary.

The C-isotope correlation between neritic and pelagic sections by AMODIO *et al.* (2008) suggested that only the upper part of the WEISSERT event is recorded in the San Lorenzello section, followed by a time of a global decrease of C-isotope values. The upper Valanginian deposits, 40-50 m thick, are mainly composed of peritidal facies and punctuated by sedimentary gaps. This is consistent with the third order global sea-level fall (HAQ, 2014) and cooling event hypothesized by some authors (*e.g.*, WEISSERT & ERBA, 2004). Starting from about 33m from the base of the section, sandy shoal facies become more frequent. These deposits record higher energy conditions at the Valanginian-Hauterivian transition and a deepening upward trend culminating in the Hauterivian interval (50-65 m overall thick), where more abundant open lagoonal facies occur. Some bivalve- rich horizons (at about 59, 63, 68, 71, 80, 93 and 96 m) characterize this portion of the section, where tidal facies are rare. This vertical facies evolution is consistent with the third order global sea-level rise starting in the Hauterivian and culminating at the base of the Barremian (HAQ, 2014). The restoration of more restricted environmental conditions characterizes the lower part of the Barremian interval (from about 115 to 155 m), with alternating restricted lagoonal and inner shoal facies. Starting from 160 m, the uppermost part of the San Lorenzello section consists of alternating lagoonal limestones and massive dolomites. However, the occurrence of intervals partially covered by modern day vegetation and soil, hinders a detailed sequence stratigraphy interpretation.

AMODIO S. (2006).- Foraminifera diversity changes and paleoenvironmental analysis: The Lower Cretaceous shallow-water carbonates of San Lorenzello, Campanian Apennines, southern Italy.-*Facies*, vol. 52, p. 53-67.

AMODIO S., BARATTOLO F. & RIDING R. (2018).- Early Cretaceous dendritic shrub-like fabric in karstified peritidal carbonates from southern Italy.- *Sedimentary Geology*, vol. 373, p. 134-146.

AMODIO S., FERRERI V., D'ARGENIO B., WEISSERT H. & SPROVIERI, M. (2008).- Carbon-isotope stratigraphy and cyclostratigraphy of shallow-marine carbonates. The case of San Lorenzello, Early Cretaceous of southern Italy.- *Cretaceous Research*, vol. 29, p. 803-813.

CARRAS N., CONRAD M.A. & RADOIČIĆ R. (2006).- *Salpingoporella*, a common genus of Mesozoic Dasycladales (calcareous green algae).- *Revue de Paléobiologie*, Genève, vol. 25(2), p. 457-517.
CHIOCCHINI M., CHIOCCHINI R.A., DIDASKALOU P. & POTETTI M. (2008).- Ricerche micropaleontologiche e biostratigrafiche sul Mesozoico della piattaforma carbonatica laziale-abruzzese (Italia centrale).- *Memorie Descrittive Carta Geologica d'It*alia, vol. 84, p. 5-170.
D'ARGENIO B., FERRERI V., AMODIO S. & PELOSI N. (1997).- Hierarchy of high-frequency orbital cycles in Cretaceous carbonate platform strata.- *Sedimentary Geology*, vol. 113, p. 169-193.
DE CASTRO P. (1991).- Mesozoic.- In: F. BARATTOLO P. DE CASTRO M. PARENTE (Eds.) Field trip guide-book, «*5th international symposium on Fossil Algae*.», p .21-38.
FERRERI V., D'ARGENIO B., AMODIO S. & SANDULLI R. (2004).- Orbital chronostratigraphy of the Valanginian-Hauterivian boundary. A cyclostratigraphic approach. *In*: D'ARGENIO B., FISCHER A.G., PREMOLI SILVA I., WEISSERT H. & FERRERI V. (eds.), Cyclostratigraphy. Approaches and case histories.- *SEPM Spec. Publ*. vol. 81, p. 153-166.
FÖLLMI K.B. & GODET A. (2013).- Palaeoceanography of Lower Cretaceous Alpine platform carbonates.- *Sedimentology*, vol. 60, p. 131-151.
HAQ B.U. (2014).- Cretaceous eustasy revisited.- *Global and Planetary Change*, vol. 113, p. 44-58.
WEISSERT H. & ERBA E. (2004).- Volcanism, CO2 and palaeoclimate: a late Jurassic - early Cretaceous carbon and oxygen isotope record.- *Journal of Geological Society of London*, vol. 161, p. 695-702.

34. Radiolarian phylogeny around the Jurassic-Cretaceous boundary and radiolarian occurrences in the Bosso Valley section, central Italy

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The Global Boundary Stratotype Section and Point (GSSP) of the Jurassic-Cretaceous boundary (JKB) is the last among the GSSPs in the Phanerozoic. It is defined as the base of the Berriasian Stage. . In 2016, the Berriasian Working Group of the International Subcommission on Cretaceous Stratigraphy selected the base of the *Calpionella alpina* Subzone as the primary marker. The definition can be applied well enough for shallow marine deposits within the western Tethys, north Atlantic and central-south America. Unfortunately, the primary marker taxon cannot be found in the Pacific and circum-Pacific regions since the distribution of Calpionellids is limited to the western Tethys, north Atlantic and central-south America. To determine the base of the Berriasian outside of these regions, alternative markers are needed.

Radiolarians are good candidates for defining the JKB because they are wide spread and can be found in both shallow and deep sedimentary facies. Pelagic sequences across the JKB have been reported in ODP/IODP sites in the western Pacific and land sections in Japan, the Philippines, southern Tibet, Iran and other locations. Evolutionary lineages of several radiolarian taxa across the JKB are reviewed and suitable bioevents, which approximate the JKB, are presented. These lineages include the radiolarian genera: *Alievium, Archaeodictyomitra, Cinguloturris, Complexapora, Crococapsa, Doliocapsa, Emiluvia, Eucyrtidiellum, Hemicryptocapsa, Hsuum, Loopus, Mirifusus, Mesovallupus, Neorelumbra, Pantanellium, Protovallupus, Protunuma, Pseudodictyomitra, Ristola, Spinosicapsa, Tethysetta, Thanarla, Vallupus*, *Xitus*, and *Zhamoidellum*. Among them, the *Loopus-Pseudodictyomitra* lineage and the *Protovallupus-Mesovallupus-Vallupus* lineage can be the most important phylogeny for defining the JKB.

As discussed by GORIČAN *et al.* (2018), the evolutionary first appearance datums (FADs) within firmly recognized lineages are extremely valuable. The *Loopus-Pseudodictyomitra* lineage is better for this than the *Protovallupus-Mesovallupus-Vallupus* lineage because the former has a much wider paleobiogeographic distribution than the latter. As applied to the radiolarian zones established so far, the JKB lies within the Unitary Association Zone 13 of BAUMGARTNER *et al.* (1995) and within the *Pseudodictyomitra carpatica* Zone of MATSUOKA (1995). The base of the *Pseudodictyomitra carpatica* Zone is defined by the evolutionary FAD of *Pseudodictyomitra carpatica*. Detailed morphological analysis of *Loopus* and *Pseudodictyomitra* species is presented and the relationship between the JKB and speciation within the lineage is discussed.

The Bosso Valley section in Umbria-Marche, central Italy, is a potential candidate for GSSP of the JKB. The Maiolica Formation, which crosses the JKB, is characterized by whitish, beige to gray colored, well-bedded micritic limestones with abundant black to gray chert layers and nodules. Calpionellid stratigraphy and magnetostratigraphy have been studied sufficiently in the section (HOUSA *et al.*, 2004). The base of the *Calpionella alpina* Subzone, *i.e.*, the JKB, is placed between Beds 77 and 78 (HOUSA *et al.*, 2004). We carried out detailed field observations and careful sample collections in a 4-m interval across the JKB. Acid-etched examination of rock samples revealed that well-preserved radiolarians are recognized inside the lime part near the chert layers or nodules. Three samples of micritic limestone below the JKB and two samples above the JKB yield moderately-preserved radiolarians. The result of radiolarian faunal analysis in the Bosso Valley section is presented.

BAUMGARTNER P.O., BARTOLINI A., CARTER E.S., CONTI M., CORTESE G., DANELIAN T., DE WEVER P., DUMITRICA P., DUMITRICA-JUD R., GORIČAN Š., GUEX J., HULL D.M., KITO N., MARCUCCI M., MATSUOKA A., MURCHEY B., O'DOGHERTY L., SAVARY J., VISHNEVSKAYA V., WIDZ D. & YAO A. (1995).- Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys based on Unitary Associations. *In*: BAUMGARTNER P.O., O'DOGHERTY L., GORIČAN Š., URQUHART E., PILLEVUIT A. & DE WEVER P. (Eds.), Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, systematics, biochronology.- *Mémoires de Géologie (Lausanne*) 23, p. 1013-1048.

GORIČAN Š., O'DOGHERTY L., BAUMGARTNER P.O., CARTER E.S. & MATSUOKA A. (2018).- Mesozoic radiolarian biochronology - current status and future directions. - *Revue de Micropaléontologie*, in press.

HOUSA V., KRS M., MAN O., PRUNER P., VENHODOVA D., CECCA F., NARDI G. & PISCITELLO M. (2004).- Combined magnetostratigraphic, paleomagnetic and calpionellid investigations across Jurassic/Cretaceous boundary strata in teh Bosso Valley, Umbria, central Italy.- *Cretaceous Research* 25, 771-785.

MATSUOKA A. (1995).- Jurassic and Lower Cretaceous radiolarian zonation in Japan and in the western Pacific.- *The Island Arc* 4, 140-153.

35. Tracking dinosaurs across the Jurassic-Cretaceous boundary

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In the late Jurassic (Kimmeridgian/Tithonian) dinosaur tracks occur in a variety of depositional environments, from tidal flats to lacustrine as well as fluvial settings. These two stages include sites from Germany, Switzerland, France, Croatia, Spain and Portugal. They show tracks and trackways of sauropods (diplodocids, titanosaurs), theropods (megalosaurids), and thyreophorans (stegosaurs) as well as those from ornithopods (camptosaurids), with a preference for sauropod/theropod assemblages (Brontopodus Ichnofacies) in tidal flat environments.

In the early Cretaceous (?Berriasian/Valanginian) dinosaur tracksites are mostly found in fluvial and lacustrine settings (Wealden Facies), they seem to be almost absent in Tethysian tidal flat settings. This includes sites in England and Northern Germany as well as Spain. The latter region is the most prolific. They yield tracks and trackways of theropods (megalosaurids, dromaeosaurids), ornithopods (iguanodontids) and some rare sauropods.

Although a shift towards more continental settings can be detected, there is no change in the diversity of dinosaur groups represented by tracks. Whereas in the late Jurassic there is a predominance of the Brontopodus Ichnofacies, a change to a dominance of the Caririchnium Ichnofacies can be observed in the early Cretaceous. This change is due to the appearance of new dinosaur groups as well as a change from more arid to more humid conditions, and tectonics resulting in large deltaic settings in Northern Europe, Southern France and the Iberian Meseta.

36. Uppermost Jurassic-lowermost Cretaceous microfossils from Piatra Craiului (Southern Carpathians, Romania) and the Jurassic-Cretaceous transition in the eastern part of the Getic Carbonate Platform

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The Piatra Craiului Massif is located in the eastern part of Southern Carpathians (Romania). It is bordered on the west by the Dămbovicioara zone, and belongs to the eastern part of the so-called Getic Carbonate Platform, a system of carbonate platforms covering the Getic Nappe of the Southern Carpathians.

Within the sedimentary succession in Piatra Craiului three lithostratigraphic intervals can be identified: (I) a lower unit consisting of coral-microbial boundstones and coarse, poorly sorted rudstones; (II) a middle unit made up of coarse bioclastic grainstones, and (III) an upper unit consisting of peloidal packstone-wackestone and cyanobacteria-bearing mudstone (peritidal limestones).

The micropaleontological assemblages also permit biostratigraphic separatation of three intervals which cannot be superposed on the lithostratigraphic ones.

Biostratigraphical interval A consists of encrusting organisms (*Crescentiella morronensis*, *Koskinobulina socialis*, and *Lithocodium aggregatum*) and bacinellid structures, (*Perturbatacrusta leini* and *Radiomura cautica*). Corals are commonly encrusted by bacinellid-*Lithocodium*. Microfossils are represented by dasycladalean algae (*Campbelliella striata*, *Clypeina sulcata*, *Neoteutloporella socialis*, *Petrascula bursiformis*, *Salpingoporella pygmaea*, *Salpingoporella annulata*, and *Steinmanniporella kapelensis*) and foraminifera (*Bramkampella arabica*, *Everticyclammina praekelleri*, *Labirynthina mirabilis*, *Neokilianina rahonensis*, *Mohlerina basiliensis*, *Parurgonina caelinensis*, and *Redmondoides lugeoni*). This biostratigraphic interval corresponds to lithostratigraphic intervals I and II. The micropaleontological assemblages point to a Kimmeridgian-early Tithonian age.

The next biostratigraphic interval (B) contains the algae Clypeina parasolkani, Clypeina sulcata, Salpingoporella annulata, and Selliporella neocomiensis, and the foraminifera Anchispirocyclina lusitanica, Pseudocyclammina lituus, Pseudotextulariella courtionensis and Rectocyclammina chouberti. It corresponds to the lower part of lithostratigraphic interval III, and indicates a late Tithonian-early Berriasian age.

The biostratigraphic interval C corresponds to the upper part of the lithostratigraphic interval III and contains, mainly in its uppermost part, the algae *Salpingoporella praturloni* and *Pseudocymopolia pluricellata*, and the foraminifera *Coscinoconus cherchiae*, *C. campanellus*, *Everticyclammina kelleri*, *Haplophragmoides joukowskyi*, *Montsalevia salevensis*, *Moulladella jourdanensis*, *Nautiloculina broennimanni*, Orbitolinidae div. sp. indet., *Pfenderina* cf. *neocomiensis*, *Protopeneroplis ultragranulata*, *Pseudocyclammina lituus*, and *Scythiolina* div. sp. This interval is considered to be late Berriasian-earliest Valanginian in age.

The entire carbonate succession from Piatra Craiului is a prograding, shallowing upward megasequence. The identified microfossil assemblages permit separatation into three biostratigraphic intervals, but the repartition of the microfossils do not trace exactly any boundary between stages, either Kimmeridgian-Tithonian, or Tithonian-Berriasian, or Berriasian-Valanginian. More detailed studies within the Dâmbovicioara area could maybe permit a better understanding of the Jurassic-Cretaceous transition in this area.

37. Astronomical calibration of the late Jurassic - early Cretaceous western Tethys

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DSDP Site 534A (Blake Bahama Basin) archives an almost complete succession of Western Tethys, mid Tithonian to early Barremian marl-limestone alternations, across a total length of 336 metres. Despite the stratigraphic importance of the Jurassic-Cretaceous boundary, very few long-term cyclostratigraphic studies have been published so far across that interval. To strengthen the stratigraphy of this important system boundary, we integrate cyclostratigraphy with already existing magnetostratigraphic (OGG, 1987), chemostratigraphic (BORNEMANN & MUTTERLOSE, 2008; LITTLER *et al.*, 2011; TREMOLADA *et al.*, 2006) and biostratigraphic (BRALOWER *et al.*, 1989; BAUMGARTNER, 1983; BERGEN, 1994; BORNEMANN & MUTTERLOSE, 2008; HABIB & DRUGG, 1983; REMANE, 1983; ROTH, 1983; TREMOLADA *et al.*, 2006) frameworks. Tuning to the La2010d solution (LASKAR *et al.*, 2011) reveals a duration of 19.8 million years for the studied part of the core, and the preservation of a wide array of MILANKOVITCH periodicities from the 20 kyr precession cycle up to 9.1 Myr eccentricity grand cycles. Comparison of our Ca/Fe elemental ratio to trends in carbon isotopes show a pacing of the WEISSERT event by the 9.1 Myr eccentricity cycle, with maxima in carbon isotope values coinciding with the maximum of this grand cycle. Astronomical forcing by grand eccentricity cycles appears as an important mechanism for the development of this widespread oceanic anoxic event.

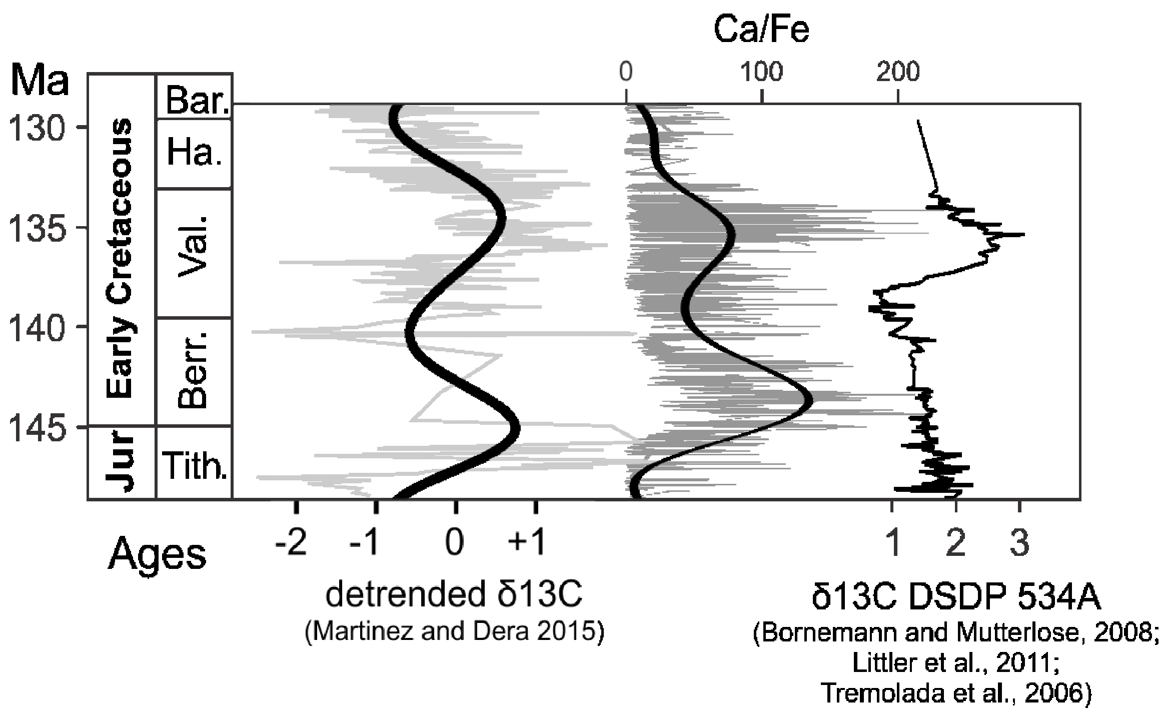

Figure 1: Calcium iron ratio and published carbon isotopes of DSDP 534A plotted against the detrended carbon isotope compilation and 9.1 Ma filter of MARTINEZ and DERA (2015).

BRALOWER T.J., MONECHI S. & THIERSTEIN H.R. (1989).- Calcareous Nannofossil Zonation of the Jurassic-Cretaceous Boundary Interval and Correlation with the Geomagnetic Polarity Timescale.- *Mar. Micropaleontol.* 14, 153-235.

BAUMGARTNER P.O. (1983).- Summary of middle Jurassic - early Cretaceous radiolarian biostratigraphy of site 534 (Blake-Bahama-Basin) and correlation to Tethyan sections.- *Initial reports Deep sea Drill. Proj.* 76, 569-571.

BERGEN J.A. (1994).- Berriasian to early Aptian calcareous nannofossils from the Vocontian Trough (SE France) and deep sea drilling site 534: New nannofossil taxa and a summary of low-lattitude biostratigraphic eventa.- *J. Nannoplankt. Res.* 16, 59-69.

BORNEMANN A. & MUTTERLOSE J. (2008).- Calcareous Nannofossil and ^{13}C Records from the Early Cretaceous of the Western Atlantic Ocean: Evidence for Enhanced Fertilization across the Berriasian-Valanginian Transition.- *Palaios* 23, 821-832.

HABIB D. & DRUGG W.S. (1983).- Dinoflagellate age of Middle Jurassic - Early Cretaceous sediments in the Blake-Bahama-Basin.- *Initial reports Deep sea Drill. Proj.* 76, 623-638.

LASKAR J., FIENGA A., GASTINEAU M. & MANCHE H. (2011).- La2010: a new orbital solution for the long-term motion of the Earth.- *Astron. Astrophys.* 532, A89.

LITTLER K., ROBINSON S.A., BOWN P.R., NEDERBRAGT A.J. & PANCOST R.D. (2011).- High sea-surface temperatures during the Early Cretaceous Epoch.- *Nat. Geosci.* 4, 169-172.

MARTINEZ M. & DERA G. (2015).- Orbital pacing of carbon fluxes by a ~9-My eccentricity cycle during the Mesozoic.- *Proc. Natl. Acad. Sci.* 112, 12604-12609.

OGG J.G. (1987).- Early Cretaceous magnetic polarity time scale and the magnetostratigraphy of Deep Sea Drilling Project Sites 603 and 534, western Central Atlantic.- *Initial reports DSDP*, Leg 93, Norfolk, Virginia to Norfolk, Virginia Part 2 849-880.

REMANE J. (1983).- Calpionellids and the Jurassic / Cretaceous boundary at deep sea drilling project site 534, western north Atlantic Ocean.- *Initial reports Deep sea Drill. Proj.* 561-567.

ROTH P.H. (1983).- Jurassic and Lower Cretaceous calcareous nannofossils in the western north Atlantic (Site 534): Biostratigraphy, preservation, and some observations on biogeography and paleoceanography.- *Initial reports Deep sea Drill. Proj.* 76, 587-621.

TREMOLADA F., BORNEMANN A., BRALOWER T.J., KOEBERL C. & SCHOOTBRUGGE B. van de (2006).- Paleoceanographic changes across the Jurassic/Cretaceous boundary: The calcareous phytoplankton response.- *Earth Planet. Sci. Lett.* 241, 361-371.

38. The new lithostratigraphic table of Switzerland - where do we stand?

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A harmonized lithostratigraphic scheme and nomenclature for Switzerland has been developed by the Swiss Geological Survey, in close collaboration with the Swiss Committee for Stratigraphy (STRASKY *et al.*, 2013). This new scheme now serves as a standardized master legend for the Geological Atlas of Switzerland 1:25000 (GA25) and is currently being implemented in vector datasets of already published map sheets, that are stepwise integrated into the geological viewer of the Swiss Confederation (www.map.geo.admin.ch > Geocatalog > Nature and Environment > Geology > GeoCover). In parallel, valid units are briefly described in an online lexicon (www.strati.ch) that also links the old terminology with the new lithostratigraphic nomenclature.

However, this first step in the countrywide harmonization of lithostratigraphy does not yet involve any geometrical modifications where cartographic mismatches occur, as this would imply a thorough revision of the individual geological maps, only achievable on the mid- to long-term. As a corollary, quite a large number of informal, no longer recognized unit assemblages (or parallel subdivisions) still have to be maintained, at least locally, as long as a new delimitation has been drawn (*i.e.*, provisional units have to be introduced until a formal definition is elaborated). Last but not least, many cartographic units are not - strictly speaking - of stratigraphic nature. This is particularly the case for tectonites, gangue rocks and purely petrographic map units, especially in crystalline basement but also for some sedimentary lithologies (*e.g.* characteristic facies recurring vertically or changing laterally without a clear stratigraphic succession within a formation, such as shell sandstone beds of the molasse). The present day state of work will be sketched based on the situation around the Jurassic/Cretaceous boundary.

In conclusion, in the transitional phase between the transposition of the harmonized lithostratigraphic master legend and the geometrical revision of the vector datasets, it is important that the remaining cartographic discrepancies be clearly documented, so that the end-user knows what is the validity and revision status of the different elements of the map he/she looks at. This is achieved through the use of a specific attribute highlighting in which cases the mapped objects are truly up-to-date and - if not - what kind of inconsistency still remains to be resolved.

STRASKY S., MORARD A. & MÖRI A. (2016).- Harmonising the lithostratigraphic nomenclature: towards a uniform geological dataset of Switzerland.- *Swiss J. Geosci.*, vol. 109, p. 123-136.

39. Catalogue of Tithonian-Berriasian radiolarians

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Radiolarians have a great potential for defining the Jurassic-Cretaceous boundary, but they are still underexplored. The number of publications dealing with taxonomy or stratigraphy of Tithonian-Berriasian radiolarians is significantly lower than for other Mesozoic stages. A great effort was made at the end of the century by the Mesozoic Working Group of InterRad (International Association of Radiolarists). However, the resolution across the Jurassic-Cretaceous boundary was unsatisfactory due to the low number of samples investigated at that time.

In this meeting we present a new taxonomic atlas of radiolarians for low- and mid-latitude areas. This atlas consists only of species whose occurrence has been reported in Tithonian and/or Berriasian strata. It includes 210 revised species, 40 of them were not previously considered in the Catalogue of BAUMGARTNER *et al.* (1995). Synonymies and illustrations of all of them should facilitate their recognition in order to build the most complete lists of taxa in samples across the J/K boundary.

The catalogue of taxa has been elaborated based on selected radiolarian-rich samples from well-constrained stratigraphic levels through the Tithonian-Berriasian stages. The taxa reported in these samples have been very-well studied and illustrated in order to positively confirm their occurrence in every sample. These rich and well-preserved samples record up to 115 already described taxa (see Dumitrica & Zügel, 2003; Jud, 1994; Matsuoka, 1998; Matsuoka *et al.*, 2005). The well-constrained stratigraphic position of samples allows us to create an artificial succession of levels and hence to create an empirical stratigraphic chart which is exhibited during this symposium. Actually, this stratigraphic atlas is the starting point of the project underway by the Mesozoic Working Group of InterRad in order to complement the definition of the J/K boundary with radiolarians. This would be of great interest because radiolarians, as opposed to calpionellids, are common in the Neotethys, assuring the traceability of the J/K boundary beyond the Central Atlantic-Western Tethysian areas.

Analysis of taxa on Italian sections (Bosso and Valdorbia, Umbria-Marche Apennines) reveals that a major turnover encompassing the first appearance of up to 25 species took place just before the J/K boundary (inside the lower part of the Maiolica facies). These preliminary results should not to be regarded as an artifact related to a major change due to preservation imposed by the change from chert- to carbonate-dominated lithologies in the Alpine-Mediterranean region because the occurrence of these new species are recorded rapidly through around the first 20m of the Maiolica facies and concomitantly with the occurrence of first true calpionellids in the uppermost Tithonian. Another valuable argument supporting this hypothesis is that the major facies in the transition from the underlying lime-poor to lime-free siliceous deposits to the Maiolica-type limestone is not marked by an extinction event. The extinctions through the Tithonian are gradual and 97 species survive the J/K boundary.

The best candidate to define the J/K boundary in the Alpine-Mediterranean region are those located in the Umbria-Marche Apennines in which magnetostratigraphy, calpionellids and calcareous nannofossils have been also investigated (Bosso and Valdorbia sections). Counterpart areas in the Northern Calcareous Alps also encompass a great potential to redefine our radiolarian scales; they belong to the Oberalm and Schrambach formations at the Trattberg-Gartenau and Kaltenhausen sections (Steiger, 1992).

Baumgartner P.O., Bartolini A., Carter E.S., Conti M., Cortese G., Danelian T., De Wever P., Dumitrica P., Dumitrica-Jud R., Goričan Š., Guex J., Hull D.M., Kito N., Marcucci M., Matsuoka A., Murchey B., O'Dogherty L., Savary J., Vishnevskaya V., Widz D. & Yao A. (1995).- Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys based on Unitary Associations. *In*: Baumgartner P.O., O'Dogherty L., Goričan Š., Urquhart E., Pillevuit A. & De Wever P. (Eds.), Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, systematics, biochronology.- *Mémoires de Géologie (Lausanne*) 23, p. 1013-1048.

Dumitrica P. & Zügel P. (2003).- Lower Tithonian mono- and dicyrtid Nassellaria (Radiolaria) from the Solnhofen area (southern Germany).- *Geodiversitas*, v. 25, no. 1, p. 5-72.

Jud R. (1994).- Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys.- *Mémoires de Géologie (Lausanne*), vol. 19, 147 p.

Matsuoka A. (1998).- Faunal composition of earliest Cretaceous (Berriasian) radiolaria from the Mariana Trench in the western Pacific.- *News of Osaka Micropaleontologists*, Special Volume 11, p. 165-187.

Matsuoka A., Yang Q. & Takei M. (2005).- Latest Jurassic-earliest Cretaceous radiolarian fauna from the Xialu chert in the Yarlung Zangbo suture zone, southern Tibet: Comparison with coeval western Pacific radiolarian faunas and paleoceanographic implications.- *The Island Arc*, vol. 14, p. 338-345.

Steiger T. (1992).- Systematik, stratigraphie und Palökologie der Radiolarien des Oberjura-Unterkreiden-Grenzbereiches im Osterhorn-Tirolikum (Nördliche Kalkalpen, Salzburg und Bayern.- *Zitteliana*, vol. 19, p. 3-188.

40. The age mismatch between the GTS2016 on the Tithonian-Berriasian boundary and the new data from South America

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In the last five years, researchers from the Institute of Andean Studies and other colleagues who studied the Mesozoic marine sequences on both sides of the Andes mountain range using different methodologies revealed a mismatch with the Geological Time Table. The chronological data used to define the Tithonian-Berriasian stage boundary do not coincide, either using the latest IUGS ICS proposal, or the GTS2016 or earlier time scales of Ogg *et al.* (2016). There is a 4 to 5 Ma difference in different sections of the Andes between the official boundary of these stages and the new data obtained by diverse methods.

The biostratigraphy of these basins, especially the Neuquén Basin, is based on several generations of biostratigraphic and paleontological studies. The first studies were carried out by German paleontologists at the end of the 19th century and the beginning of the 20th century, who were familiar with the faunas of the Tethys Ocean. These studies made the first correlations of the ammonite fauna between the two regions, establishing different assemblage zones for the Tithonian and Berriasian stages. New biostratigraphic studies and revisions of these ammonite faunas conducted in recent decades have shown that although part of the faunas of these basins have certain endemism, there are key fossils and assemblages that can be correlated with the Standard zonations of the Tethys (Riccardi, 1988, 1991, 2015; Leanza, 1945; Leanza *et al.*, 2011; Vennari, 2016; Vennari *et al.*, 2014; Lena *et al.* 2018, in rev.). These works were complemented by studies in calcareous nannofossils, calpionellids, radiolarians, and others (López-Martínez *et al.*, 2017, 2018, and cites there in).

These biostratigraphic studies were performed in forearc and retroarc basins close to the Jurassic-Cretaceous volcanic arcs, and as a result of this proximity these basins contain numerous deposits of Plinian fall tuffs (Ramos and Folguera, 2005). Due to its position south of the tropic of Capricorn, even in the Jurassic the prevailing winds were from the southwest sector, which is why the retroarc basins have more frequent levels of tuffs interbedded with the marine sediments. These tuffs were dated in the last years using U-Pb techniques such as laser-ablation MC-ICPMS, SHRIMP II ion microprobe, and more recently chemical abrasion ID-TIMS analyses. All these analyses gave coherent results indicating a difference in the different sections studied with the official limits of the Tithonian-Berriasian stage boundary as being between 140 and 141 Ma (Vennari *et al.*, 2014; Naipauer, 2016, Lena *et al.*, 2018, in. rev.).

When these results are analyzed with the evolution in the last decades of the age of the Tithonian-Berriasian stage boundary, interesting data emerge. The limit between these stages has varied from 130 to 145 Ma, highlighting the proposal of EXXON 88, where the limit was close to 141 million years (Gradstein *et al.*, 2012). The big change occurred when the magnetic anomaly model of the Shatsky Rise was introduced (Gradstein *et al.*, 2004), which brought the limit to 145.5 Ma (GTS2004). The studies of calcareous nannofossils and their correlation with the magnetic anomalies of CHANNELL *et al.* (2010), brings this limit again to 141.5 Ma, age much more in line with our determinations. Apparently, the Hawaiian block model, even using constant spreading rates (CHANNELL *et al.*, 1995, 2010; MALINVERNO *et al.*, 2012), gives values closer to the 140-141 Ma interval determined in the Andes.

The examination of the biostratigraphic constrains used on the Shatsky Rise, as well as the chronological Ar-Ar data from the altered basalts, indicate that the age of this proposed limit is about 4 to 5 Ma older than the new data, and needs to be deeply modified. The stage boundary identified in different sectors of the Andes, together with the new and precise U-Pb ages, leads to consider that the limit should be close to 140-141 Ma.

CHANNELL J.E.T., ERBA E., NAKANISHI M. & TAMAKI K. (1995).- Late Jurassic-Early Cretaceous timescales and oceanic magnetic anomaly block models. *In*: BERGGREN W.A., KENT D.V., AUBRY M. & HARDENBOL J. (eds.), Geochronology, time scales and stratigraphic correlation.- *SEPM Sp. Pub*., 54, p. 51-63.

CHANNELL J.E.T., CASELLATO C.E., MUTTONI G. & ERBA E. (2010).- Magnetostratigraphy, nannofossil stratigraphy and apparent polar wander for Adria-Africa in the Jurassic-Cretaceous boundary interval.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 293, p. 51-75.

GRADSTEIN F.M., OGG J.G. & SMITH A. (2004).- *A Geologic Time Scale*.- Cambridge University Press, Cambridge, 589 p.

GRADSTEIN F.M., OGG J.G., SMITH M.D.& OGG G.M. (2012).- The Geologic Time Scale 2012.- Elsevier, 1144 p.

LEANZA A.F. (1945).- Ammonites del Jurásico superior y del Cretácico inferior de la Sierra Azul en la parte meridional de la provincia de Mendoza.- *An. del Mus. La Plata (NS)* 1, 99 p.

LEANZA H.A., SATTLER F., MARTÍNEZ R.S. & CARBONE O. (2011). La Formación Vaca Muerta y equivalentes (Jurásico Tardío-Cretácico Temprano) en la cuenca neuquina.- *Relatorio del 18º Congr. Geol. Arg.*, p. 113-129, Neuquén.

LÓPEZ-MARTÍNEZ R., AGUIRRE-URRETA B., LESCANO M., CONCHEYRO A., VENNARI V. & RAMOS V.A. (2017).- Tethyan calpionellids in the Neuquén Basin (Argentine Andes), their significance in defining the Jurassic/Cretaceous boundary and pathways for Tethyan-Eastern Pacific connections.- *J. S. Am. Earth Sci.* 78, p. 116-125.

LÓPEZ-MARTÍNEZ R., AGUIRRE-URRETA B., LESCANO M., CONCHEYRO A., VENNARI V. & RAMOS V.A. (2018).- Reply to comments on: «Tethyan calpionellids in the Neuquén Basin (Argentine Andes), their significance in defining the Jurassic-Cretaceous boundary and pathways for Tethyan-Eastern Pacific connections» by KIETZMANN & IGLESIA LLANOS.- *J. S. Am. Earth Sci.* 84, p. 448-453.

MALINVERNO A., HILDEBRANDT J., TOMINAGA M. & CHANNELL J.E.T. (2012).- M-sequence geomagnetic polarity time scale (MHTC12) that steadies global spreading rates and incorporates astrochronology constraints.- *J. G. Res*., 117, B06104.

LENA L., LÓPEZ-MARTÍNEZ R., LESCANO M., AGUIRRE-URRRETA B., CONCHEYRO A., VENNARI V., NAIPAUER M., SAMANKASSOU E., PIMENTEL M., RAMOS V. & SCHALTEGGER U. (in review).- Cross-continental age calibration of the Jurassic/Cretaceous boundary.- *Solid Earth Discussion*.

NAIPAUER M. (2016).- Edades U-Pb en circones detríticos de la Formación Tordillo en la cuenca neuquina, centro-oeste de Argentina: implicancias en la edad absoluta del límite jurásico-cretácico.- *Anales Acad. Nac. de Cs. Ex., Fís. y Nat*. 68, p. 73-84.

OGG J.G., OGG G.M.& GRADSTEIN F.M. (2016).- A concise geologic time scale.- Elsevier, 235 p.

RAMOS V.A. & FOLGUERA A. (2005). Tectonic evolution of the Andes of Neuquén: Constraints derived from the magmatic arc and foreland deformation. *In*: VEIGA G., SPALLETTI L.A., HOWELL J.A. & SCHWARZ E. (eds.), The Neuquén Basin: A case study in sequence stratigraphy and basin dynamics.- *GSL Sp. Pub*. 252, p. 15-35.

RICCARDI A.C. (1988).- The Cretaceous System of southern South America.- *Mem. GSA* 168, 161 p.

RICCARDI A.C. (1991).- Jurassic and Cretaceous marine connections between the southeast Pacific and Tethys.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 87, p. 155-189.

RICCARDI A. (2015).- Remarks on the Tithonian-Berriasian ammonite biostratigraphy of west central Argentina.- *Volumina Jurassica* 13, p. 23-52.

VENNARI V.V. (2016).- Tithonian ammonoids (Cephalopoda-Ammonoidea) from the Vaca Muerta Formation, Neuquén Basin, west-central Argentina.- *Palaeontograph. Abteilung* A 306, p. 85-165.

VENNARI V.V., LESCANO M., NAIPAUER M., AGUIRRE-URRETA B., CONCHEYRO A., SCHALTEGGER U., ARMSTRONG R., PIMENTEL M. & RAMOS V.A. (2014).- New constraints on the Jurassic-Cretaceous boundary in the High Andes using high-precision U-Pb data.- *Gond. Res*. 26, p. 374-385.

41. Singular aragonitic foraminifers from the Berriasian of Bosnia

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The use of aragonite in the construction of foraminiferal tests has been identified in both tubular (*e.g.*, Involutinida, Tubulastellidae) and multichambered, benthic (*e.g.*, Robertinina) and planktonic (Favusellidae) forms. All aragonitic foraminifers that have been described so far have shown a test made up of aragonite needles presenting a c-axis more or less perpendicular to the wall surface. We here illustrate for the first time three aragonitically-preserved fossil foraminifers, the tests of which are made of more or less randomly arranged bundles of aragonite needles.

These new multichambered foraminifers have been found in exceptionally well-preserved Berriasian levels of Bosnia. Due to their metastable nature, aragonitic tests are extremely rarely preserved in the fossil record. However, based on morphological and structural characteristics, we suspect that the newly described group may have a long but hidden evolutionary history. Morphologically comparable foraminifers have been found in a moderate state of preservation in the Jurassic and in the Triassic. The discovery of a new wall-type in Mesozoic aragonitic foraminifers questions the long-accepted monophyly of the order Robertinida.

42. Panboreal and Boreal-Tethysian correlation of the Volgian Stage by ammonites

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The Volgian Stage, terminal stage of the Jurassic System, has been introduced by S.N. NIKITIN (1881) for European Russia but during the last decades it is became widely used throughout the Panboreal Superrealm. Strong restrictions of latitudinal faunal immigration between different basins in the latest Jurassic lead to significant problems in Boreal-Tethysian correlation and also to a high level of provinciality within superrealms. However, although zonal and infrazonal successions applied for different Boreal areas sometimes lack any similarities in zonal index species (good examples are successions of NW Europe, the Russian Platform and Northern Siberia, which have no common zones and subzones), substage boundaries are very well correlated throughout the Panboreal Superrealm. The lower boundary of the Volgian Stage coincides with the appearance of key virgatitid and dorsoplanitid genera (*Ilowaiskya* and *Virgatosphinctoides* respectively), which show independent disappearance of lappets, typical for their ancestral taxa. In the Subboreal and Submediterranean areas this boundary is also marked by the extinction of aulacostephanids (ROGOV, 2010; GALLOIS, 2011). The lower boundary of the middle Volgian substage is marked by important evolutionary events (appearance of *Zaraiskites*, *Pavlovia* and *Dorsoplanites*) as well as by palebiogeographic changes, which lead to very wide distribution of early dorsoplanitids throughout the Boreal areas. In spite of strong differences in zonal and infrazonal subdivision of the middle Volgian, its upper boundary can be easily traced, being marked by evolutionary turnover (appearance of *Craspedites* and Craspeditinae subfamily, which were common in the nearly all basins except NW Europe), and slightly postdating the late middle Volgian crisis (ROGOV, 2013) marked by significant decreases of shell size, weakening of ribbing and changes in suture line patterns in Boreal ammonoid lineages as well as by a long-term drop of Boreal ammonoid diversity. The boundary between the Volgian and Ryazanian stages cannot be precisely identified in the Russian Platform, the type region of these units, due to a regional unconformity, but it is easily traceable in other Boreal areas. It is marked by the disappearance of *Volgidiscus* and the appearance of typical Ryazanian genus *Praetollia*.

Boreal-Tethysian correlation of the Volgian Stage with the Tithonian and lowermost Berriasian is only partially based on occurrences of Submediterranean ammonites in Subboreal regions and Subboreal *Gravesia* in Submediterranean areas. These ammonite records provide a good background for precise correlation of the lower Volgian in its type area with the Tithonian succession (ROGOV, 2010). Above the lower Volgian, biogeographic segregation of ammonite faunas became very strong and the lack of any common ammonites in the Boreal and Tethysian areas prevents usage of these fossils for correlational purposes. The uppermost part of the middle Volgian Scythicus Zone in Poland contains calpionellids typical for the middle-late Tithonian Boneti Subzone of the Chitinoidella Zone (PSZCZÓŁKOWSKI, 2016). The uppermost middle Volgian and upper Volgian could be correlated with the Tethysian succession only by means of magnetostratigraphy (HOUŠA *et al.*, 2007; BRAGIN *et al.*, 2013; SCHNABL *et al.*, 2015). The lower boundary of the Volgian Stage is the only level which could be easily traced in both the Boreal and Tethysian areas by ammonites, but substage boundaries of the Volgian Stage lie far from well-correlated levels in the Tithonian Stage and vice versa. Although diverse and numerous occurrences of Tethysian-derived ammonites in the Ryazanian Stage of the Russian Platform are have been well-known for more than one hundred years, their taxonomy and correlational potential still remain matters of controversies.

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BRAGIN V.Yu., DZYUBA O.S., KAZANSKY A.Yu. & SHURYGIN B.N. (2013).- New data on the magnetostratigraphy of the Jurassic-Cretaceous boundary interval, Nordvik Peninsula (northern East Siberia).- *Russian Geology and Geophysics*, vol. 54, p. 335-348.

GALLOIS R. (2011).- A revised description of the lithostratigraphy of the Kimmeridgian-Tithonian and Kimmeridgian-Volgian boundary beds at Kimmeridge, Dorset, UK.- *Geoscience in South-West England*, vol. 12, p. 288-294.

HOUŠA V., PRUNER P., ZAKHAROV V. A., KOSTAK M., CHADIMA M., ROGOV M. A., ŠLECHTA S. & MAZUCH M. (2007).- Boreal-Tethyan correlation of the Jurassic-Cretaceous boundary interval by magneto- and biostratigraphy.- *Stratigraphy and Geological Correlation*, vol. 15, p. 297-309.

NIKITIN S. (1881).- Die Jura-ablagerungen zwischen Rybinsk, Mologa und Myschkin. I. Der oberen Wolga.- *Mémoires de l'Academie Impériale des Sciences de St.-Pétersbourg,* VII série, t. XXVIII, no. 5, p. 1-98.

PSZCZÓŁKOWSKI A. (2016).- The Tithonian Chitinoidellidae and other microfossils from Owadów-Brzezinki quarry (central Poland).- *Volumina Jurassica*, vol. 14, no. 1, p. 133-144.

ROGOV M.A. (2010).- A precise ammonite biostratigraphy through the Kimmeridgian-Volgian boundary beds in the Gorodischi section (Middle Volga area, Russia), and the base of the Volgian Stage in its type area.- *Volumina Jurassica*, Vol. VIII, p. 103-130.

ROGOV M.A. (2013).- The end-Jurassic extinction. *In*: Extinction. Grzimek's Animal Life Encyclopedia.- Gale/Cengage Learning, Detroit, p. 487-495.

SCHNABL P., PRUNER P. & WIMBLEDON W.A.P. (2015).- A review of magnetostratigraphic results from the Tithonian-Berriasian of Nordvik (Siberia) and possible biostratigraphic constraints.- *Geologica Carpathica*, vol. 66, p. 489-498.

43. Stratigraphy and lithologic characterization of the Jurassic-Cretaceous boundary across the Arabian Plate

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The Jurassic-Cretaceous boundary in the Arabian Plate varies from conformable to unconformable in different parts of the basin. The boundary was the subject of early investigations that were associated with the exploration for hydrocarbons in the Middle East during the first half of the last century. Both Jurassic and Cretaceous strata were primary exploration targets and were subjected to extensive stratigraphic and paleontological studies in both outcrops and the subsurface. The first work on the Jurassic - Cretaceous boundary was the identification of the Jurassic ammonites in the mountains of Kurdistan, northern Iraq which was adapted and used later in different parts of the world (SPATH, 1950). Presently, there are three stratigraphic configurations that describe the contact across the Arabian Plate that extend from northern Iraq to Oman. In the deeper parts of the basin, such as northeastern Iraq, it is believed that the sedimentation was continuous across the boundary, as represented by the Chia Gara Formation (middle Tithonian - Berriasian). The thickness of this formation is around 232 m and it consists of radiolarian, ammonite-bearing, thin-bedded limestone and bituminous shale. Ammonite zonation was carried out on the formation outcrops by the geologists of the oil companies working in the region in the middle of the last century. The major ammonites identified include *Berriasella calisto* ORBIGNY and *Berriasella carpathica* ZITTEL. In the subsurface, where it is difficult to get full ammonite samples, tintinnids and calpionellids were used for dating the strata encountered. Three zones have been recognized. These are, on the generic level, the Tithonian *Calpionella* zone; the lower Berriasian *Tintinnopsella/Calpionella* zone and the upper Berriasian *Tintinnopsella* zone, which indicate that sedimentation was continuous across the Jurassic-Cretaceous boundary in the subsurface also. This part of the basin is called the Permeant Basin, or Kirkuk Embayment in Iraq and Garau Basin in western Iran (AQRAWI *et al.*, 2010).

On the shallower, shelfal areas of the Plate, the Gotnia Basin was the dominant sedimentation location during the middle Tithonian. At the center of the basin, sediments were of a condensed, low-stand nature and consist of organic and evaporitic shales and thin-bedded micritic limestones. The Gotnia Basin eventually evolved into the full evaporitic flat lands of the Hith Anhydrite Formation that marks the upper Jurassic boundary in most of the southern parts of the Plate such as Saudi Arabia and United Arab Emirates (Fig. 1; GOFF, 2005). On the flanks of the basin, normal, shallow-water carbonates were forming, such as the limestones and dolomites of the Najmah Formation and the Arab Formation to the west and the Surmeh Formation to the east. Although there are no specific foraminifera species that can be used to identify the Jurassic-Cretaceous boundary but there are certain foraminifera population that differentiate between the Jurassic and the Cretaceous sediments. These are formed of large benthonic foraminifera.

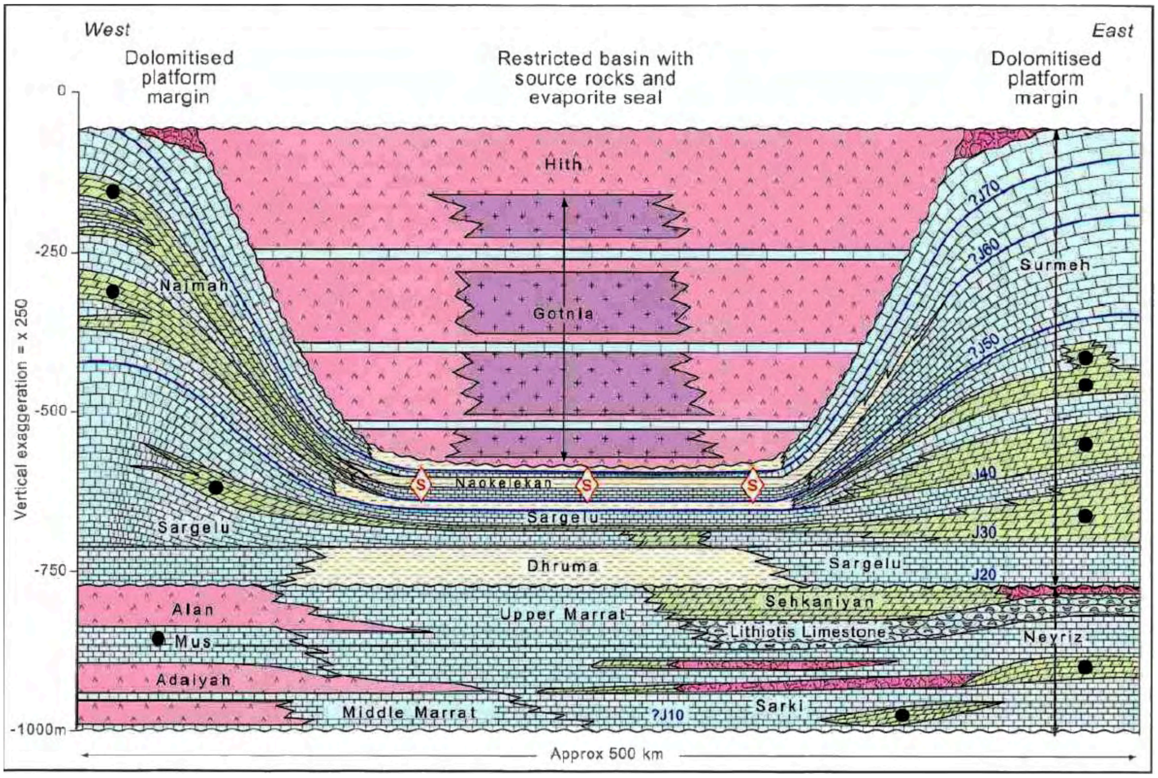

Figure 1: Stratigraphic configuration of the Jurassic Gotnia Basin in the shelfal area of the Arabian Plate (GOFF, 2005; AQRAWI *et al.*, 2010).

The Oxfordian-Kimmeridgian Najmah Formation is recognized by the presence of *Valvulinella* cf. *jurassica* HENSON, *Nautiloculina oolithica* MOHLER, *Pfenderina* spp., *Trochammina* spp., and *Haurania* spp., while the Cretaceous Sulaiy Formation is characterized by the presence of *Pseudocyclammina* cf. *lituus*, *Spirocyclina* sp., and *Ammobaculites.* These foraminiferal assemblages were used for stratigraphic control because most of the studied samples were cores and cuttings derived from drilled oil wells. Some workers delineate the Jurassic-Cretaceous boundary in the lower part of the Sulaiy Formation based on the presence of *Bramkampella* sp. in the lower part of the Sulaiy and the *Everticyclammina* sp. Zone in the overlying Yamama Formation (Cretaceous), but these species have long ranges and cannot be used for this purpose.

In areas where the Hith Anhydrite Formation is prevalent, this formation represents an unconformity surface and is considered to be the top of the Jurassic. Whatever covers it belongs to the Cretaceous. Although this seems a reasonable assumption, some of these evaporites may be aqueous and do not necessarily indicate the presence of unconformity (ALSHARHAN & KENDALL, 1994).

The third stratigraphic situation is found in the areas of western Iraq, Jordan and Syria. In these parts of the basin, the late Jurassic-early Cretaceous sediments are either missing or consist of clastic materials.

ALSHARHAN A.S. & KENDALL C.G.St.C. (1994).- Depositional setting of the Upper Jurassic Hith Anhydrite of the Arabian Gulf: An analog to Holocene evaporites of the United Arab Emirates and Lake MacLeod of Western Australia.- *AAPG Bulletin*, vol. 78, p. 1075-1096.

AQRAWI A.M., GOFF J.C., HORBURY A.D. & SADOONI F.N. (2010).- The Petroleum Geology of Iraq.- Scientific Press, 424 p.

GOFF J.C. (2005).- Origin and potential of unconventional Jurassic oil reservoirs on the northern Arabian Plate.- SPE-93505-PP7.

SADOONI F.N. (1997).- Stratigraphy and petroleum prospects of the Upper Jurassic carbonates in Iraq.- *Petroleum Geosciences*, vol. 3, p. 233-243
SPATH L.F. (1950).- A new Tithonian ammonoid fauna from Kurdistan, north Iraq.- *Brit. Mus. (Nat. Hist.) Geology Bull.*, vol. 1, p. 96-137.

44. Ammonites from the Tithonian - Hauterivian (upper Jurassic - lower Cretaceous) Lo Valdés Formation in central Chile

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The Lo Valdés Formation in the Andes of central Chile contains abundant and well preserved ammonites, indicating a Tithonian-Hauterivian age (late Jurassic-early Cretaceous) for this unit. In the type locality at Lo Valdés, and also in the Cajón del Morado and Cruz de Piedra sections, a total of 1206 ammonites were collected, and 39 species were distinguished belonging to 22 genera. This faunal assemblage is here described and discussed for the first time. *Aulacosphinctes proximus*, *Micracanthoceras spinulosum*, *Corongoceras* cf. *koellikeri*, *Substeueroceras koeneni*, *Argentiniceras fasciculatum*, *Pseudofavrella angulatiformis*, *Crioceratites andinum*, and *Cr. diamantense* were informally recorded previously from the Lo Valdés Formation. *Frenguelliceras magister* is a new record for the unit and for central Chile. *Pterolytoceras exoticum*, *Aspidoceras rogoznicense*, *Micracanthoceras microcanthum*, *M. vetustum*, *Corongoceras lotenoense*, *C. mendozanum*, *Spiticeras acutum*, *Sp. pricei*, *Sp. spitiense*, *Groebericeras rocardi*, *Berriasella* (*Berriasella*) *jacobi*, *Malbosiceras malbosi*, *Chigaroceras bardensis*, *Tirnovella kayseri*, *Thurmaniceras thurmanni*, *Crioceratites perditum*, and *Bochianites* sp. are first registers for Chile. *Lytohoplites paredesi* n.sp., *L. zambranoi* n.sp., *L. varelae* n.sp., and *L. rauloi* n.sp. are new species. *Parodontoceras* is here considered a junior synonym of *Substeueroceras*. Other lectotypes were designated for *Micracanthoceras spinulosum*, *M. vetustum*, *Spiticeras acutum*, *Substeueroceras calistoide*, *Argentiniceras fasciculatum*, *Tirnovella kayseri*, *Crioceratites andinum*, *Cr. diamantense*, and *Cr. perditum*. *Spiticeras acutum* is considered a morphologically variable taxon. *Berriasella* "*jacobi fraudans*" is considered a synonym of *B. jacobi*. Nevertheless *B. jacobi* is a widely used index taxon for the base of the Berriasian and the name should be kept.

The following upper Tithonian to upper Hauterivian index fossils are used to subdivide the Lo Valdés Formation: *Micracanthoceras microcanthum* (lower upper Tithonian), *Corongoceras alternans*, *Berriasella jacobi*, *Groebericeras rocardi*, *Substeueroceras koeneni* (lowermost Berriasian), *Thurmanniceras thurmanni*, *Argentiniceras fasciculatum*, and *Crioceratites diamantense*.

45. Biostratigraphy and bioevents during the Tithonian - Hauterivian of central Chile

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Ammonites of the Lo Valdés Formation were collected from sections at Lo Valdés, Cajón del Maipo and Cruz de Piedra. A total of 1206 ammonites were collected in the Lo Valdés Formation (LV, CM and CP) and these specimens were assigned to 39 species. Here we propose the following zones, from base to top: Zone 1 *Micracanthoceras microcanthum* / *Corongoceras alternans*, Zone 2 *Substeueroceras koeneni* (*Berriasella fraudans* and *Groebericeras rocardi* sub-zone), Zone 3 *Thurmaniceras thurmanni* / *Argentiniceras fasciculatum*, Zone 4, Zone 5 and Zone 6 *Crioceratites diamantense*.

Data of "relative abundance", "relative richness", "evenness and SHANNON diversity index" of Baños del Flaco and Lo Valdés formations are integrated and the data set was grouped in stratigraphic intervals, which correspond to the 9 biozones identified.

The "abundance" increases gradually from the lower part of the middle Tithonian to the upper Tithonian, with the highest values reached during the upper Tithonian. From the upper Tithonian to the upper Valanginian the "relative abundance" decreases gradually. Ammonites are rare to absent in the upper Valanginian to lower Hauterivian interval and the "relative abundance" drops to low values or even zero but rises again to low «relative abundance» levels in the upper Hauterivian.

"Richness" is high during the middle and late Tithonian and into the early Berriasian. During this latter stage numbers decrease to the early Valanginian. No ammonites were identified for the upper Valanginian and lower Hauterivian interval. "Richness" is low for the upper Hauterivian.

Our species turn-over analysis of ammonites is based on sections. There is zero similarity between the lower and the middle Tithonian. From the upper Tithonian to the upper Berriasian, similarity values increase gradually, coincident with the gradual decline of the diversity. Similarity values are highest during the late Tithonian, coincident with a high diversity. Similarity declines by 20% during the early Berriasian, as most taxa registered in the upper Tithonian are absent during the early Berriasian.

Ecological indices, such as "relative abundance", "relative richness", "evenness" and the "Shannon" diversity index show that the highest relative abundance and diversity were reached during the middle to late Tithonian, with the main bioevent occurring at the end of the upper Tithonian. The ecological index is still high for the lower Berriasian, with the highest richness, but taxa differ between these stages, with the exception of *Substeueroceras callistoide.* The JACCARD index is low.

Relative richness and relative abundance data for the Baños del Flaco and Lo Valdés formations, during the Tithonian to Hauterivian are as follows: the ecological index shows similar values during the Tithonian and Berriasian; 41% and 41% richness and 43% and 42% abundance. During the Valanginian richness and abundance decrease abruptly to values of 12% and 13% respectively. During the Hauterivian the values are lower, due to the low number of ammonites collected in the sections.

46. *Bispiraloconulus serbicus*, a giant arborescent benthic foraminifera from the Berriasian of Serbia

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A new giant (centimeter-sized) benthic foraminifera displaying arborescent morphology is described as *Bispiraloconulus serbicus* from Berriasian shallow-water carbonates of the Kurilovo area, eastern Serbia. The sample yielding the new taxon belongs to a carbonate succession outcropping north-north-east of Niš city, in the vicinity of Kamenica village. The limestones from this area belong to the Kurilovo fold structure or anticline that is part of the Gornjak-Stuva Planina unit. This unit occurs in the westernmost part of the Carpatho-Balkanids of Eastern Serbia. North of the Danube River it continues as the Sasca unit belonging to the Getic domain of the South Carpathians. The dimorphic taxon is characterized by an adult part with rectilinear chambers, a thin wall (epiderm) with short polygonal subepidermal network (exoskeleton), and thin septa exhibiting cribrate foramina. The chamber interior contains a 3D-construction of (bio-) clasts fixed (agglutinated) to the septa and the exoskeleton by means of micritic columnar elements. All these features are characteristic for the genus *Spiraloconulus* ALLEMANN & SCHROEDER (Aalenian-Berriasian) with its three species *S. perconigi* ALLEMANN & SCHROEDER, *S. giganteus* CHERCHI & SCHROEDER, and *S. suprajurassicus* SCHLAGINTWEIT. The branching-arborescent test morphology, however, differentiates the Serbian form from *Spiraloconulus,* being unbranched and conical to cylindro-conical. Following current classifications of agglutinating foraminifera, test bifurcation is considered a generic criterion (*e.g.*, compare *Reophax* vs *Bireophax*; see LOEBLICH & TAPPAN, 1987; KAMINSKI, 2014) and consequently a new genus was established: *Bispiraloconulus*. With this characteristic *Bispiraloconulus* can be compared with the Barremian-Aptian *Torremiroella* BRUN & CANÉROT or the Cenomanian *Thomasinella* SCHLUMBERGER. Among the agglutinating foraminifera *Bispiraloconulus* is unique for its arborescent test combined with a wall displaying a subepidermal network. *Bispiraloconulus* belongs to a group of larger benthic foraminifera displaying internal agglutination that fills large parts of the chamber interior: *Spiraloconulus* ALLEMANN & SCHROEDER (Aalenian-Berriasian), *Bostia* BASSOULLET (Bathonian), *Robustoconus* SCHLAGINTWEIT & VELIĆ (Bajocian), and *Torremiroella* BRUN & CANÉROT (Barremian-Aptian). Another allied taxon also displaying an exoskeleton and "large globular particles incorporated into the septa" (LOEBLICH and TAPPAN, 1986, p. 335) is *Dhrumella* REDMOND, 1965 (Bathonian). Still poorly known, *Dhrumella* might also belong to this group and can be considered a compressed, peneropliform *Spiraloconulus*. This peculiar internal structure obviously contributed considerably to test rigidity, allowing an adaptation to agitated shoal and near-shoal paleoenvironments. Delicate large-sized arborescent agglutinated taxa with simple wall and lacking internal constructive elements instead are reported from bathyal depths.

KAMINSKI M.A. (2014).- The year 2010 classification of the agglutinated foraminifera.- *Micropaleontology*, vol. 60, p. 89-108.

LOEBLICH A.R.Jr. & TAPPAN H. (1986).- Some new and redefined genera and families of Textulariina, Fusulinina, Involutinina and Miliolina (Foraminiferida).- *Journal of Foraminiferal Research*, vol. 16 no. 4, p. 334-346.

LOEBLICH A.R. Jr. & TAPPAN H. (1987).- Foraminiferal genera and their classification, Van Nostrand Reinhold, New York, 2 vol., 970 p. (847 Pls.).

SCHLAGINTWEIT F., BUCUR I.I. & SUDAR M.N. (2019).- *Bispiraloconulus serbiacus* gen. et sp. nov., a giant arborescent benthic foraminifer from the Berriasian of Serbia. In: VSI: Jurassic-Cretaceous Transition.- *Cretaceous Research*, vol. 93, p. 98-106.

47. Frosty times in the Sverdrup Basin: The Jurassic-Cretaceous transition in the Rollrock Section, Canadian Arctic Archipelago

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The Rollrock Section on northern Ellesmere Island (Canadian Arctic Archipelago, Nunavut) exposes an over 500 m thick, continuous succession of late Jurassic to early Cretaceous sediments, and was regarded as the most important Jurassic-Cretaceous transition section of the Canadian Arctic by JELETZKY (1984). The succession is assigned to the Ringnes and Deer Bay formations, and is dominated by mudstones, with minor siltstones and subordinate fine-grained sandstones. The Deer Bay Formation grades upwards into the sand-dominated Isachsen Formation at its top. The sediments were deposited in the Sverdrup Basin, most likely on a moderately shallow shelf in a relatively proximal position. They correspond to the climax and post-climax intervals of a major syn-rift stage (HADLARI *et al.* 2016).

The Rollrock Section was logged and sampled by the first author, with the help of field assistant Alex CHAVANNE, during five days in July 2015. Mudstone samples were collected at 1.5 m intervals, and sideritic mudstone concretions, which occur in discrete horizons, were carefully examined for macrofossils. The base of the Ringnes Formation is not exposed, but the lower 251 m of the logged interval are assigned to this unit. Its uppermost 20 m are dominated by fine-grained sandstones and siltstones. A rapid change back to mudstone deposition and the sudden occurrence of abundant dropstones mark the onset of the Deer Bay Formation. Similar dropstones, *i.e.* up to 100 mm-sized dark chert and milky quartz pebbles, occur throughout the Deer Bay Formation. Together with common glendonites, which are confined to ~10 horizons in the upper half of the unit, these dropstones document cold, Arctic conditions during the deposition of the Deer Bay Formation. It is open to debate whether ice rafts formed seasonally or by calving of glaciers.

Fossil bivalves, mostly *Buchia* spp., were found in four concretion horizons of the upper Ringnes Formation (192, 196, 197 and 203 m) and in seven horizons of the Deer Bay Formation (307, 328, 333.5, 355, 356 and 363.5 m). The meter values refer to distance above the base of the exposure. Additionally, six levels yielded ammonites (297, 307, 355, 356, 357 and 363.5 m; Fig. 1). In the upper half of the unit, belemnites were collected from three horizons (410.5, 425 and 470 m).

Figure 1 : Field assistant Alex CHAVANNE, posing with giant *Dorsoplanites maximus*, at 307 m log height.

Collectively, these fossils document early Tithonian to Valanginian ages. Based on the occurrence of *Buchia rugosa*, the 192, 196 and 197 m horizons are assigned to the early Tithonian *Buchia rugosa* Zone. The co-occurrence of *Dorsoplanites maximus* (Fig. 1) and *D. sachsi* in the 307 m horizon indicates the mid Tithonian Dorsoplanites maximus Zone.

A monospecific *Buchia terebratuloides* shell pavement at 333.5 m places this horizon in the latest Tithonian to earliest Berriasian; this is the fossil horizon closest to the Jurassic-Cretaceous boundary. The ammonites *Praetollia maynci* at 355 m, *Pseudocraspedites* at 356, 357 and 363.5 m, and *Borealites* at 363.5 m, together with *Buchia okensis* at 355, 356 and 363.5 m, collectively indicate an early Berriasian age for this interval. Finally, belemnites determined as *Arctoteuthis* cf. *porrectiformis,* collected at 410.5 and 425 m, are Valanginian in age.

The new macrofossils significantly improve the dating of the Rollrock Section, underlining its importance for interpreting the Sverdrup Basin succession as a whole. Furthermore, the well-dated macrofossil horizons provide constraints for future analyses of microfossils, palynomorphs and geochemistry, which are underway.

HADLARI T., MIDWINTER D., GALLOWAY J.M., DEWING K. & DURBANO A.M. (2016).- Mesozoic rift to post-rift tectonostratigraphy of the Sverdrup Basin, Canadian Arctic.- *Marine and Petroleum Geology*, vol. 76, p. 148-158.

JELETZKY J.A. (1984).- Jurassic-Cretaceous boundary beds of western and Arctic Canada and the problem of the Tithonian-Berrisian stages in the Boreal Realm. *In*: WESTERMANN G.E.G. (ed.), Jurassic-Cretaceous biochronology and biogeography of North America.- *Geological Association of Canada, Special paper*, vol. 27, p. 175-255.

48. Clay minerals as a tool to monitor the widespread paleoclimatic changes at the Jurassic-Cretaceous boundary in the Tethysian realm

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The earliest views of an equable warm, and mostly ice-free «Mesozoic world» have been widely challenged since the pioneering works of HALLAM (1984, 1986) and FRAKES (1992). This evolution was notably parallel during the 90's to the discoveries of evidence for ice at high latitude at certain periods (PRICE, 1999) and to the increasing body of oxygen isotope data obtained on various paleontological material (brachiopods, belemnite guards, mollusk shells and fish teeth). These combined efforts led to recent attempts at system-scale syntheses (see for example DERA *et al.*, 2011) which match the quality of Cenozoic paleoclimatic syntheses (*e.g.*, ZACHOS *et al.*, 2001). The common picture of Jurassic and Cretaceous paleoclimates is now largely that of both long-term (*i.e.*, ≥ Myr duration) and «short-term» temperatures changes and dry/wet oscillations, that can be documented within various basins (*e.g.*, PRICE *et al.*, 1999).

The Jurassic-Cretaceous boundary is associated with one of those large-scale and long-term paleoclimatic fluctuations (HALLAM, 1984, 1986; ABBINK *et al.,* 2001; SCHNYDER *et al.*, 2006). Evidence of at least local high latitude ice development has also been recorded (PRICE, 1999).

Among the paleoclimatic proxies that can be used to reconstruct past climates, clay minerals are probably one of the best to evaluate wet/dry long-term paleoclimatic trends (CHAMLEY, 1989; VELDE, 1995; DERA *et al.*, 2009). The most common clay minerals used in this respect are kaolinite-which may reflect more warm and humid climates- and smectite, which may reflect dryer and/or seasonally humid climates.

Here, we present a synthesis of clay mineral data spanning the Jurassic-Cretaceous Boundary from various basins of the Western Tethysian area. The documented stratigraphic record extends from the late Kimmeridgian into part of the Berriasian. Most data show an intensification of a seasonal semi-arid paleoclimate that begins in the latest Kimmeridgian-earliest Tithonian and is associated with a long-term sea-level fall leading to the development of Purbeckian facies in North-West Europe (*e.g.*, JACQUIN *et al.,* 1998). It changes into a more humid climate during the Berriasian. Surprisingly, most of the Tethysian sections show that the change from a dryer to a wetter climate can be precisely dated from the topmost part of calpionellids zone B, in times of rising long-term sea-level (*e.g.*, JACQUIN *et al.,* 1998). This rather «synchronous» climatic event recorded in the Tethysian realm is thus here tentatively associated to a warming trend leading to the melting of ice at high latitudes and an overall sea-level rise.

ABBINK, O., TARGARONA, J., BRINKHUIS, H., VISSCHER, H. (2001). Late Jurassic to earliest Cretaceous palaeoclimatic evolution of the southern North Sea. Global and Planetary Change, 30, p. 231-256.
CHAMLEY, H. (1989). Clay sedimentology. Springer Verlag, 623 p.

DERA, G., PELLENARD, P., NEIGE, P., DECONINCK, J.-P., PUCÉAT, E., DOMMERGUES, J.-L. (2009). Distribution of clay minerals in Early Jurassic Peritethyan seas: Palaeoclimatic significance inferred from multiproxy comparisons. Palaeogeography, Palaeoclimatology, Palaeoecology, 271, p. 39-51.

DERA, G., BRIGAUD, B., MONNA, F., LAFONT, R., PUCÉAT, E., DECONINCK, J.-F., PELLENARD, P., JOACHIMSKY,M.M., DURLET, C. (2011). Climatic ups and downs in a disturbed Jurassic world. Geology, 39, p. 215-218.

FRAKES, L.A., FRANCIS, J.E., SYKTUS, J.I. (1992). Climate modes of the Phanerozoic. Cambridge University Press, Cambridge, 274p.

HALLAM, A. (1984). Continental humid and arid zones during the Jurassic and Cretaceous. Palaeogeography, Palaeoclimatology, Palaeoecology, 47, p. 195-223.

HALLAM, A. (1986). Role of climate in affecting late Jurassic and early Cretaceous sedimentation in the North Atlantic. In Summerhayes, C.P., et Shackelton, N.J. (eds), North Atlantic Palaeoceanography, Geological Society Special Publication, 21, p. 277-281.

JACQUIN, T., DARDEAU, G., DURLET, C., GRACIANSKY, P.-C. de, HANTZPERGUE, P. (1998). The North-Sea cycle : an overview of 2nd-order transgressive/regressive facies cycles in western Europe. In Mesozoic and Cenozoic Sequence Stratigraphy of European Basins, SEPM Special Publication, 60, p. 445-466.

PRICE, G.D. (1999). The evidence and implication of polar ice during the Mesozoic. Earth-Science Reviews, 48, p. 183-210.

SCHNYDER, J., RUFFELL, A., DECONINCK, J.-F., BAUDIN, F. (2006). Conjunctive use of spectral gamma-ray logs and clay mineralogy in defining late Jurassic-early Cretaceous palaeoclimate change (Dorset, U.K.). Palaeogeography, Palaeoclimatology, Palaeoecology, 229, p. 303-320.

VELDE, B., ed. (1995). Origin and mineralogy of clays. Clays and the environment. Springer Verlag, 334 p.

ZACHOS, J., PAGANI, M., SLOAN, L., THOMAS, E., BILLUPS, K., (2001). Trends, rhythms, and aberrations in global climate 65 Ma to present. Science 292, 686-693 (New Series).

49. Jurassic-Cretaceous boundary bioevents and magnetochrons: A stratigraphic experiment

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The search for a Global Section and Point (GSSP) for the upper Jurassic-lower Cretaceous/Tithonian-Berriasian stage boundary has eluded stratigraphers for many years (MICHALÍK & REHÁKOVÁ, 2011). Characterizing this boundary is difficult because few evolutionary events are dramatic, paleoenvironmental and tectonic changes are subtle and none are global. Paleomagnetic reversals are potential markers because they are recorded in marine and non-marine strata. Ammonites, calpionellids and calcareous nannofossils are the principle biota used to distinguish the Tithonian-Berriasian-Valanginian stages (MICHALÍK & REHÁKOVÁ, 2011).

This paper is a stratigraphic experiment to evaluate multiple criteria by applying a quantitative method to integrate the first and last appearances of these fossil groups with magnetochrons. Biostratigraphic checklists by well-known biostratigraphers have been published for thirty-eight well documented measured sections and deep-sea cores. The first and last occurrences (FOs/LOs) of taxa were cross plotted in X/Y diagrams with a geologic time scale (OGG *et al.*, 2016) to create hypotheses of synchroneity between section pairs. The correlation line of synchroneity extended the FOs and LOs relative to each other. The range extensions approximate first and last appearance datums (FADs, LADs) and were composited into a single range chart (LOK2CSDB) and calibrated to numerical ages (Ma). This stratigraphic experiment places the ammonite FADs in the same order as REBOULET *et al.* (2014) and OGG *et al.* (2016) (Fig. 1). However the ammonite events project into the magnetostratigraphic scale slightly differently.

The FAD of *Berriasiella jacobi* at 145.7 Ma is close to the base of M19n at 145.4 Ma (Fig. 1). The FAD of *Calpionella alpina* (145.8 Ma) rather than its «explosion» is at magnetic polarity Chron M20-M19. Nannofossil bioevents are the FADs of *Nannoconus globulus globulus* at 145.1 Ma, *Crucielllipsis cuvillieri* at 144.8 Ma, and *Zeugrhabdotus erectus* at 145.0 Ma (Fig. 1). The LAD of *Crassicollaria intermedia* is at 145.8 Ma.

The base of the middle Berriasian Substage is the FAD of *S. subalpina* (144.1 Ma) at the base of the *Subthurmannia occitanica* Zone (Fig. 3). In LOK2CSDB the FAD of *S. subalpina* projects close to the base of Chron M18. The base of the upper Berriasian Substage is the FAD of *Malbosiceras [Mazenoticeras] paramimounum* (142.4 Ma) (Reboulet *et al.*, 2014) at the base of the *Subthurmannia boiseri* Zone. New data projects this bioevent at about the boundary between chrons M17 and M16 (Fig. 1).

The base of the Valanginian Stage is at the FAD of *Thurmanniceras pertransiens* (139.7 Ma) and *Calpionellites darderi* (139.7 Ma) and above the FAD of *Calcicalathina oblongata* (141.2 Ma) (Reboulet *et al.*, 2014) (Fig. 1). In this experiment base Valanginian correlates with the upper part of Chron M15 instead of polarity Chron M14r. The base of the upper Valanginian is at the base of the *Saynoceras verrucosum* Zone and its FAD is 132.3 Ma (Fig. 1).

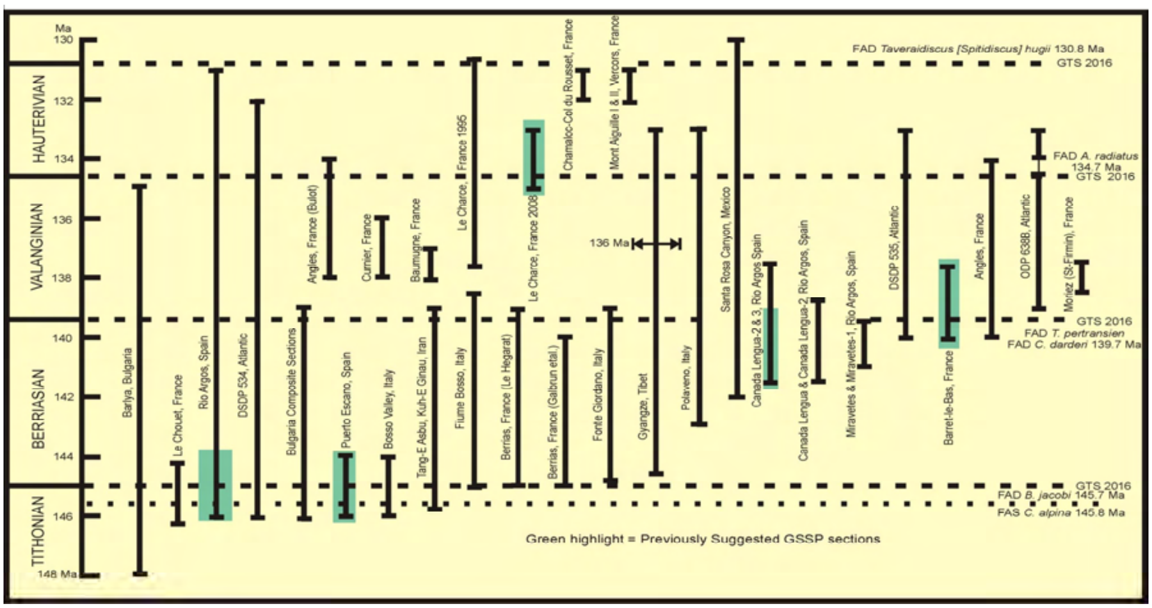

Figure 1: Chronostratigraphic range chart of the stratigraphic section data that compose LOK16 Chronostratigraphic Database LOK2016CSDB; sections listed in Appendix 1 with references and locations.

Michalík J. & Reháková D. (2011).- Possible markers of the Jurassic/Cretaceous boundary in the Mediterranean Tethys: A review and state of art.- *Geoscience Frontiers,* Beijing, vol. 2, no. 4, p. 475-490.

Ogg J.G., Ogg G.M. & Gradstein F.M. (2016).- The concise geologic time scale 2016.- Elsevier B.V., Amsterdam, 234 p.

Reboulet S., Szives O., Aguirre-Urreta M.B., Barragán R., Company M., Idakieva V., Ivanov M., Kakabadze M.V., Moreno-Bedmar J., Sandoval J., Baraboshkin E.J., Çağlar M.K., Főzy E., González-Arreola C., Kenjo S., Lukeneder A., Raisossadat S.N., Rawson P.F. & Tavera J.M. (2014).- Report on the 5th International Meeting of the IUGS Lower Cretaceous Ammonite Working Group, the Kilian Group (Ankara, Turkey, 31st August 2013).- *Cretaceous Research*, London, vol. 50, p. 126-137.

50. The Kimmeridgian-Tithonian boundary in the Central Iberian Basin (Spain): New stratigraphic information

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The location of the Kimmeridgian-Tithonian boundary in the coastal to shallow marine successions recorded in the central part of the Iberian Basin (NE Spain), has been the subject of discussion over the last years. In this work we report on further data that allows an accurate calibration of the uppermost Kimmeridgian-lowermost Tithonian interval recorded in the Aguilón and Galve sub-basins.

In the Aguilón sub-basin, Jurassic marine sedimentation ends with an up-to 80 m thick-succession of oncolitic, peloidal and skeletal shallow marine carbonates (Higueruelas Fm). The age of this unit has been the subject of debate and, in previous works, has been considered lower Tithonian (*e.g.*, AURELL *et al.*, 2010). However, the presence of mid-Kimmeridgian ammonites (*i.e.*, *Acanthicum*/*Eudoxus* zones) in the underlying open-marine unit, the widespread record of *Alveosepta jaccardi* all across the Higueruelas Fm and the new isotopic strontium data (belemnites, brachiopods, oyster shells) indicate that the Higueruelas Fm was deposited in the latest Kimmeridgian (upper *Eudoxus* and *Beckeri* zones).

In the Galve sub-basin, there is a continuous sedimentary record across the Jurassic-Cretaceous transition, including the latest Kimmeridgian Higueruelas Fm. The overlaying Villar del Arzobispo Fm consists of an up-to 180 m thick succession of shallow lagoon carbonates to coastal/alluvial siliciclastics stacked in four carbonate-siliciclastic reciprocal sequences (S1-S4). The lagoonal carbonates of the lower (S1) sequence mark the last presence of *Alveosepta jaccardi* and therefore was deposited in the latest Kimmeridgian. On the other hand, the strontium isotope data (oyster shells) indicates that the overlying S2-S4 sequences were deposited in the earliest Tithonian (*i.e.*, Hybonotum Zone). The reported data update previous interpretations on the age of the lower boundary of the Villar del Arzobispo Fm in the Galve sub-basin, which was previously considered to be younger (mid-early Tithonian; AURELL *et al.*, 2016) or older (mid-Kimmeridgian, CAMPOS-SOTO *et al.*, 2017). In the Galve sub-basin, the Jurassic-Cretaceous boundary occurs in the overlaying Aguilar del Alfambra Fm although its precise location within this unit is still debatable (AURELL *et al.*, 2016).

AURELL M., BÁDENAS B., IPAS J. & RAMAJO J. (2010).- Sedimentary evolution of an Upper Jurassic epeiric carbonate ramp, Iberian Basin, NE Spain.- *Geological Society, London, Spec. Public*. 329 (1), p. 89-111.

AURELL M., BÁDENAS B., GASCA J.M., CANUDO J.I., LIESA C.L., SORIA A.R., MORENO-AZANZA M. & NAJES L. (2016).- Stratigraphy and evolution of the Galve sub-basin (Spain) in the middle Tithonian-early Barremian: Implications for the setting and age of some dinosaur fossil sites.-*Cretaceous Research* 65, p. 138-162.

CAMPOS-SOTO S., COBOS A., CAUS E., BENITO M.I., FERNÁNDEZ-LABRADOR L., SUAREZ-GONZALEZ P. & ALCALÁ L. (2017).- Jurassic Coastal Park: A great diversity of palaeoenvironments for the dinosaurs of the Villar del Arzobispo Formation (Teruel, eastern Spain).- *Palæogeography, Palæoclimatology, Palæoecology*, 485, p. 154-177.

51. Middle-late Volgian regression as it expressed in different depositional environments of Central Russian Sea

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Upper Jurassic deposits of the Russian Platform accumulated in an extensive shallow epeiric sea covering a tectonically stable old craton and subjected to slow subsidence and low terrigenous supply. As a result, the depositional record is characterized by low thickness and high fragmentation due to numerous episodes of non-deposition and submarine erosion. The Russian sea basin was strongly "shoaled" by the end of Volgian stage (Tithonian to earliest Berriasian). The well-known middle Volgian Oil Shale, corresponding to the Panderi ammonite Zone and covering large areas of the Russian Platform, could be assigned as a record of the latest widespread late Jurassic transgression. The overlying uppermost Jurassic sediments contained a low portion of clay component and accumulated in a wide range of shallow-marine environments.

Middle-upper Volgian deposits were investigated in the Rybinsk, Moscow and Ul'yanovsk-Syzran regions, traditionally considered key localities for Russian Platform biostratigraphy. The results were obtained by detailed sedimentological and biostratigraphical examinations of well-known and newly found exposures, and was supplemented by measurement of new comprehensive core material, acquired from technical drilling in Moscow. Biostratigraphic control was based on the ammonite zonation, which has significantly improved in recent years. The main objective was to create elements of a lateral transect (about 800 km in length), passing through the main sites of stable late Jurassic marine sedimentation from the Moscow syneclise in the north-west, to the Ul'yanovsk-Saratov trough in the south-east, and target it for reconstruction of depositional systems and their evolution under external and internal controls.

Three general types of depositional environment were distinguished in the studied regions and their main evolutional trends were recognized (Fig. 1).

In the Rybynsk region the middle-late Jurassic sediments (about 30-40 m thick) were accumulated within a storm- and wave-dominated shoreface that progressively prograding basinward. The studied interval is represented by a coarsening upward succession of medium- to coarse-grained sandbodies, separated by discontinuity surfaces, that are marked by phosphoritic conglomerates. From the bottom to top of the succession, sandstones exhibit sediment structures that reflect a progressive increasing of wave energy. The lowest, yellow bioturbated sandstone (about 6 m, of which 1-1.5 m could be observed) corresponds to the Virgatus ammonite Zone. It is overlain by red sandstone of Nikitini, Fulgens and Catenulatum Zones (about 6-7 m of which could be observed), which is moderately bioturbated (Neoeione, Rosselia) and characterized by preserved fragments of large (about 1 m in length) gently sloping swaley cross stratification. The uppermost unit is represented by red sandstone (about 12 m) with distinct

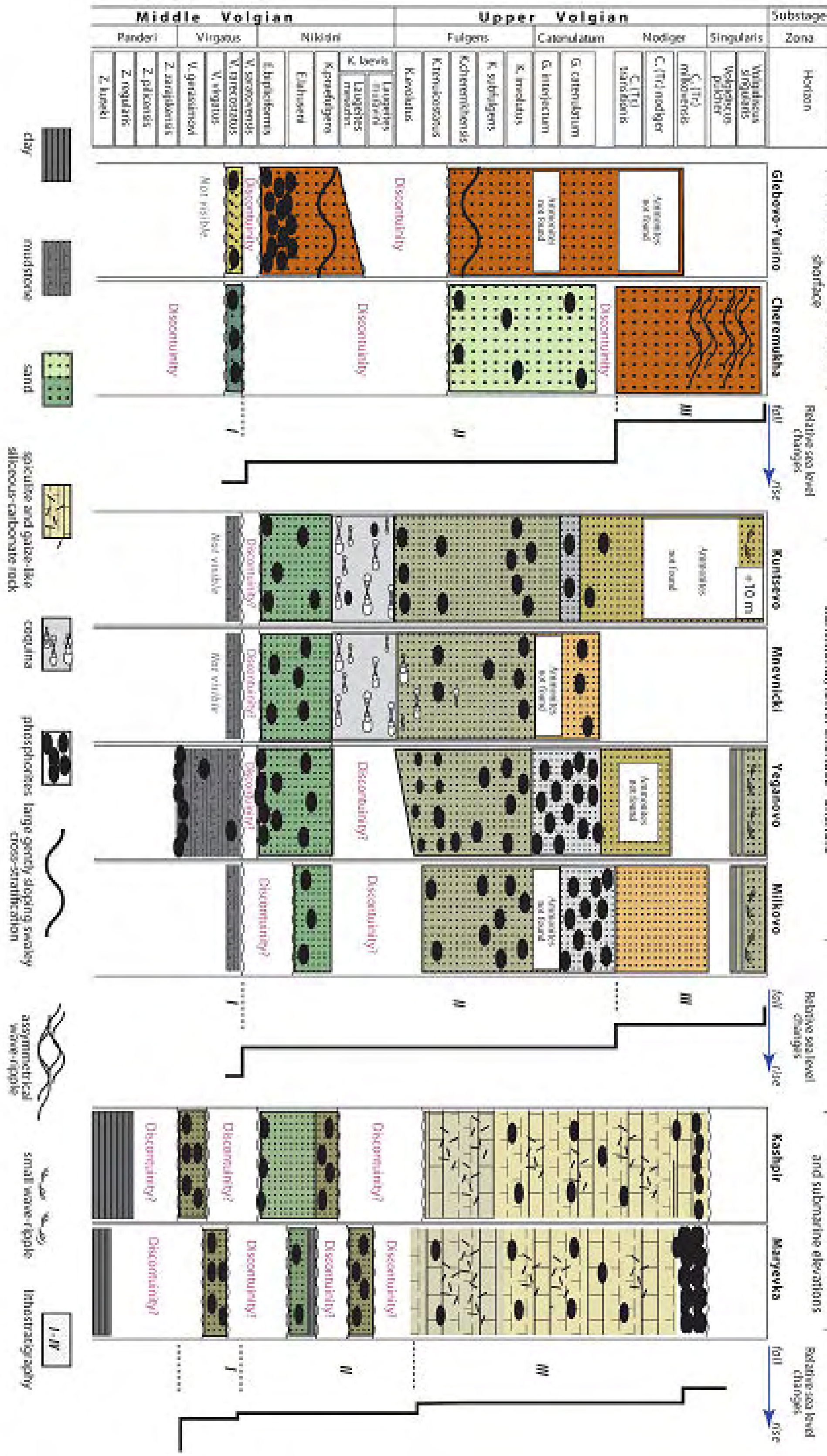

Figure 1: Middle-late Volgian depositional sequences, accumulated in different facies belts of Central Russian Sea.

wave ripple cross-stratification, and identified as belonging to Nodiger Zone and topmost Jurassic Singularis Zone. It passes up-section into Ryazanian coarse-grained gravely sandstones with wave-ripple and trough-like cross-stratification.

In the Moscow region the studied interval (20-40 m thick) is composed of fine-grained and muddier siliciclastic material, and seems to have accumulated in a low-energy and more offshore environment, subjected to only weak storm activity, but progressively approaching a fair-weather wave base. It is composed of interbedded fine-grained sandstones and dark grey micaceous and green mudstones. Glauconitic pellets, mollusks shells and reworked phosphorites are abundant in the lower part of the succession, corresponding to basal beds of the Virgatus Zone (1-2 to ~30 m) and to the interval of the Nikitini, Fulgens and Catenulatum Zones (2.5-4.5 m). The upper part of the sequence is thicker (9-13 m) due to increased terrigenous supply and shows elimination of autochthonous basinal sedimentary components, decreased burrowing and the occurrence of numerous dm- scale intervals with well preserved wave ripple cross-bedding. In this thick interval ammonites of the Nodiger Zone were found only near the base, while its uppermost part could be correlated to the uppermost red sandstone of the Nodiger and Singularis Zones in the Rybynsk region.

In the Ul'yanovsk-Syzran region the studied sequence is substantially reduced in thickness (5-6 m) due to the effects of sediment starvation and multiple "renewals" and amalgamation of omission surfaces, and demonstrates negligible signs of reworking by waves. The sediments are composed of very-fine sandy, silty and muddy material, with a high proportion (to 25-50 % and more) of autochthonous basinal biogenic and autogenous components, such as a glauconite, carbonate shells, scelets and detritus, siliceous sponge spicules, and pristine and reworked phosphorites. Numerous levels of enrichment in phosphorites, belemnites and shells are typical for the sequence

The suggested depositional environment is nearshore to offshore shallow-shelf, around Islands or submarine elevations that could provide a calm hydrodynamic, low siliciclastic influx and high nutrient availability. The sequence is subdivided into lithostratigraphical units. The lower one corresponds to the middle Volgian Virgatus and Nikitini Zones, represented by strongly condensed (from tens cm to ~1.5 m in thickness) subsequences, built of very fine- to fine-grained sandstones with a high (50 % and more) concentration of glauconite and with numerous levels enriched in phosphorites, belemnites and shells. They are overlain by ~3.5 m thick interbeds of spiculites and "guaize"-like, very fine-grained sandstones, enriched in silica spicules and carbonate shell detritus, which correspond biostratigraphically to the upper Volgian.

Thus, the general trend of regression is manifested by depositional sequences, accumulated in different facies belts of the Central Russian Sea since the end of middle Volgian to Ryzanyan time period. The trend shows similar stepwise evolutional dynamics in different depositional environments that are expressed in sub-synchronous impulses of progradation and intervening «delays». The later seems to be recorded within transitional intervals of the Virgatus-Nikitini Zones, the Nikitini Zone, and probably the Catenulatum-Nodiger Zones.

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52. The Jurassic-Cretaceous boundary interval in the Jura Mountains and the Vocontian Basin: Sedimentological aspects

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During the latest Jurassic and earliest Cretaceous, the paleogeographic realm of the Jura was a topographic high between the Tethys Ocean and the Paris Basin, on which a shallow carbonate platform developed. Hiatuses are abundant and biostratigraphically relevant fossils are rare. In the Vocontian Basin, lowstand sediments predominated, precluding an undisturbed stratigraphic record.

In the Swiss Jura, the Tithonian strata are represented by the Twannbach Formation where dolomitization and features implying subaerial emergence are common. It is overlain by the early Berriasian Goldberg Formation, which corresponds to the «Purbeck facies». Periods of subaerial exposure are indicated by black pebbles and calcretes.

Overlying the Goldberg Formation, the Pierre-Châtel Formation developed in fully marine, shallow-lagoonal conditions. The climate was semi-arid. Its base, dated to the Subalpina subzone of the middle Berriasian Occitanica zone (Clavel *et al.*, 1986), represents a first transgressive surface that can be correlated over the entire Jura platform. The overlying Vions Formation records a more humid climate, indicated by terrigenous input of clays and quartz, iron-staining, root traces, and coal layers. The Chambotte Formation displays bioclastic and oolitic limestones, again implying fully marine conditions in a more arid climate. This is the result of a second transgressive pulse, dated to the base of the Otopeta subzone of the late Berriasian Boissieri zone (Charollais *et al.*, 2008). A tectonic tilt of the Jura platform resulted in non-deposition and/or erosion of parts of the Vions and Chambotte formations.

The early Valanginian is represented by the reddish limestones («calcaires roux») of the Vuache Formation (Strasser *et al.*, 2016). Locally, the base of the formation contains a marly interval («Marnes d'Arzier»). The limestone beds display hummocky and swaley cross-stratification implying storm activity. The facies are bioclastic and oolitic packstones to grainstones rich in echinoderm and bryozoan fragments. The depositional environment was that of an open shelf. Ammonites and dinocysts assign the main body of the Vuache Formation to the Pertransiens and Neocomiensiformis ammonite zones, while the Inostranzewi and Verrucosum zones are condensed at its top (Monteil, 1993; Charollais *et al.*, 2008).

In the Vocontian Basin, the Tithonian commonly displays thickly bedded hemipelagic limestones («barre tithonique»). Facies and sedimentary structures imply deposition mainly as mudflows, grainflows, debris flows, and occasional turbidites. The early Berriasian is dominated by slumps and debris flows. Starting within the Privasensis subzone (Occitanica zone), cyclic hemipelagic sedimentation resulted in a more expanded stratigraphic record. The sections are rich in ammonites, which allow a relatively precise biostratigraphic dating (*e.g.*, LE HÉGARAT, 1971; BUSNARDO *et al.*, 1979; ATROPS & REBOULET, 1993).

Some of the prominent sequence-stratigraphic elements of HARDENBOL *et al.* (1998) can be correlated between platform and basin (PASQUIER & STRASSER, 1997). For example, the transgressive surface above sequence boundary Be4 corresponds to the base of the Pierre-Châtel Formation on the platform. TRESCH and STRASSER (2010) have shown that the transgression occurred step-wise, following the platform morphology, and that it occurred within a time span of about 200 kyr. While the platform started to be flooded, lowstand conditions continued in the basin. The transgressive surface seen in the basin (in the Dalmasi subzone) corresponds to an important increase in accommodation on the platform (PASQUIER & STRASSER, 1997).

Both the Tithonian-Berriasian and Berriasian-Valanginian boundaries are badly defined on the Jura platform. The transgressive surface at the base of the Pierre-Châtel Formation may be relatively well dated and correlatable over a wide area but, being within the Berriasian stage, is not a good candidate for a system boundary. In the Vocontian Basin, the Tithonian-Berriasian boundary is commonly characterized by gravity deposits. Geochemistry is not helpful as there were no significant oceanic events occurring in the Jurassic-Cretaceous boundary interval. Therefore, other paleogeographic areas with continuous, undisturbed stratigraphic records have to be evaluated.

ATROPS F. & REBOULET S. (1993).- Nouvelles données sur la zonation par ammonites du Valanginien supérieur de l'hypostratotype d'Angles (Alpes de Haute-Provence) et sur ses corrélations.- *C. R. Acad. Sci. Paris*, vol. 317, p. 499-506.

BUSNARDO R., THIEULOY J.-P. & MOULLADE M. (eds., 1979).- Hypostratotype mésogéen de l'étage Valanginien (Sud-Est de la France).- Ed. CNRS, Les stratotypes français, vol. 6, 143 p.

CHAROLLAIS J., CLAVEL B. & BUSNARDO R. (2008).- Biostratigraphie et découpage séquentiel des formations du Crétacé inférieur de la plateforme jurassienne (France, Suisse).- *A Terra: Conflitos e ordem*, p. 197-207.

CLAVEL B., CHAROLLAIS J., BUSNARDO R. & LE HÉGARAT G. (1986).- Précisions stratigraphiques sur le Crétacé inférieur basal du Jura méridional.- *Eclogae Geol. Helv.*, vol. 79, p. 319-341.

HARDENBOL J., THIERRY J., FARLEY M.B., JACQUIN T., GRACIANSKY P.-C. de & VAIL P.R. (1998).- Cretaceous sequence chronostratigraphy. *In:* GRACIANSKY P.-C. de, HARDENBOL J., JACQUIN T. & VAIL P.R. (eds.), Mesozoic and Cenozoic sequence stratigraphy of European basins.- *SEPM Spec. Publ.*, vol. 60, chart.

LE HÉGARAT G. (1971).- Le Berriasien du Sud-Est de la France.- *Doc. Lab. Géol. Fac. Sci. Lyon*, vol. 43, 567 p.

MONTEIL É. (1993).- Dinoflagellate cysts biozonation of the Tithonian and Berriasian of South-East France: correlation with sequence stratigraphy.- *Bull. Cent. Rech.-Expl. elf-Aquitaine,* vol. 17, p. 249-273.

PASQUIER J.-B. & STRASSER A. (1997).- Platform-to-basin correlation by high-resolution sequence stratigraphy and cyclostratigraphy (Berriasian, Switzerland and France).- *Sedimentology*, vol. 44, p. 1071-1092.

STRASSER A., CHAROLLAIS J., CONRAD M.-A., CLAVEL B., PICTET A. & MASTRANGELO B. (2016).- The Cretaceous of the Swiss Jura Mountains: an improved lithostratigraphic scheme.- *Swiss J. Geosciences*, vol. 109, p. 201-220.

TRESCH J. & STRASSER A. (2010).- History of the Middle Berriasian transgression on the Jura carbonate platform: revealed by high-resolution sequence- and cyclostratigraphy (Switzerland and France).- *Int. J. Earth Sciences*, vol. 99, p. 139-163.

53. The age of the Phu Kradung Formation (Khorat Group, NE Thailand): Indications from the turtle faunas

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The Mesozoic Khorat Group (NE Thailand) contains five formations (from bottom to top, the Phu Kradung, Phra Wihan, Sao Khua, Phu Phan and Khok Kruat formations; RACEY, 2009). It is now generally accepted that most formations of the Khorat Group are of early Cretaceous age, while the age of its basal unit, the Phu Kradung Formation, is still uncertain. The evidence from vertebrate paleontology, notably dinosaurs, supports a late Jurassic age for that formation whereas palynology and detrital zircon thermochronology suggest an early Cretaceous age. Composed of sandstones, siltstones and mudstones of mainly fluvial origin, the Phu Kradung Formation is rich in vertebrate remains, including freshwater sharks, bony fishes, temnospondyl amphibians, turtles, crocodiles, pterosaurs and various dinosaurs (sauropods, theropods, stegosaurs and ornithopods).

Turtle remains are abundant in the Phu Kradung Formation. In the lower part of the formation, two sites (Phu Noi and Ban Khok Sanam) in Kalasin Province have yielded xinjiangchelyids. *Phunoichelys thirakhupti* is represented by several incomplete shells and isolated shell elements. This small turtle may be related to some primitive xinjiangchelyids from the Sichuan Basin, China (TONG *et al.*, 2015). *Kalasinemys prasarttongosothi*, a more advanced xinjiangchelyid, consists of several shells and a well preserved skull. It has a more heavily built shell and is distinct from *Phunoichelys* in having a smooth shell surface and in other shell features. The structure of the arterial system on the skull is characteristic of xinjiangchelyids, and the skull outline is close to *Annemys* (TONG *et al.*, in press). At Ban Khok Sanam, a few fragmentary shell elements with fine radiating ridges on the carapace are reminiscent of some xinjiangchelyids and macrobaenids from China, although the fragmentary nature of the material prevents a precise systematic assignment. In the upper part of the formation, remains of a basal trionychoid turtle, *Basilochelys macrobios*, are common (TONG *et al.*, 2009). Several localities in Mukdahan Province (Kham Phok, Huai Sai, Dan Luang, Huai Pai, Dan Kaeng) have yielded abundant material. *Basilochelys* was also found recently in Kalasin Province, together with a large incomplete primitive eucryptodiran turtle shell, which has strong radiating ridges on the carapace. The small and strip-shaped epiplastra and reduced leaf-shaped entoplastron are reminiscent of Macrobaenidae.

The Phu Kradung Formation thus appears to have two distinct turtle faunas. That from the lower part of the formation consists of diverse xinjiangchelyids and has close affinities with those from the late Jurassic of China and Mongolia, which seems to support a similar age for that part of the formation. The upper part of the formation has yielded mainly basal trionychoids and has no clear equivalent in mainland Asia, where the early Cretaceous turtle faunas are dominated by sinemydids/macrobaenids, with a few more advanced trionychoids. The recent discovery of a macrobaenid in Kalasin Province seems to support an early Cretaceous age for the upper part of the Phu Kradung Formation. It is noteworthy that turtle faunas from the upper part of the Phu Kradung Formation, as well as from the overlying Sao Khua and Khok Kruat formations are more comparable with those from the early Cretaceous Tetori Group of Japan in having various primitive trionychoids and some sinemydids/macrobaenids, on the basis of which stratigraphical correlations can be made.

RACEY A. (2009).- Mesozoic red bed sequences from SE Asia and the significance of the Khorat Group of NE Thailand.- *Geological Society, London, Special Publications*, vol. 315, p. 41-67.

TONG H., CLAUDE J., NAKSRI W., SUTEETHORN V., BUFFETAUT E., KHANSUBHA S., WONGKO K. & YUANGDETKLA P. (2009).- *Basilochelys macrobios* n. gen. and n. sp., a large cryptodiran turtle from the Phu Kradung Formation (latest Jurassic-earliest Cretaceous) of the Khorat Plateau, NE Thailand.- *Geological Society*, London, Special Publications, vol. 315, p. 153-173.

TONG H., NAKSRI W., BUFFETAUT E., SUTEETHORN V., SUTEETHORN S., DEESRI U., SILA S., CHANTHASIT P. & CLAUDE J. (2015).- A new primitive eucryptodiran turtle from the Upper Jurassic Phu Kradung Formation of the Khorat Plateau, NE Thailand.- *Geological Magazine*, vol. 152, p. 166-175.

TONG H., NAKSRI W., Buffetaut E., SUTEETHORN S., SUTEETHORN V., CHANTHASIT P. & CLAUDE J. (in press).- *Kalasinemys*, a new xinjiangchelyid turtle from the Late Jurassic of NE Thailand. *Geological Magazine*.

54. Decoupling of carbon isotope records across the Tithonian and Berriasian

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The published carbonate $\delta^{13}C$ record across the Jurassic-Cretaceous boundary (from the base of the Kimmeridgian to the base of the Valanginian), shows no major negative carbon isotope excursions (CIEs; see global $\delta^{13}C$ stack of PRICE *et al.*, 2016). This composite $\delta^{13}C_{carbonate}$ curve includes data from many sites, but is dominated by Tethysian data. The organic carbon $\delta^{13}C$ record for this interval is much more limited, with published data from only a few sites in the northern hemisphere. Arctic $\delta^{13}C_{org}$ data (from Svalbard and Arctic Russia; HAMMER *et al.*, 2012; ZAKHAROV *et al.*, 2014; KOEVOETS *et al.*, 2016) show a prominent negative excursion of c. 4 ‰ in the Tithonian, whereas $\delta^{13}C_{org}$ data from Dorset, UK (MORGANS-BELL *et al.*, 2001), and the North Sea (TURNER *et al.*, 2018), do not show such an excursion. It may be that the lack of a prominent negative excursion in these Tethysian and Boreal records relates to limited coverage of the key Tithonian interval. However, it may be that pools of organic carbon and dissolved inorganic carbon during this time were effectively decoupled, or there was latitudinal decoupling between the Arctic and Tethysian/Boreal Seas. A high Arctic

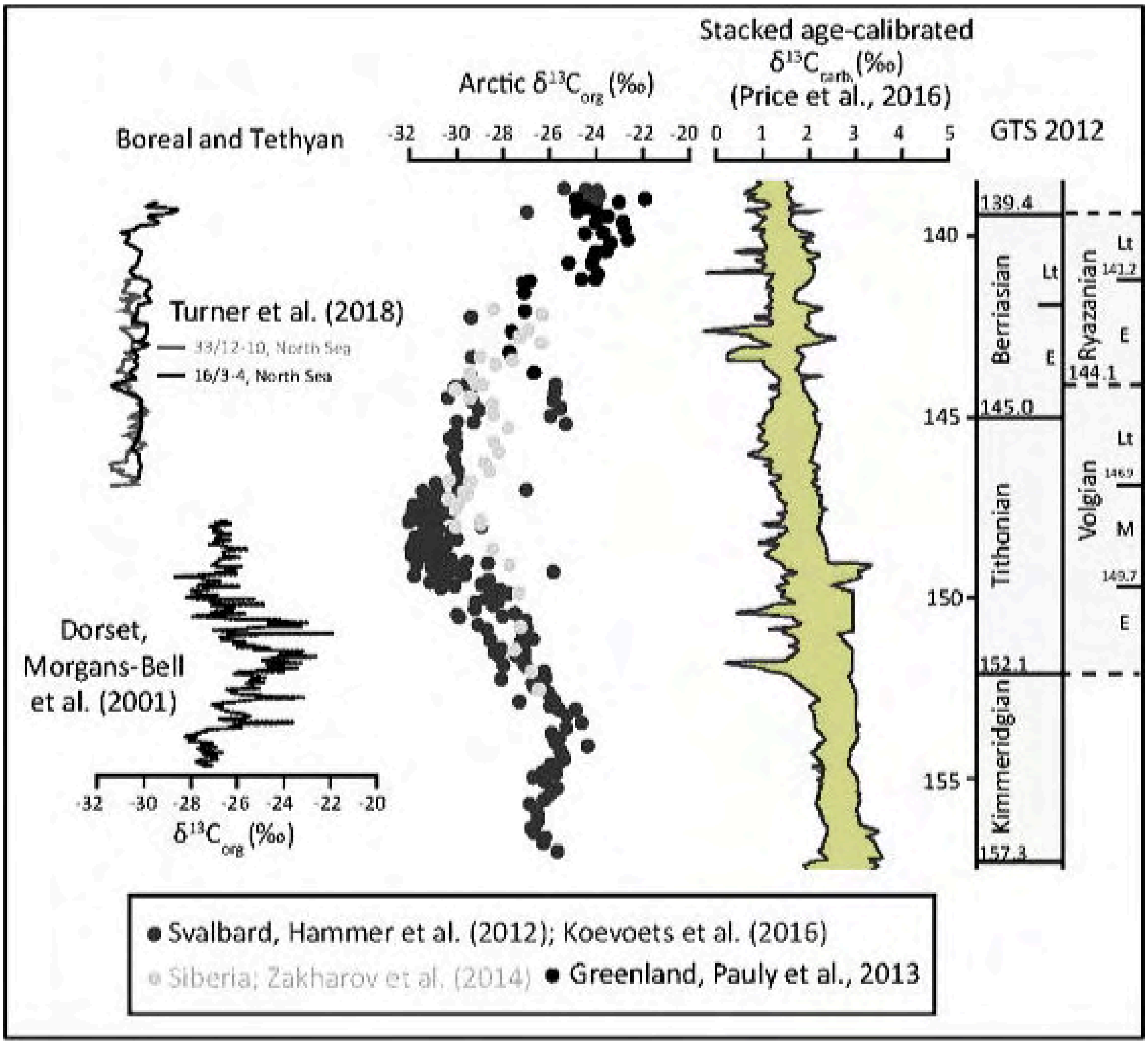

Figure 1: Plots of the published carbonate and organic carbon records from the Kimmeridgian to base Valanginian (see references on figure). The data has been scaled to the geological timescale of Gradstein *et al.* (2012). GTS 2012 = Geological Time Scale 2012.

carbonate dataset and more extensive Tethysian organic carbon data is necessary to resolve the cause of this Arctic organic CIE.

Gradstein F.M., Ogg J., Schmitz M. & Ogg G. (2012).- The geologic time scale 2012 (2 volume set).- Elsevier, 1176 p.

Hammer Ø., Collignon M. & Nakrem H.A. (2012).- Organic carbon isotope chemostratigraphy and cyclostratigraphy in the Volgian of Svalbard.- *Norwegian Journal of Geology*, Trondheim, vol. 92, p. 103-112.

Koevoets M., Abay T., Hammer Ø. & Olaussen S. (2016).- High-resolution organic carbon-isotope stratigraphy of the Middle Jurassic-Lower Cretaceous Agardhfjellet Formation of central Spitsbergen, Svalbard.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 449, p. 266-274.

Morgans-Bell H.S., Coe A.L., Hesselbo S.P., Jenkyns H.C., Weedon G.P., Marshall J.E.A., Tyson R.V. & Williams C.J. (2001).- Integrated stratigraphy of the Kimmeridge Clay Formation (Upper Jurassic) based on exposures and boreholes in south Dorset, U.K.- *Geological Magazine*, Cambridge, vol. 138, p. 511-539.

Pauly S., Mutterlose J. & Alsen P. (2013).- Depositional environments of Lower Cretaceous (Ryazanian-Barremian) sediments from Wollaston Forland and Kuhn Ø, North-East Greenland.- *Bulletin of the Geological Society of Denmark*, Copenhagen, vol. 61, p. 19-36.

Price G.D., Főzy I. & Pálfy J. (2016).- Carbon cycle history through the Jurassic-Cretaceous boundary: A new global δ^{13}C stack.- *Palæogeography, Palæoclimatology, Palæoecology*, vol. 451, p. 46-61.

Turner H.E., Batenburg S.J., Gale A.S. & Gradstein F.M. (2018).- The Kimmeridge Clay Formation (Upper Jurassic-Lower Cretaceous) of the Norwegian continental shelf and Dorset, UK: a chemostratigraphic correlation.- *Newsletters on Stratigraphy*, 32 p. DOI: https://doi.org/10.1127/nos/2018/0436

Zakharov V.A., Rogov M.A., Dzyuba O.S., Žák K., Košťák M., Pruner P., Skupien P., Chadima M., Mazuch M. & Nikitenko, B.L. (2014).- Palaeoenvironments and palaeoceanography changes across the Jurassic/Cretaceous boundary in the Arctic realm: case study of the Nordvik section (north Siberia, Russia).- *Polar Research*, vol. 33, no. 1, p. 1-19.

55. Late Jurassic-early Cretaceous oceanography

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In this study, the evolution of low-latitude east-west trending Atlantic and Tethys oceans is traced from the late Jurassic into the early Cretaceous. C-isotope geochemistry serves as a stratigraphic tool and as a proxy of global carbon cycling through geological time.

Late Jurassic Oceans experienced a major change in their carbonate system. Calcareous nannoplankton started to proliferate in open ocean settings and became a rock-forming constituent. The establishment of a global pelagic carbonate factory occurred during the late Jurassic. In the Tethys Ocean pelagic sedimentation changed from a radiolarian-dominated facies to a calcareous nannofossil facies. Pelagic nannofossil limestones, forming the Southern Tethysian Maiolica Formation, can be traced from the western North Atlantic through the «Alpine Tethys Ocean» into the eastern Tethys. A change from siliceous pelagic sediments (Sidr Chert) to a siliceous white nannofossil limestone is documented from the Hawasina Basin (Oman Mountains). This change in carbonate production resulted in the establishment of a deep Calcite Compensation Depth (CCD) in the modern oceanographic sense. The base of the Maiolica formation and its equivalents are dated as Tithonian and the transition into the Cretaceous occurs within the lower part of the Maiolica Formation. Pelagic nannofossil limestones were formed in low latitude oceans, under oligotrophic conditions across the Jurassic-Cretaceous boundary.

A major change in low-latitude oceanography occurred during the Valanginian, when gradual deepening of the Hispanic corridor reached a critical depth and deep-water exchange between Atlantic and Pacific Oceans became possible. A change from white nannofossil limestones to a limestone-marlstone/claystone succession was established in the Atlantic Ocean and in the Tethys Ocean. A transequatorial east-west trending surface-water current was established. Equatorial upwelling was, according to ocean circulation models, intensified. These were the boundary conditions which facilitated increased burial of organic carbon during times of major, volcanically driven C-cycle perturbations. The first of these perturbations occurred during the late Valanginian and marks the beginning of an oceanography marked by multiple OAEs. This early Cretaceous oceanography ended at a time when a deep North-South connection was established in the Atlantic Ocean.

From a perspective of low-latitude oceanography there is no evident change occurring near the proposed Jurassic - Cretaceous boundary. Major changes occurred in the Tithonian and later in the Valanginian.

56. The drowned Oman Exotics - upper Jurassic to Cretaceous pelagic and hardground successions

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The time between the late Jurassic and the early Cretaceous experienced dramatic changes in plate configuration, paleoceanography and global carbon cycle.

The Jurassic-Cretaceous transition remains best documented in the Western Tethys and North Atlantic Oceans. Available data from the eastern part of the Tethys and the Pacific Ocean are not very abundant and additional information from these regions is of importance for better understanding how these regions were affected by oceanographic and tectonic changes. As shown by CELESTINO *et al.* (2017), the Oman Mountains preserve Mesozoic successions, which were deposited along the Arabian continent in the eastern Tethys. In addition, the seamounts of the «Oman Exotics» (*e.g.*, BERNOULLI & WEISSERT, 1987), preserve pelagic successions of late Jurassic and Cretaceous age in the Kawr Group. These sediments serve as archive of equatorial ocean history at the Jurassic-Cretaceous transition. Sediments of the Kwar Group provide data for the reconstruction of the impact of climatic and/or environmental changes in a region, which can be described as a window towards the Indo-Pacific Ocean.

Stable carbon and oxygen isotope geochemistry was performed on bulk carbonate samples from the sedimentary successions of the Kawr Group (upper Jurassic to lower Cretaceous) formed on two isolated seamounts (Kawr and Hamrat al Hasan). In addition, calpionellid assemblages were defined, allowing the definition of biostratigraphic tie points. These exotics form part of the Hawasina Nappe pile containing continental slope, deep marginal basin and the seamount units. The highly deformed sediments of the Hawasina Nappes are outcropping today in the Central Oman Mountains.

The calpionellid biostratigraphy and the measured $\delta^{13}C$ values confirm the late Jurassic to early Cretaceous time frame. Condensed red crinoidal limestones (Fatah Fm) of latest Jurassic age mark the beginning of continuous marine sedimentation after a long time of condensed sedimentation and hardground formation, and therefore indicate a major change in paleoceanographic conditions. The successions are overlain by pelagic chert-nodule-bearing nannofossil limestones (Nadan Fm) of earliest Cretaceous age. The top of the Nadan Fm on the Hamrat al Hasan seamount is of late Valanginian age, which can be shown by the onset of the prominent perturbation of the carbon cycle, interpreted as the Valanginian C-isotope Event (CIE). The change towards more positive $\delta^{13}C$ values is accompanied by an increase in silicified limestone beds and chert layers. This succession is in contrast with the succession of the Kawr seamount. There, the top of the Nadan Formation seems to be eroded, probably due to strong currents affecting the exposed seamount surfaces during the late early to mid-Cretaceous. The eroded top of the Nadan Fm on the Kawr seamount is again overlain by the Cenomanian to late Turonian Safil Fm (WOHLWEND, 2015).

The equatorial position of the Hawasina Basin, with the isolated drowned seamounts, provides information on a peculiar oceanographic situation. The Hamrat al Hasan seamount preserves a complete succession of the Nadan Fm containing the Valanginian CIE, while the Kawr seamount provides evidence of an enhanced circumequatorial current system, which may have become active in the late Valanginian, causing erosion on parts of the Kawr seamount.

BERNOULLI D. & WEISSERT H. (1987).- The upper Hawasina nappes in the central Oman Mountains: stratigraphy, palinspastics and sequence of nappe emplacement.- *Geodinamica Acta*, vol. 1, p. 47-58.

CELESTINO R., WOHLWEND, S., REHÁKOVÁ, D. & WEISSERT, H. (2017).- Carbon isotope stratigraphy, biostratigraphy and sedimentology of the Upper Jurassic-Lower Cretaceous Rayda Formation, Central Oman Mountains.- *Newsletters on Stratigraphy*, vol. 50, no. 1, p. 91-109.

WOHLWEND S. (2015).- Cretaceous oceanography and oceanic anoxic events: an East-west transect through the Tethys ocean from the Oman mountains to the Alps.- (Doctoral dissertation, ETH Zurich).

57. The Jurassic-Cretaceous Boundary in marine sedimentary successions in Turkey: A review

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The Jurassic-Cretaceous boundary in Turkey can be observed within shallow water platform carbonates, pelagic carbonates and even deep basin facies in different parts of Turkey representing different zones in Sakarya and Tauride platforms and basins.

Many studies including the Jurassic Cretaceous boundary have been published based on benthic foraminifera, dasyclad algae, calpionellids, radiolaria and even Sr isotopes (Altiner *et al.*, 1991; Yilmaz, 1999; Yilmaz *et al.*, 2016; Atasoy *et al.*, 2018; Bartolotti *et al.*, 2018, Kirmaci *et al.*, 2018; Vincent *et al.*, 2018) from different localities until now.

Platform carbonates display indistinct facies changes along the boundary in both Taurides and Pontides. The J/K boundary can be tracked by *Anchispirocyclina sp., Protopeneroplis striata,* and *Campbelliella striata* for the Tithonian, and the last occurrence of *Clypeina sulcata* (ex *jurassica*), presence of *Haplophragmoides joukowski, Coscinoconus delphinensis, C. campanellus,* and *Charentia cuvillieri* for the Berriasian (Altiner *et al.*, 1991, Yilmaz, 1999; Yilmaz *et al.*, 2016; Atasoy *et al.*, 2018). However the J/K boundary can be defined within a couple of meters instead of centimeters.

Pelagic carbonate facies can display the J/K boundary by the presence of the *Saccacoma* biozone, *Tubiphytes morronensis*, and the *Calpionellid* biozone A, and maybe calcareous nannofossil biozones, like *M. chiatius* biozone, for the Tithonian, and calpionellid biozone B-C, and calcareous nannofossil biozones, like *N. steinmanni* biozone, for the Berriasian (Altiner *et al.*, 1991; Yilmaz, 1999; Yilmaz *et al.*, 2016; Atasoy *et al.*, 2018).

In the eastern Pontides, NE Turkey, a hiatus around the Tithonian-Berriasian boundary is determined by Sr isotope age and foraminiferal biostratigraphy on the shallow-water platform carbonates (Vincent *et al.*, 2018). In this region, upper Jurassic volcanics are more dominant. A possible effect of tectonics is more likely around the boundary in this region and can possibly be correlated with the Caucasus. However, the J/K boundary can be tracked within dolostones in some localities in the eastern Pontides too.

In the central western Turkey, a late Tithonian age is obtained by radiolarians in the deep basin facies (basalt-chert facies) (Bartolotti *et al.*, 2017). However, a clear boundary just at the Tithonian and Berriasian is not recorded. A radiolarian assemblage spanning the J/K boundary was recorded within clayey limestones and marls in NW Turkey, around the city of Ankara (Bragin & Tekin, 1999).

Altiner D., Koçyiğit A., Farinacci A., Nicosia U. & Conti M.A. (1991).- Jurassic-Lower Cretaceous stratigraphy and paleogeographic evolution of the southern part of north-western Anatolia.- *Geologica Romana* 28, p. 13-80.

Atasoy S.G., Altiner D. & Okay A.I. (2018).- Reconstruction of a Late Jurassic-Early Cretaceous carbonate platform margin with composite biostratigraphy and microfacies analysis (western Sakarya Zone, Turkey): Paleogeographic and tectonic implications.- *Cretaceous Research* 92, p. 66-93.

Bortolotti V., Chiari M., Göncüoglu M.C., Principi G., Saccani E., Tekin U.K. & Tassinari R. (2018).- The Jurassic-Early Cretaceous basalt-chert association in the ophiolites of the Ankara Mélange, east of Ankara, Turkey: age and geochemistry.- *Geol. Mag.* 155**,** *2,* p. 451-478.

Bragin N.Y. & Tekin U.K. (1999).- Stratigraphy and the Upper Jurassic-Lower Cretaceous radiolarians from carbonatesiliceous deposits Ankara region, Turkey.- *Stratigraphy and Geological Correlations* 7, p. 130-140.

KIRMACI M.Z., YILDIZ M., KANDEMIR R. & EROĞLU-GÜMRÜK T. (2018).- Multistage dolomitization in Late Jurassic-Early Cretaceous platform carbonates (Berdiga Formation), Başoba Yayla (Trabzon), NE Turkey: Implications of the generation of magmatic arc on dolomitization.- *Marine and Petroleum Geology* 89, p. 515-529.
VINCENT S.J., GUO L., FLECKER R., BOUDAGHER-FADEL M.K., ELLAM R.M. & Kandemir R. (2018).- Age constraints on intra-formational unconformities in Upper Jurassic-Lower Cretaceous carbonates in northeast Turkey; geodynamic and hydrocarbon implications.- *Marine and Petroleum Geology* 91, p. 639-657.
YILMAZ İ.Ö. (1999).- Taxonomic and paleogeographic approaches to the dasyclad algae in the Upper Jurassic (Kimmeridgian) - Upper Cretaceous (Cenomanian) peritidal carbonates of the Fele (Yassıbel) area (Western Taurides, Turkey).- *Turkish Journal of Earth Science*, 8, 2-3, p. 81-101.
YILMAZ I.O., ALTINER D. & OCAKOGLU F. (2016).-. Upper Jurassic-Lower Cretaceous depositional environments and evolution of the Bilecik (Sakarya Zone) and Tauride carbonate platforms, Turkey.- *Palæogeography, Palæoclimatology, Palæoecology*, 449, p. 321-340.

58. Radiolarian rich, siliceous interval within an Hauterivian pelagic succession in the central Sakarya, Pontides, NW Turkey

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The study area lies at the Sogukcam village, central Sakarya region, central Pontides, in NW Turkey. An interval of pelagic carbonates 106 meters thick has been measured in detail within the Sogukcam Limestone. This limestone has a transgressional contact with underlying units. Microfacies, sedimentary features and radiolarian biochronology of the Sogukcam Limestone have been carried out in this study.

In the Sakarya region, lithofacies at the basal part of the Sogukcam Limestone consists of an alternation of foraminifera and calpionellid bearing wackestones and mudstones. Higher in the sequence, an interval characterized by thick-bedded, bioturbated, siliceous limestones with radiolarian and sponge spicule assemblages is found. Pyrites and iron mineralization have also been recorded within these same beds. Within this interval, spumellarian type radiolarian have been recognized (*e.g.*, *Dicerosaturnalis trizonalis dicranacanthos, Aurisaturnalis variabilis variabilis, Cecrops septemporatus, Crucella svinitzensis, Paronaella trifoliacea*, and *Suna hybum*) as a major component. Some nassellarian type of radiolarians are also present (*e.g.*, *Stichomitra* spp., *Podobursa* spp., *Xitus* sp., *Crolanium* sp. and *Mictyoditra* sp.) as a minor component. Based on previous studies (*e.g.*, BAUMGARTNER *et al.*, 1995; DUMITRICA *et al.*, 1997), the age of this radiolarian rich limestones can be assigned as Hauterivian.

At the bottom of the succession, just below the siliceous interval, there is a shale/mudstone interval alternating with thin marls and calcareous sandstones. This siliceous interval in the studied area can be correlated to a radiolarian bearing sequence encountered in the Sogukcam Limestone in other parts of the basin (BRAGIN & TEKIN, 1999; OKAY & ALTINER, 2016, 2017). According to BRAGIN and TEKIN (1999), pelagic deposits belonging to Sogukcam Limestone first appear in the middle Oxfordian (late Jurassic). Due to gradual deepening of the basin, radiolarian-rich, siliceous limestones of this formation took place in the entire basin in the Hauterivian period (OKAY & ALTINER, 2016, 2017). Our findings correlate well to previous studies. Geochemical analysis related to this formation will be carried out in the future.

BAUMGARTNER P.O., O'DOGHERTY L., GORIČAN S., DUMITRICA-JUD R., DUMITRICA P., PILLEVUIT A., URQUHART E., MATSUOKA A., DANELIAN T., BARTOLINI A., CARTER E.S., DE WEVER P., KITO N., MARCUCCI M. & STEIGER T. (1995a).- Radiolarian catalogue and systematics of Middle Jurassic to Early Cretaceous Tethyan genera and species. *In*: BAUMGARTNER P.O., O'DOGHERTY L., GORIČAN S., URQUHART E., PILLEVUIT A. & DE WEVER P. (Eds.). Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, systematics, biochronology.- *Mémoires de Géologie (Lausanne)*, vol. 23, p. 37-685.

BRAGIN N.Y. & TEKIN U.K. (1999).- Stratigraphy and the Upper Jurassic-Lower Cretaceous radiolarians from carbonate siliceous deposits Ankara region, Turkey. *Stratigraphy and Geological Correlations* 7, p. 130-140.

DUMITRICA P., IMMENHAUSER A. & DUMITRICA-JUD R. (1997).- Mesozoic radiolarian biostratigraphy from Masirah ophiolite, Sultanate of Oman, Part 1. Middle Triassic, Uppermost Jurassic and Lower Cretaceous spumellarians and multisegmented nassellarians.- *Bulletin of the National Museum of Natural Sciences*, Taiwan, vol. 9, p. 1-106.

OKAY A.I. & ALTINER D. (2016).- Carbonate sedimentation in an active margin: Cretaceous history of the Haymana region, Pontides.- *International Journal of Earth Sciences*, vol. 105, p. 2013-2030.

OKAY A.I. & ALTINER D. (2017).- Alacaatlı Olistostromes: Geology of Alcı and Baglum regions in Ankara.- Field Guide Book, Turkish Geological Congress, 41 p. [in Turkish with English Abstract].

59. Evolution of mixed shelf at the Jurassic-Cretaceous boundary: Case study of the S Setifian shelf (NE Algeria)

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This study focuses on an area located at the convergence of the allochthonous and the Atlasic forelands of the Northern Algerian Alpine Belt. The objective of this work is to reconstruct the paleogeographical history of the Jurassic-Cretaceous carbonate shelf and discuss its relationship with the geodynamic evolution of the Southern Tethysian margin.

The Jurassic series are characterized by various facies and depositional environments, all of which record shallow bathymetry. During the Kimmeridgian and the Portlandian, the bioclastic character becomes increasingly marked with the presence of bioclasts, gravels and oolites, characteristic of high energy deposits in the northern part of the study area (Dj. Messaouda and Dj. Mestaoua). On the other hand, the southern part (Belezma-Batna Mts.) is characterized by deep water facies consisting of mudstones with intercalations of marl and clay limestones.

The lower Cretaceous is represented by clay-sandstone sedimentation, typical of a deltaic environment in a shelf context. In order to better constrain the interpretation of facies in terms of depositional environments (foreshore, shoreface, offshore ...) and bathymetric zonation, three facies associations were defined and recognized in the several sections studied.

The Jurassic-Cretaceous boundary is characterized by the presence of a pelagic fauna where the Ammonites *(Malbosiceras* aff. *parmimounum, Mazenoticeras affuralense, Fauriella boissieri, Jabronella isaris*, *Spiticeras* sp.) are dominant. Calpionellids (*Calpionella alpina* LORENZ, *etc.*) allow determination of a younger Berriasian age to the pelitic-sandy complex, which contains rare intercalations of thin beds of argillaceous limestones with ripple marks, and marls.

The regional distribution of facies and thicknesses suggests a complex structural history.

AFTERWORD

The "Carnets de Géologie" Editing House was a scientific partner of this meeting together with 15 national or international societies (Asociación Paleontológica Argentina (APA), Association Paléontologique et Évolutive Libanaise (APEL), Association Paléontologique Française (APF), Sociedad Española de Paleontología (SEP), Società Paleontologica Italiana (SPI), Societatea Paleontologilor din România (SPR), Comité Suisse de Stratigraphie (strati.CH), International Subcommission on Stratigraphic Classification (ISSC), International Research Group on Ostracoda (IRGO), Юрская комиссия МСК (Russian "Jurassic Commission"), Меловая комиссия МСК (Russian "Cretaceous Commission"), Stratigraphy, Sedimentology and Palaeontology (SSP) - European Geosciences Union (EGU), International Association of Sedimentologists (IAS), Society for Sedimentary Geology (SEPM), The Paleontological Society).

There were 74 registrations from 25 countries (Africa: Algeria, Morocco; Americas: Argentina, Chile, USA; Asia: China, Iraq, Japan, Jordan, Lebanon, Qatar, Thailand, Turkey; Europe: Denmark, France, Germany, Italy, Netherlands (the), Poland, Romania, Russian Federation, Slovenia, Spain, Switzerland, United Kingdom), 59 contributions (6 keynotes, 33 presentations, 25 posters including 5 to supplement regular oral presentations or keynotes) from 176 authors and coauthors.

The last day of the meeting, in order to have a FAIR and OPEN discussion on the system boundary (we did not discuss any stage boundaries or GSSP), there was a survey to tentatively measure attendees' opinions, perceptions and orientations. There were several options (with space for comments) for the Jurassic-Cretaceous system boundary:

- 1st option, the base Berriasian (the primary marker is the base of the acme of *Calpionella alpina* inside the M19n, as designed by the Berriasian WG) got 17% of the votes;
- 2nd option, the base Valanginian (the primary marker is the FAD of *Calpionellites darderi*, as designed by the Valanginian WG) got an ABSOLUTE MAJORITY (52%);
- 3rd option, the base Ryazanian got 7% of the votes;
- 4th option, a Radiolarian marker inside the M20n got 21 % of the votes (this option should be ruled out because, at this stage, it is in disagreement with the ICS's, ISCS's and Berriasian WG's decisions).

During the discussion that followed, the chairperson -Bruno GRANIER- offered a voice mostly to those people who did not vote for the Valanginian (and even to people who did not vote at all). One person stated that "it is too late to change!"... which is ALL but a scientific justification (!):
1) The Gelasian was recently shifted into the Pleistocene (hence into the Quaternary);
2) The Tithonian-Berriasian boundary changed 3 times in the recent years!

The Radiolarian turnover take place in the late Tithonian (not at the stage boundary ... it is not even in the same magnetozone!). Several other fossil groups show a turnover at the Berriasian-Valanginian boundary (ammonites, foraminifers, calpionellids, ...) whereas there is no such event at the Tithonian-Berriasian boundary (except for the Calpionellids). Radiolarian people said they agreed to investigate the Berriasian-Valanginian boundary too (so far they were given priority to the sole Tithonian - Berriasian boundary).

◀ Photos Peter SCHUCHERT

Geochemistry demonstrates that the Jurassic does not end with the Tithonian but with the Berriasian. The Weissert event marks the dawn of the Cretaceous and its OAEs. Helmut WEISSERT himself stated that "OPPEL was right!" (with the Titonische = Tithonian + Berriasian) because there is NO geochemical break near the Tithonian - Berriasian boundary. The system boundary has to be located at a stage boundary ... between the end of OPPEL's Tithonische and the WEISSERT event. There is only one stage boundary that meets this requirement, *i.e.*, the (base) Valanginian.

At the end of the day further to this open discussion, which was not "sterile" (!), it looks like a vast majority of people would like the option of the base Valanginian as the JK boundary to be fully reconsidered, particularly because it looks more stable and also more easy to correlate. This large majority includes people who initially voted for the Valanginian (the absolute majority), people who changed their mind, and people who are not completely against considering it as a potential candidate for the system boundary.

In conclusion, today, it looks like the door is wide open for a real reconsideration of the Berriasian-Valanginian boundary as the base of the Cretaceous (sensu ORBIGNY, OPPEL, COQUAND, ÉNAY, ...)!

Bruno GRANIER
President of JK2018

Authors, coauthors, and attendees

- W -

- Y -

- Z -

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