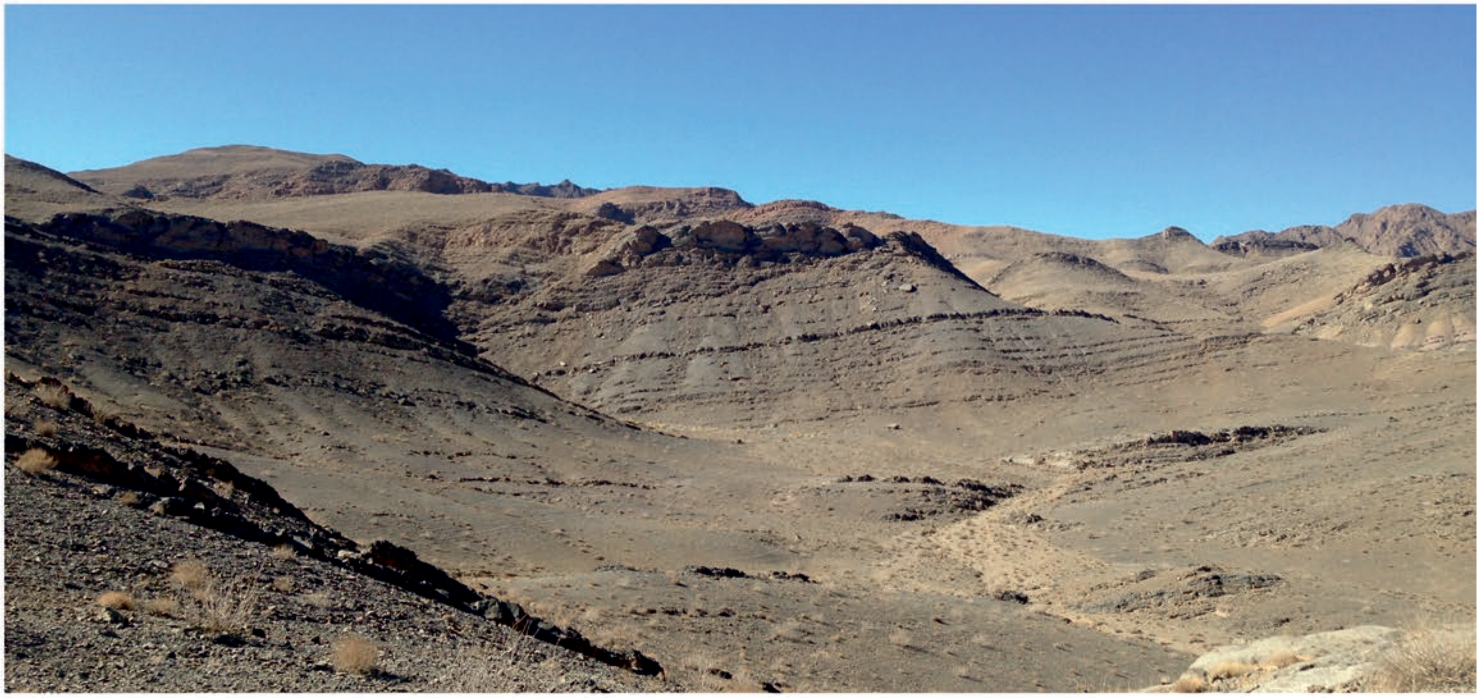
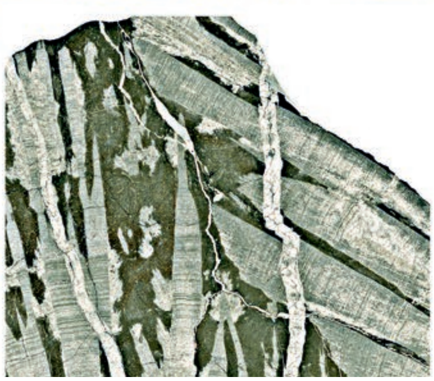
Permophiles

International Commission on Stratigraphy





Newsletter of the Subcommission on Permian Stratigraphy
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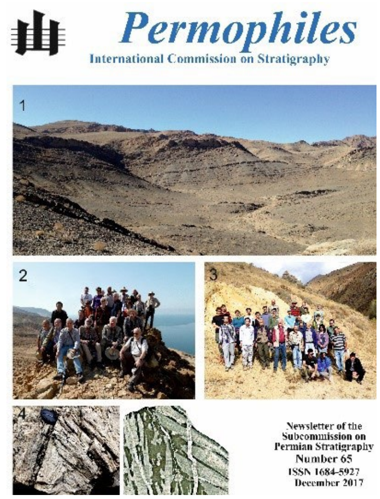

Fig. 1. Overview of the Abadeh section in entral Iran. Angiolini e al., this issue.
Fig. 2. Participants to the 14th International Permian-Triassic Field Workshop on Permian strata above the Dead Sea. Bachmann, this issue.
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EXECUTIVE NOTES

Notes from the SPS Secretary

Lucia Angiolini

Introduction and thanks

We are all very busy with our research, but also with administration, which makes our life hectic. This is probably why we did not get enough contributions in the first half of this year and we delayed the publication of Permophiles 65 to December 2017. We were also busy in preparing the proposal for the Global Stratotype Section and Point (GSSP) for the base-Sakmarian Stage (Cisuralian, Lower Permian) at the Usolka section (southern Urals, Russia) by Chernykh et al., a proposal that was sent to ICS at the end of October 2017.

This Permophiles issue contains discussions on a wide range of Permian topics, and I thank Gerhard Bachmann, Sahakyan and co-authors, Charles Henderson, Jurikova and co-authors, Spencer Lucas, Schneider and co-authors and Mike Stephenson for their very interesting contributions to this issue. Shuzhong Shen and I have very recently visited the Abadeh section in Central Iran, so this issue also contains a brief report of our successful field work.

I would like to thank Claudio Garbelli for his assistance in editing this issue of Permophiles.

I would also like to keep drawing your attention to the new SPS webpage that Shuzhong Shen has provided at http://permian.stratigraphy.org/, where you can find information about Permophiles, what's going on in the Permian Subcommission, an updated version of the list with addresses of the SPS corresponding members, and the newly updated Permian timescale (also included in this issue).

While finalizing this issue, I was given very sad news: Maurizio Gaetani, palaeontologist and stratigrapher, suddenly passed away on 19, December 2017. He was my mentor, and during his fruitful life of research, he also contributed to Permian studies.

Previous and forthcoming SPS Meetings

A forthcoming SPS meeting is scheduled during the 5th International Palaeontological Congress, which will be held in Paris, France from 9 to 13 July 2018. A second meeting can be organized during the 8th International Brachiopod Congress, held in Milano, Italy from 11 to 14 September 2018.

Permophiles 65

This issue starts with the annual report of SPS written by Shuzhong Shen, followed by the third harangue of Charles Henderson. I used to define his harangues a "laudable attempt to stimulate debate inside the Permian community" but now I think they are much more than an attempt, because they really succeed in stimulating discussion and curiosity. This third harangue reveals a profound truth, underscoring the fact that recent and advanced research often does not consider early literature - an early literature that is often right, because it is based on detailed observation and mapping in the field. Charles is correct when he writes that we have to keep going into the field to understand better its record and collect new and higher resolution data.

The second contribution of this issue, by Mike Stephenson, is strictly related to the comprehensive proposal for the Global Stratotype Section and Point (GSSP) for the base-Sakmarian Stage. It deals with the description of the palynological succession at Usolka and investigates the potential for correlation. The description is accompanied by plates that beautifully illustrate the associations. However, the recorded distribution of terrestrial palynomorphs is of limited use for correlation of the GSSP. Algal palynomorphs in the succession are distinctive, but are known to be sensitive to environment.

The next contribution is by Spencer Lucas who underscores the need to define the beginning of the Illawara Superchron and its age, as it represents a very important datum by which to correlate mid Permian successions. This topic reminded me of my first attempt to approach the Permian community: to obtain answers to my doubts on mid Permian correlation. In the nineties, I wrote to Permophiles with the title "A question from an ordinary Permain worker" and I got a good answer from B. Wardlaw. Of course, nowadays, the contribution by Spencer is much more exhaustive and outlines that, notwithstanding a lot of research that went on in the last 10-20 years, the age of the beginning of the Ilawarra is still problematic. He concludes his report, writing that it is now time "to fix the beginning of the Illawara Superchron in a well-dated section with fully documented magnetostratigraphy" and I think that we all agree that this should be one of the main focus of SPS in the next years.

In the next contribution, Hana Jurikova and co-authors present new research funded by the European Union's Horizon 2020 research and innovation programme. The applied methodology is quite new: $\delta^{11}B$ analyses were performed on pristine brachiopod calcite from the PTB interval of the Dolomites, northern Italy, to reconstruct a high-resolution seawater pH record for the Paleo-Tethys Ocean, based on $\delta^{11}B$ to pH relationships. In particular, the newly obtained results suggest a drop in seawater pH at the onset of the end-Permian extinction event.

The contribution by Schneider and his numerous co-authors is an outstanding report on the state of the art of the activities of the Late Carboniferous – Permian – Early Triassic Nonmarine-Marine Correlation Working Group, for 2016 and 2017. The prolific activity of this working group resulted in many publications showing the data recently acquired in China, Russia, Germany, Czech Republic, Italy, France, Spain, Jordan, North America, Morocco and South Africa by the different regional working groups. The report contains a very exhaustive reference list and a figure showing the updated late Carboniferous (Bashkirian) to early Triassic (Induan) conchostracan biozonation.

The following three reports are perfectly tuned with the message contained in Charles Henderson's harangue: lets go out into the field again and again.

Shuzhong Shen and I, with our co-authors, report about our brief, but intense, field excursion to sample for conodonts, foraminifers, brachiopods and geochemistry in the Upper Permian-Lower Triassic Abadeh, Hambast and Elikah formations at Abadeh, Central Iran.

Gerhard Bachmann presents an interesting and accurate report of the 14th International Permian-Triassic Field Workshop in Jordan, organised and guided by Abdalla M.B. Abu Hamad of Amman University. Internationa participants from Europe, Israel and China visited several well exposed Permian-Triassic sections and had a good look also at the Permian-Triassic boundary interval.

This contribution is followed by another interesting and very well illustrated field work report by Sahakyan et al., who describe the IGCP 630 Conference and Field Workshop, October 8-14, 2017, held in Armenia. During the conference and field workshop organized by Lilit Sahakyan, Aymon Baud, and Zhong-Qiang Chen, an international team had the opportunity to visit the very famous Upper-Permian-Triassic successions of Armenia at the Ogbin, Chanakchi and Vedi sections. Remarkable are the PTB shales and the basal Triassic giant sponge-microbial buildups.

The issue ends with a few advertisements on publications and conferences that may be of interest to the Permian community.

Future issues of Permophiles

The next issue of Permophiles will be the 66th issue.

Contributions from Permian workers are very important to move Permian studies forward and to improve correlation and the resolution of the Permian Timescale, so I kindly invite our colleagues in the Permian community to contribute papers, reports, comments and communications.

The deadline for submission to **Issue 66** is **30th June, 2018**. Manuscripts and figures can be submitted via email address (lucia.angiolini@unimi.it) as attachments.

To format the manuscripts, please follow the TEMPLATE that you can find on the new SPS webpage at http://permian.stratigraphy.org/ under Publications.

We welcome your contributions, letters, comments, answers and advice to improve our communication as we move forward.

Notes from the SPS Chair

Shu-Zhong Shen

First of all, I would thank Aymon Baud, Lilit Sahakyan, and Zhongqiang Chen for their organization of the IGCP 630 meeting in Yerevan and field excursion in southeast Armenia. The field excursion was fantastic and provided an excellent opportunity to visit a few well-known traditional Permian-Triassic sections which were described by Ruzhentsev and Sraytcheva (1965) (see a report by Aymon Baud et al. in this issue). We also enjoyed the local culture, recreation and hospitality which were far beyond geology. I would also thank Lucia Angiolini and Gaia Crippa for having organized a field excursion in the Abadeh area in central Iran. Our group had already visited the Abadeh section in 2009, but, unfortunately, some sample bags were damaged during the shipment and this time we collected much denser samples at the Abadeh section. The outcrops are wonderful in the Abadeh area. We saw a surprisingly thick Capitanian deposits at the section. Thank to Mansour Ghorbani for his excellent organization of this field trip and to Mohsen Ghorbani and Masoud Ovissi for their hard work with us in the field.

Charles and I also organize a field trip to the Guadalupe Mountain National Park in Texas and measured a new section which contains more strata across the Wordian/Capitanian boundary. We also visited all the GSSP sections again and collected more samples to test the FADs of the index species and quality of those GSSP. We thank Jonena Hearst for her kind support during the field work.

I am pleased to announce that we have submitted the Sakmarian-base GSSP proposal to the International Commission on Stratigraphy (ICS) for discussion and voting. We hope this proposal can be approved in 2018 and we can continue to work on the Artinskian-base and Kungurian-base GSSP proposals. I would thank our Russian colleagues who excavated the Dalny Tulkas and Mechetlino Quarry sections. I would herein call again that all the SPS voting members are welcome to visit and collect samples for these two candidate sections. SPS has a little money to support any voting member of SPS to go to southern Urals for GSSP work.

A Special Publication 450 of Geological Society, London titled "The Permian Timescale" edited by Spencer Lucas and Shuzhong Shen has been recently published online (http://sp.lyellcollection.org/online-first/450) (also see a brief introduction of this special publication in this issue). The formal publication with page number will be available before Feburary, 2018. This Special Publication 450 includes 17 papers and it reviews the state of the art of the Permian timescale including multiple fossil biostratigraphy (conodonts, ammonoids, brachiopods, radioralians, fusulinids, small foraminifers, rugose corals, tetrapod and tetrapod footprints, palynology, conchostracans, megaflora), magnetostratigraphy, geochronology, Sr chemostratigraphy, etc. In addition, Shuzhong Shen and Jiayu Rong are organizing a Special Issue of Science China Earth Sciences on the Geological Timescale of China which will be published in early 2018.

SUBCOMMISSION ON PERMIAN STRATIGRAPHY

ANNUAL REPORT 2017

1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

International Subcommission on Permian Stratigraphy (SPS)
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2. OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

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

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

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN 2017

A field excursion to all three GSSPs in the Guadalupe Mountains in Texas, USA between May 26 and June 4, 2017 was organized by Shuzhong Shen and Charles Henderson. Numerous supplementary samples for the three defined GSSP sections were collected. In addition, a new section potentially to provide an important reference for the Capitanian-base GSSP was measured and collected in a high-resolution way.

A formal proposal of the Sakmarian-base GSSP has been submitted to International Commission on Stratigraphy and is waiting for discussion and voting among ICS members. This proposal has been extensively discussed and revised based on numerous discussions among the SPS voting members. Finally, palynological data from the section were added in before it was submitted.

3b. List of major publications of subcommission work (books, special volumes, key scientific paper)

A volume of Special publication (*The Permian Timescales*. Geological Society, London, Special Publication **450**, https://doi.org/10.1144/SP450.15) has been organized by Lucas, S.G. and Shen, S.Z.). This volume reviews the state of the art of the Permian timescales of the SPS including geochronology, high-resolution biostratigraphy based on various fossil groups (conodonts, fusulinids, brachiopods, plant fossils, radiolarians etc.), magnetostratigraphy etc. and a latest Permian Timescale is also presented. All the papers are already available online and a formal printed publication will be available in January, 2018.

Two issues of *Permophiles* (Issues 63 and 64) have been published since October, 2016. They are all available on the SPS website (http://permian.stratigraphy.org/pub/pub.asp).

3c. Problems encountered, if appropriate

We have encountered problems that discrepancy in conodont taxonomy and selection of the index species of the Artinskian-base GSSP is present. The condont species *Sweetognathus* aff. *whitei* was selected as the index species of the FAD, however, this species needs to be described and investigated intensively before it can be used for the definition.

We also met a problem for the Lopingian-base GSSP which will be flooded after a dam established in five years for electronic power in the downstream of the Hongshui River in Guangxi, South China. We have extensively discussed with the local government and a protected dam around the GSSP section has been designed and will be established which will cost about 45 millions Chinese Yuan. In addition, detailed field work for searching the replacement of the GSSP section nearby the GSSP has been made in 2017. Field work to search replacement section in South China was carried out during 2016 as well.

4a. OBJECTIVES AND WORK PLAN FOR NEXT YEAR (2018)

The primary objectives are to complete the last three GSSPs (Sakmarian, Artinskian, and Kungurian stages) and redefine the three GSSPs of the Guadalupian Series (Roadian, Wordian and Capitanian). A formal proposal for the Sakmarian-base GSSP has been submitted to ICS. The Russian Stratigraphic Committee has excavated the Dalny Tukas (Artinskian-base) and Mechetlino Quarry (Kungurian-base) sections as well, SPS will call an international joint field excursion to collect various samples in those sections and will use a part of the 2018 budget to support the field excursions to southern Urals and any other activities related to GSSP establishment.

We will also extensively work on the new section and all the samples collected in 2017 from the three GSSP sections in the Guadalupe Mountains will be processed as early as possible.

4b. Specific GSSP Focus for 2018

The priority of 2018 for GSSP is to: 1) get the Sakmarian-base GSSP proposal for discussion and voting in ICS, 2) intensively study and clarify numerous problems in the three defined Guadalupian GSSPs, and 3) establish a protected dam around the Lopingian-base GSSP at Penglaitan, South China.

5. SUMMARY OF EXPENDITURES IN 2017

We received an allocated budget 2195.0 Euro from ICS this year. As planned in the 2016 annual report, this money was mainly used for supporting the publication of *Permophiles*, all activities of SPS voting members to do work related to GSSP. A joint field work in the Guadalupian Mountains National Park in Texas was organized in May, 2017. This little money from ICS is far from enough to cover all the expenditure of those activities.

6. BUDGET REQUESTS AND ICS COMPONENT FOR 2018

1. The Dalny Tukas and the Mechetlino Quarry sections for the Artinskian and Kungurian GSSPs have been excavated by the Russian colleagues. Although we called once to do field work in those potential GSSP sections, so far no voting members have gone there to do field work. So, we continue to call all voting members for field work on the three potential GSSP sections in southern Urals to collect samples. We will use a part of the 2018-year budget to support any voting member to go to southern Urals (2000US$).
2. Shuzhong Shen will send some students to the Penglaitan section to guide the establishment of a dam to protected the Lopingian-base GSSP. This section will be flooded, if it is not protected, due to the establishment of a water power station in the downstream of the Hongshui River (1000US$).
3. Shuzhong Shen will go to Milano in September, 2018 to meet SPS secretary Lucia Angiolini to edit the next *Permophiles* (2000US$).

In total: **US$5000**

APPENDICES

7. CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2012-2017)

1) A Special Publication "The Permian Timescale" has been published online in Geological Society of London, Special Publication **450**.
2) Three GSSP bronze markers have been placed on the GSSPs in the Guadalupe National Park in USA.
3) A high-resolution timescale of the Permian system has been significantly refined and updated from time to time (see SPS webpage Permian Timescale, also *Permophiles* 64).
4) A formal proposal for the Sakmarian-base has been submitted to ICS. The Artinskian-base GSSP proposals have been published on *Permophiles* based on extensive discussions among SPS.
5) Two monuments have been built and a protected area has been established at Penglaitan, Laibin, Guangxi Province, China for the Wuchiapingian-base GSSP.
6) Nine formal issues and one supplementary issues of *Permophiles* have been published since 2011.
7) A Working Group on the Carboniferous-Permian transition between marine and non-marine sequences has been organized in 2015.

8. OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2018-2021)

1) Publishing the revised version of the proposals, organizing the field excursions and establishing the three (at least two) GSSPs for the Cisuralian.
2) Continue to work on the Guadalupian GSSPs and global correlation for chemostratigraphy and geochronologic calibration. Publish the official papers for the three Guadalupian GSSPs.
3) Searching the replacement of the Lopingian-base GSSP nearby the stratotype section at Penglaitan, Guangxi, South China because the original will be flooded in 5-10 years by a dam for electronic power. Some progresses have been made during the last two years.

9.ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

9a. Names and Addresses of Current Officers and Voting Members

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9b. List of Working (Task) Groups and their officers

1) Sakmarian-base and Artinskian-base GSSPs Working Group; Chair-Valery Chernykh.
2) Guadalupian Series and global correlation; Chair-Charles Henderson.
3) Correlation between marine and continental Carboniferous-Permian Transition; Chair-Joerg Schneider.
4) Neotethys, Paleotethys, and South China correlations; Chairs Lucia Angiolini and Yue Wang.

9c. Interfaces with other international project

SPS interacts with many international projects on formal and informal levels. SPS chair Shuzhong Shen organized an international cooperative project on the correlation of the Guadalupian Series between South China and Mt. Guadalupe in Texas, USA, which has been approved by NSFC.

Henderson's Harangue #3

Charles M. Henderson
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Introduction

As an attempt to stimulate debate or perhaps simply because something smells fishy, I deliver my third harangue. In Italian, it would be "L' arringa di Henderson" (the double "r" is important).

You reach a certain point in your career and you start thinking about your legacy. For many of us, this means that we will dust off those shelves and finish some work that we should have finished years earlier. In some cases, it may be good that some items remained in the closet until their time. I feel I have learned so much during my career that I am now in a good position to make better interpretations. Of course, I might have reached this point sooner had I finished some of those projects earlier in my career, even if some of the ideas might have been wrong. There is little sense in giving it too much thought; it is in the past and nothing will change that, but I can change what I am doing now.

The vast majority of Permophiles readers deal with the past. Many of us are finalizing the time scale. Others are reconstructing ancient environments and interpreting paleoecologic constraints. We utilize many new technologies to arrive at these conclusions, but in so doing, we sometimes forget to look at the early literature on a topic. It has occurred to me several times recently that the older literature is often right or very close to right. I think this is because authors of much of the older literature solved problems through detailed observation and mapping in the field. Spencer Lucas (2017) alluded to this in his short essay on "the best sections method of studying mass extinctions". He suggested that we need more field-based studies of the best sections and less "literature-based compilations". The fact that such compilations "seem to work" often is testament to the value of the past literature. A problem of using those published data, however, is that often they are limited in temporal and spatial resolution – resolution that is necessary for meaningful compilations. We seem to often depend on previous samples or data and subject them to increasingly new techniques, but perhaps without the intimate knowledge of their field context. As we enter the "big data era", it is possible that some of our current students will never step into the field, except in an introductory field course. I actually have to advertise and provide information sessions these days to

Fig. 1. Permophiles editors Lucia Angiolini and Shuzhong Shen, among others, collecting new data in sections near Abadeh, Iran.

convince some of our students to take my senior field school in Nevada. In summary, the older literature is very valuable, but the demand for higher and higher resolution means we have to keep getting out into the field.

As I type this essay, I just received a text message on my Blackberry phone (the new Blackberry Classic) from the City of Calgary, reminding me that it is garbage day tomorrow morning. Actually, it is recycle and compost day, and the following day will be the landfill garbage day. However, it reminds me of the old adage "garbage in – garbage out".

The time of transition into the information/big data age is creating winners and losers. There are so many papers these days that it is difficult to keep up with the literature, even in our narrow specialties. It is also difficult to keep up with the requests to review papers, but it is important to try. The peer-review process works, but I fear it has taken a bit of a hit recently. So many reviews are anonymous, and many seem to be quite shallow, probably because there simply is not time. The harshest critique could be paraphrased, as "this doesn't fit my predetermined view of the ancient world". How dare someone suggest that the end-Permian mass extinction (EPME) has only a single pulse, when it is clear there are two? "Reject". My personal opinion is that there is only one pulse and that it occurred before the PTB, but it is fair to ask me to point out alternative interpretations and any limitations of my own view and it is fair to ask me to review some of the early literature. "Reject" is too easy and it may in fact slow progress. Sometimes "reject" is justified, but as a reviewer, it is important to justify that decision. During this transitional time, it seems to be easier to get into the open access literature so long as we can pay the big fees, but editors deny this. We may need more forums in which to debate some of this literature.

One such forum is Permophiles. Early issues have recorded a number of debates, but not so much lately. The editors of Permophiles (Fig. 1) would like more papers. I suggest that one debate could centre on the EPME. We could start with a paper published by Baresel et al. (2017). It is a very thought provoking paper, but are the conclusions justified? Can you extrapolate geochronologic ages to the extent they have? Does a short hiatus indicate that the driving mechanism for transgression must be glacial eustatic, even when more evidence points to a tectonic origin? Can you suggest glaciation, when all oxygen isotopic data point to significant warming during the interval? Can you justify with maximal associations that the microbial unit begins at the PTB when traditional biostratigraphy suggests that the PTB is within the microbial unit? Sounds like it might constitute my next harangue.

So what is my point? Transitions are difficult. Analyses of big data will lead to some unexpected innovations, but some of it might need to be recycled or composted. In such cases, maybe we need to get back into the field and collect new data with fresh eyes and new techniques. It always amazes me how I learn something new every time I visit a favourite nearby section. That is because the rock record is cryptic, but of course, that is exactly what makes it fun.

References

Baresel, B., Bucher, H., Bagherpour, B., Brosse, M., Guodin, K., and Schaltegger, U., 2017. Timing of global regression and microbial bloom linked with the Permian-Triassic boundary mass extinction: implications for driving mechanisms. Scientific Reports, v.7, p. 43630, DOI: 10.1038/srep43630.

Lucas, S.G., 2017. The best sections method of studying mass extinctions. Lethaia, DOI 10.1111/let.12237.

Preliminary results of palynological study of the Usolka section, location of the proposed basal Sakmarian GSSP

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Introduction and materials

As part of the palaeontological study of the proposed basal Sakmarian GSSP, palynological samples were taken from the Usolka section in southern Urals in July 2007 (see Permophiles no. 49). The objective of this short note is to describe briefly the palynological succession at Usolka and investigate the possibility that the succession may help to correlate the GSSP. Small samples (mass <200g) were collected and processed using standard techniques (Wood et al., 1996) at the palynological laboratories of the British Geological Survey. The lithologies of the section include limestone, mudstone, shale, limestone breccia and nodules and interbeds of chert.

Description of palynology

Fig. 1. Sample 56677 from Bed 26/2 (Bed 32 of original nomenclature) showing dark fine-grained lithology apparently favourable for palynological recovery.

The fourteen samples yielded organic residue including palynomorphs, black equant fragments (probably charcoal or vitrinite) and amorphous organic matter. Palynomorphs were common in several samples but were universally poorly preserved, showing signs of contemporaneous oxidation such that spore and pollen exine was near colourless and transparent in some cases. Saccate pollen was particularly poorly preserved with sacci commonly separated from corpi. The poor preservation necessitated staining with Safranin O to improve possibility of determination. Several of the samples contain large numbers of probable algal palynomorphs. These were often marginally better preserved than the terrestrial palynomorphs.

The lower three samples yielded the most diverse and best preserved assemblages: MPA 56682, 56679 and 56671 (see Table 1). This sample range is below the proposed GSSP. The samples above the proposed GSSP contain only rare, very poorly preserved terrestrial palynomorphs.

The lower three samples are dominated by indeterminate non-taeniate and taeniate bisaccate pollen (often detached corpi or sacci). Also present are *Vittatina* spp. (mainly *V. subsaccata* Samoilovich). Other taxa recorded include *Pteruchipollenites indarraensis* (Segroves) Foster, *Limitisporites monstruosus* Luber and Valts, *Protohaploxypinus* spp., *Hamiapollenites fusiformis* Marques-Toigo emend. Archangelsky and Gamerro, *Vesicaspora* spp. and *Striatopodocarpites* spp. (Plates 1 and 2).

A variety of ?Algal forms such as *Azonaletes* cf. *compactus* Luber are locally common. A distinct taxon occurring in the upper three samples (MPA 56683, 56667, 56674; Algal palynomorph sp. 1) is characterised by a complex tight reticulum or tectum (Plate 1, 1-6).

Interpretation and utility for correlation of the GSSP

The presence of poorly preserved terrestrial palynomorphs well below the proposed base Sakmarian GSSP, and the absence of significant assemblages above that level makes the palynological succession of Usolka of very limited use for correlation of the GSSP. The best preserved and distinctive palynomorphs in the assemblages are of probable algal origin. Two distinctive forms, Algal palynomorph sp. 1 and 2 occur above the GSSP. Algal palynomorph sp. 1 has a dense ?reticulate to ?tectate ornament and Algal palynomorph sp. 2 has a thick punctate wall similar to some forms of *Tasmanites*. However algal palynomorphs of this type are known to be sensitive to environment (e.g. Stephenson et al., 2004) and are therefore unlikely to have regional or local correlation potential.

Sampling of a longer stratigraphic interval spanning the GSSP in more favourable lithologies might improve the potential of the palynological succession for correlation.

A forthcoming publication will describe in more detail the Dal'ny Tulkas (Stephenson, 2007) and Usolka assemblages.

Acknowledgement

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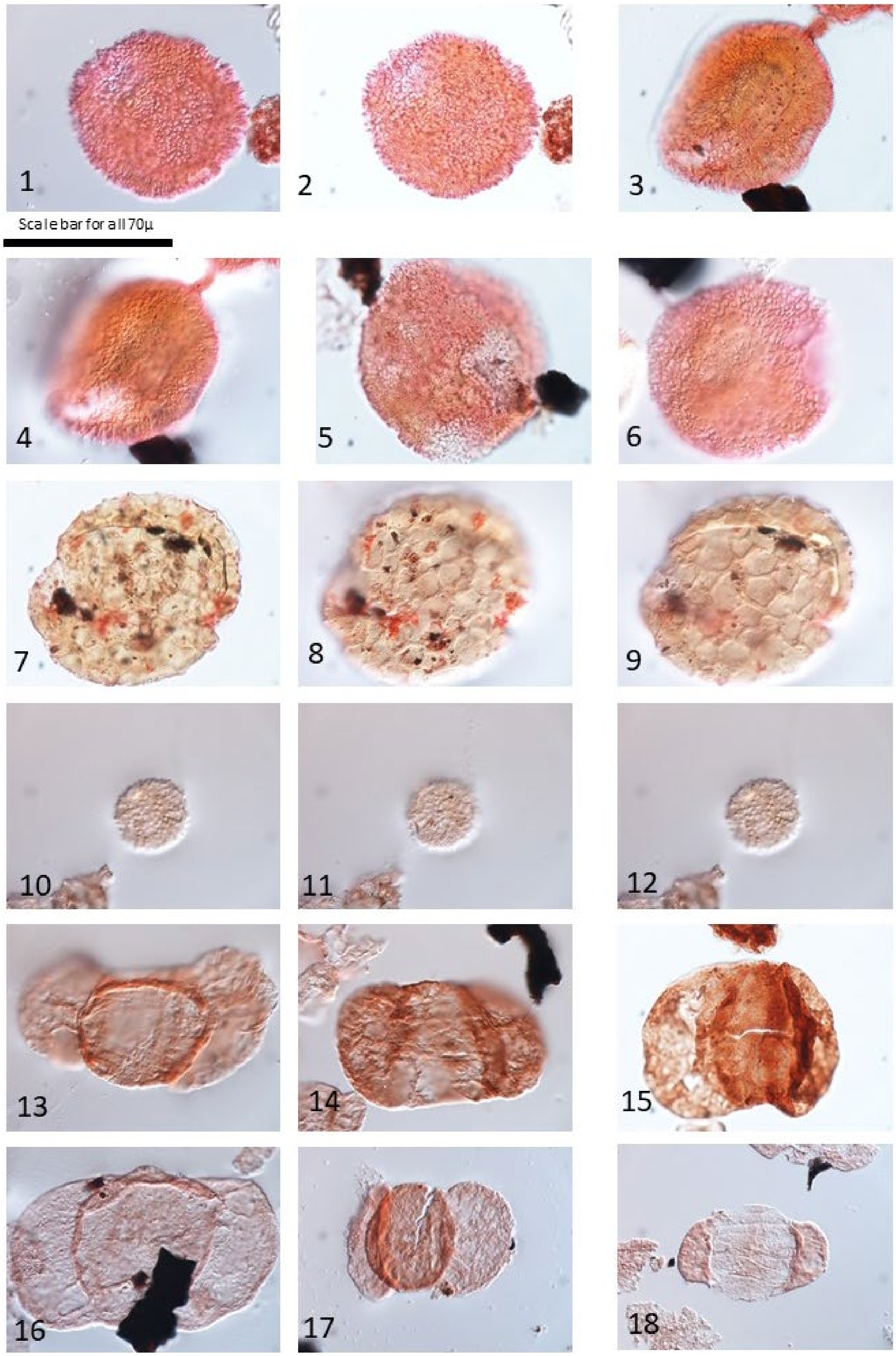

Plate 1. Palynomorphs from the Usolka section. Slides are held in the collection of the BGS, Keyworth, Nottingham, NG12 5GG, UK. Locations of specimens are given first by England Finder code, then by BGS collections numbers (MPA). The scale bar represents approx. 70 microns. 1, 2. Algal palynomorph sp. 1, L39/1, 56674. 3, 4, Algal palynomorph sp. 1 C39, 56674. 5, Algal palynomorph sp. 1, D48/2, 56674. 6, Algal palynomorph sp. 1, D53/1, 56674. 7-9, *Azonaletes* cf. *compactus*, C52/3, 56678. 10-12, ?*Apiculatisporis* sp. 1, C52/3, 56682. 13, *Striatopodocarpites* sp. C45/3, 56682. 14, *Protohaploxypinus amplus*, G54, 56682. 15, *Limitisporites monstruosus*, R51, 56682. 16, ?*Pteruchipollenites* sp. A54/4, 56679. 17, *Platysaccus* sp. D47/3, 56679. 18, *Vittatina subsaccata*, M59/4, 56679.

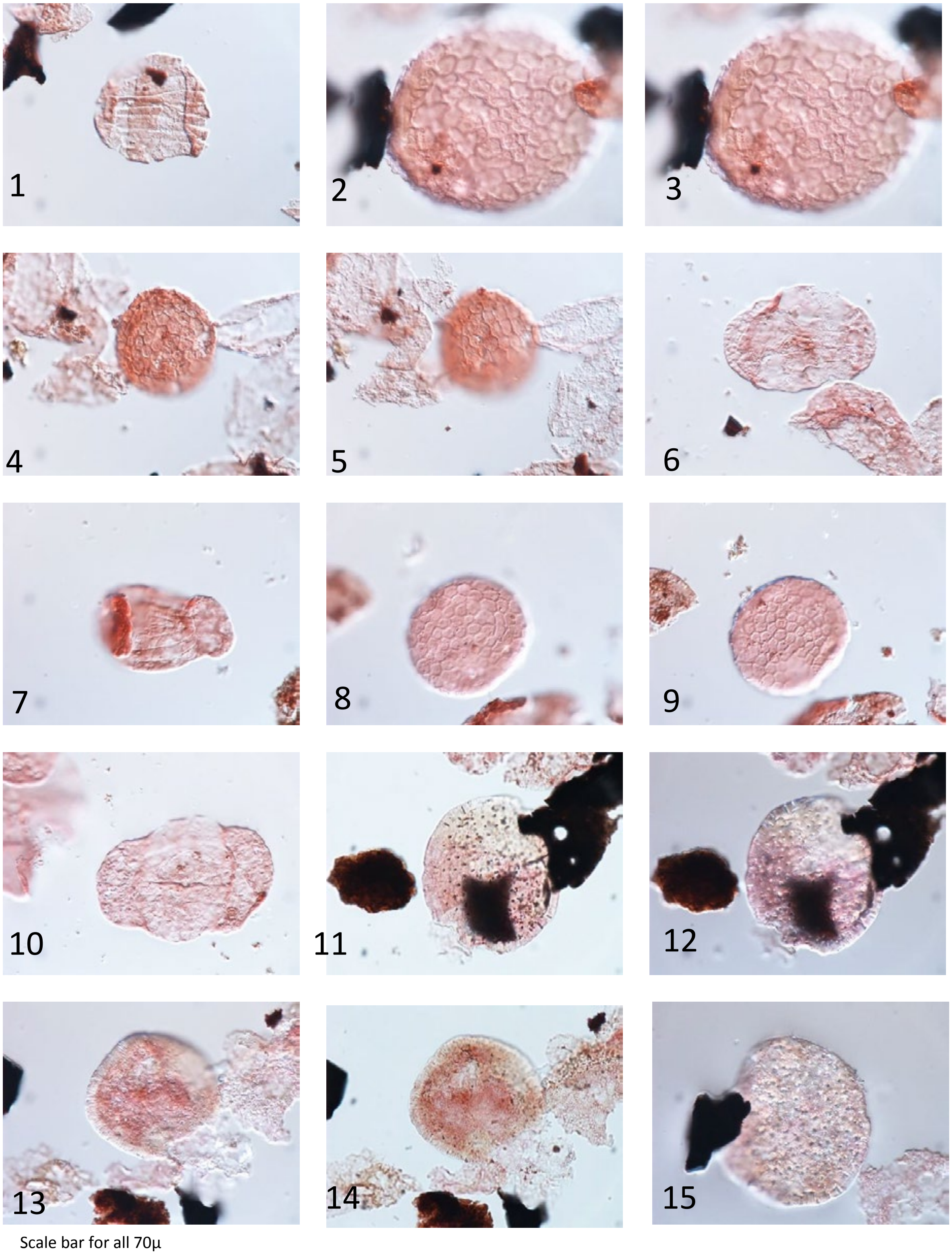

Plate 2. Palynomorphs from the Usolka section. Slides are held in the collection of the BGS, Keyworth, Nottingham, NG12 5GG, UK. Locations of specimens are given first by England Finder code, then by BGS collections numbers (MPA). The scale bar represents approx. 70 microns. 1, *Vittatina costabilis*, M55/3, 56679. 2, 3, *Azonaletes* cf. *compactus*, M48/3, 56679. 4, 5, *Azonaletes* cf. *compactus*, P45/4, 56671. 6, *Protohaploxypinus* sp., D65, 56671. 7, *Vittatina subsaccata*, J48, 56671. 8, 9, *Azonaletes* cf. *compactus*, N52/1, 56671. 10, *Protohaploxypinus limpidus*, F51/1, 56671. 11, 12, Algal palynomorph sp. 2, J46/3, 56670. 13, 14, Algal palynomorph sp. 2, J46, 56670. 15, Algal palynomorph sp. 2, V49/4.

Stage	Collector's Sample No.	BGS slide number	Position in bed	Palynological summary
Sakmarian	14	56674	?Upper part of Bed 27/2	Organic residue contains only ?algal bodies characterised by a complex tight reticulum or tectum. No terrestrial palynomorphs recorded
	13	56667	Lower part of Bed 27/2	Organic residue is dominated by ?algal bodies characterised by a complex tight reticulum or tectum. *Vittatina* spp., indeterminate bisaccate pollen, *Hamiapollenites fusiformis* , *Limitisporites* spp.. ?*Retusotriletes* and *Pteruchipollenites* spp. also present
Asselian	9	56683	Upper part of Bed 26/2	Organic residue is dominated by ?algal bodies characterised by a complex tight reticulum or tectum. Rare indeterminate bisaccate pollen also present
	8	56677	Centre of Bed 26/2	Organic residue is dominated by poorly preserved ?algal bodies. No terrestrial palynomorphs recorded.
	11	56685	Close to the base of Bed 26/1	Sparse organic residue containing poorly preserved ?algal bodies. No terrestrial palynomorphs recorded.
	7	56680	Bed 25/4	Organic residue is dominated by poorly preserved ?algal bodies. No terrestrial palynomorphs recorded.
	6	56675	Lower part of Bed 25/3	Organic residue is dominated by poorly preserved ?algal bodies. No terrestrial palynomorphs recorded.
	10	56678	Close to the base of Bed 23	Organic residue is dominated by poorly preserved ?algal bodies and equant black fragments. Rare coarsely reticulate *Azonaletes* cf. *compactus* present. No terrestrial palynomorphs recorded.
	5	56676	Upper part of Bed 21	Organic residue is dominated by poorly preserved ?algal bodies and equant black fragments. No terrestrial palynomorphs recorded.
	4	56670	Middle of Bed 21	Organic residue is dominated by poorly preserved ?algal bodies. Most specimens poorly preserved but some display thick punctate walls similar to thse of *Tasmanites* spp. No terrestrial palynomorphs recorded.
	2	56669	Upper part of Bed 19	Organic residue is dominated by poorly preserved ?algal bodies. No terrestrial palynomorphs recorded
	12	56671	Middle of Bed 19	Organic residue is dominated by poorly preserved ?algal bodies, pollen and spores. Pollen includes common indeterminate bisaccate pollen, taeniate bisaccate pollen, monosaccate pollen. Main taxa are *Vittatina* spp., *Pteruchipollenites indarraensis* , *Protohaploxypinus* spp., *Hamiapollenites fusiformis* and *Platysaccus* spp.
	3	56679	Lower part of Bed 19	Organic residue is dominated by poorly preserved pollen and spores. Pollen includes common indeterminate bisaccate pollen, taeniate bisaccate pollen, monosaccate pollen. Main taxa are *Vittatina* app., *Florinites* spp., *Pteruchipollenites indarraensis* , *Limitisporites monstruosus* , *Limitisporites* spp., *Protohaploxypinus* spp., *Platysaccus* spp. and *Vesicaspora* spp.
	1	56682	Upper part of Bed 18	Organic residue is dominated by poorly preserved ?algal bodies, *Leiosphaeridia* spp., and pollen and spores. Pollen includes common indeterminate bisaccate pollen, taeniate bisaccate pollen, monosaccate pollen. Main taxa are *Vittatina* app., *Florinites* spp., *Pteruchipollenites indarraensis* , *Limitisporites monstruosus* , *Limitisporites* spp., *Protohaploxypinus* spp., *Striatopodocarpites* spp., *Hamiapollenites fusiformis* and *Vesicaspora* spp.

Table 1. Summary of palynological succession in the Usolka section.

References

Stephenson, M.H., 2007. Preliminary results of palynological study of the Dal'ny Tulkas section, location of the proposed basal Artinskian GSSP. Permophiles, v. 50, p. 22-25.

Stephenson, M.H., Williams, M., Leng, M.J. & Monaghan, A., 2004. Aquatic plant microfossils of probable non-vascular origin from the Ballagan Formation (Lower Carboniferous), Midland Valley, Scotland. Proceedings of the Yorkshire Geological Society, v. 55, p. 145-158.

Wood, G.D., Gabriel, A.M. and Lawson, J.C.. 1996. Palynological techniques – processing and microscopy. In Jansonius, J. and McGregor, D.C. eds. Palynology: Principles and Applications. American Association of Stratigraphical Palynologists Foundation v. 1, p. 29-50.

Identification and age of the beginning of the Permian-Triassic Illawara Superchron

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Introduction

Permian magnetic polarity history has long been thought to consist of a lengthy interval of reversed polarity (Kiama Superchron) that lasted from the Pennsylvanian through the early part of the middle Permian (more than 50 million years), followed by an interval of mixed polarity (Illawara Superchron) of middle-late Permian age that continues into the Triassic. The beginning of the Illawara Superchron has long provided an important datum by which to correlate middle Permian strata, especially those of nonmarine origin. However, the age assigned to the beginning of the Illawara Superchron has changed during the last two decades (Fig. 1). And, we now know of short, normal chrons within the Kiaman Superchron, the youngest of which is Roadian and thus very close to the currently accepted age of the beginning of the Illawara Superchron. We thus need to clarify our definition of what is the beginning of the Illawara Superchron, and what is its age, so that it can continue to serve as a datum for correlation.

Illawara Identified and Assigned a Tatarian age

Irving and Parry (1963), in a very early study of the magnetism of Permian igneous rocks in the Sydney basin of Australia, identified two normal polarity events separated by a relatively long interval of reversed polarity. They termed these the Carboniferous Paterson reversal (normal) and the Permian Illawara reversal (normal), with the intervening Kiaman magnetic division (reversed). Irving and Parry (1963, p. 410) very presciently noted that "the possible correlation of the Illawara Reversal…is a point of potential importance for intercontinental correlation." However, Irving (1971) later withdrew the name Kiaman, proposing to call it the "late Palaeozoic reversed interval," and Irving and Pulliah (1976) replaced the term Kiaman with "Permo-Carboniferous reversed quiet [reversed] interval" or "polarity superchron" (PCRS).

The precise age of the "type locality" of the "Illawara reversal" (beginning of the Illawara Superchron) is not known because the rocks in the Sydney basin upon which it was based do not yield precise ages, numerical or biostratigraphic. Irving and Parry (1963) and Irving (1971) placed the age of the beginning of the Illawara Superchron within the "Tatarian," based on early studies of the paleomagnetic history of the Russian Permian section. However, despite this, Harland et al. (1982, 1990) considered the beginning of the Illawara Superchron to be at the Permo-Triassic boundary.

In Russia, extensive studies of paleomagnetism of the younger part of the Permian section (e.g., see reviews by Khramov and Rodionov, 1987 and Lozovsky,1992; and more recent work by Gialanella et al., 1997 and Taylor et al., 2009) have long identified the beginning of the Illawara Superchron in the lower part of the Tatarian, in the regional Urzhumian substage (now referred to as the Urzhumian Stage of the Biaraman Series). The problem is that the Urzhumian strata are nonmarine, so their correlation to the standard global chronostratigraphic scale has long been imprecise and debatable, though they have generally been considered equivalent to part or all of the Wordian (Fig. 1).

Early Capitanian Age for the Beginning of the Illawara Superchron

Peterson and Nairn (1971 reported magnetic polarity data from Permian strata in New Mexico, Oklahoma and Texas, USA. However, this was not a magnetostratigraphic study, but instead a paleopole study, so they only sampled single sites or short stratigraphic intervals sporadically through the thick Permian succession. Thus, the data of Peterson and Nairn (1971) only provided "snapshots" of the polarity pattern. The important result was that the stratigraphically lowest interval of normal polarity in the Permian strata they studied is in the Yates Formation of the Artesia Group in New Mexico. The Yates Formation is part of the backreef shelf that developed behind the great Capitan reef (e. g., Hill, 1986). Thus, Peterson and Nairn (1971) not only provided the first (though not precise) evidence of the beginning of the Illawara Superchron in marine strata, but they identified it in strata of Capitanian age.

At Nammal Gorge in the Salt Range of Pakistan, Haag and Heller (1991) identified Illawara in strata of late Murgabian age, in the conodont zone of *Mesogondolella praedivergens*, which is late Wordian- earlyCapitanian (Henderson, 2016). Embleton et al. (1996) identified the beginning of the Illawara Superchron in the lowermost part of the upper Shihezi Formation in Shanxi, China, nonmarine strata that they judged to be Ufimian in age. However, Menning and Jin (1998) explained why the Shihezi Formation is likely younger, of Capitanian age (also see Lucas, 2017).

In an abstract, Menning (2000) briefly summarized (but never fully documented) limited magnetostratigraphic data from West Texas by which he placed the beginning of the Illawara Superchron just below the Pinery Limestone Member of the Bell Canyon Formation, just above a tuff with a numerical age of ~ 265 Ma (Bowring et al., 1998). Menning (2001)

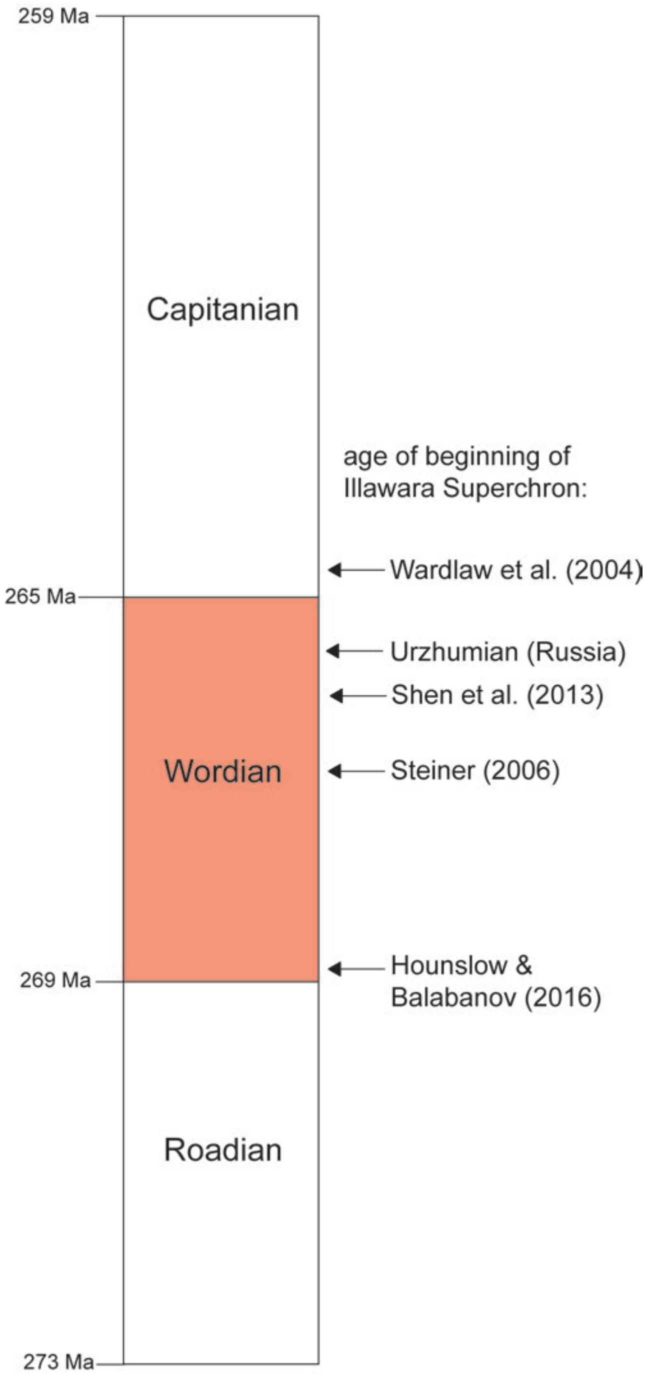

Fig. 1. Some of the different ages assigned to the beginning of the Illawara Superchron.

reviewed previous age estimates of Illawara, which ranged from Kungurian to Tatarian, to conclude it is lower Tatarian, noting that older age assignments were largely based on questionable palynostratigraphic correlations. Thus, for example, Menning and Jin (1998) rejected palynostratigraphic correlations of the type Illawara level to the Russian Ufimian by Théveniaut et al. (1994) as based on provincialized biostratigraphy incapable of supporting such a correlation.

In GTS 2004, Wardlaw et al. (2004) placed the age of Illawara near the base of the Capitanian (just younger than ~ 265 Ma: Fig. 1) near the top of the *Jinogondolella serrata* conodont zone in West Texas and near the top of the *Mesogondolella praedivergens* conodont zone in the Pakistani Salt Range. They cited as primary sources Haag and Heller (1991), Gialanella et al. (1997) and Menning (2000). However, in evident contradiction, Wardlaw et al. (2004, fig. 16.2) equated the Urzhumian to the late Wordian.

Wordian Age for the Beginning of the Illawara Superchron

Steiner (2006), in a very influential paper, identified a normal polarity interval of Wordian age (her "Word N") as the beginning of the Illawara Superchron. She based this on magnetostratigraphic data from the Grayburg Formation of West Texas, the Goose Egg Formation in Wyoming and the Transcausasian section in Russia, which suggests late Murgabian age for the beginning of the Illawara Superchron (Kotlyar et al., 1984). Other than their summary presentation in Steiner (2006, fig. 2), the West Texas and Wyoming magnetostratigraphic data have never been published. Despite this, wide acceptance of Steiner's (2006) positioning of the beginning of Illawara Superchron in the Wordian followed (one of the few exceptions is Isozaki, 2009). Thus, although Henderson et al. (2012) repeated much of the content of Wardlaw et al. (2004), they followed Steiner (2006) in placing the "Illawara geomagnetic polarity reversal" in the Wordian at the normal polarity chron Word N of Steiner.

In the Delaware basin of West Texas-New Mexico, the Grayburg Formation overlies the upper San Andres Formation and is correlative to the middle Cherry Canyon Formation above the Cherry Canyon Sandstone Tongue. These strata (including the lower Grayburg) contain Wordian fusulinids of the zone of *Parafususlina lineata-deliciasensis* of Wilde (1990), which are of middle-upper Wordian age in the traditional sense (Wilde and Todd, 1968). In conodont terms, the Cherry Canyon and equivalent strata of the Grayburg Formation are early Wordian, in the *Jinogondolella aserrata* conodont zone (Lambert et al., 2007). Thus, if the beginning of the Illawara Superchron is recorded in the Grayburg Formation, this datum is Wordian in age, early or middle Wordian, depending on how the biostratigraphy is interpreted. Steiner (2006) showed the datum as middle Wordian, but according to Hounslow and Balabanov (2016), it is early Wordian, ~ 267 Ma.

Even less straightforward is correlation of the Goose Egg Formation magnetostratigraphy of Steiner (2006). She identified a normal polarity chron in the Glendo Member as the beginning of the Illawara Superchron. The Glendo Member is siliciclastic red beds bracketed by marine units of debatable or uncertain ages (see discussion in Steiner, 2006). Thus, identification of the beginning of Illawara in the Glendo Member not only is based on unpublished magnetostratigraphic data but also brings no biostratigraphic clarity to the age of this datum.

Even though Steiner's (2006) assignment of a Wordian age to the beginning of the Illawara Superchron was supported by few data, some later studies appear to confirm the age assignment. Thus, Kirschvink et al. (2015) determined the magnetic polarity of middle-late Permian limestones deposited on a seamount that is now preserved in an accretion complex in Kyushu, Japan. They identify the beginning of the Illawara Superchron in the middle Wordian in the upper part of the fusulinid zone of *Neoschwagerina craticulifera* (cf. Ota and Isozaki, 2006; Kasuya et al., 2012). In Kansas, USA, Illawara appears to begin in the Wordian Whitehorse Formation (Soreghan et al., 2015), though a precise age within the Wordian cannot be determined in the core studied. Thus, Wordian is the currently accepted age of the beginning of the Illawara Superchron (e.g., Shen et al., 2013; Lucas and Shen, 2016), though the precise position within the Wordian has varied among different workers (Fig. 1).

Roadian Normal Chron(s)

Hounslow and Balabanov (2016) recently presented a comprehensive review of Permian magnetostratigraphy. They note that within the reverse polarity Kiaman Superchron, long considered to have no normal polarity magnetochrons, there appear to be three normal magnetochrons during the early Permian--during the early Asselian, late Artinskian and mid Kungurian. There is also a weakly supported short normal chron in some Roadian strata. Indeed, without a clear idea of the age of the original Illawara Superchron, it could be Roadian, as suggested by Lanci et al. (2013; but see discussion by Hounslow and Balabanov, 2016 and Lucas, 2017)

Terminology and Age of the Beginning of the Illawara Superchron

As is clear from the above, various terms have been used to refer to the long intervals of reversed and mixed magnetic polarity of Permian time. Like Hounslow and Balabanov (2016), among others, I prefer the simple terms Kiaman Superchron and Illawara Superchron to refer to these polarity bias superchrons. The beginning of the Illawara Superchron or the Kiama-Illawara (KI) boundary are also usages I advocate. Given that we may never know the precise age of the Sydney basin strata in which the Kiaman and Illawara superchrons were first identified, there might be reason to abandon the names and use others. However, the names Kiaman and Illawara have been in the literature for more than half a century, are widely used and are well understood concepts, so I advocate continuing to use these names.

The real problem that remains is what age is the beginning of the Illawara Superchron and how do we know that? Different ages in the Capitanian and the Wordian have been assigned to the beginning of the Illawara Superchron since its recognition in the 1960s (Fig. 1). Here are the issues:

1. The precise age of the “type” Illawara in the Sydney basin has not been determined and may be undeterminable.
2. Extensive data from the Russian section identify the beginning of the Illawara Superchron as a lower Tatarian (Urzhumian) event, which may be Wordian.
3. Marine sections provide some documentation of the beginning of the Illawara Superchron in the Wordian, though exact placement within the Wordian varies.
4. There may be at least one short normal in Roadian time, and why shouldn’t this be called Illawara?

The time has come to fix the beginning of Illawara by agreeing on what normal polarity chron in which section should be used to define it. This should be a marine section with direct biostratigraphic age control, and one of the few sections that meets these criteria is the Japanese section described by Kirschvink et al. (2015).

Clearly, many of the magnetostratigraphic and/or biostratigraphic data that have been used to identify and assign an age to the beginning of the Illawara Superchron are problematic. Furthermore, there are evident inconsistencies and contradictions in the perceived age of the beginning of the Illawara Superchron in different sections. Only if we agree to fix the beginning of the Illawara Superchron in a well-dated section with fully documented magnetostratigraphy can it continue to be used as a datum in Permian correlations.

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References

Bowring, S.A., Erwin, D.H., Jin, Y.G., Martin, M.W., Davidek, K. and Wang, W., 1998. U/Pb zircon geochronology and tempo of the end-Permian mass extinction. Science, v. 280, p. 1039-1045.

Embleton, B.J.J., McElhinny, M.W., Zhang, Z. and Li, Z. X., 1996. Permo-Triassic magnetostratigraphy in China: The type section near Taiyuan, Shanxi Province, north China. Geophysical Journal International, v. 126, p. 382-388.

Gialanella, P.R., Heller, F., Haag, M., Nurgaliev, D., Borisov, A., Burov, B., Jasonov, P., Khosanov, D., Ibragimov, S. and Zharkov, I., 1997. Late Permian magnetostratigraphy on the eastern Russian platform. Geologie en Mijnbouw, v. 76, p. 145-154.

Haag, M. and Heller, F., 1991. Late Permian to Early Triassic magnetostratigraphy. Earth and Planetary Science Letters, v. 107, p. 42-54.

Harland, W.B., Cox, A.V., Llewellyn, P.G., Pickton, C.A.G., Smith, A.G. and Walters, R., 1982. A Geologic Time Scale. Cambridge University Press, Cambridge, 131 p.

Harland, W.B., Armstrong, R.L., Cox, A.V., Craig, L.E., Smith, A.G. and Smith, D.G., 1990. A Geologic Time Scale 1989. Cambridge University Press, Cambridge, 262 p.

Henderson, C.M., 2016. Permian conodont biostratigraphy. In Lucas, S.G. and Shen, S.Z., eds. The Permian timescale. Geological Society, London, Special Publications 450, https://doi.org/10.1144/SP450.9.

Henderson, C.M., Davydov, V.I. and Wardlaw, B.R., 2012. The Permian Period. In Gradstein, F.M., Ogg, J.G., Schmitz, M.D. & Ogg, G.M. eds. The geologic time scale 2012. Volume 2. Amsterdam, Elsevier, p. 653-679.

Hill, C., 1996. Geology of the Delaware basin Guadalupe, Apache and Glass Mountains New Mexico and West Texas. Permian Basin Section-SEPM, Publication no. 96-39, 480 p.

Hounslow, M.W. and Balabanov, Y.P., 2016. A geomagnetic polarity timescale for the Permian, calibrated to stage boundaries. In Lucas, S.G. and Shen, S.Z., eds. The Permian timescale. Geological Society, London, Special Publications, v. 450, https://doi.org/10.1144/SP450.8.

Irving, E., 1971. Nomenclature in magnetic stratigraphy. Geophysical Journal of the Royal Astronomical Society, v. 24, p. 529-531.

Irving, E. and Parry, L.G., 1963. The magnetism of some Permian rocks from New South Wales. Geophysical Journal of the Royal Astronomical Society, v. 7, p. 395-411.

Irving, E. and Pulliah, G., 1976. Reversals of the geomagnetic field, magnetostratigraphy, and the relative magnitude of paleosecular variation in the Phanerozoic. Earth Science Reviews, v. 12, p. 35-64.

Isozaki, Y., 2009. Illawara reversal: The fingerprint of a superplume that triggered Pangean breakup and the end-Guadalupian (Permian) mass extinction. Gondwana Research, v. 15, p. 421-432.

Kasuya, A., Isozaki, Y. and Igo, H., 2012. Constraining paleo-latitude of a biogeographic boundary in mid-Panthalassa: Fusuline province shift on the late Guadalupian (Permian) migrating seamount. Gondwana Research, v. 21, p. 611-623.

Khramov, A.N. and Rodionov, V.P., 1987. The geomagnetic field during Palaeozoic time. In McElhinny, M. W., Khramov, A.N., Ozima, M. and Valencio, D.A., eds. Global reconstruction and the geomagnetic field during the Palaeozoic: Advances in Earth and Planetary Sciences, v. 10, p. 99-115.

Kirschvink, J.L., Isozaki, Y., Shibuya, H., Otofuji, Y., Raub, T.D., Hilburn, I.A., Kasuya, T., Yokoyama, M. and Bonafacie, M., 2015. Challenging the sensitivity limits of paleomagnetism: Magnetostratigraphy of weakly magnetized Guadalupian-Lopingian (Permian) limestone from Kyushu, Japan. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 418, p. 75-89.

Kotlyar, G.V., Komissarova, R.A., Khramov, A.N. and Chediya, I.O., 1984. Paleomagneitaya kharakhteristika verkhnepermakikh otlozheniy iz Zakavkazya [Paleomagnetic characteristics of upper Permian outcrops of Transcaucasia]. Doklady Akademii Nauk SSSR, v. 2756, p. 669-674.

Lambert, L.L., Wardlaw, B.R. and Henderson, C.A., 2007. *Mesogondolella* and *Jinogondolella* (Conodonta): Multielement definition of the taxa that bracket the basal Guadalupian (middle Permian Series) GSSP. Palaeoworld, v. 16, p. 208-221.

Lanci, L., Tohver, E., Wilson, A. and Flint, S., 2013. Upper Permian magnetic stratigraphy of the lower Beaufort Group, Karoo basin. Earth and Planetary Science Letters, v. 375, p. 123-134.

Lozovsky, V.R., 1992. The Permian-Triassic boundary in continental series of Laurasia and its correlation with the marine scale. International Geology Review, v. 34, p. 1008-1014.

Lucas, S.G., 2017. Permian tetrapod biochronology, correlation and evolutionary events. In Lucas, S.G. and Shen, S.Z., eds. The Permian timescale. Geological Society, London, Special Publications 450, https://doi.org/10.1144/SP450.12.

Lucas, S.G. and Shen, S.Z., 2016. The Permian chronostratigraphic scale: history, status and prospectus. In Lucas, S.G. and Shen, S.Z., eds. The Permian timescale. Geological Society, London, Special Publications 450, https://doi.org/10.1144/SP450.3.

Menning, M., 2000 Magnetostratigraphic results from the middle Permian type section, Guadalupe Mountains, West Texas. Permophiles, v. 37, p. 16.

Menning, M., 2001. The Permian Illawara reversal in SE-Australia as global correlation marker versus K-Ar ages and palynological correlation. Contributions to Geology and Palaeontology of Gondwana in Honour of Helmut Wopfner, Cologne, p. 325-332.

Menning, M. and Jin, Y.G., 1998. Comment on 'Permo-Triassic magnetostratigraphy in China: The type section near Taiyuan, Shanxi Province, north China' by B. J. J. Embleton, M. W., McElhinney, X. Ma, Z. Zhang and Z. X. Li. Geophysical Journal International, v. 133, p. 213-216.

Ota, A. and Isozaki, Y., 2006. Fusuline biotic turnover across the Guadalupian-Lopingian (middle-upper Permian) boundary in mid-oceanic carbonate buildups: Biostratigraphy of accreted limestone in Japan. Journal of Asian Earth Sciences, v. 26, p. 353-368.

Peterson, D.N. and Nairn, A.E.M., 1971. Palaeomagnetism of Permian redbeds from the south-western United States. Geophysical Journal of the Royal Astronomical Society, v. 23, p. 191-205.

Shen, S., Schneider, J.W., Angiolini, L. and Henderson, C.M., 2013. The international Permian timescale: March 2013 update. New Mexico Museum of Natural History and Science Bulletin, v. 60, p. 286-311.

Soreghan, G.S., Benison, K.C., Foster, T. M., Zambito, J. and Soreghan, M.J., 2015. The paleoclimatic and geochronologic utility of coring red beds and evaporates: A case study from the RKB core (Permian, Kansas, USA). International Journal of Earth Science, v. 104, p. 1589-1603.

Steiner, M. B. 2006. The magnetic polarity timescale across the Permian-Triassic boundary. In: Lucas, S.G., Cassinis, G. and Schneider, J.W., eds. Non-marine Permian biostratigraphy and biochronology. Geological Society, London, Special Publications, v. 265, p. 15-38.

Taylor, G.K., Tucker, C., Twitchett, R.J., Kearsey, T., Benton, M.J., Newell, A.J., Surkov, M.V. and Tverdokhlebvov, V.P., 2009. Magnetostratigraphy of Permian/Triassic boundary sequences in the Cis-Urals, Russia: No evidence for a major temporal hiatus. Earth and Planetary Science Letters, v. 281, p. 36-47.

Théveniaut, H., Klootwijk, C., Foster, C. and Giddings, J., 1994. Magnetostratigraphy of the late Permian coal measures, Sydney and Gunnedah basins: A regional and global correlation tool: 28th Newcastle Symposium on 'Advances in the Study of the Sydney Basin', p. 11-23.

Wardlaw, B.R., Davydov, V. and Gradstein, F.M., 2004. The Permian Period. In Gradstein, F. M., Ogg, J.G. and Smith, A.G., eds. A geologic time scale 2004. Cambridge University Press, p. 249-270.

Wilde, G.L., 1990. Practical fusulinid zonation: The species concept; with Permian basin emphasis. West Texas Geological Society Bulletin, v. 29, p. 5-15, 28-34 [Reprinted in West Texas Geological Society Bulletin, v. 44, p. 5-23].

Wilde, G.L. and Todd, R.G., 1968. Guadalupian biostratigraphic relationships and sediments in the Apache Mountain region, West Texas. Permian Basin Section SEPM Publication, v. 68-11, p. 10-31.

Assessing ocean acidification and carbon cycle perturbations during the end-Permian extinction using boron isotopes

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The Permian-Triassic mass extinction represents the most severe environmental crisis in Earth's history, which dictated the course for evolution of life until today. Volcanism from Siberian traps played a significant role involving a substantial input of relatively light carbon into the atmosphere leading to a combination of global warming by ~6°C, sporadic anoxia or euxinia, and ocean acidification. However, its detailed manifestation and environmental impact is yet to be fully understood. This lack of knowledge also extends to a better quantification of emitted and sequestered carbon budgets (cf. Gutjahr et al., 2017).

In order to reconstruct potential changes in seawater chemistry during this time interval, we examined the boron isotope composition ($\delta^{11}B$) of brachiopod shells. Although rarely applied to Paleozoic settings such as the Permian-Triassic (Clarkson et al., 2015), the $\delta^{11}B$ of marine calcium carbonate is considered one of the most reliable paleo-pH proxies (e.g., Foster, 2008; Hönisch et al., 2012). The principle of the $\delta^{11}B$ proxy is based on the speciation of boron in seawater, where it is present as boric acid $[B(OH)_3^-]$ and borate ion $[B(OH)_4^-]$, and their relative proportion is pH dependant. Furthermore, because an isotopic fractionation exists between the two species, and principally borate ion is incorporated into the crystal lattice, the $\delta^{11}B$ composition of biogenic calcium carbonate can be used to reconstruct ancient seawater pH.

Brachiopods present a rich, and largely underutilised archive for Phanerozoic reconstructions considering their high abundance in the geological record that can be traced back to the early Cambrian. Moreover, their shell made of low-magnesium calcite makes these marine calcifiers more resilient to post-depositional diagenetic alterations of primary chemical signals. We performed $\delta^{11}B$ analyses (together with B/Ca and other major and trace element–to–Ca ratios as additional controls on preservation and environmental conditions) on carefully chosen pristine specimens (class Rhynchonellata and Strophomenata) from Val Brutta, Sass de Putia and Tesero sections in northern Italy. These sections cover the negative $\delta^{13}C$ excursion in excess of 4‰ (Brand et al., 2012) and are associated with major climate and environmental perturbations that led to the mass extinction event. Using selected $\delta^{11}B$ to pH relationships and bulk seawater $\delta^{11}B$ scenarios we reconstructed a high-resolution seawater pH record for the Paleo-Tethys Ocean. Our $\delta^{11}B$ results show a significant decline in $\delta^{11}B$ succeeding the $\delta^{13}C$ excursion, suggesting a substantial drop in seawater pH at the onset of the extinction event in the Late Permian related to carbon cycle perturbations. To corroborate the extent of ocean acidification, we additionally measured several brachiopod specimens from the Shangsi section, South China (Garbelli et al., 2017). This confirms our findings from Italy, and implies that ocean acidification may have been a widespread phenomenon in the Paleo-Tethys, adversely impacting the marine life. Combining our pH record paired with $\delta^{13}C$ data with a quantitative modelling approach we aim to delineate the unfolding carbon cycle dynamics and budget involved that may have been responsible for initiating the catastrophic extinction.

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References

Brand, U., Posenato, R., Came, R., Affek, H., Angiolini, L., Azmy, K. and Farabegoli, E., 2012. The end-Permian mass extinction: A rapid volcanic CO_2 and CH_4-climatic catastrophe. Chemical Geology, v. 323, p. 121–144, doi:10.1016/j.chemgeo.2012.06.015.

Clarkson, M.O., Kasemann, S.A., Wood, R.A., Lenton, T.M., Daines, S.J., Richoz, S., Ohnemueller, F., Meixner, A., Poulton, S.W. and Tipper, E.T., 2015. Ocean acidification and the Permo-Triassic mass extinction. Science. v. 348, p. 229–232, doi: 10.1126/science.aaa0193.

Foster, G.L., 2008. Seawater pH, pCO_2 and $[CO_3^{2-}]$ variations in the Caribbean Sea over the last 130 kyr: A boron isotope and B/Ca study of planktic foraminifera. Earth and Planetary Science Letters, v. 271, p. 254–266. doi: 10.1016/j.epsl.2008.04.015.

Garbelli, C., Angiolini, L., and Shen, S.-Z., 2017. Biomineralisation and global change: A new perspective for understanding the end-Permian extinction. Geology, v. 45, p. 19–22, doi: 10.1130/G38430.1.

Gutjahr, M., Ridgwell, A., Sexton, P.F., Anagnostou, E., Pearson, P.N., Pälike, H., Norris, R.D., Thomas, E., and Foster, G.L., 2017. Very large release of mostly volcanic carbon during the Paleocene-Eocene Thermal Maximum. Nature, v. 548, p. 573–577, doi: 10.1038/nature23646.

Hönisch, B., Ridgwell, A., Schmidt, D., Thomas, E., Gibbs, S., Sluijs, A., Zeebe, R., Kump, L., Martindale, R.C., Greene, S.E., et al. 2012. The Geological Record of Ocean Acidification. Science, v. 335, p. 1058–1063. doi: 10.1126/science.1208277.

Report on the activities of the Late Carboniferous – Permian – Early Triassic Nonmarine-Marine Correlation Working Group for 2016 and 2017

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The report for 2016 and 2017 highlights already published results obtained from recent studies in China, Russia, Germany, Czech Republic, Italy, France, Spain, Jordan, North America, Morocco and South Africa by the different regional working groups to draw attention to these publications.

Teams of the Nanjing Institute of Geology and Palaeontology, supported by colleagues from other institutions, published important new data on the correlation of continental and transitional continental-coastal marine sequences with the mass extinction level in the marine GSSP of the PTB in Meishan, South China, based on Shen et al. (2011). Zhang et al. (2016) concluded from the disappearance of the *Gigantopteris* megaflora, from microflora data as well as from a distinct negative $\delta^{13}C_{org}$ shift the position of the continental end-Permian mass extinction in the Kayitou Formation of South China, which should be of latest Changhsingian, rather than Triassic age. Partially based on the same sections (Guanbachong and Chahe) as well as some newly investigated sections, including paralic and shallow marine sections, Chu et al. (2016) state that the Kayitou Formation is of Permian-Triassic transitional age. Most important for long-distance interregional correlation, e.g. with Russia and Europe, is the proposal to use the *Euestheria gutta*-bearing conchostracan fauna and the *Pteria ussurica variabilis-Towapteria scythica-Eumorphotis venetiana* bivalve assemblage as markers of the Permian-Triassic transitional beds in continental-marine siliciclastic settings of South China (Chu et al., 2016, 2017 in press; Scholze et al., 2016, 2017a, b). In a recently accepted manuscript, Bourquin et al. (in press) state that the Chahe and Zhejue sections as reference sections of the continental Permian – Triassic transition must be handled with caution. Both sections have been strongly affected by polyphase deformations. Therefore, palaeoenvironmental reconstructions, the interpretation of geochemical trends and correlations to the marine sections at Meishan should be reconsidered. Newly sampled conchostracans from the Kayitou and Dongchuan formations of the Longmendong, Lubei, and Zhejue sections in South China are at present being investigated by a team from Freiberg, Nanjing and Yunan universities. The expected results in combination with data from Germany, European Russia, and Siberia will contribute to the more precise identification of the PTB in continental deposits.

Members of the working group from Germany, UK and China have published a multistratigraphic approach to pinpoint the Permian-Triassic boundary in continental deposits of Central Europe (Scholze et al., 2017b). The analysed samples were obtained from both classical key sections of the continuous and undisturbed Zechstein–Lower Buntsandstein transition in the Central European Basin of Germany. In combination with conchostracan biostratigraphy, investigations of isotope-chemostratigraphy ($\delta^{13}C_{org}$, $\delta^{13}C_{carb}$, $\delta^{18}O_{carb}$), major and trace element geochemistry, magnetostratigraphy, and palynology were carried out. In conclusion it is proposed to place the Permian-Triassic boundary in the lower part of the Upper Fulda Formation of the uppermost Zechstein Group, which is biostratigraphically confirmed by the first occurrence date of the Early Triassic *Euestheria gutta-Palaeolimnadiopsis vilujensis* conchostracan fauna, palynological data and magnetostratigraphy (Fig. 1). An interesting early Triassic conchostracan fauna, discovered by a Jordan-German team at the Dead Sea, was already reported in Permophiles 62/2015 and is meanwhile published in detail (Scholze et al., 2017a). The dominat genus *Rossolimnadiopsis* was previously recorded only from two localities in the Moscow syncline in Central Russia. In addition to Jordan, the genus has been identified in India and possibly in Germany. All these occurrences seem to be restricted to a narrow stratigraphic interval ranging from the late Permian to the Early Triassic.

The South African team of A. Götz published a first basin-wide correlation of marine black shales and coal deposits of the Main Karoo Basin based on palynostratigraphy and palynofacies analysis (Götz et al., in press). A major transgressive event ("Whitehill event") during the early Guadalupian (Roadian) is documented in the peak abundance of marine phytoplankton within the Whitehill shales of the southern Karoo Basin and glauconitic silt- and sandstones of correlative coal deposits of the north-eastern basin parts.

Members of the working group supported the Kazan Summer School GeoKazan 2016, held 25-30 July at the Institute of Geology and Petroleum Technologies, Kazan Federal University, Tatarstan. Participants and presenters from 10 countries (Russia, Germany, Italy, Spain, UK, Syria, South Africa, Bolivia, Ecuador, and USA) met in Kazan to discuss and learn about the Late Palaeozoic Energy Resources of European Russia, with a focus on stratigraphy, sedimentology, geochemistry, and organic facies. Scientists of the Kazan Institute of Geology and Petroleum Technologies and international collaboration partners from Germany (Andreas Brosig, Frank Scholze), Italy (Giovanna Della Porta), UK (Annette E. Götz) and the USA (Vladimir I. Davydov) presented a broad program to a group of international MSc and PhD students covering carbonate sedimentology, basin analysis, biostratigraphy and palynofacies, 3D modelling and GIS. A one day field trip to the Permian continental type sections of the Volga-Kama region led by Vladimir Silantiev completed the extensive program.

A principle task of the Nonmarine-Marine Correlation Working Group is the presentation and discussion of recent research developments of the regional teams at biennial stratigraphic meetings. In September 2017, the one week Second Kazan Golovkinsky Stratigraphic Meeting and the Fourth All-Russian Conference "Upper Palaeozoic of Russia - Upper Palaeozoic Earth systems: high-precision biostratigraphy, geochronology and petroleum resources" was attended by 92 scientists from 8 countries (Russia, Germany, UK, China, USA, Kyrgyzstan, India, Morocco). The presentations at the Golovkinsky Meeting showed the significant progress in studying the Permian and Triassic boundaries of marine and nonmarine deposits. Two workshops addressed the challenging task of the position of the Permian and Triassic boundaries in continental sections. Another two workshops focused on the stratigraphy of the marine Carboniferous of the Volga-Ural region, in particular conodont taxonomy and biostratigraphy as well as the Carboniferous stage boundaries in Russia. The Late Carboniferous-Permian-Early Triassic Nonmarine-Marine Correlation Working Group held a business meeting focussing on the middle Permian problem, i.e. on the so far missing detailed biostratigraphy and interregional correlation of continental late early Cisuralian and Guadalupian deposits. The first promising results to tackle this problem based on conchostracan biostratigraphy of the middle and late Permian continental reference sections of the Volga and Kama river regions were presented during the Golovkinsky Meeting by Zharinova et al. (2017) (see Fig. 1).

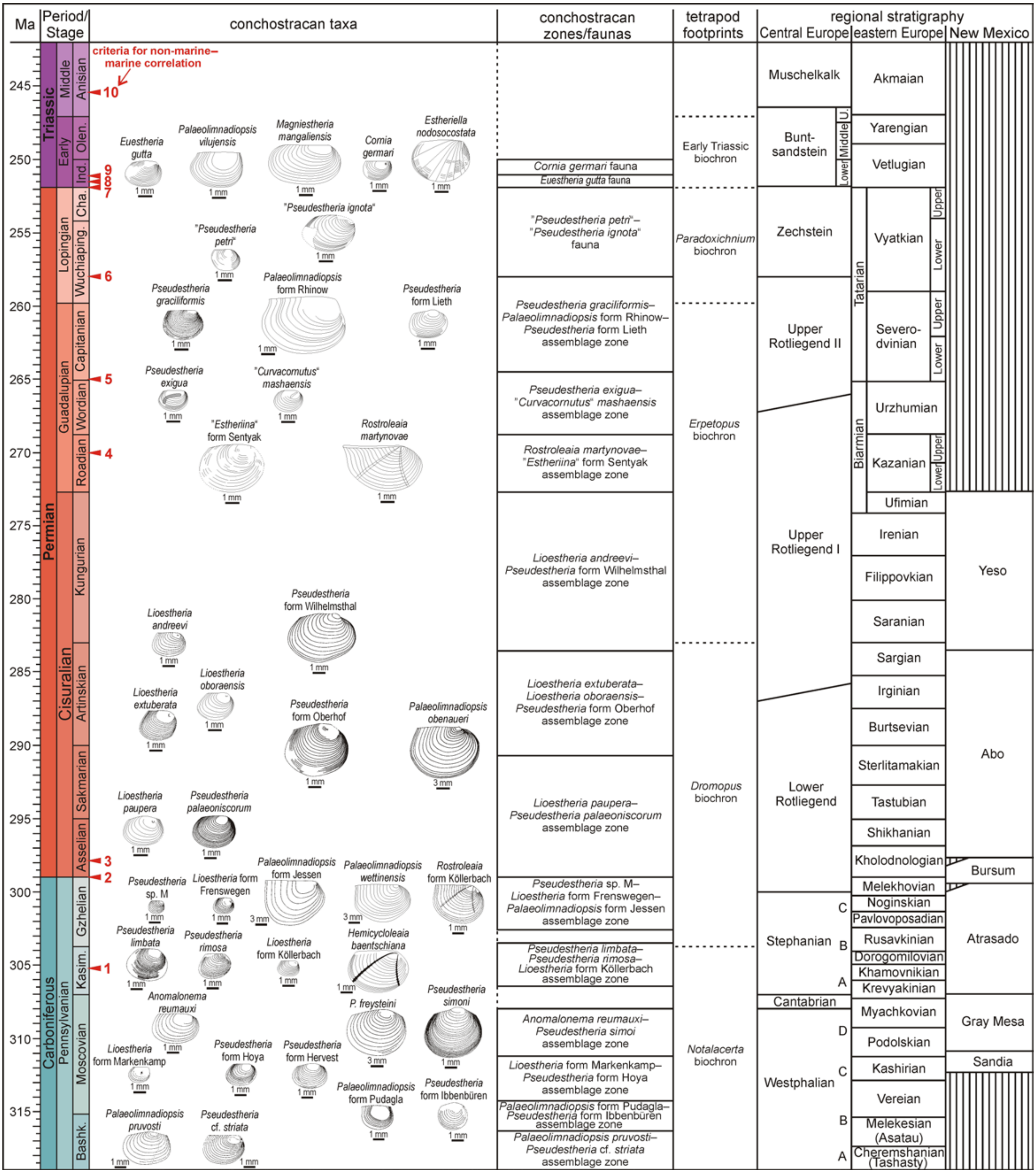

Fig. 1. Outline of a late Carboniferous (Bashkirian) to early Triassic (Induan) conchostracan biostratigraphy combined with pinpoints for non-marine–marine correlation (marked by red numbers). The ranges of the conchostracan assemblage zones are based on two or more index species (Schneider and Scholze, 2016). Instead of species designations, for some of the here shown conchostracans a open taxonomy is used. Instead of zones, the latest Permian and early Triassic intervals are preliminary defined as "faunas". Key to the non-marine–marine correlation: **(1)** co-occurrences of the insect-zone species *Syscioblatta allegheniensis* and the conodonts *Idiognathodus corrugatus* and *I. cherryvalensis*, Kinney Brick quarry, Atrasado Formation, New Mexico (Lucas et al., 2011); **(2)** 299 ± 3.2 Ma SHRIMP U-Pb age, upper Siebigerode Formation; Saale Basin, Germany (Schneider & Scholze, 2016); **(3)** correlation of the *Sysciophlebia ilfeldensis–Spiloblattina weissigensis* insect zone and the *Streptognathodus nevaensis* conodont zone, Bursum Formation, New Mexico (e.g., Lucas et al., 2013; Schneider & Scholze, 2016); **(4)** occurrences of conchostracans and the conodont *Kamagnathus khalimbadzhae* in the Sentyak section, Tatarstan, early Kazanian (Silantiev et al., 2015); **(5)** palaeomagnetic Illawarra Reversal at ~265 Ma (e.g., Menning & Bachtadse, 2012); **(6)** occurrence of the conodont *Mesogondolella britannica* in the Kupferschiefer equivalent, basal Zechstein Group (Legler & Schneider, 2008); **(7)** marine and continental early Triassic occurrences of the amphibian *Tupilakosaurus* (e.g., Nielsen, 1954; Shishkin et al., 2000; Sennikov & Golubev, 2012; Scholze et al., 2015); **(8)** occurrences *Euestheria gutta* in marine-continental sections of South China, Kayitou Formation, Early Triassic (e.g., Chu et al., 2013) or transitional latest Permian–earliest Triassic (e.g., Zhang et al., 2016); **(9)** co-occurrence of the conchostracan *Magniestheria mangaliensis* and marine bivalves in northern China, Sunjiagou Formation, early Triassic (Liu & He, 2000); **(10)** occurrences of the conodont *Nicoraella germanica* in the middle and upper part of the Lower Wellenkalk Horizon, Jena Formation, Lower Muschelkalk Subgroup, Bithynian, early Anisian (e.g., Kozur, 1999). The conchostracan data of Central Europe were obtained from Malzahn (1957), Martens (1983), Goretzki (2003), Schneider & Scholze (2016, and literature cited therein), and Scholze et al. (2016, 2017); preliminary middle Permian conchostracan data of the East European Platform from Novozhilov (1952), Silantiev et al. (2015), and Zharinova (2017a,b); tetrapod footprint ichnostratigraphy from Voigt & Lucas (2016); regional stratigraphic subdivisions for Central Europe, eastern Europe, and New Mexico from Schneider et al. (2014) and Schneider & Scholze (2016).

The activities of the Czech team focused on re-evaluation of lithostratigraphy of the Late Palaeozoic continental basins of the Bohemian Massif, a segment of the central European Variscides, which now forms the principal part of the Czech Republic (Opluštil et al., 2016a,b, 2017, a,b) . The continental basins archive rich fossil and climatic records, the full understanding of which, however, is possible only when high-resolution stratigraphy is established. So-far only biostratigraphic data were used as a chronostratigraphic tool. Therefore, numerous intercalated acid volcanic ash beds were sampled for high-precision radioisotopic dating in the framework of projects of the Grant Agency of the Czech Republic P210-11-1431 (Climatic archives recorded in the Late Palaeozoic basins of the Bohemian Massif: proxies for reconstruction of climatic changes) and P210-12-2053 (High-resolution floristic changes as a response to climatic dynamics during the Late Palaeozoic ice age recorded in the basins of the Bohemian Massif). About 18 U-Pb CA-IDTIMS high-precision ages obtained from single zircon crystals separated from volcanic ash beds and ignimbrites allowed improvement of the stratigraphy of the basins in central and western Bohemia (=central and western Czech Republic) and in the Sudetic area in the NE part of the country (Fig. 2). Although most radioisotopic data are located in the Carboniferous part of the succession, several U-Pb ages were obtained from Cisuralian strata. The data were used for constraining the ages of lithostratigraphic units in different basins and their correlation to global stages. Detailed correlation of individual basins via a dense borehole network allowed the establishment of an integrated time-calibrated lithostratigraphical model for the entire 10 000 km^2 size complex of the continental basins in both areas. In addition, radioisotopic ages allowed for calibration of some macrofloral biozones of Wagner and Álvarez-Vázquez (2010) as well as of amphibian (Werneburg and Schneider, 2006), blattoid insect (Schneider and Werneburg, 2012) and local fish biozones and, in turn, their correlation to global stages. Current research focuses on floral diversity, vegetation patterns and their changes throughout Pennsylvanian and Cisuralian time. Part of this research deals with high-resolution macrofloral biostratigraphy (Fig. 2) from the Pennsylvanian to Cisuralian in the Intra-Sudetic and the Boskovice basins (Opluštil et al., 2016a,b, 2017a,b; Martinek et al., 2017).

Fundamental new data on the correlation of the Carboniferous-Permian boundary in continental basins with the marine stratotype as well as for the numerical age calibration of non-marine biozones have been published by a French-US team (Pellenard et al., 2017). CA-ID-TIMS U–Pb ages are obtained from ashfall deposits, recorded within lacustrine to swamp deposits of the Igornay and Muse formations in the Autun Basin of the French Massif Central. The middle part of the Igornay Formation is dated at 299.9 ± 0.38 Ma, the Lally oil-shale bed is dated at 298.91 ± 0.08 Ma and the upper part of the Muse oil-shale bed is dated between 298.05 ± 0.19 and 298.57 ± 0.16 Ma. The Muse Formation is the stratum typicum of *Apateon dracyi*, a zone-species of the *Apateon dracyi - Melanerpeton sembachense* amphibian zone (Schneider and Werneburg, 2012). Additionally, *Sysciophlebia balteata,* a zone species of the insect zonation of Schneider and Werneburg (2012) probably occurs in the same formation. The isotopic ages of the Muse Formation allow for the first time the calibration of both biozonations in this level with the marine Standard Global Chronostratigraphic Scale. The applicability of the Autunian as a regional West-European stage has been long discussed because of the lack of a definition of its base (e.g. Broutin et al., 1999). The new isotopic ages in combination with future improvements to the biostratigraphic data it seems possible to propose Autunian as a reliable West European regional stage. After Pellenard et al. (2017) caution must be paid in the application of the definition of the range of the West European regional stages after Wagner and

Álvarez-Vázquez (2010): based on the new French isotopic ages of the Autunian flora it is no longer acceptable to consider the middle and late Autunian as terminal substages of the Pennsylvanian.

An astonishing amount of work has been done by an Italian-Spanish research group lead by A. Ronchi, J. López-Gómez and others within the Spanish Ministerio de Economía y Competitividad project "Continent-ocean relationship in the crisis and recovery of the ecosystems in the western margin of the Tethys during the Permian-Triassic transition". Data collection was focused on Permian to Early/Middle Triassic continental deposits of the Catalan Pyrenees in NE Spain, the Balearic Island of Majorca in eastern Spain, the island of Sardinia as well as the Dolomites region of western and northern Italy, respectively. A report on the results was already given in Permophiles 63 and published in detail in PPP (Mujal et al. 2016a, b). Vertebrate remains from red bed units of the youngest Permian strata below the 1st order P/T unconformity in the Catalan Pyrenees were ascribed to the middle Permian. The discovery of Early Triassic tetrapod tracks as well as the reconsideration of palynological data allowed dating of the overlaying Buntsandstein red-beds as Olenekian (Spathian?). Interesting in this context is the discovery of an assumed continuous Permian-Triassic red bed section at the Coll de Terres in the Catalan Pyrenees by a team of Barcelona University (Mujal et al., 2017). Uninterrupted continental P-T sections were hitherto unknown in the Mediterranean region (= peri-Tethyan domain of Southern Europe and Northern Africa in Bourquin et al., 2011). The uppermost Permian strata at Coll de Terres yield a relatively diverse ichnoassemblage dominated by tetrapod footprints and arthropod traces. *Dicynodontipus*-like tetrapod tracks are used to assign a late Permian age to the strata immediately below the Buntsandstein facies (Mujal et al., 2017).

Gaggero et al. (2017) published new isotopic ages of latest Carboniferous to early Permian volcanic rocks of the southern Variscides in Sardinia. One of them, the 295 ± 3.5 Ma U-Pb (Zr) age of the Punta Guardiola dacite in the Perdasdefogu basin, though not very precise, is in relatively good agreement with the supposed Sakmarian age (based on the temnospondyl amphibians *Melanerpeton eisfeldi*, *Apateon kontheri* and *Apateon flagrifer*: Werneburg et al., 2007) of the underlying Rio sa Luda Formation.

Significant progress has been made in tetrapod ichnostratigraphy. Based on the study of approximately 20,000 Palaeozoic tetrapod footprints from more than 120 public and private collections on five continents, Voigt and Lucas (2017) propose a subdivision of the Permian into three tetrapod footprint biochrons (comp. Fig. 1): (1) *Dromopus* – latest Carboniferous (approximately Gzhelian) to

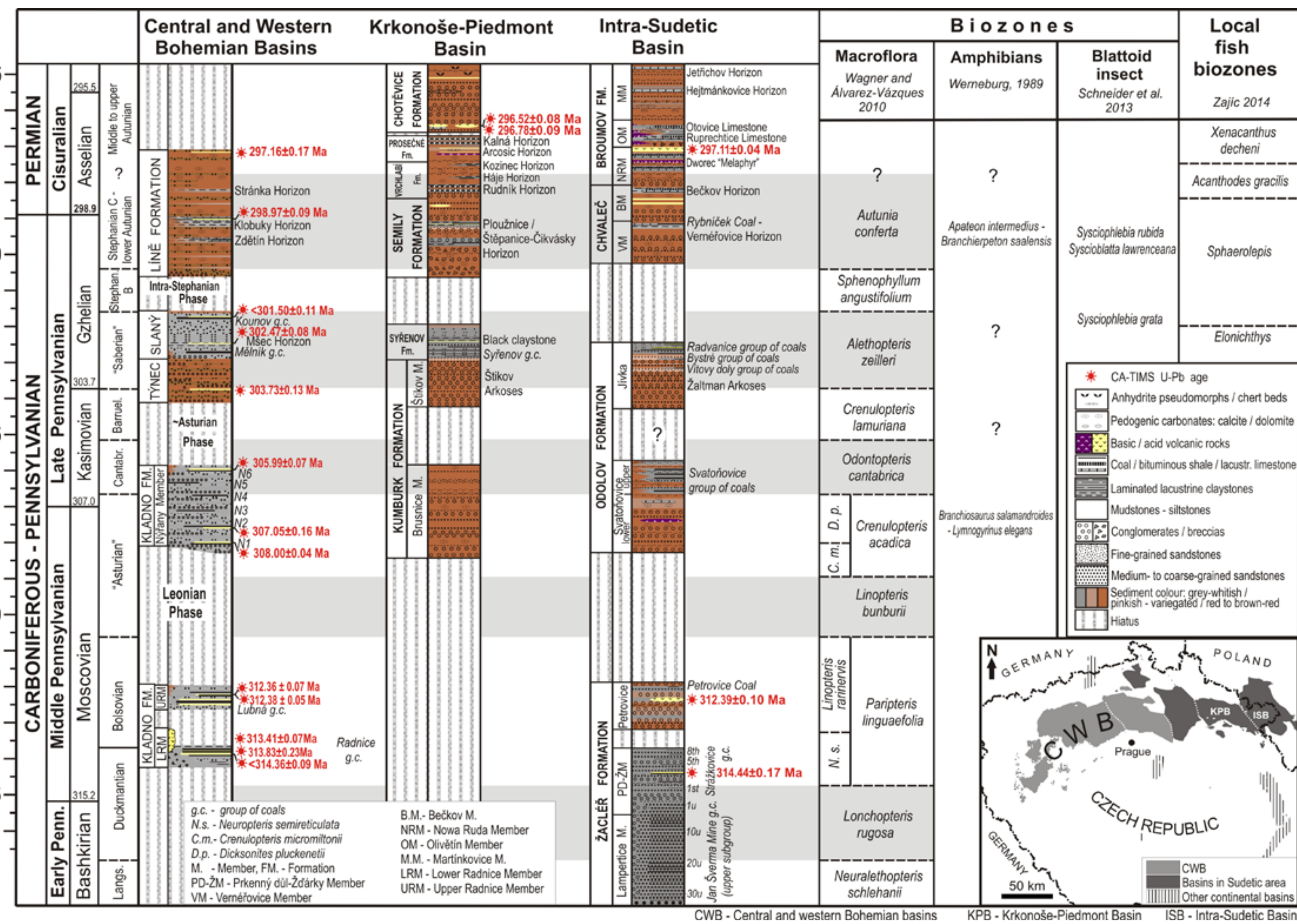

Fig. 2. Chronostratigraphic correlation of the lithostratigraphic units in the Late Palaeozoic continental basins of the Czech Republic. Based on data from Opluštil et al., 2016a, b.

late early Permian (approximately Artinskian); (2) *Erpetopus* – late early Permian (approximately Kungurian) to late middle Permian (approximately Capitanian); and (3) *Paradoxichnium* – late Permian (Wuchiapingian and Changhsingian). This conservative biochronology has potential to become refined to almost stage-level resolution by near-future comprehensive analyses, especially of Permian captorhinomorph and therapsid footprints. An international group of vertebrate ichnologists lead by Lorenzo Marchetti, Sebastian Voigt and Hendrik Klein, also focused on tetrapod ichnology at the Permian-Triassic transition exemplified by their recent comprehensive revision of the famous Val Gardena Sandstone vertebrate ichnoassemblage of the Dolomites region in northern Italy (Marchetti et al., 2017). The Val Gardena Sandstone, which interfingers with shallow marine deposits of the Bellerophon Formation, is considered to be of Lopingian age, most likely representing just part of the Wuchiapingian (Kustatscher et al., 2017). The tetrapod ichnoassemblage of the Val Gardena Sandstone includes 10 out of 12 tetrapod ichnogenera hitherto known from Lopingian deposits worldwide and thus constitutes a key for the understanding of the *Paradoxichnium* biochron.

A remarkable tetrapod ichnofossil assemblage of supposed late Guadalupian (Capitanian) to early Lopingian (Wuchiapingian) age was recently discovered in an active crushed stone quarry near Mammendorf, Saxony Anhalt (Buchwitz et al., 2017). This part of northern Germany was once situated at the southern border of the huge north-central European Southern Permian Basin and yields tetrapod tracks of at least five different morphotypes: *Erpetopus*, cf. *Procolophonichnium*, cf. *Dicynodontipus*, cf. *Paradoxichnium* and aff. *Pachypes*. Ongoing study has the potential to turn the Mammendorf locality into one of the most important mid/late-Permian (ichno-)fossil sites in Central Europe as well as a reference for the biostratigraphy of dry playa red beds of this specific stratigraphic interval.

Starting in the last decade, the Moroccan late Palaeozoic to Mesozoic deposits have been the object of enhanced palaeontological and sedimentological research carried out by a Moroccan-German team. Recent fossil exploration of the Souss Basin in the Western High Atlas Mountains led to the discovery of tetrapod footprints assigned to the plexus *Batrachichnus*, *Limnopus*, *Dimetropus*, and *Ichniotherium* (Lagnaoui et al., 2017). This moderately diverse tetrapod footprint assemblage is important because it is the second-oldest record of tetrapod footprints from Africa and only the second record of the well-known ichnogenus *Ichniotherium* from outside of North America and Europe. Publications on extensive collections of fossil insects, conchostracans, and a newly discovered temnospondyl amphibian skeleton of this basin are in preparation.

To promote the application of ichnofossils not only for environmental analysis but also for biostratigraphy, the 2nd International Conference of Continental Ichnology (ICCI 2017) was held in South Africa, Nuy Valley (Western Cape Winelands). The conference was organised by Emese Bordy and her post-graduate students from the Sedimentology–Palaeontology Group at the University of Cape Town (UCT), and was attended by 50 international delegates from Canada, USA, Uruguay, Argentina, France, Germany, Sweden, Switzerland, Russia, Spain, UK, Italy, Poland, South Africa and Lesotho. One third of the delegates were postgraduate students, and about one quarter of them were international students. The delegates presented research that focused on investigating various ichnofossils such as burrows, nests, tracks and trails. The conference was followed by an ichnological and geological field trip across the Permian to Lower Jurassic of the main Karoo Basin from the 1st to 8th of October 2017, which showcased some of the best ichnological outcrops in South Africa and Lesotho.

A North American-European team of the New Mexico Museum of Natural History gives a comprehensive summary on the Carboniferous-Permian transition in Socorro County, New Mexico (Lucas, DiMichele and Krainer, eds., 2017). The results of 20+ years of field, laboratory and museum research on the Pennsylvanian-Permian rocks and fossils of Socorro County were documented. Lithostratigraphy, sedimentary petrography, microfacies analysis and sedimentological interpretation as well as diverse paleontological studies (fossil plants, calcareous microfossils, conodonts, fossil insects, tetrapod footprints, coprolites and fossil fishes) are presented. The Pennsylvanian strata of this area are a complex succession of sedimentary rocks of marine and nonmarine origin deposited during the Middle-Late Pennsylvanian. The co-occurrence of marine zone fossils (fusulinids, conodonts) with non-marine guide fossils (insects) allows for the improved calibration of the nonmarine biostratigraphy to the Standard Global Chronostratigraphic Scale (Schneider et al., 2017). Based on almost 500 tetrapod track specimens, assigned to the ichnogenera *Amphisauropus, Batrachichnus*, *Dimetropus*, *Dromopus*, *Erpetopus*, *Hyloidichnus*, *Ichniotherium*, *Limnopus*, *Tambachichnium* and *Varanopus*, Voigt and Lucas (2017) demonstrate the turnover from the *Dromopus* biochron to the *Erpetopus* biochron in early Permian red beds.

A comprehensive overlook on the state of the art of Permian marine and non-marine biostratigraphy was compiled by 15 authors in Lucas and Shen (eds., 2016; to be fully published in February, 2018): The Permian Timescale. This and the present report show that further development of the Late Palaeozoic and Early Mesozoic chronostratigraphic scale should focus on GSSP selection for the remaining, undefined marine stage bases, and further correlation of the nonmarine late Carboniferous – Permian – early Triassic deposits to the chronostratigraphic scale with all available biostratigraphic tools in combination with radioisotopic, magnetostratigraphic and chemostratigraphic methods for cross correlation and calibration.

References

Bourquin, S., Bercovici, A., López-Gómez, J., Diez, J.B., Broutin, J., Ronchi, A., Durand, M., Arche, A., Linol, B., Amour, F., 2011. The Permian-Triassic transition and the onset of Mesozoic sedimentation at the northwestern peri-Tethyan domain scale: palaeogeographic maps and geodynamic implications. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 299 (1–2), p. 265–280. http://dx.doi.org/10.1016/j.palaeo.2010.11.007.

Bourquin, S., Rossignol, C., Jolivet, M., Poujol, M., Broutin, J. and Yu, J., (in press). Terrestrial Permian–Triassic boundary in southern China: New stratigraphic, structural and palaeoenvironment considerations. Palaeogeography, Palaeoclimatology, Palaeoecology, doi:10.1016/j.palaeo.2017.11.055

Broutin, J., Châteauneuf, J.J., Galtier, J. and Ronchi, A., 1999. L'Autunien d'Autun reste-t-il une référence pour les dépôts continentaux du Permien inférieur d'Europe? Apport des données paléobotaniques. Géologie de la France, v. 2, p. 17–31.

Buchwitz, M., Luthardt, L., Marchetti, L., Trostheide, F., Voigt, S. and Schneider J.W., 2017. A Middle to Late Permian tetrapod tracksite from Germany. 2nd International Conference of Continental Ichnology, Nuy Valley, Western Cape, South Africa, 1st-4th October 2017, Abstract Book, p. 15-16.

Chu, D., Tong, J., YU, J., Song, H. and Tian, L., 2013. The Conchostracan fauna from the Kayitou Formation of western Guizhou, China. Acta Palaeontologica Sinica, v. 52, p. 265–280.

Chu, D., Yu, J., Tong, J., Benton, M.J., Song, H., Huang, Y., Song, T. and Tian, L., 2016. Biostratigraphic correlation and mass extinction during the Permian-Triassic transition in terrestrial-marine siliciclastic settings of South China. Glob. Planetary Change, v. 146, p. 67–88.

Chu, D., Tong, J., Benton, M.J., Yu, J., Huang, Y., (in press). Mixed continental-marine biotas following the Permian-Triassic mass extinction in South and North China. Palaeogeography, Palaeoclimatology, Palaeoecology [https://doi.org/10.1016/j.palaeo.2017.10.028]

Gaggero L., Gretter N., Langone A. and Ronchi A., 2017. U-Pb geochronology and geochemistry of Late Palaeozoic volcanism in Sardinia (Southern Variscides). Geoscience Frontiers, http://dx.doi.org/10.1016/j.gsf.2016.11.015

Götz, A.E., Ruckwied, K. and Wheeler, A., (in press). Marine flooding surfaces recorded in Permian black shales and coal deposits of the Main Karoo Basin (South Africa): implications for basin dynamics and cross-basin correlation. International Journal of Coal Geology.

Goretzki, J., 2003. Biostratigraphy of Conchostracans: A Key for the Interregional Correlations of the Continental Palaeozoic and Mesozoic – Computer-aided Pattern Analysis and Shape Statistics to Classify Groups Being Poor in Characteristics. PhD thesis, Technische Universität Bergakademie Freiberg, Freiberg.

Kozur, H.W., 1999. The correlation of the Germanic Buntsandstein and Muschelkalk with the Tethyan scale. Zentralblatt für Geologie und Paläontologie Teil I 1998 (7–8), p. 701–725.

Kustatscher, E., Bernardi, M., Petti, F.M., Franz, M., Van Konijnenburg-van Cittert, J.H.A. and Kerp., H., 2017. Sea-level shifts in the Lopingian of the north-western Tethys (Dolomites, N-Italy) and their effects on the palaeoenvironment and fossil preservation. Global and Planetary Change, v. 148, p.166–180.

Lagnaoui, A., Voigt, S., Belahmira, A., Saber, H., Klein, H., Hminna, A. and Schneider, J.W., 2017. Late Carboniferous tetrapod footprints from the Souss Basin, Western High Atlas Mountains, Morocco: Ichnos, DOI: 10.1080/10420940.2017.1320284.

Lagnaoui, A., Voigt, S., Belahmira, A., Saber, H., Klein, H., Hminna, A. and Schneider, J.W., 2017. Late Carboniferous Tetrapod Footprints from the Souss Basin, Western High Atlas Mountains, Morocco, Ichnos, DOI: 10.1080/10420940.2017.1320284

Legler, B. and Schneider, J.W., 2008. Marine ingressions into the Middle/Late Permian saline lake of the Southern Permian Basin (Rotliegend, Northern Germany) possibly linked to sea-level highstands in the Arctic rift system. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 267, p.102–114.

Liu, S.-W. and He, Z.-J., 2000. Marine conchostracans from the "Sunjiagou Formation" of Qishan, Shaanxi. Acta Palaeontologica Sinica, v. 39 (2), p. 230–236.

Lucas, S.G., 2017. Permian tetrapod biochronology, correlation and evolutionary events. In Lucas, S.G. and Shen, S.Z. eds. The Permian Timescale. Geological Society, London, Special Publications, v. 450.

Lucas, S.G. and Shen, S.Z., eds., 2017. The Permian Timescale. Geological Society, London, Special Publications, v. 450, https://doi.org/10.1144/SP450.3

Lucas, S.G., Allen, B.D., Krainer, K., Barrick, J., Vachard, D., Schneider, J.W., DiMichele, W.A. and Bashforth, A.R., 2011. Precise age and biostratigraphic significance of the Kinney Brick Quarry Lagerstätte, Pennsylvanian of New Mexico, USA. Stratigraphy, v. 8 (1), p. 7–27.

Lucas, S.G., Barrick, J.E., Krainer, K. and Schneider, J.W., 2013. The Carboniferous-Permian boundary at Carrizo Arroyo, Central New Mexico, USA. Stratigraphy, v. 10 (13), p. 153–170.

Lucas, S.G., DiMichele, W.A. and Krainer, K., eds., 2017, Carboniferous-Permian transition in Socorro County, New Mexico. New Mexico Museum of Natural History and Science Bulletin, v. 77, p. 1-16.

Malzahn, E., 1957. Neue Fossilfunde und vertikale Verbreitung der niederrheinischen Zechsteinfauna in den Bohrungen Kamp 4 und Friedrich Heinrich 57 bei Kamp-Lintfort. Geologisches Jahrbuch, v. 73, p. 91–126.

Marchetti, L., Voigt, S. and Klein, H., 2017. Revision of Late Permian tetrapod tracks from the Dolomites (Trentino-Alto Adige, Italy), Historical Biology, DOI: 10.1080/08912963.2017.1391806

Martens, T., 1983. Zur Taxonomie und Biostratigraphie der Conchostraca (Phyllopoda, Crustacea) des Jungpaläozoikums der DDR, Teil I. Freiberger Forschungshefte, v. C 382, p. 7–105.

Martínek, K., Pešek, J. and Opluštil, S., 2017. Significant hiatuses in the terrestrial Late Variscan Central and Western Bohemian basins (Late Pennsylvanian–Early Cisuralian) and their possible tectonic and climatic links. Geologica Carpathica, v. 68 (3), p. 269 – 281.

Menning, M. and Bachtadse, V., 2012. Magnetostratigraphie und globale Korrelation des Rotliegend innervariscischer Becken. In: Stratigraphie von Deutschland X. Rotliegend. Teil I: Innervariscische Becken. Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften, v. 61, p. 176–203.

Mujal E., Gretter N., Ronchi A., López-Gómez J., Falconnet J., Diez J. B., De la Horra R., Bolet A., Oms O., Arche A., Barrenechea J. F., Steyer J.-S. and Fortuny J., 2016. Constraining the Permian/Triassic boundary in continental environments: stratigraphic and paleontological record from the Southern-Eastern Pyrenees (NE Iberian Peninsula). Palaeogeography, Palaeoclimatology, Palaeoecology, v. 445, p. 18-47.

Mujal, E., Gretter, N., Ronchi A., López-Gómez, J., Falconnet, J., Diez, J. B., De la Horra, R., Bolet A., Oms, O., Arche, A., Barrenechea, J. F., Steyer, J.-S. and Fortuny, J., 2016. Insights on the Permian/Triassic transition in Western Tethys: new stratigraphic and paleontological data from the Catalan Pyrenees (NE Iberian Peninsula). Permophiles, v. 63, p. 21-27.

Mujal, E., Fortuny, J., Pérez-Cano, J., Dinarès-Turell, J., Ibáñez-Insa, J., Oms, O., Vila, I., Bolet, A. and Anadón, P., 2017. Integrated multi-stratigraphic study of the Coll de Terrers late Permian–early Triassic continental succession from the Catalan Pyrenees (NE Iberian

Peninsula): A geologic reference record for equatorial Pangaea. Global and Planetary Change, v. 159, p. 46-60.

Nielsen, E., 1954. *Tupilakosaurus heilmani* n. g. et n. sp. An interesting batrachomorph from the Triassic of East Greenland. Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland v. 72 (8), p. 5–33.

Novozhilov, N.I., 1952. Novye rodovye gruppy listonogikh rakoobraznykh semeistva Leaiid [New genera of the group of the phyllopod crustacean of the leaiid family]. Doklady Akademiya Nauk SSSR, v. 85 (6), p. 1369–1372. [in Russian]

Opluštil, S., Schmitz, M., Cleal, C.J. and Martínek, K., 2016a. A review of the Middle-Late Pennsylvanian west European regional substages and floral biozones, and their correlation to the Global Time Scale based on new U-Pb ages. Earth Science Reviews, vol. 154, p. 301-335.

Opluštil, S., Schmitz, M., Kachlík, V. and Štamberg, S., 2016b. Re-assessment of lithostratigraphy, biostratigraphy, and volcanic activity of the Late Paleozoic Intra-Sudetic, Krkonoše-Piedmont and Mnichovo Hradiště basins (Czech Republic) based on new U-Pb CA-ID-TIMS ages. Bulletin of Geosciences*,* v. 91(2), p. 399–432.

Opluštil, S., Šimůnek, Z., Pšenička, J., Bek, J. and Libertín, M., 2017a. A 25 million year macrofloral record (Carboniferous–Permian) in the Czech part of the Intra-Sudetic Basin; biostratigraphy, plant diversity and vegetation patterns. Review of Palaeobotany and Palynology, v. 244, p. 241-307.

Opluštil, S., Jirásek, J., Schmitz, M. and Matýsek, D., 2017b. Biotic changes around the radioisotopically constrained Carboniferous-Permian boundary in the Boskovice Basin (Czech Republic). Bulletin of Geosciences, v. 92(1), p. 95–122.

Pellenard, P., Gand, G., Schmitz, M., Galtier, J., Broutine, J. and Stéyer, J.-S., 2017: High-precision U-Pb zircon ages for explosive volcanism calibrating the NW European continental Autunian stratotype.- Gondwana Research, v. 51 (2017), p. 118–136

Schneider, J.W. and Scholze, F., 2016. Late Pennsylvanian–Early Triassic conchostracan biostratigraphy: a preliminary approach. In: Lucas, S.G. and Shen, S. eds. The Permian Timescale. Geological Society, London, Special Publications, v. 450. [doi: 10.1144/SP450.6]

Schneider, J.W. and Werneburg, R., 2012. Biostratigraphie des Rotliegend mit Insekten und Amphibien. In Deutsche Stratigraphische Kommission: Stratigraphie von Deutschland X. Rotliegend. Teil I: Innervariscische Becken. – Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften, v. 61, p. 110-142.

Scholze, F., Golubev, V. K., Niedźwiedzki, G., Sennikov, A.G., Schneider, J.W. and Silantiev, V.V., 2015. Early Triassic Conchostracans (Crustacea: Branchiopoda) from the terrestrial Permian–Triassic boundary sections in the Moscow syncline. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 429, p. 22–40.

Scholze, F., Schneider, J.W. and Werneburg, R., 2016. Conchostracans in continental deposits of the Zechstein-Buntsandstein transition in central Germany: Taxonomy and biostratigraphic implications for the position of the Permian-Triassic boundary within the Zechstein Group. Palaeogeography, Palaeoclimatology, Palaeoecology v. 449, p. 174–193.

Scholze, F., Abu Hamad, A., Schneider, J.W., Golubev, V.K., Sennikov, A.G., Voigt, S. and Uhl, D.,

2017 (a). An enigmatic 'conchostracan' fauna in the eastern Dead Sea region of Jordan: First records of *Rossolimnadiopsis* Novozhilov from the Early Triassic Ma'in Formation. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 466, p. 314–325.

Scholze, F., Wang, X., Kirscher, U., Kraft, J., Schneider, J.W., Götz, A.E., Joachimski, M.M. and Bachtadse, V., 2017(b). A multistratigraphic approach to pinpoint the Permian-Triassic boundary in continental deposits: The Zechstein–Lower Buntsandstein transition in Germany. Global and Planetary Change, v. 152, p. 129–151.

Sennikov, A.G. and Golubev, V.K., 2012. On the Faunal Verification of the Permo–Triassic Boundary in Continental Deposits of Eastern Europe: 1. Gorokhovets–Zhukov Ravine. Paleontological Journal, v. 46, p. 313–323.

Shen, S.-Z., Crowley, J.L., Wang, Y., Bowring, S.A., Erwin, D.H., Sadler, P.M., Cao, C.-Q., Rothman, D.H., Henderson, C.M., Ramezani, J., Zhang, H., Shen, Y., Wang, X.-D., Wang, W., Mu, L., Li, W.-Z., Tang, Y.-G., Liu, X.-L., Liu, L.-J., Zeng, Y., Jiang, Y.-F. and Jin, Y.-G., 2011. Calibrating the end-Permian mass extinction. Science, v. 334, p. 1367–1372.

Shishkin, M.A., Ochev, V.G., Lozovskii, V.R. and Novikov, I.V., 2000. Tetrapod biostratigraphy of the Triassic of Eastern Europe, In: Benton, M.J., Shishkin, M.A., Unwin, D.M. and Kurochkin, E.N. (eds.), The Age of Dinosaurs in Russia and Mongolia. Cambridge University Press, Cambridge, p. 120–139.

Silantiev, V.V., Nurgalieva, N.G., Mouraviev, F.A., Kabanov, P.B., Scholze, F., Ivanov, O.A., Bulanov, V.V., Urazaeva, M.N., Khaziev, R.R., Fakhrutdinov, E.I., Mozzherin, V.V. and Egorova, K.A., 2015. August 19. Stop 1. Sentyak section. Upper Kazanian in continental facies. In: Nurgaliev, D.K., Silantiev, V.V. and Nikolaeva, S.V., (Eds.), Type and reference section of the Middle and Upper Permian of the Volga and Kama River Regions. – XVIII International Congress on the Carboniferous and Permian, August 1-15, 2015, Field Guidebook, Kazan, p. 154–170.

Voigt, S. and Lucas, S.G., 2017. Outline of a Permian tetrapod footprint ichnostratigraphy. In: Lucas, S. G. and Shen, S. Z. eds. The Permian Timescale. Geological Society, London, Special Publications, v. 450, https://doi.org/10.1144/SP450.10

Wagner, R.H. and Álvarez-Vázquez, C., 2010. The Carboniferous floras of the Iberian Peninsula: a synthesis with geological connotations. Revue of Palaeobotany and Palynology, v. 162, p. 239–324.

Werneburg, R. and Schneider, J.W., 2006. Amphibian biostratigraphy of the European Permo-Carboniferous. – In: Lucas, S.G., Cassinis, G. and Schneider J.W. eds. Non-marine Permian Biostratigraphy and Biochronology. Geological Society of London, Special Publications, v. 265, p. 201–215.

Werneburg, R., Ronchi, A. and Schneider, J.W., 2007. The Lower Permian Branchiosaurs (Amphibia) of Sardinia (Italy): systematic palaeontology, paleoecology, biostratigraphy and palaeobiogeographic problems. Paleogeography, Paleoclimatology, Paleoecology, v. 252, p. 383-404.

Zhang, H., Cao, C.-q., Liu, X-l., Mu, L., Zheng, Q.-f., Liu, F., Xiang, L., Liu, L.-j. and Shen, S.-z., 2016. The terrestrial end-Permian mass extinction in South China. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 448, p. 108–124.

Zharinova, V., Scholze, F., Silantiev, V.V. and Schneider, J.W. (2017a). Biostratigraphic significance of the Permian conchostracans from Eastern Europe and Western Siberia. In Nurgaliev, D.K., Silantiev, V.V. and Zharinova, V.V. eds. Kazan Golovkinsky

Stratigraphic Meeting – 2017 and Fourth All-Russian Conference "Upper Palaeozoic of Russia" Upper Palaeozoic Earth systems: high-precision biostratigraphy, geochronology and petroleum resources. Abstract volume. Kazan, September, 19–23, 2017, p. 216–217.

Zharinova, V., Scholze, F., Silantiev, V.V. and Schneider, J.W. (2017b). Permian Conchostraca from continental deposits in Eastern Europe (Volga-Kama region) – first taxonomic results. In Nurgaliev, D.K., Silantiev, V.V. and Zharinova, V.V. eds. Kazan Golovkinsky Stratigraphic Meeting – 2017 and Fourth All-Russian Conference "Upper Palaeozoic of Russia" Upper Palaeozoic Earth systems: high-precision biostratigraphy, geochronology and petroleum resources. Abstract volume. Kazan, September, 19–23, 2017, p. 218–219.

Abstract volumes of the Kazan Golovkinsky-Meeting 2017 and the 2nd International Conference of Continental Ichnology (ICCI 2017) are available as pdf´s under the following links:

http://kpfu.ru/portal/docs/F1616694132/2017.Golovkinsky_2017.Abstract.Volume._zip.pdf

https://sites.google.com/site/icci2017conference/home/2017-abstract-book

Report of the Chinese, Italian, Iranian working group: The Permian-Triassic boundary sections of Abadeh revisited

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At the end of November 2017, a research group composed of a Chinese party with S.Z. Shen, H. Zhang, and Y.C. Zhang, an Italian party with L. Angiolini and G. Crippa and an Iranian party with M. Ghorbani, M. Ghorbani and M. Ovissi, visited the section of Abadeh in the Hambast Valley, near Abarqu in Central Iran (Fig. 1).

During the field trip, we sampled in great details for conodonts, foraminifers, brachiopods and geochemistry the sedimentary succession comprising the Upper Permian Abadeh and Hambast formations and the Lower Triassic Elikah Formation (Figs 2-3). The main goals were:

1) to establish a refined conodont and foraminifer biozonation for the Changhsingian of central Iran through a very detailed sampling and a direct comparison and correlation with the biozonation of Djulfa (NW Iran) and South China. Besides this the focus of the field work was to perform a very detailed geochemical analysis of bulk rock samples, conodont apatite and brachiopod calcite;

2) to study the brachiopod evolution approaching the Permian-Triassic boundary, focusing on the palaeocology and functional morphology of the fauna and the possible change in brachiopod biomineralization and geochemistry which are among the best tools to reconstruct the chemical condition of the oceans in this critical time interval (e.g. Garbelli et al., 2007; Jurikova et al., this Permophiles issue).

3) to study the geochemistry of the bulk rock at the PTB.

The Abadeh section is well known to Permian specialists around the world from the detailed study published by Taraz et al. (1981), which is still quite modern in contents and methodology and the more recent researches on the conodonts faunas (Shen and Mei, 2010).

However, there are still open problems mainly related to the conodont taxonomy and succession (Kozur, 2004, 2005; Shen and Mei, 2010) and the position of the Guadalupian-Lopingian boundary in the upper part of the Abadeh Formation, which, due to the scarcity of conodonts and the occurrence of non-resolutive foraminifer biozones, is tentatively placed at about 8 m below the top of the formation based on the geochemical record (Liu et al., 2013) and the necessity to sample both the PTB boundary and GLB intervals in still greater details (sample strategy with spatial resolution of 10 cm in some intervals).

With this in mind, we reached the section which crops out in very good conditions and in a very beautiful landscapes at about 20 minutes walk from the car, and since the first day (November, 24th), Shuzhong Shen was able to find the exact position on the section and on the PTB where he took a photo in 2009 (Fig. 4): as

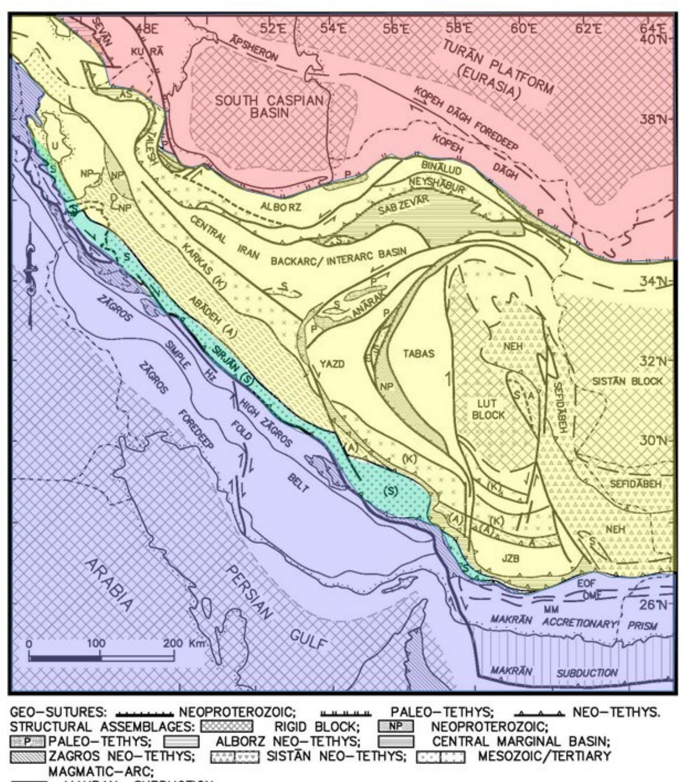

Fig. 1. Main structural zones of Iran, with the position of the Abadeh region. Modified from Berberian (2014).

you can see there have not been many change in the outcrop!

We benefitted of some new discoveries during our detailed field work: from the systematic point of view, we found very well preserved and diversified brachiopods among which a beautiful specimen of a species of the rare and bizarre genus *Permianella* and large species of *Leptodus* and *Permocryptospirifer*, but probably one of the most proficous finding was the discovery of the Boundary Clay, just below the thrombolite of the Elikah Formation (Fig. 5). This clayey unit, is very important as it contains the boundary interval in other sections in Iran and elsewhere (e.g. Ghaderi et al., 2013, 2014; Angiolini et al., 2013; et al., Sahakyan et al. this Permophiles issue).

Our team enjoyed a lot the field work which was lead in very good humor, with constructive discussion and harmonious collaboration (Fig. 6) and ended with the visit of the spectacular archeological sites that record the deep and glorious history of the Iranian people (Fig. 7).

We hope to be able to share soon new interesting results with the Permian community.

References

Angiolini, L., Shen S.Z., Bahrammanesh, M., Abbasi, S., Birjandi, M., Crippa, G., Yuan, D. and Garbelli, C., 2013. Report of the Chinese, Iranian, Italian working group: The Permian-Triassic boundary sections of Julfa and Zal revisited. Permophiles, v. 58, p. 33-35.

Sahakyan, L., Baud, A., Chen, Z.Q., and Fang, Y, 2017. Report on the IGCP 630 Conference and Field Workshop, October 8-14, 2017, in Armenia. Permophiles, v. 65.

Berberian, M., 2014. Earthquakes and coseismic surface faulting on the Iranian Plateau; a historical, social, and physical approach. Elsevier, Developments in Earth Surface Processes, v. 17, p. 1-714. ISBN: 978-0-444-63292-0.

Ghaderi, A., Ashouri, A., Kozur, H.W., and Korn D., 2013. Age assignment of section 4 of Teichert et al. (1973) at Ali Bashi Mountains (Julfa, NW Iran). Permophiles, v. 58, p. 35-39.

Ghaderi, A., Garbelli, C., Angiolini, L., Ashouri ,A.R., Korn, D., Rettori, R. and Gharaie, M.H.M., 2014. Faunal change near the end-Permian extinction: the brachiopods of the Ali Bashi Mountains, NW Iran. Rivista Italiana di Paleontologia e Stratigrafia, v. 120, p. 27-59.

Henderson, C.M., Mei, S.L., Shen , S.Z., Wardlaw, B.R., 2008. Resolution of the reported Upper Permian conodont occurrences from northwestern Iran. Permophiles, v. 5, p. 2-8.

Kozur, H.W., 2004. Pelagic uppermost Permian and the Permian–Triassic boundary conodonts of Iran, Part I: Taxonomy. Hallesches Jahrbuch für Geowissenschaften B, Beiheft, v. 18, p. 39–68.

Kozur, H.W., 2005. Pelagic uppermost Permian and the Permian–Triassic boundary conodonts of Iran. Part II: Investigated sections and evaluation of the conodont faunas. Hallesches Jahrbuch für Geowissenschaften B, Beiheft, v. 19, p. 49–86.

Liu, X.C., Wang, W., Shen, S.Z., Gorgij, M.N., Ye, F.C., Zhang, Y.C., Furuyama, S., Kano, A., and Chen, X.Z., 2013. Late Guadalupian to Lopingian (Permian) carbon and strontium isotopic chemostratigraphy in the Abadeh section, central Iran. Gondwana Research, v. 24 (1), p. 222-232.

Shen, S.Z., 2007. The conodont species Clarkina orientalis (Barskov and Koroleva, 1970) and its spatial and temporal distribution. Permophiles, v. 50, p. 25-37.

Shen, S.Z. and Mei, S.L. 2010. Lopingian (Late Permian) high-resolution conodont biostratigraphy in Iranwith comparison to South China zonation. Geological Journal, v 45, p. 135–161.

Taraz, H., Golshani, F., Nakazawa, K., Shimizu, D., Bando, Y., Ishii K., Murata, M., Okimura, Y., Sakagami, S., Nakamura, K., Tokuoka, T., 1981. The Permian and the Lower Triassic Systems in Abadeh Region Central Iran. Memoirs of the Faculty of Science, Kyoto University. Series of geology and mineralogy, v. 47 (2), p. 61-133.

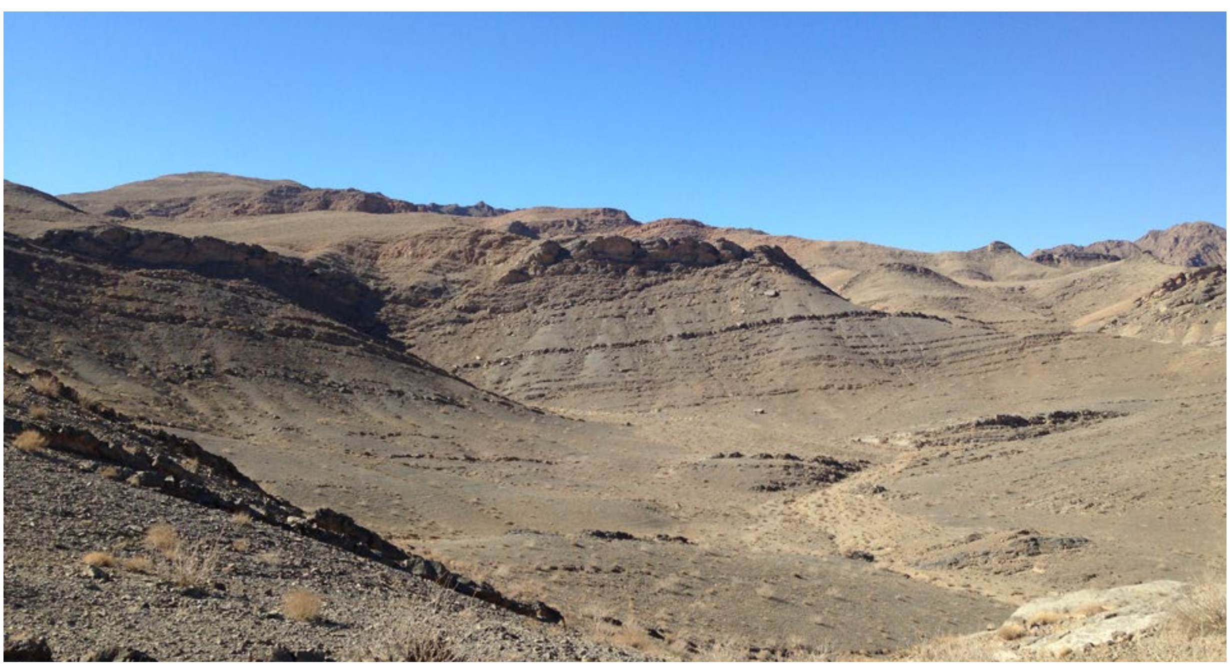

Fig. 2. General view of the Abadeh section measured along the ridge in the centre of the photo.

Fig. 3. The Hambast Formation and on top the Elikah Formation. The pink dot indicate the PTB interval.

Fig. 4. Shuhong Shen on the PTB interval; in 2009 and 2017.

Fig. 5. Thrombolites at the base of the Elikah Formation.

Fig. 6. Barbecue at the top of the Abadeh Formation.

Fig. 7. The spectacular Achaemenid tombs of Darius, Xerxes and Artaxerses at Naqsh-e Rostam, about 12 km northwest of Persepolis.

14th International Permian-Triassic Field Workshop, Dead Sea area, Jordan, March 4–10, 2017

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The 14th International Permian-Triassic Field Workshop was held in Jordan, organised and guided by Prof. Dr. Abdalla M. B. Abu Hamad of Amman University. His invitation was accepted by 25 international participants from Germany, France, UK, Italy, Switzerland, Norway, Israel, Poland and China. The workshop hotel was in the town of Madaba south of Jordan‘s capital Amman. Madaba is famous for its early Christian mosaics, especially a mosaic map of the "Holy Land" on the floor of the Greek-Orthodox St. George‘s Church.

Permian and Triassic strata crop out in several deep wadis on the eastern side of the Dead Sea. They exhibit some 700 m of continental and marine sediments of partly Germanotype character that were deposited in an epicontinental basin at the southern margin of the Tethys. The road from Madaba leads past the approximately 500 m high Mount Nebo, from which Moses saw the „Promised Land". The view extends far to the west across the Jordan Valley to the mountains of Judea. A winding road leads down to the Dead Sea at about 400 m below sea level, the lowest point on the earth's surface (Fig. 1). The vertical tectonic offset of the Jordan Graben is about 7 km, the left-lateral displacement about 120 km. Hot springs emerge from the fault zones, which have left thick travertines behind.

Fig. 1. Workshop participants on Permian strata above the Dead Sea

One of the best outcrops in the rift valley is in the lower part of Wadi Mukheiris showing continental upper Permian, the Permian-Triassic unconformity, as well as continental and marine lower and middle Triassic. More good outcrops occur along the so-called Panorama Road and the road along the shore of the Dead Sea. The Permian-Triassic boundary interval is particularly well exposed at the so-called „Dyke Plateau", where the whole succession is cut by an approximately 3 m thick, vertical, E-W striking Cretaceous dolerite dyke (Fig. 2). The Permian is very rich in plant remains and palynomorphs and also contains conchostrachans. The 60 m thick Hisban Limestone Formation in Wadi Hisban has a Middle Triassic (Anisian) age. Its lithology and fossil content are surprisingly similar to the German Muschelkalk limestones ("Arabian Muschelkalk"). Upper Triassic strata of Carnian age were visited in Wadi Zarqa north of Amman that are quarried for their gypsum deposits and are overlain by sandy shales of the "Carnian Wet Intermezzo", an equivalent of the German Schilfsandstein (Fig. 3; "Arabian Keuper").

The participants enthusiastically visited a number of tourist highlights including taking the usual bath in the Dead Sea. One very special locality was „Bethany-beyond-the-Jordan", where, according to the Bible, Jesus was baptized by John the Baptist. Today, the River Jordan is only about 15 m wide, quite muddy, and marks the border between Jordan and Palestine. Another highlight was the visit to Tell al-Hammad farther to the northeast, at first a Chalcolithic and a Bronze Age settlement, which later became Roman and Byzantine. The locality has been excavated for several years by US archaeologists who suggest that this was the site of the biblical Sodom. The group also visited Amman, the capital of Jordan which has an excellent restored Roman amphitheater. Also very impressive are the ruins of the Roman city of Geresa (Jerash) north of Amman, and the small Hellenistic palace complex Qasr al-Abad southwest of the capital.

More than half of the participants took part in a following four-day trip to southern Jordan, where the famous desert necropolis of Petra, Wadi Rum (both in Cambrian sandstones) and the port city of Aqaba were visited. Afterwards some of the participants went to the so-called "desert palaces" in the gravel desert east of Amman including Qasr al-Azraq, a massive black fortress made of local basalt stones which served Lawrence of Arabia as winter quarters in 1917.

Fig. 2. PTB interval at the "Dyke Plateau", cut by a vertical Cretaceous dolerite dyke

Fig. 3. Carnian strata quarried for gypsum overlain by deposits of the "Carnian Wet Intermezzo"

Report on the IGCP 630 Conference and Field Workshop, October 8-14, 2017, in Armenia

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Introduction

The IGC Program 630, starting in 2014 under the leadership of Prof. Zhong-Qiang Chen, aims to investigate the recovery of ecosystems following the end-Permian mass extinction through analyses of the rock and fossil records via studies of biostratigraphy, paleontology, paleoecology, sedimentology, geochemistry and biogeochemistry. This conference and field workshop was organized by Lilit Sahakyan, Aymon Baud, and Zhong-Qiang Chen. As a first IGCP 630 workshop was held in June 2017 at Sendai (Japan) by Prof. Kaiho, this workshop, originally planned in May, was postponed to October 8-14. Aymon Baud, with Lilit Sahakyan and the help of Evelyn Friesenbichler and Sylvain Richoz, prepared the field workshop guide-book, available at:

https://www.researchgate.net/publication/320426260_The_Permian-Triassic_transition_in_Southern_Armenia

This guide-book (Sahakyan et al., 2017) takes into account the important contributions of Rostovtsev and Azaryan (1973), Kotlyar et al. (1983), Aslanian (1984), Baud et al. (1989), Leven (1989), Zakharov et al. (2005) and Frisenbichler et al. (2017).

On October 9th, at the Round hall of the of Presidium of the National Academy of Sciences of the Republic of Armenia (Fig. 1), a welcome speech was given by the Director of IGS, Dr. Sc. Kh. Meliksetian, followed by a presentation and a review of the geology and tectonics of the territory of Armenia based on new data, by Lilit Sahakyan, Deputy Director of IGS.

Aymon Baud presented an introduction to the fieldtrip. The main topics to be discussed were the Upper Permian shallow water succession followed by deeper water limestone with red ammonoid *Paratirolites* beds, the Permian-Triassic transition with the boundary shale, and the Lower Triassic stratigraphic succession with its sponge-microbial build-ups at the three main visited localities: Ogbin, Chanakchi and Vedi (Fig 2).

Four sessions and fourteen talks characterized the first day of the conference (session contents and abstracts are available at:

https://www.researchgate.net/publication/320467445_IGCP630_CONFERENCE_PROGRAM_Armenia

At the end of the four sessions, Zhong-Qiang Chen gave information on the IGCP 630 closure meeting 2018, to be held next May in Wuhan (China).

A group photo was taken on the steps of the Academy building entrance (Fig. 3).

On October 10th, at the same place, the second day of the conference started with four talks followed by a poster session and a visit to the Geological Museum followed by a visit to the Matenadaran Museum - Institute of Ancient Manuscripts that holds one of the world's richest depository of medieval manuscripts and books. This spans a broad range of subjects, including history, philosophy, medicine, literature, art history and cosmology in Armenian and many other languages.

In the afternoon, we took the opportunity to go to the KhorVirap monastery that is located in the Ararat plain in Armenia, near the closed border with Turkey. It is a shrine and a pilgrimage site important to Armenian Christianity (Fig. 4).

October 11th, the first day field workshop was dedicated to the most eastern of the three sections, Ogbin one, which is situated along the Tchahuk river (Fig. 5).

One of us (A. Baud) gave information on the seven stops of the day and Araik Grigoryan provided personal information on the Upper Permian and Lower Triassic conodont succession. The Wuchiapingian part of the Khachik Formation was examined which contains fossiliferous shallow water limestone, followed by the deeper water Akhura Formation (upper Wuchiapingian - Changhsingian, Fig. 6).

We spent time to look at the uppermost Permian *Paratirolites* beds which are very similar to the Ali Bashi (NW Iran) *Paratirolites* limestone, cropping out 70 km to the south.

According to Ghaderi et al. (2014), at Ali Bashi this 5 m thick topmost unit is highly fossiliferous with 8 ammonoid zones and 6 conodont zones of latest Changhsingian age.

Our last stop of the day involved examination of the Permian - Triassic transition with badly outcropping boundary shale, followed by small sized sponge-micrbial build-ups (Fig. 7).

Zhong-Qiang Chen and his four Ph.D. students, started a detailed sampling of the Induan platy limestone of the Karabaglyar Formation (the hill on Fig. 7.

October 12th, the second day field workshop was dedicated to the Chanakhchi section (Transcaucasia, S. Armenia), which is situated about 60km SE of Yerevan. It was described in the last century as the Sovetachen section (Fig. 8).

Situated in the upper part of the Chanakhchi hill (Fig. 9), the biochronology of this Permian-Triassic section has been worked out recently by Zakharov et al. (2005 with ref. to Grigoryan, 1990).

Before looking at the Giant Sponge-Microbial Build-ups (GSMB) presented during the conference by Baud et al., (2017), we spent time to look at the Upper Permian Khachick and Akhura formations. Araik Grigoryan described the stratigraphy and conodont content of the Permian - Triassic boundary shales (Fig. 10).

The basal Triassic giant sponge-microbial buildups (GSMB) took all our attention with their two phases of growth. The first one is shown in Fig. 11.

Part of the group had a long discussion on the main giant sponge-microbial (GSMB) growth phase that is illustrated in Figs 12 and 13.

At the top of the Chanakhchi section, observed and discusses the Dienerian mini-sponge microbial build-up with our Chinese and Australian colleagues (Fig. 14). A group photo of participants was taken at the Chanakhchi section (Fig. 15)

Going back to our hotel in Vayk and Amrots, we got the opportunity to visit the 13th-century Noravank monastery near the top of the Norvank Valley. The church, completed in 1339, is said to be the masterpiece of the great medieval Armenian architect Momik (Fig. 16).

October 13th, the Vedi section, the subject of the last field day. After a night of heavy rain, we were lucky to get a sunny day and on the way to Vedi, and we had the opportunity to see the snow-covered Ararat Volcano through the clouds. Situated at the core of a large anticline, the Vedi sections expose well the Upper Permian carbonates followed by the thin bedded Lower Triassic platy limestones (Fig. 17).

At the Vedi 2 section, we started to look in detail the vertical bedded shallow-water Khachik Formation. As with the other South Armenian sections, a major facies change occurs at the top of the Khachik Formation (middle Wuchiapingian) due to drowning of the carbonate platform between the Upper Khachik Formation and the Lower Akhura Formation. We had a close look at the uppermost Permian *Paratirolites* limestone, exclusively of gray color here, and Araik Grigoryan gave explanation on the conodont biochronology from Wuchiapingian to Induan.

At this section, the Permian-Triassic is well exposed with vertical beds. We focussed on the onset of the basal Triassic SMB that directly overlies the Permian-Triassic Boundary shale (Fig. 18).

A few meters higher up in the section, the first ichnofacies appears on the bedding surfaces of platy limestones, along with a large collection of small SMB.

To look at a larger SMB, we moved to locality Vedi 4 where Lilit Sahakyan showed the participants a 12 m high Sponge Microbial Build-up (Fig. 20).

In the evening, the official dinner took place in the Yervan Pandok Restaurant (Fig. 21) and the participants, so pleased by the success of the workshop, addressed warm thanks to the organizers, and particularly to Lilit Sahakyan and her group of students (Taron Grigoryan, Hayk Hovakimyan and Kristina Sahakyan) who helped greatly in the field work organization and lunch preparation.

On October 14th, most of the participants started their journey home and Lilit Sahakyan provided the necessary special permission for sample exportat as required by some of the participants. Lilit Sahakyan also helped Zhong-Qiang Chen and his Ph. D. students to pack the large number of collected samples.

References

Aslanian, A.T. ed., 1984. The Armenian Soviet Socialist Republic excursion: General outook of the Permian-Triassic deposits. 27th Internat. Geol. Congr., Moscow, Guidebook 102, 86-98 .

Avagyan, A., Sahakyan, L., Sosson, M., Vardanyan, S., and Martirosyan, M. 2015. Tectonic of the southeast Ararat depression. Proceedings of the NAS RA, Earth Sciences, v. 68 (1), p. 47-67.

Baud, A., Magaritz, M. and Holser, W., 1989. Permian-Triassic of the Tethys: Carbon isotope studies. Geologische Rundschau, v. 78, p. 649–677.

Baud, A., Friesenbichler, E., Richoz, S., Krystyn, L. and Sahakyan, L., 2017. Induan (Early Triassic) giant sponge-microbial build-ups in Armenia. 5th IGCP 630 International conference and field workshop, 8-14 October, 2017, Yerevan, Program and Abstract, p. 13.

Friesenbichler, E., Baud, A., Reitner, J., Peckmann, J., Heindel, K., Krystyn, L., Sahakyan, L., Vardanyan, S., Richoz, S., in press. Sponge-microbial build-ups from the lowermost Triassic Chanakhchi section in southern Armenia: Microfacies and stable carbon isotopes. Palaeogeography, Palaeoclimatology, Palaeoecology.

Ghaderi, A., Leda, L, Schobben, M., Korn, D. and Ashouri, A. R., 2014. High-resolutionstratigraphy of the Changhsingian (Late Permian) successions of NW Iran and the Transcaucasus based on lithological features, conodonts and ammonoids. Fossil Record, v. 17, p. 41–57.

Kotlyar, G., Zakharov, Yu.D., Koczyrkeviscz, B.V., Kropatcheva, G.S., Rostovtsev, K.O., Chedija, I.O., Vuks, G.P. and Guseva, E.A., 1983. Evolution of the latest Permian Biota: Dzhulfian and Dorashamian regional stages in the USSR. Leningrad, “Nauka” LeningradskoyeOtdeleni (in Russian), p. 1-200.

Leven, E. J., 1998. Permian fusulinids assemblages and stratigraphy of Transcaucasia. Rivista Italiana di Paleontologia e Stratigrafia, v. 104, p. 299-328.

Rostovtsev, K.O. and Azaryan, N.R., 1973. The Permian-Triassic boundary in Transcaucasia. In: Logan, A. et al (Eds), The Permian and Triassic systems and their mutual boundary. Canadian Society of Petroleum Geologists Memoir, v. 2, p. 89–99.

Sahakyan, L., Baud, A., Grigoryan, A., Friesenbichler, E., and Richoz, S., eds., 2017. The Permian-Triassic transition in Southern Armenia. 5th IGCP 630 International conference and field workshop, 8-14 October, 2017, National Academy of Sciences of the Armenia Republic, Institute of Geological Sciences, Yerevan, Field Guide Book, p. 1-53.

Zakharov, Y., Biakov, A., Baud, A. and Kozur, H., 2005. Significance of Caucasian sections for working out carbon-isotope standard for Upper Permian and Lower Triassic (Induan) and their correlation with the Permian of North-Eastern Russia. Journal of China University of Geosciences, v. 16, p. 141-151.

Fig. 1. The Round-hall of the conference.

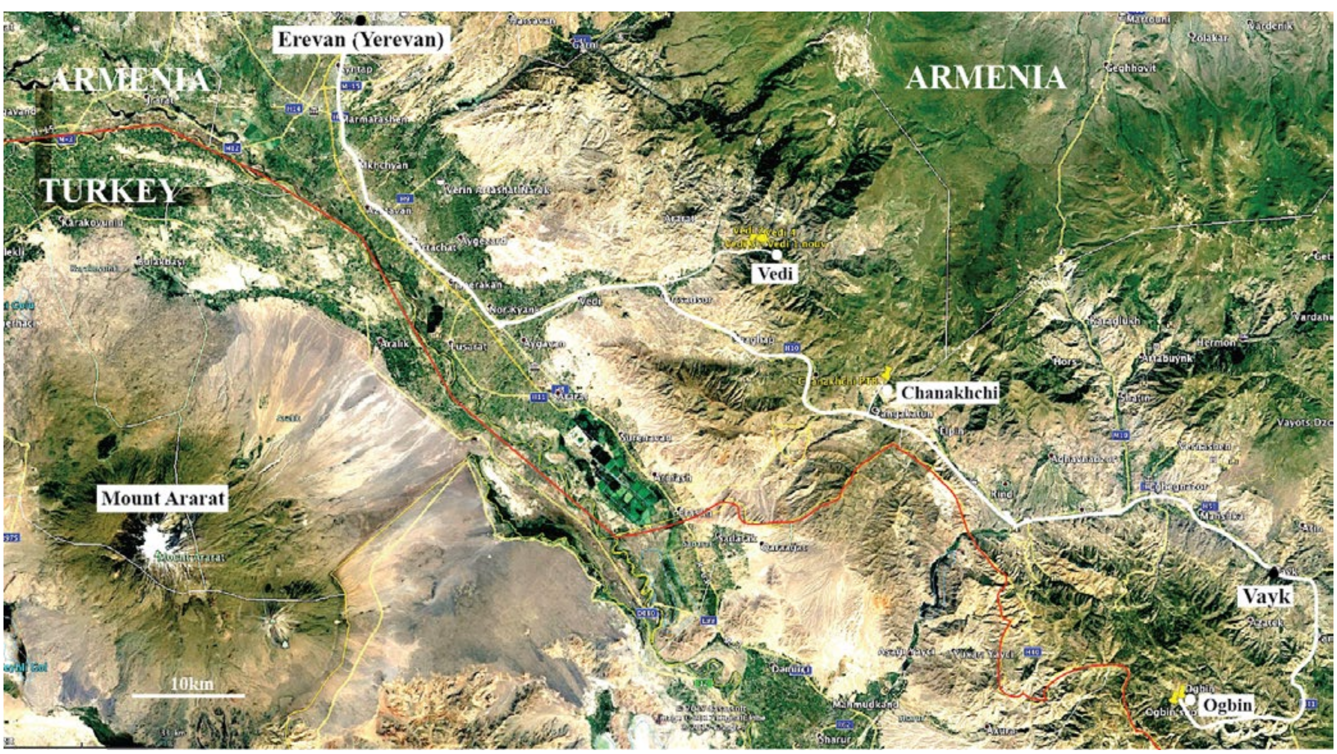


Fig. 2. Field workshop Itinerary (road in white, border in red).

Fig. 3. Participants at the conference, in the front, left to right: Dr. H.M. Adamyan, Prof. G. Bachmann, Prof. Z-Q. Chen, Dr. L. Sahakyan, Dr. A. Baud, Prof. S-Z. Shen, Prof. A. Biakov, Prof. L-S. Zhao.

Fig. 4. The Khor Virap Monastery at the foot of the Ararat Mountain, 5165m high.

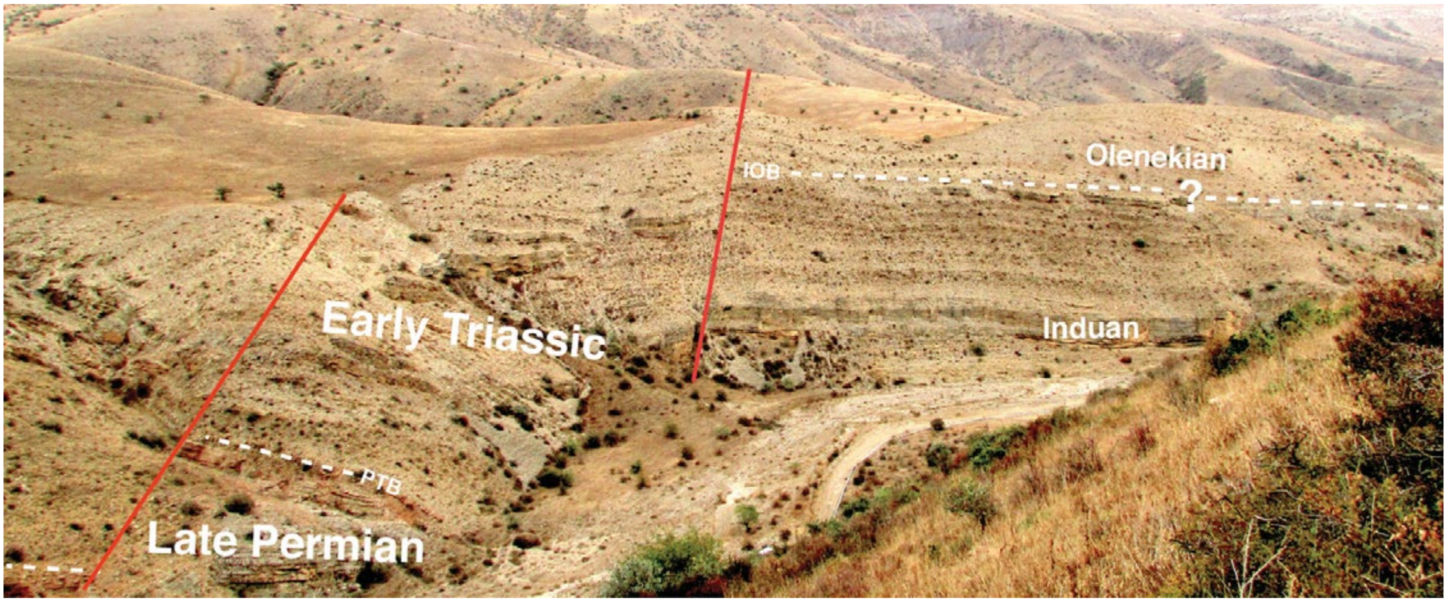


Fig. 5. The Ogbin section area looking to the NE, along the Tchahuk river.

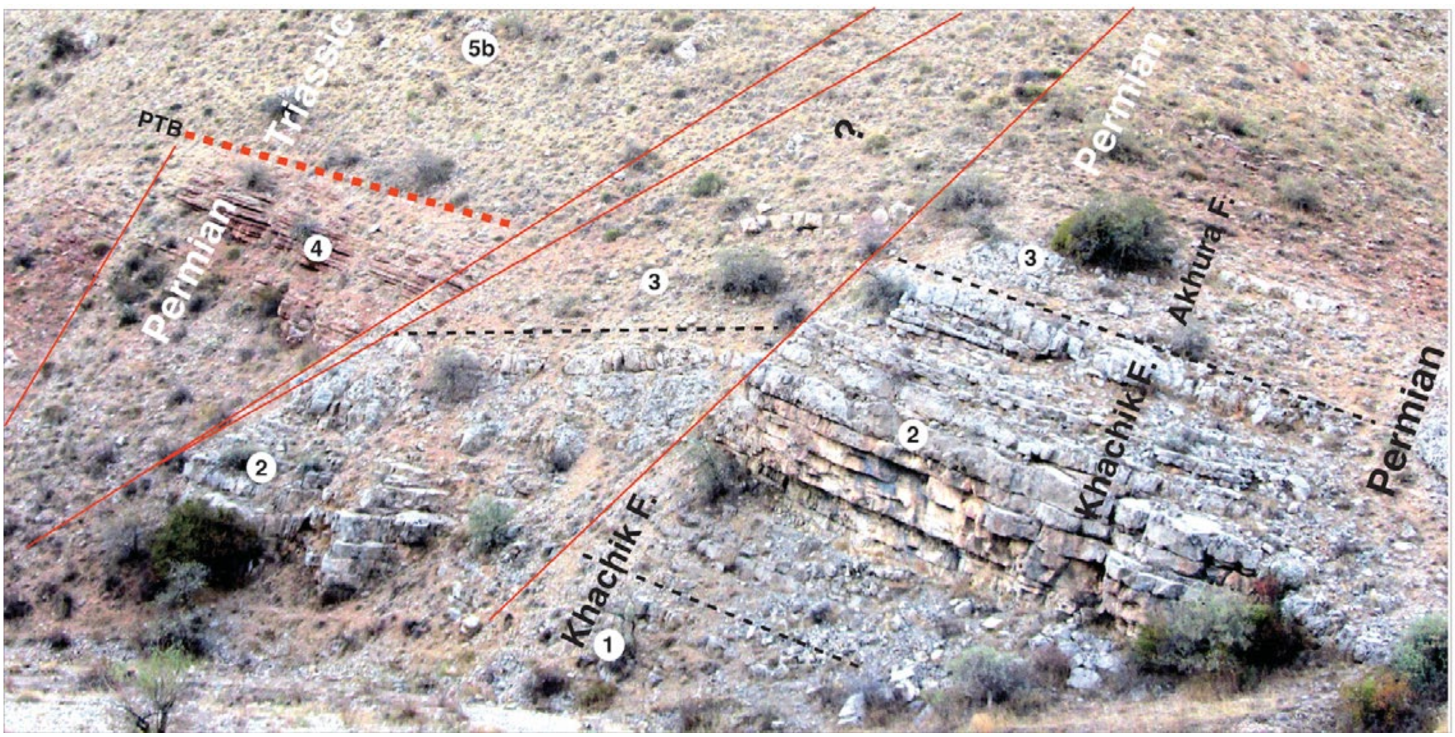


Fig. 6. Bottom right, outcrop of the Middle-Upper Permian Khachik Formation (Units 1-2); Unit 1, top of the Middle Permian (Capitanian) dark gray limestones. Unit 2, *Reichelina* - *Araxilevis* beds (lower Wuchiapingian), gray limestones followed by the upper Permian Akhura Formation (Units 3-4). Unit 3, *Araxoceras* and *Vedioceras* beds, gray yellowish marly limestones (upper Wuchiapingian). Unit 4, *Phisonites* to *Paratirolites* beds, red nodular marls and limestones (Changhsingian). Unit 5b, thin bedded limestones with SMB (Induan). Dashed black line: boundary between lithological units. Dashed red line: Permian-Triassic Boundary (PTB).

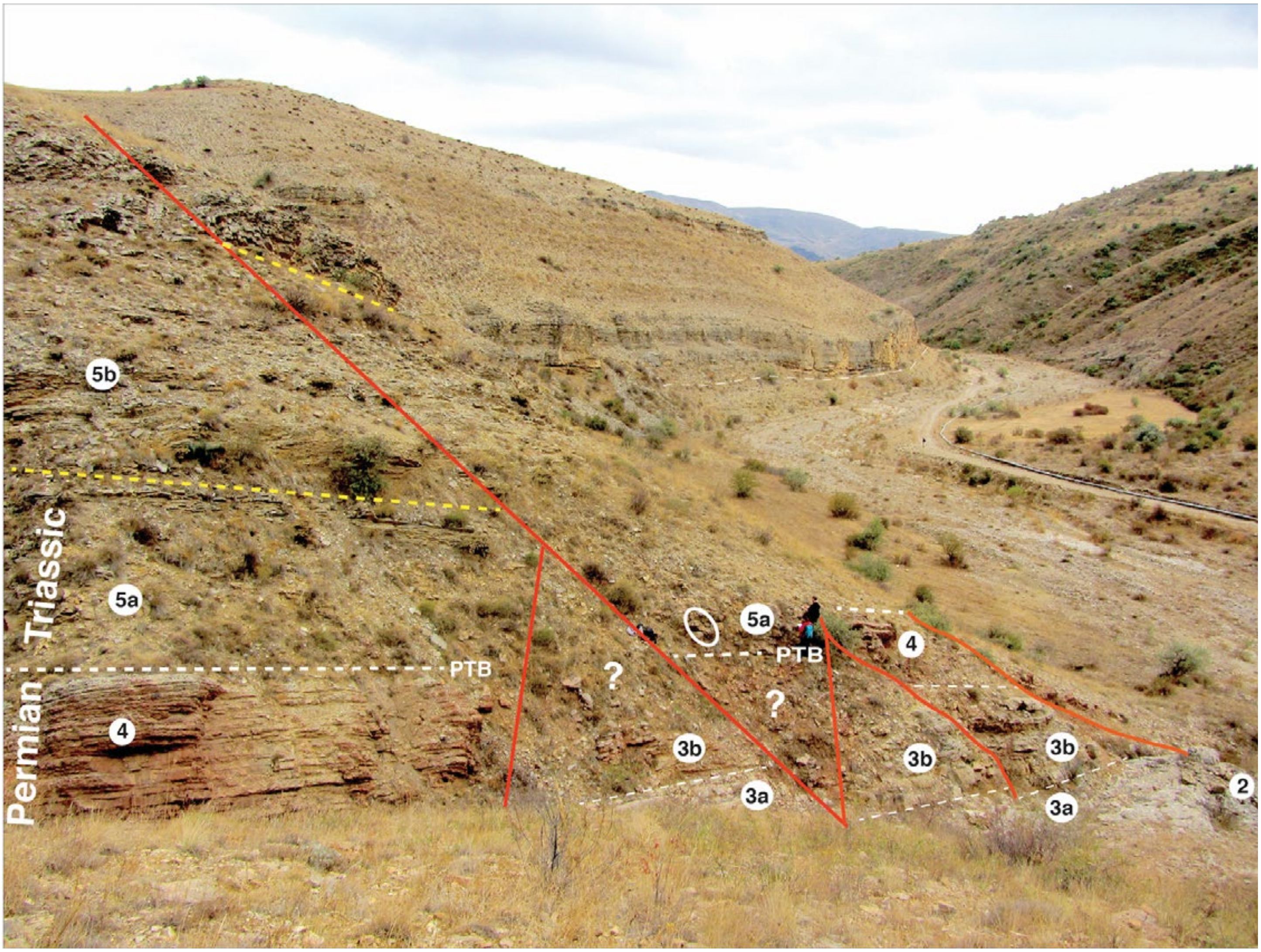


Fig. 7. View of the Permian-Triassic boundary and the red *Paratirolites* beds (4) bottom left (for unit 3 to 5, see caption in Fig. 6).

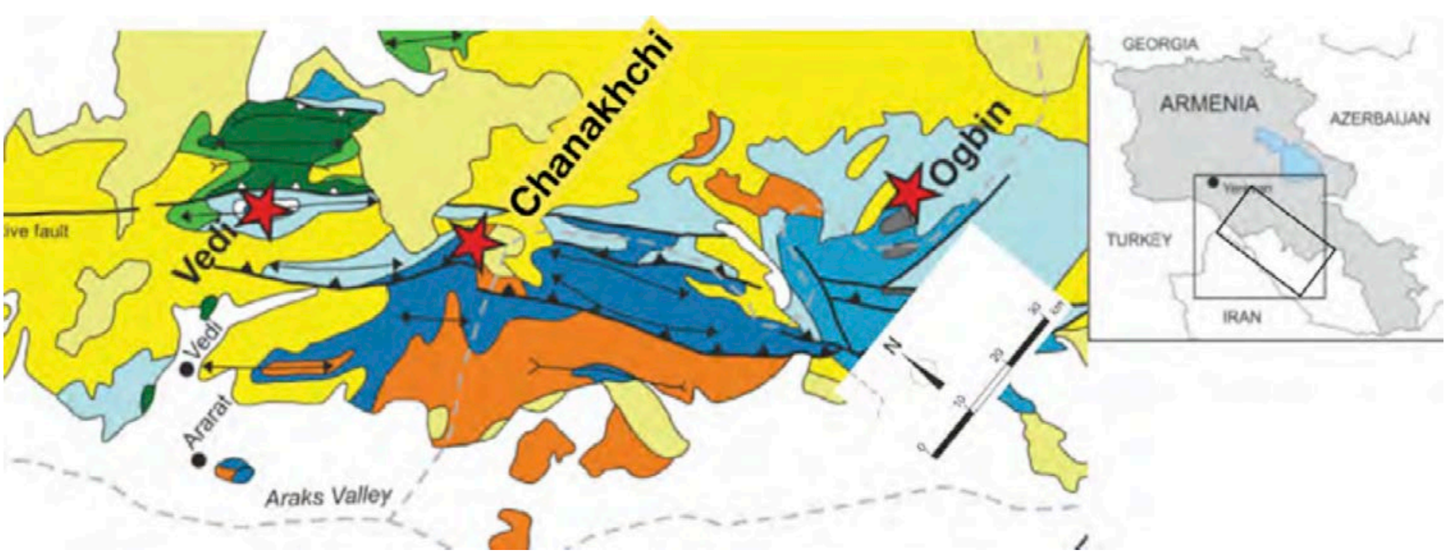


Fig. 8. Geological map of the area (Chanakhchi section: middle red star).

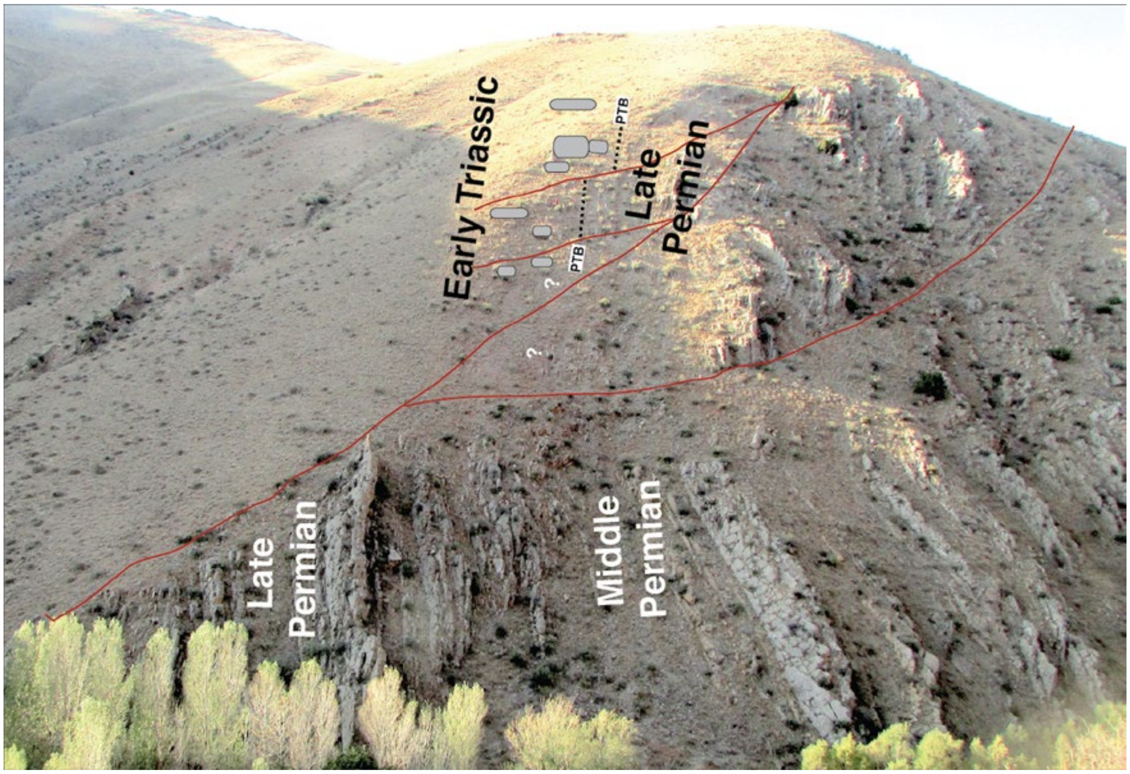


Fig. 9. View on the Chanakhchi hill from the opposite side. The vertical bedding of the Permian to Lower Triassic limestone is cut by large faults. The visited outcrops are in the upper part of the hill. Small gray surfaces: Sponge Microbial Build-ups (SMB). Dashed black line: PTB.

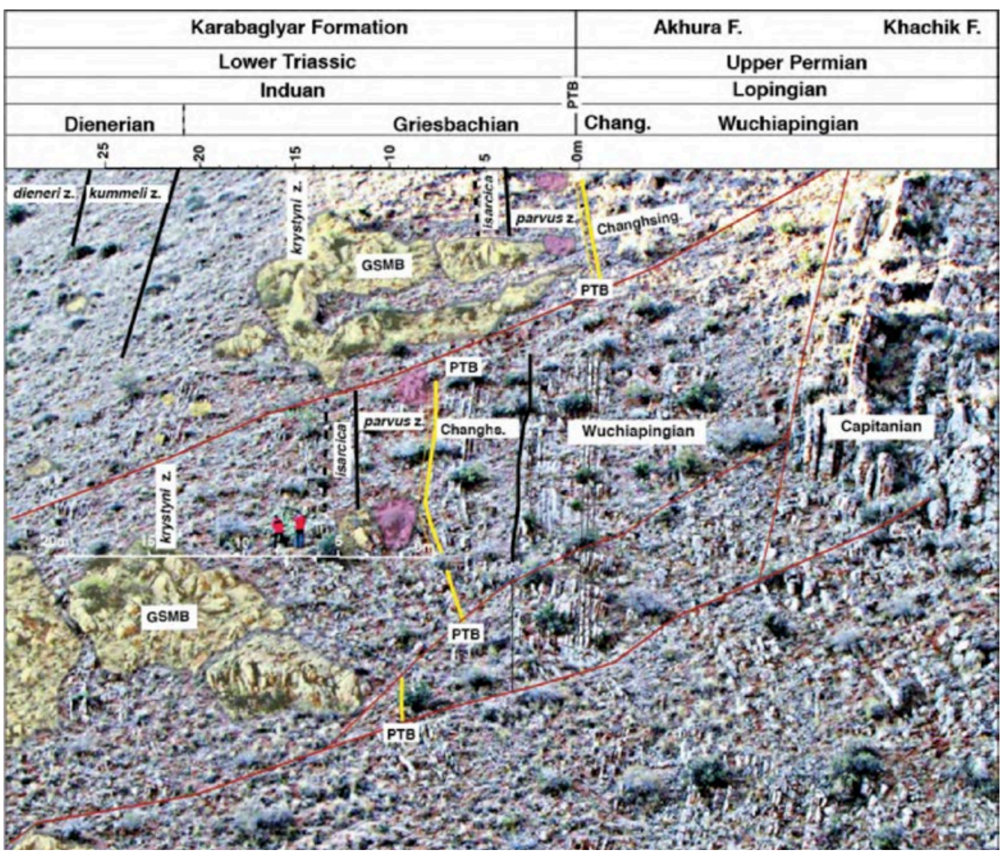


Fig. 10. Stratigraphic data across the Permian-Triassic Boundary (PTB: yellow line); red line: fault. Scale is given by two geologists with red jacket in the middle, just above horizontal white scale. Beds are vertical. The basal Triassic Giant Sponge-Microbial Build-ups (GSMB), highlighted in yellow and early phase of growth in pink).

Fig. 11. The Permian-Triassic transition, from right to left: top of the *Paratirolites* beds, in red the boundary shale (with 1 m scale along) and above the domal structure of the early phase of growth of 2 m-thick Sponge-Microbial Build-ups, with coalescent stromatolite or acicular stromatolite.

Fig. 12. A. Baud is giving explanations on the main giant sponge-microbial build-up discovered three years before.

Fig. 13. The main giant Sponge-Microbial Build-up behind part of a happy group after discussion.

Fig. 14. Dienerian small cylinder Sponge-Microbial Build-up (in front) with from left to right: Prof. Z-Q.Chen, Prof. S-Z. Shen, Dr. A. Baud, Dr. L. Sahakyan and Prof. G. Shi

Fig. 15. Participants to the 5th IGCP 630 International Conference and Field Workshop. Photo taken at Chanakhchi section.

Fig. 16. The medieval Noravank monastery (1339).

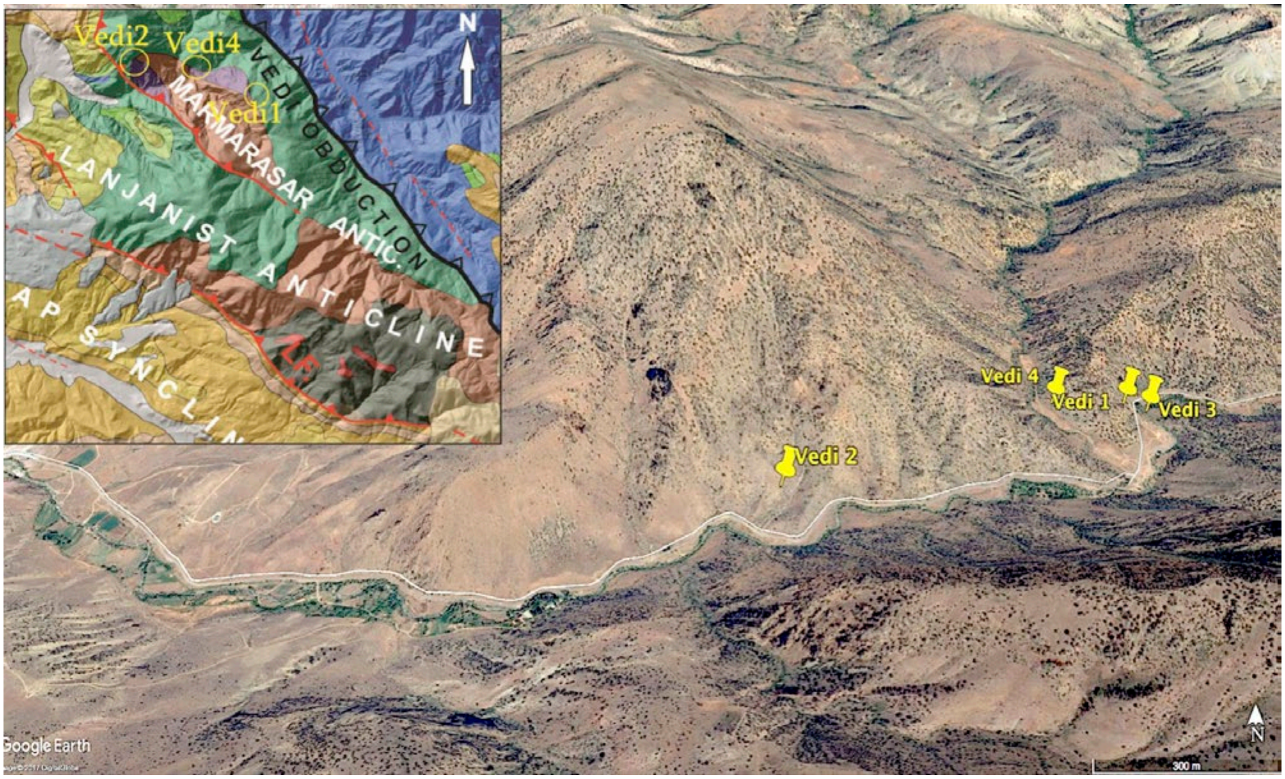


Fig. 17. Google Earth view on the Vedi river valley showing the position of the localities Vedi 1 to 4. Top left: Geological map of the Vedi area (Avagyan et al., 2015), with the Marmarasar (or Terterasar) anticline and the Vedi localities 1, 2and 4 (yellow circles).

Fig. 18. The Permian-Triassic transition with, from left to right, the basal Triassic SMB with fan structures, the boundary shale, the top of the *Paratirolites* bed. Scale (yellow), 20 cm.

Fig. 19. Left, detailed field view on part of the early growth of the basal Triassic SMB with its fan structures up to 20 cm high. Right, thin section scan view of the stromatolite microstructures. Scale bar: 1 cm.

Fig. 20. Dr. Lilit Sahakyan explaining the large Sponge Microbial Build-up at the Vedi 4 locality.

Fig. 21. Official dinner with Aymon's last song (Alouette).

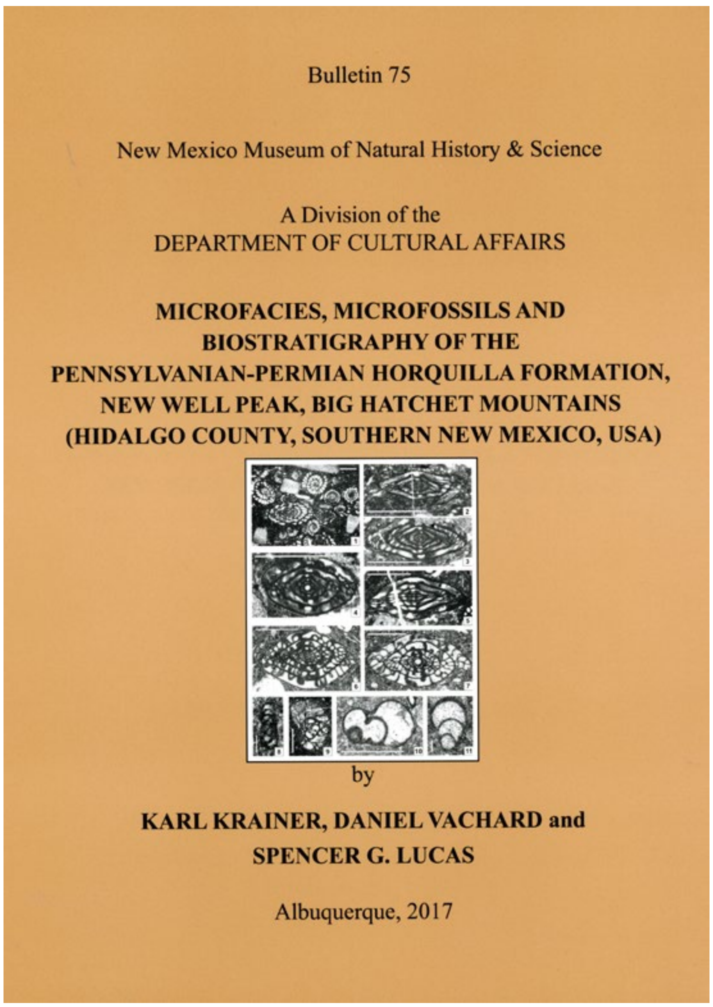
ANOUNCEMENTS

ANNOUNCING PUBLICATION OF NMMNH&S BULLETIN 75

Microfacies, microfossils and biostratigraphy of the Pennsylvanian-Permian Horquilla Formation, New Well Peak, Big Hatchet Mountains (Hidalgo County, southern New Mexico, USA)

by Karl Krainer, Daniel Vachard and Spencer G. Lucas

This 163-page volume presents a complete analysis of microfacies and calcareous microfossils of one of the world's most complete stratigraphic sections across the Carboniferous-Permian boundary.



If you are interested in ordering Bulletin 75, it costs $16 and you can contact Holly Lowe, Store Manager for the NMMNH&S, at hlowe@naturalhistoryfoundation.org to place orders.

ANNOUNCING PUBLICATION OF NMMNH&S BULLETIN 77

Carboniferous-Permian transition in Socorro County, New Mexico

Edited by S. G. Lucas, W. A. DiMichele & K. Krainer

This 352-page volume presents the results of 20 years of research on the Carboniferous and Permian fossils and strata of Socorro County, central New Mexico, USA

Contents

Paleoichthyological assemblages of the Upper Carboniferous-lower Permian of Socorro County, New Mexico
John-Paul M. Hodnett and Spencer G. Lucas

A new vertebrate coprolite locality from the Late Pennsylvanian of central New Mexico, USA and the environmental context and biochrononology of Carboniferous and Permian bromalites
Adrian P. Hunt and Spencer G. Lucas

A Pennsylvanian phylloid algal mound complex near Ojo de Amado northeast of Socorro, New Mexico
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Microfacies and sedimentary petrography of Pennsylvanian limestones and sandstones of the Cerros de Amado Area,
east of Socorro (New Mexico, USA)
Karl Krainer, Daniel Vachard, Spencer G. Lucas and Andrej Ernst

The Pennsylvanian section in the Los Pinos Mountains, Socorro County, New Mexico
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The pseudofossil *Astropolithon* from the lower Permian Abo Formation of Socorro County, central New Mexico
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The Permian System east of Socorro, central New Mexico (USA)
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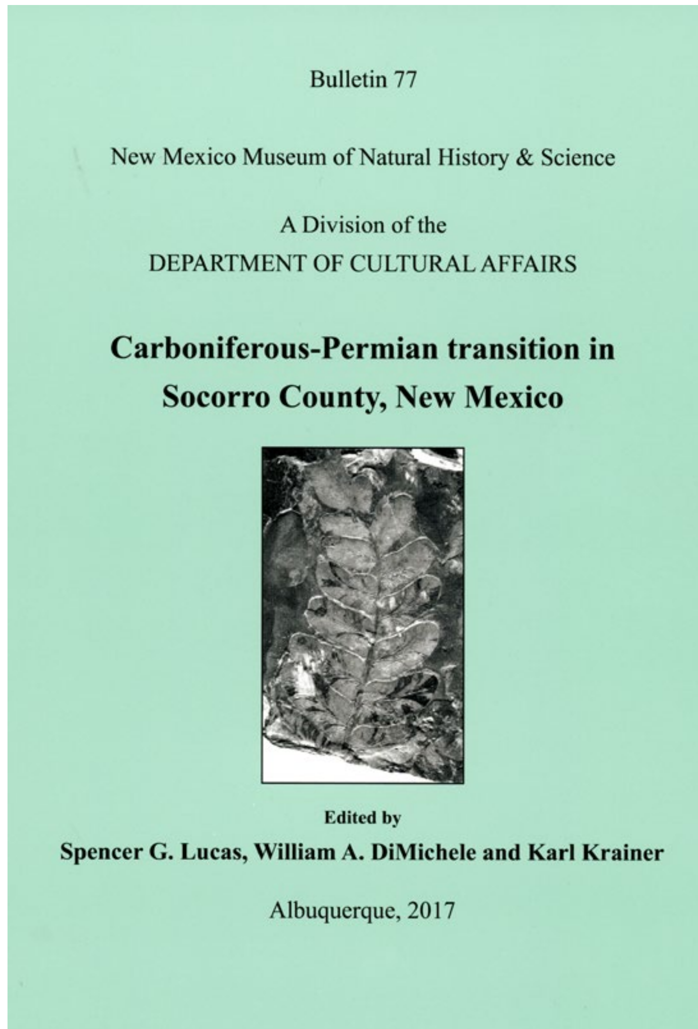
Early Permian tetrapod footprints from central New Mexico
Sebastian Voigt and Spencer G. Lucas



If you are interested in ordering Bulletin 77, it costs $30 and you can contact Holly Lowe, Store Manager for the NMMNH&S, at hlowe@naturalhistoryfoundation.org to place orders.

The Permian Timescale

Edited by Spencer G. Lucas and Shuzhong Shen
Geological Society, London, Special Publications 450
To be published in February 2018

This volume brings together state-of-the-art reviews of the non-biostratigraphic and biostratigraphic data that are used to define and correlate Permian time intervals. It includes analyses of Permian radio-isotopic ages, magnetostratigraphy, isotope-based stratigraphy and timescale-relevant biostratigraphy. It is the first book devoted to this subject and represents the cutting edge of Permian time-scale research.

All of the chapters of the volume have been released online at: http://dx.doi.org/10.1144/SP450

The Fossil Week

Paris – 9th-13th July, 2018

GENERAL INFORMATION

Web site: https://ipc5.sciencesconf.org
Contact: congress-ipc5-contact@mnhn.fr

Key dates

Deadline for **Early bird registration**	December 31st 2017
Deadline for **Abstract submission**	February 15th 2018
Deadline for **second wave registration**	March 31st 2018
Scientific program and 3rd circular	May/June 2018

	Scientific sessions	Organizers
S1	Ancient ecosystems trapped in amber	B. Wang, V. Perrichot, E. Jarzembowski
S2	Angiosperms, from the beginning to their diversification	A. Boura, D. De Franceschi, J.B. Diez-Ferrer
S3	Back to the sea: from Late Palaeozoic to Cenozoic, the Tetrapod adventure	N. Bardet, V. Fischer, A. Houssaye, S. Jouve, O. Lambert, P. Vincent
S4	Big Data in Paleontology: sharing knowledge for leveraging research options	W. Kiessling, L. Villier, J. Bardin
S5	Biodiversity changes through times: crisis and radiations	S. Crasquin, T. Addatte
S6	Biominerals through time: evolution, taphonomy and traces in the geological record	A.H. Knoll, K. Benzerara, S. Bernard
S7	Bird in the past environments	D. Angst, A. Chinsamy-Turan
S8	Cenozoic palaeobiology of the tropical Americas: palaeoecology, biodiversity and evolution	D.A.T. Harper, S.K. Donovan, R.W. Portell
S9	Coevolution of Life and Environments: Integrating the Paleoecological, Sedimentological and Geochemical Records	L. Tackett, L. Tarhan
S10	Conservation paleobiology and historical ecology of marine ecosystems	P.G. Albano, A. O'Dea, M. Zuschin
S11	Data, dispersals and interchanges through time: a land mammal perspective	P.O. Antoine, V. Zeitoun, L.J. Flynn
S12	Early animal life	J. Vannier, J.B. Caron

S13	Evolution of Indo-Pakistan biotas from the break-up of Gondwanaland (Late Jurassic) to the initiation of the collision with Eurasia (Eocene): between endemism and dispersals	G. Métais, D. De Franceschi, G.V.R. Prasad
S14	Evolution of trees and forests	B. Meyer Berthaux, A.L. Decombeix, P. Gerrienne
S15	Experimental approaches in paleontology: new data from old fossils	G. Merceron, T. Tütken, G. Bérillon
S16	Fossil 2D/3D imagery: approaches, advances, management	R. Lebrun,M. Orliac, I. Rahman, I. Rouget, G. Clément
S17	Fossils and Recent, molecules and morphology: dialogs in phylogenetics	G. Billet, N. Puillandre, G. Giribet
S18	Functional morphology of the cranium in vertebrates	C. Pfaff, J. Kriwet
S19	How to build a palaeontological collection : expeditions, excavations, exchanges.	E. Buffetaut, I. Podgorny
S20	Intimate interactions	O. Béthoux, N. Robin, T. Wappler
S21	Konservat-Lagerstätten	S. Charbonnier, J.T. Haug
S22	Life in Palaeozoic seas and oceans	E. Nardin, V. Perrier, T. Vandenbroucke
S23	Life in the time of Pangaea: volcanism, warming, anoxia, acidification and extinction	A.M. Dunhill, D.P.G. Bond, P.B. Wignall
S24	Macroecology and the Fossil Record	G. Escarguel, E. Fara, S. Fritz
S25	Mesozoic Paleontology and Paleoenvironments of Indochina	J. Legrand, T. Tsuihiji, T. Komatsu
S26	Microorganism evolution and interaction with biogeochemical cycles and climate	A. Bartolini, S. Gardin, L. O'Dogherty
S27	Neogene continental environments in Africa and Eurasia	B. Senut, L. Ségalen, N. Fagel
S28	New trends in stratigraphy - Stratigraphic section (SGF) session	E. Nardin, D. Desmares, J. Palfy
S29	Origins of phyla and the assembly of animal body plans	D. Murdock, I. Rahman, A. Daley, P. Smith
S30	Palaeobiodiversity of Southeast Asia	H. Tong, V. Suteethorn, J. Claude
S31	Palaeontology and geological heritage	G. Egoroff, S. Charbonnier, A. Lefort
S32	Paleobiodiversity and evolutionary history of vertebrates in Africa	N. Jalil, E. Gheerbrant, A. Chinsamy-Turan, E. Seiffert
S33	Paleobiogeography	S. Kiel
S34	Shell beds through time: implications for paleoecology, taphonomy and evolution	J.H. Nebelsick, M. Zuschin, A. Tomasovych
S35	Testing and developing Phylogenetic methods in Palaeontology	J.O'Reilly, M. Puttick, D. Pisani, P. Donoghue
S36	The conservation of paleontological collections: challenge and perspectives	V. Rouchon
S37	The Devonian: life, environments and time	J. Marshall, L. Slavik, C. Brett
S38	The onset of the Gre**at Ordovician Biodiversification (GOBE): fossils, radiations and Lagerstätten - IGCP 653 session**	T. Servais, D. Harper, B. Lefèvre, A. Hunter
S39	The role of biotic interactions in the evolution of tropical ecosystems	J.-R. Boisserie, Faysal Bibi

S40	Timetrees	M. Laurin, G. Didier
S41	Vertebrate paleophysiology	J. Cubo, A.K. Huttenlocker
S42	XXIst Century paleohistology of mineralized tissue	M. Rücklin, G. Cuny, D. Germain, S. Sanchez
S43	Open session	D. Gommery, S. Peigne, M.B. Forel

SHORT COURSES & WORKSHOPS

Some short courses and workshops will be organized on Wednesday July 11th.

Geobiodiversity Database

1 session - maximum of 60 participants in this session

Organiser: Fan Junxuan, *fanjunxuan@gmail.com*

Palaeontology, databases and interactive keys, a winning combination?

1 session - maximum of 20 participants in this session

Organiser: Adeline Kerner, *adeline.kerner@mnhn.fr*

Scientific illustrations

2 sessions - maximum of 20 participants in any session

Organiser: Sophie Fernandez, *sophie.fernandez@mnhn.fr*

EXCURSIONS AND FILD TRIPS

The capacity of field trips is limited and will be filled on a first-come first-served basis. Registrations to the field trips must happen with the registration to the conference. Trips may be cancelled if under-subscribed.

Before purchasing travel tickets for the point of departure/arrival, please ask the organizers for confirmation that the trip will actually take place. The transport costs will be supported by the participant. If you have further question, please contact the organizers.

Participants are advised to take out their own personal health and travel insurance for their participation at excursions and field trips.

ABSTRACT SUBMISSION

Abstract submission will be handled entirely by our system. Please follow the guidelines given in the submission workflow. The abstract text body should be limited to 2,500 characters including spaces.

Due to the high number of participants, **oral presentation is limited to one as first author** (you can be first author of several posters and co-author of several oral presentations).

The abstract submission deadline is February 15th 2018.

You may submit your abstract by visiting our abstract submission system.

- To submit an abstract you need to be connected in the SciencesConf system (https://ipc5.sciencesconf.org/, the login icon on Home page). If you are not registered you will be asked to do so. If you are already registered in SciencesConf, please enter your username and password.

- At the beginning you will be asked to enter or paste the title (a **maximum of 200 characters** including spaces) and then the abstract text (a **maximum of 2,500 characters** including spaces and Arial 12-point font size are allowed). Your abstract should only contain text, no key-words, nor references neither figures are allowed.
- Then follow the submission step by selecting the session. Talk and poster presentation options are available for selection.
- Next step will bring you to the authors' page (all abstracts are limited to a maximum of **10 authors** and **one institution** by author). Fill the form as required.
- At the end you will be redirected to a summary page where you can either accept your upload or return and edit your content. Once you finished the submission, you will receive an acknowledgement of your submission by email.
- Abstract can be modified online until the deadline. Supplemental files might be uploaded but this is clearly optional.

Acceptance and the next steps

Abstract will be considered for revision only if the corresponding author is fully registered (including payment). Please notice that an abstract not accompanied with a full registration will be deleted after the 15th of March 2018.

- The submitted abstracts will be evaluated and the acceptance will be communicated no later than April 15th 2018. The authors should suggest their preferred mode of presentation (oral or poster), but the scientific session boards will decide the final destinations of the abstracts.
- The online version of the programme along with the abstracts will be available on line during the congress.
- All accepted abstracts will be scheduled for oral or poster presentation and will be compiled in PDF format. A digital version of the abstracts and the congress's final programme will be available on the IPC5 Congress's website.

8th IBC Milan, Italy, 2018

8th INTERNATIONAL BRACHIOPOD CONGRESS

Brachiopods in a changing planet: from the past to the future

Milan, 11-14 September 2018
www.8brachiopodcongress.com

The *8th International Brachiopod Congress: Brachiopods in a changing planet: from the past to the future* will take place between the 11th and 14th of September 2018 in Milano, Italy, in the prestigious venue of Università degli Studi, via Festa del Perdono 7, Milano, just a few steps from the famous Duomo Cathedral.

The quality of accommodation and tourist attractions of the City of Milano and the excellent transportation links with most Italian and European towns will make this event very appealing to an international audience. The Congress is expected to attract about 200 participants from universities and research institutes from around the world.

Participants will come to discover the past, latest and future developments of brachiopod research. They will also come to experience the fantastic nature and profound culture of Italy, a safe and beautiful country. Within the 3-day meeting, participants will have the opportunity to present their latest results in stimulating and vibrant sessions, discuss at length and be deeply involved in the brachiopod world. The topics of the Congress will include all aspects of the study of brachiopods, from systematics and evolution to biostratigraphy, palaeoecology, palaeobiogeography, biomineralization and geochemistry, to the biology of extant brachiopods.

In addition to scientific oral and poster sessions, and three prestigious plenary lectures, the Congress will be preceded and followed by wonderful field excursions (two in Italy: Dolomites and Sicily, one in the UK and one in Spain). A pleasant interlude will be offered by two Mid-Congress excursions only a short distance from Milano.

In order to promote cultural exchange and scientific development of young people, European and non-European graduate students will be able to participate on particularly favourable terms.

We thank you in advance for your attention and hope to welcome many of you to Italy in September 2018.

To know more, visit the website Congress website: http://www.8brachiopodcongress.com/index.html

Looking forward to meet you in Milano!

The General Chairs of the Congress
Lucia Angiolini and Renato Posenato

GENERAL CHAIRS
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Renato Posenato, *Università di Ferrara, Italy*

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Daniela Henkel, *GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany*
Marco Romanin, *Polish Academy of Science, Warsaw, Poland*
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Alberto Pérez-Huerta, *University of Alabama, United States*
Renato Posenato, *Università di Ferrara, Italy*
Shuzhong Shen, *Nanjing Institute of Geology and Palaeontology, China*

The 19th International Congress on the Carboniferous and Permian will take place from July 29th to August 2nd, 2019, in Cologne, Germany.

Four days with scientific sessions and a mid-congress field trip will provide ample time for scientific presentations and discussions. Pre-congress and post-congress field trips are planned to visit Carboniferous and Permian strata in Germany and adjacent countries. After the Carboniferous congresses held in Krefeld (1971), Kraków (1998) and Utrecht (2003), the meeting finally will find its way back to central Europe, giving a splendid opportunity to explore some of the most classical regions of the Carboniferous and the special Rotliegend and Zechstein facies of the Permian outside of the Palaeotethys realm.

In the remaining weeks of 2017 we will set up the organisation committee and a website. However, all help is greatly appreciated to make the congress a success. Therefore, we invite everybody to propose topics for sessions, workshops, fieldtrips, etc. For the time being, please address me for all information and proposals.

To know more, visit the website of the preceding ICCP in Kazan, where you will find our successful proposal to host the congress in Cologne at http://kpfu.ru/iccp2015

Looking forward to meet you in summer 2019!
Hans-Georg Herbig
herbig.paleont@uni-koeln

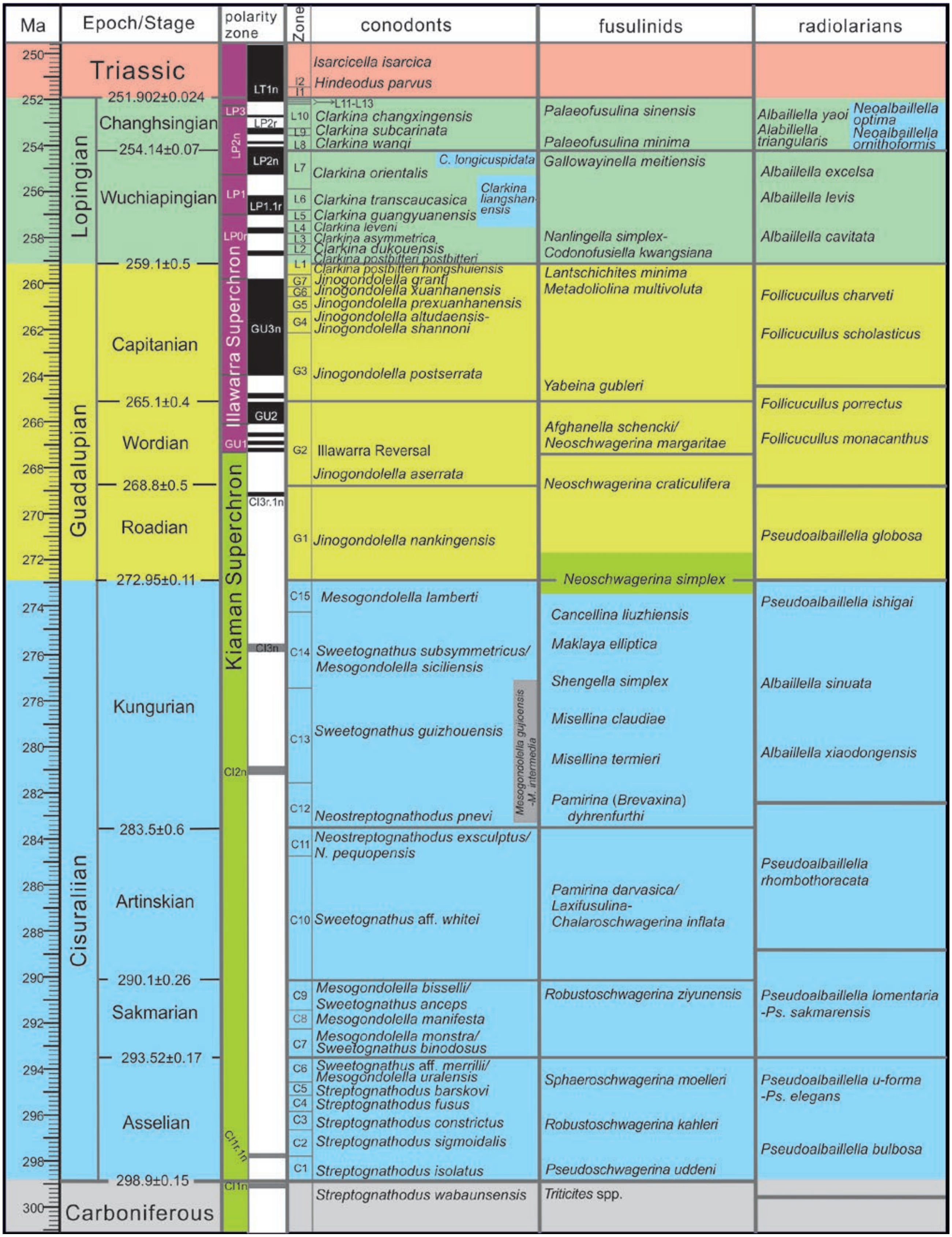
SUBMISSION GUIDELINES FOR ISSUE 66

It is best to submit manuscripts as attachments to E-mail messages. Please send messages and manuscripts to Lucia Angiolini's E-mail address. Hard copies by regular mail do not need to be sent unless requested. To format the manuscripts, please follow the TEMPLATE that you can find on the new SPS webpage at http://permian.stratigraphy.org/ under Publications. Please submit figure files at high resolution (600 dpi) separately from text one. Please provide your E-mail addresess in your affiliation. All manuscripts will be edited for consistent use of English only.

Prof. Lucia Angiolini (SPS secretary)

Università degli Studi di Milano, Dipartimento di Scienze della Terra "A. Desio", Via Mangiagalli 34, 20133 MILANO Italy, E-mail: lucia.angiolini@unimi.it

The deadline for submission to Issue 66 is June, 30th, 2018.



This is the latest timescale of the Permian System credited by Shuzhong Shen and Lucia Angiolini. The data are integrated from the online publications by Ramezani and Bowring (geochronology), Zhang and Wang (fusulinids), Henderson (conodonts), Zhang et al. (radiolarians), Hounslow and Balabanov (magenetostratigraphy) in the Special Publication 450 of Geological Society, London (http://sp.lyellcollection.org/online-first/450). This special publication will be formally published with page number in early 2018.