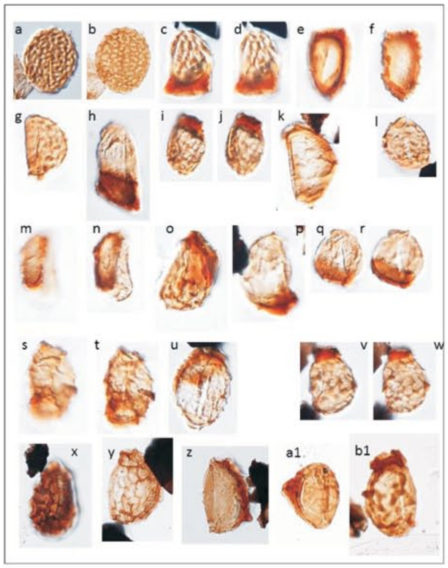
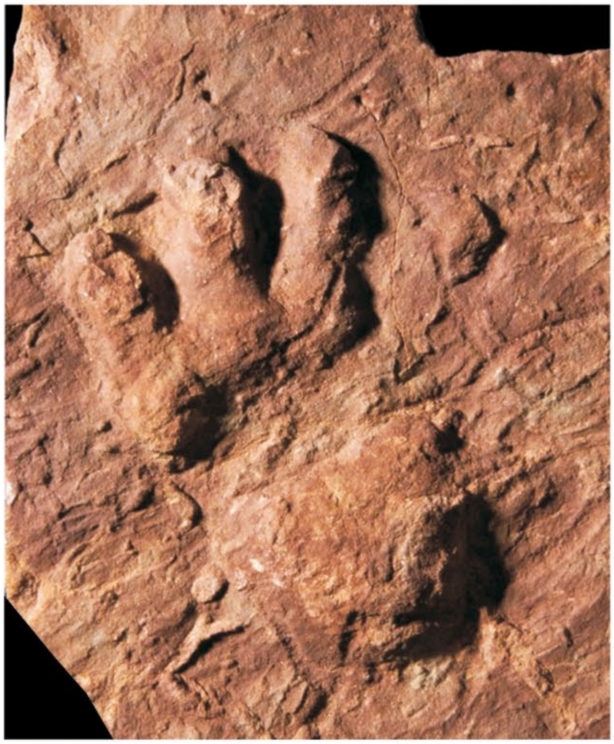
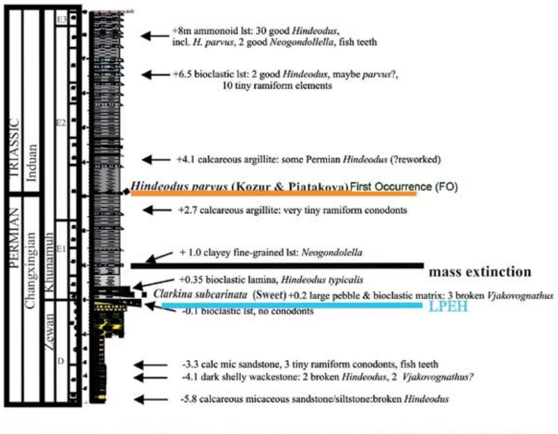
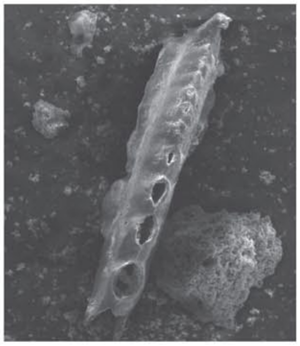
Permophiles

International Commission on Stratigraphy
International Union of Geological Sciences









Newsletter of the
Subcommission on
Permian Stratigraphy
Number 61
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June 2015

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EXECUTIVE NOTES

Notes from the SPS Secretary

Lucia Angiolini

Introduction and thanks

The preparation for Permophiles 61 was done in Nanjing between May 22th and 24th, 2015, when I had the opportunity to participate in the 7th International Brachiopod Congress, organized by Shuzhong Shen and Renbin Zhan. Permian colleagues participated in the congress, held in the beautiful city of Nanjing, and we had the opportunity to continue our discussion on Permian brachiopods and Permian global events.

In this foreword, I would like to thank Shuzhong Shen for supporting my stay in Nanjing, as well as offering 18 young scientists the opportunity to participate in the Brachiopod Congress. In particular, Huang Bing and Shuzhong Shen edited the abstract volume of the 7th International Brachiopod Congress, which has been published (already online since May 2015!) as a supplement to this Permophiles issue.

I want to express my gratitude to our Permian colleagues who made this issue rich and interesting with their contributions: Hafid Saber, Spencer Lucas and coauthors, Joerg Schneider and Spencer Lucas, Amalia Spina and coauthors, Mike Stephenson, Fabio Petti and coauthors and Michael Brookfield and Yadong Sun.

Also, I would like to thank Claudio Garbelli for his assistance in editing this and previous issues of Permophiles.

Finally, I would like to keep drawing your attention to the new SPS webpage that Shuzhong Shen has provided at http://www.stratigraphy.org/permian/, 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, very important, the updated Permian timescale.

Forthcoming SPS Meetings

An SPS meeting is scheduled during the XVIII International Congress on the Carboniferous and Permian (ICCP 2015) to be held at the Kazan Federal University, City of Kazan, Russia, August 11 – August 15, 2015. All voting members are warmly invited to participate in a pre-congress field excursion organized by the Permian Subcommission on Stratigraphy to investigate the three candidate Cisuralian GSSPs in the southern Urals (Permophiles 60, p. 39).

An up-to-date summary of the event and the link to the congress web-site are available at the end of this Permophiles issue.

Permophiles 61

This issue starts with reports of two recently held congresses: The First International Congress on Continental Ichnology ICCI-2015 by Hafid Saber and the 7th International Brachiopod Congress 7IBC by Lucia Angiolini.

ICCI-2015 was held in the Faculty of Sciences, Chouaïb Doukkali University, El Jadida, Morocco, on 21-25 April, 2015 and was attended by more than 50 ichnologists from 5 continents and 18 countries. The first two days of the congress were devoted to keynotes, oral presentations, and posters; the last three days to a field excursion to the famous Permian, Triassic, and Jurassic ichnosites of the Argana region (western High Atlas). The event was very important for discussion of current problems and future perspectives on vertebrate and invertebrate ichnology and their application on biostratigraphy, paleobiogeography and paleoecology and was linked to the activities of the "Non-Marine - Marine Correlation Working Group".

The 7th International Brachiopod Congress was held on May 22-25, 2015 in Nanjing, China, hosted by the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences. It was attended by 104 delegates from 20 countries/regions of Europe, Asia, America, and Australia, who had the opportunity to exchange their knowledge on Brachiopoda and related areas, and recent advances in the field. The congress included a 3-day in-door meeting, one mid-conference excursion within Nanjing and three post-conference field excursions (Kunming of eastern Yunnan; central Anhui, western Zhejiang and northeastern Jiangxi; Guilin of Guangxi). The event was very important for discussion of the main topics in brachiopod research, including also Permian brachiopods.

The first report in this issue of Permophiles by Lucas et al. provides a clear view of the correlation of nonmarine and marine Lower Permian strata in New Mexico, USA. This sedimentary succession provides a remarkable opportunity to correlate nonmarine and marine biostratigraphic units of the Carboniferous-Permian boundary and of the Lower Permian, as it preserves a N-S paleoenvironmental transect from nonmarine red beds, to transitional strata, to wholly marine beds. The authors provide a table of correlation of nonmarine and marine strata from north to south across central New Mexico, and discuss the foraminiferal biozonation of the marine Lower Permian of southern New Mexico, that can be correlated to the standard global chronostratigraphic scale.

Stephenson illustrates unusual and varied monolete spores from the uppermost Permian Umm Irna Formation of Jordan, large numbers of which in the Permian are often considered to suggest Cathaysian palaeophytogeographic affinity. Palynologists and palaeobotanists have long suspected that the palaeotropical conditions of Cathaysia may have provided a refuge for the vegetation of the Pennsylvanian swamps of Euramerica, but abundant monolete spores are rarely described from the latest Permian of the Middle East.

The next report by Spina and coauthors concerns an original study of organic microfossils from the Faraghan Formation, which is part of a project on the paleontology and biozonation of Palaeozoic sediments of Central Iran and the Zagros Basin. This new research suggests a Guadalupian age for the formation, younger than that proposed before.

Petti and co-authors report the occurrence of a specimen assigned to cf. *Protochirotherium* sp. from the Upper Permian Arenaria di Val Gardena of NE Italy. This finding is very important as it suggests an earlier FAD for the taxon, and it shifts the lower boundary of the Protochirotherium biochron, previously considered Induan, into the Changhsingian. It also confirms that Chirotheriid footprints cannot be considered exclusive to Mesozoic units.

Brookfield and Sun describe new conodont findings at the Permian-Triassic boundary section of Guryul ravine, Kashmir. They confirm the FAD of *H. parvus* in bed 52, and record the occurrence of the cold water taxon *Vjalovognathus* in the pre-mass extinction beds. This has important implications for understanding the palaeoclimate evolution leading to the Permian-Triassic boundary events.

The paradox of global anoxia in the latest Permian is briefly discussed by Garbelli et al., with the aim of stimulating some scientific discussion and less speculation.

Finally, a very important call is made by Schneider and Lucas, who solicit contributions from Permian colleagues to achieve the main objective of the Nonmarine-Marine Working Group, that is the compilation of a Pennsylvanian-Permian-Early Triassic Nonmarine-Marine Correlation Chart. **Please, if you can, answer this call!**

Future issues of Permophiles

The next issue of Permophiles will be the 62th 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 for next issue**.

The deadline for submission to **Issue 62** is **15th November, 2015**. Manuscripts and figures can be submitted via email address (lucia.angiolini@unimi.it) as attachments.

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

We welcome your contributions and advice to improve the webpage as we move forward.

Notes from the SPS Chair

Shuzhong Shen

I would thank Lucia for her coming to Nanjing to join in the 7th Brachiopod Congress and edit this issue of Permophiles. I would also thank all contributors to make this issue very interesting. Permophiles is a platform of SPS to publish your reports quickly, provide free discussion and make announcements for the Permian community. Your contributions are very important to move the Permian issues forward.

SPS has organized a field excursion to the three potential GSSP candidates of the Cisuralian Series in southern Urals (A3 of ICCP 2015, August 6-10). We hope more voting members will join in the field excursion. It is very important for you to see all sections before you make your decision and provide your suggestions to choose the GSSPs of the Cisuralian. SPS will cover the field excursion fees for all voting members with the funding from ICS for those who attend the excursion.

The ICCP 2015 will be held in Kazan, Russia on August 11-15, 2015. I will give a talk on the current status of all ratified GSSPs and potential GSSP candidates. I hope all of you are going to provide your suggestions how to move forward the remaining GSSP work in the Permian. We are still waiting for the description of the conodonts (Sweetognathus aff. whitei) from the Dulny Tulkas section and we hope we will reach agreement on which conodont species (Sweetognathus merrilli or Mesogondolella uralensis) should be used for the index species of the Sakmarian Stage at the Usolka section. We hope we can conduct a voting process for the Artinskian-base and Sakmarian-base GSSP candidates after the field excursion of ICCP 2015.

The current executive committee of SPS will finish their task in August, 2016. We will move forward with election of chair and vice-chair(s) of the Permian Subcommission on Stratigraphy for the term of 2016-2020. We have nominated our former SPS Chair Charles Henderson as the Chair of the Nominations Committee tasked with either drawing up a slate of candidates for election of the new chair and vice-chair of SPS or gathering your opinions whether you agree with the current executive committee serves another 4-year term or not. Please let Charles know if there are any names you would like to bring to the Nominations Committee's attention, with a few lines in support of your suggestion. Charles will send an email to all voting members to gather their opinions for the next SPS executive committee. New term of Chair and Vice-Chair will begin at the end of IGC in 2016. Results of elections of new officers and voting members are to be submitted by end of August 2015 to the ICS Executive for approval. This is also a good time for us to consider voting members of our subcommission. If you have any suggestion, please send your opinion to our SPS secretary Lucia Angiolini.

In early April, I organized another field trip to the Guadalupe Mts. in West Texas to collect additional samples from the three GSSP sections and some others. The purpose of this trip was to refine the GSSPs in the Guadalupe National Park and realize high-resolution correlation with the Guadalupian Series of South China. Those samples will be processed shortly. A few ash beds in the Guadalupian Series were collected as well. Jahan Ramezani, Douglas Erwin, Hua Zhang, Yichun Zhang and Dongxun Yuan joined in the field trip. I appreciate Jonena Hearst's guide to the sections and numerous helps during our field trip.

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REPORTS

Report on the First International Congress on Continental Ichnology [ICCI-2015], El Jadida, Morocco, 21-25 April, 2015

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Organization and objectives of the meeting

The First International Congress on Continental Ichnology (ICCI-2015) was held at the Faculty of Sciences, Chouaïb Doukkali University, El Jadida, Morocco, from 21st to 25th April, 2015. The first two days were devoted to keynotes, oral presentations, posters and the last three days for the field excursion.

The Department of Geology, Faculty of Sciences, Chouaïb Doukkali University - El Jadida, has the most important collection of Late Palaeozoic-Early Mesozoic continental trace fossils in North Africa. In this context, the Ichnological Association of Morocco and Laboratory of Geodynamic and Geomatic, in collaboration with the Institute of Geology (TU Bergakademie Freiberg, Germany), the Urweltmuseum Geoskop (Thallichtenberg, Germany) and the Saurierwelt Paläontologisches Museum (Neumarkt, Germany) with the assistance of the International Commission on Stratigraphy, “Subcommission on Permian Stratigraphy”, organized the “First International Congress on Continental Ichnology” (ICCI-2015). The ICCI-2015 was devoted to vertebrate and invertebrate ichnology and their application on biostratigraphy, paleobiogeography and paleoecology from a global perspective and originates from activities in the "Non-Marine - Marine Correlation Working Group". It was also a major meeting of ichnologists and palaeontologists to discuss current problems and future perspectives of ichnotaxonomy of vertebrate and invertebrate ichnofossils from continental deposits as well as biostratigraphic and paleobiogeographic aspects of trace fossils and their potential producers.

The two main topics consisted of (1) Vertebrate and invertebrate ichnology of continental deposits and (2) Methods, applications and conservation.

The event was financially sponsored by the Chouaïb Doukkali University, Faculty of Sciences, O.C.P. Group (The Cherifian Office of Phosphates, Morocco), IAS (International Association of Sedimentologists), C.N.R.S.T. (National Center for Scientific and Technical Research), and A.M.G. (Moroccan Association of Geosciences). Further organizations supported ICCI-2015, such as IIA (International Ichnological Association), IPA (International Paleontological Association), EAVP (Eauropean Association of Vertebrate Paleontologists), ASRO (Acadimic and Scientific Research Organization) and YES (Young Earth Scientists Network).

The opening ceremony

The opening ceremony was chaired by B. Tanouti President of Chouaïb Doukkali University in the presence of the Miss Vice President of the University, A. Belafhal the Dean of the Faculty of Sciences and the Vice Dean of the Scientific Research, J.W. Schneider the Vice-Chairman of the Subcommission on Permian Stratigraphy, A. Uchman the President of International Ichnological Association, H. Saber President of Ichnological Association of Morocco, as well as researchers and PhD students from national and international universities (Fig. 1).

The ceremony also saw the effective presence of the OCP Group of Jorf Lasfar in the person of Mrs. Bouchra Ameur.

Oral presentations and posters

More than 50 participants attended the ICCI-2015; 5 keynotes, 27 oral presentations and 16 posters were provided by ichnologists colleagues from five continents and 18 countries (Fig. 2). Some colleagues were unable to join us for various reasons (logistical, financial, visa or other administrative reasons). The organization of this meeting comes from the desire to integrate ichnology in a global paleogeographic scheme.

The keynotes, oral and poster communications presented scientific results on vertebrate and invertebrate ichnology of continental deposits, including the palaeobiology and ichnotaxonomy of trace fossils, taphonomy of trace fossils and microbially induced sedimentary structures, palaeoenvironmental, paleobiogeographical and biostratigraphical analyses of ichnofossils and Track-tracemaker reconstruction and the evolutionary contributions of invertebrate and vertebrate ichnology. Furthermore, a session on Methods, applications and conservation was dedicated to present the importance of the ichnology of ecosystem engineers in the geologic record, photogrammetry and 3D modelling in ichnology and geo-conservation and valorization of the palaeoichnological heritage.

Roundtable (April 22, 2015)

The ICCI-2015 covered the chronobiostratigraphic and paleobiogeographic interest of vertebrate and invertebrate Paleoichnology. The keynotes and the communications offered many opportunities to learn the principles of Ichnology and Ichnotaxonomy, discussed the current problems and future of the vertebrate and invertebrate ichnotaxonomy of the continental ecosystems and recognition of outcrops/quarries of classical localities of the worldwide continental ichnosites.

The roundtable of the First International Congress on Continental Ichnology, animated by Profs. Alfred Uchman (President of

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Fig. 1. Opening ceremony of the First International Congress on Continental Ichnology. From left to right: J.W. Schneider (Vice-Chairman of the Subcommission on Permian Stratigraphy), A. Uchman (President of International Ichnological Association), B. Tanouti (President of Chouaïb Doukkali University), A. Belafhal (Dean of the Faculty of Sciences), H. Saber (President of Ichnological Association of Morocco).
Fig. 2. The ICCI-2015 participants.

International Ichnological Association [IIA]), Jörg W. Schneider (Vice-chairman of the International Stratigraphy Sub-commission of Permian) and Hafid Saber (President of Ichnological Association of Morocco), was devoted to evaluate the ICCI-2015 and to discuss their positive and negative points, while the global appreciation of the participants and the organizers was positive and encouraging.
The participants discussed also the relationship between diverse associations interested in ichnology, which should work under the umbrella of the International Ichnological Association.
Several points were discussed by the participants such as the name of the meeting, that will be changed to International Conference on Continental Ichnology (ICCI). Due to the scarcity of meetings on Ichnology, especially Continental Ichnology, most participants voted holding the International Conference on Continental Ichnology (ICCI) every two years. Furthermore, the next edition, Second International Conference on Continental Ichnology (ICCI-2017), will be held in Cape Town (South Africa), after the single proposal by Dr. Emese Bordy from the University of Cape Town.
Finally, we are pleased to inform you that our request to have a special volume, with selected papers has been accepted and we have an official authorization to begin to work on this special issue, dedicated to papers from ICCI-2015.
ICCI-2015 brought together a wide variety of papers from different part of the world from the five continents dealing with invertebrate and vertebrate ichnology, their application in palaeoenvironnemental and biostratigraphy, methods, technics and conservation of paleoichnological heritage.

Post congress field excursion
The excursion, guided by Prof. H. Saber, Prof. J.W. Schneider, Mr. H. Klein, Prof. Mr. Masrour, Prof. F. Perez-Lorente and A. Belahmira, took place from 23th to 25th April 2015. The three days post-Congress Field-Excursion was dedicated to the continental formations of the Argana region (western High Atlas). It was an opportunity to visit the main paleontological sites, in particular, the famous Permian, Triassic, Jurassic and Cretaceous ichnosites (Figs 3-4).

The first day was devoted to the recognition of different outcrops between El Jadida and Imin-Tannoute. We visited the wall of Jurassic outcrop that is characterized by sauropod trackways (Fig. 5). The second day was dedicated to visit the T2 member (T2 Middle-Upper Permian fluvial deposits) and T3 member (Lower Triassic red beds with the *Protochirotherium-Synaptichnium* and *Rhynchosauroides* ichnofauna). This assemblage of chirotherian footprints, abundant and well preserved, represents the first record of Lower Triassic fossils in Morocco. We observed also the T4 member, where complex tetrapod burrows were discovered besides a vertebrate ichnoassemblage composed of typical Middle Triassic tetrapod footprints. At the same locality, we visited Upper Triassic deposits (T5 member) that yielded tracks of the ichnogenera *Rhynchosauroides*, *Apatopus*, *Synaptichnium*, *Parachirotherium*, *Atreipus–Grallator*, and *Eubrontes*, indicating characteristic Carnian-Norian communities mixed with a few “survivors” thus far known only from the Middle Triassic, and invertebrate burrows of the ichnospecies *Scoynia gracilis* White, 1929.

The last day was devoted to visit the Upper Cretaceous tracksite with theropod trackways of Anza near d’Agadir city (Figs 6-7).

Acknowledgements
Our thanks go to all people, researchers and students, public and private institutions that have contributed and collaborated in the organization of the First International Congress on Continental Ichnology (ICCI-2015).
We want to thank all our partners and sponsors, in particular the OCP Group, for his great financial support and his efforts to help us to succeed in this event.

Links
- Official website of the event:
https://sites.google.com/site/icci2015congress/home

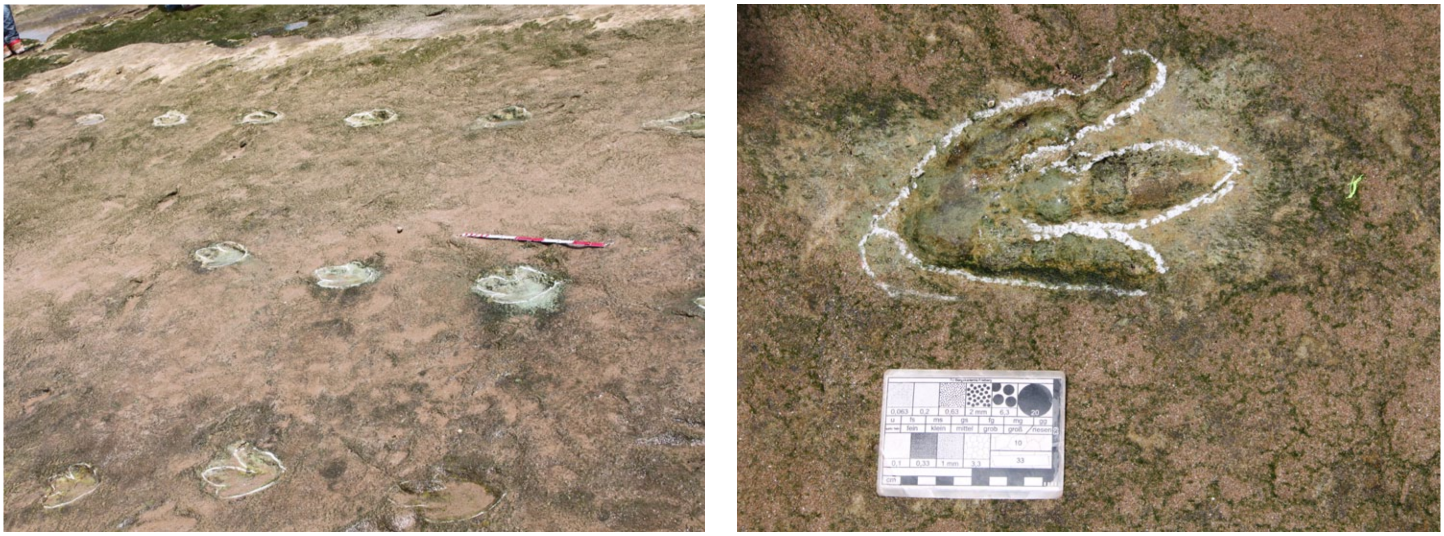
- 2M TV Channel:
https://www.youtube.com/watch?v=EP-H8lAa8Gg

- Electronic press:
http://machahid.info/?p=36821

- Facebook page of the AMORS.association (Anza, Agadir):
https://www.facebook.com/AMORS.association/photos


Figs 3-4. Photos in the field near Aït Moussi village (Argana basin)

Fig. 5. Photography of the ICCI-2015 participants of the excursion in the Argana basin.



Figs 6-7. Theropod trackways of Anza near d'Agadir city

Report on the 7th International Brachiopod Congress, May 22-25, 2015 Nanjing, China

Lucia Angiolini
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The 7th International Brachiopod Congress was held on May 22-25, 2015 in Nanjing, China, hosted by the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences. The theme of the congress was "The Brachiopod World" and it was attended by 104 delegates from 20 countries/regions of Europe, Asia, America, and Australia, who had the opportunity of exchange their knowledge on Brachiopoda and related areas (Fig. 1) and discussed the recent advances in this field of research. The congress included 3-day in-door meeting, one mid-conference excursion within Nanjing and three post-conference field excursions.

The organization of the congress was very efficient: the discussions very stimulating and many new ideas and new collaborations saw the light during the meeting - all this made the 7thIBC a very successful event.

A supplementary issue of Permophiles including all abstracts submitted to the 7th IBC was published and it is available online in the SPS website.

Organizing Committee

Prof. Rong Jiayu (honorary chair): Nanjing Institute of Geology and Palaeontology, Nanjing, China.
Shen Shuzhong (co-chair): Nanjing Institute of Geology and Palaeontology, Nanjing, China
Zhan Renbin (co-chair): Nanjing Institute of Geology and Palaeontology, Nanjing, China
Huang Bing (secretary): Nanjing Institute of Geology and Palaeontology, Nanjing, China
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He Weihong: China University of Geosciences, Wuhan
Li Guoxiang: Nanjing Institute of Geology and Palaeontology, Nanjing, China
Sun Yuanlin: Peking University, Beijing, China
Zhang Zhifei: Northwest University, Xian, China

Oral Presentations and Posters

The Congress included 4 invited plenary lectures, 56 talks of which 7 invited keynote talks, and 31 posters. The talks were organized into 6 special sessions, as follows:

S1. Systematics, phylogeny and morphological patterns of brachiopods
Conveners: Jin Jisuo (Western University, Ontario, Canada), Las Holmer (Uppsala University, Sweden).
S2. Brachiopod palaeoecology, taphonomy and interactions with other organisms
Conveners: Perez-Huerta, Alberto (The University of Alabama, USA), Chen Zhongqiang (China University of Geosciences, Wuhan).

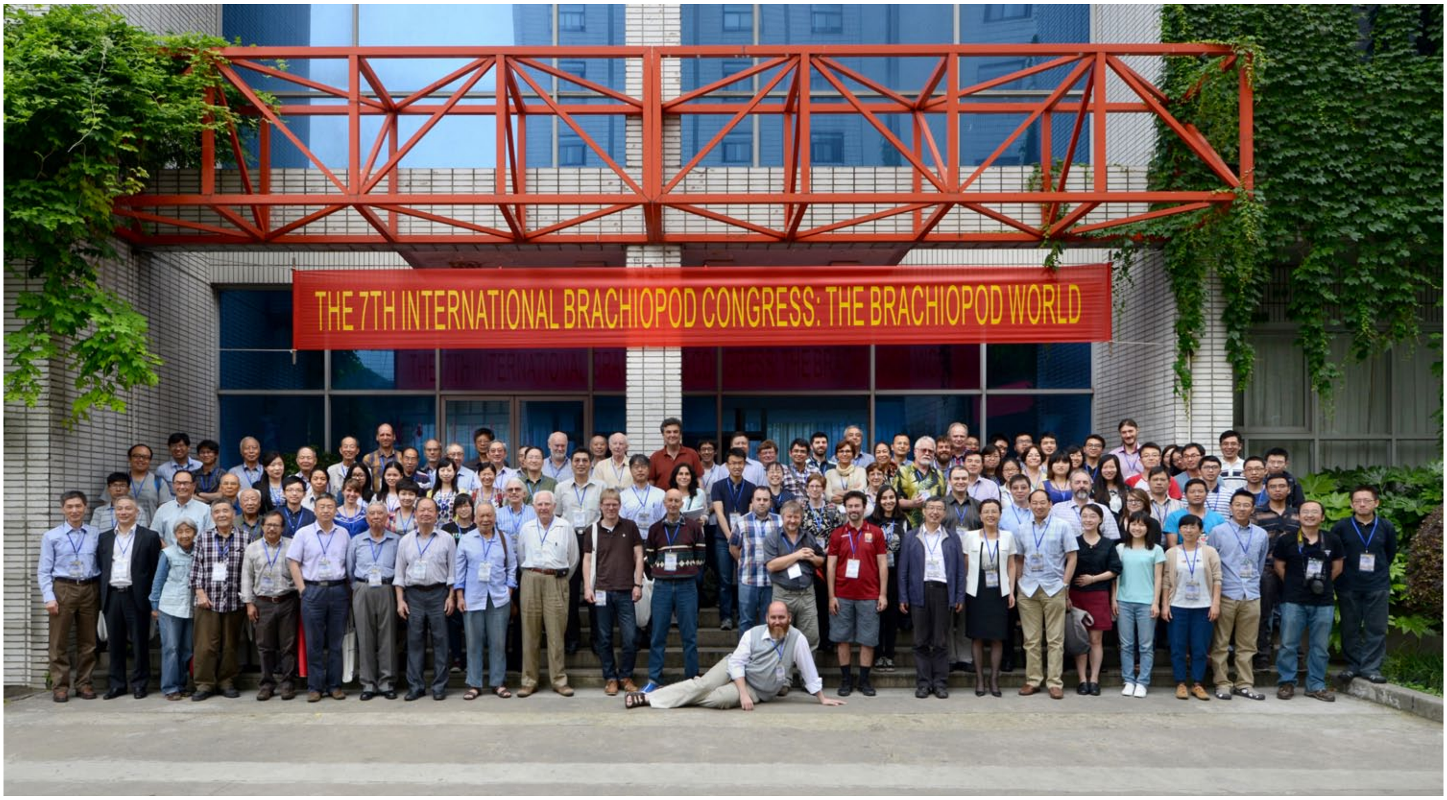

Fig.1. Participants of The 7th International Brachiopod Congress in May 22-25, 2015 in Nanjing, China, hosted by the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences.

Figs 2-3. Participants of the post-conference field excursions E1 (on the left) and E2 (on the right)

S3. Biostratigraphy, chemostratigraphy, and past environmental and climate changes

Conveners: Lucia Angiolini (University of Milano, Italy), Uwe Brand (Brock University, Ontario, Canada).

S4. Origination, diversity and extinction of brachiopods

Conveners: Zhan Renbin (Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences), Shen Shuzhong (Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences).

S5. Palaeobiogeography, gradients and palaeogeographical implications

Conveners: Shi G. R. (Deakin University, Melbourne, Australia), Robin Cocks (The Natural History Museum, London, UK).

S6. Living brachiopods

Conveners: Maria Aleksandra Bitner (Polish Academy of Sciences, Warszawa, Poland), Carsten Lueter (Museum fuer Naturkunde, Leibniz-Institut fuer Evolutions- und Biodiversitaetsforschung, Berlin, Germany).

Several talks were devoted to Permian brachiopods and related topics in session S1 to S5, showing that brachiopodologists are active in investigating Permian paleontology and stratigraphy. Angiolini et al. presented the systematics of a silicified fauna from the lower Guadalupian Gundara Formation of Darvaz, Pamir; a functional morphology analysis of a Lower Permian brachiopod from Oman was given by Shiino & Angiolini; Lee et al. presented an interesting topic on antitropicality and convergent evolution in Neospiriferine brachiopods. One of the main topic discussed during the congress concerned the ongoing multidisciplinary researches on the Changhsingian faunas and the PTB: Zhang et al. described Changhsingian brachiopods from shallow water clastic facies of S China; Garbelli et al. reported the geochemical and the temperature change at the dawn of the end Permian mass extinction and Garbelli and Angiolini showed the evolution of brachiopod biomineralization during the Permian; Chen et al. described the evolutionary dynamics of brachiopods across the PTB, whereas Tu and Chen discussed the debated relationships between brachiopods and bivalves at the Permian-Triassic transition; He et al. presented evidence that the end Permian extinction began in deeper waters; Shen et al. described the Upper Permian brachiopods from the exotic block of Gyanima, Tibet; Shi et al. discussed the onshore-offshore patterns in brachiopod diversity and size in the Changhsingian and their implications for understanding the biotic crisis.

Finally, the 7th IBC Organizing Committee encouraged Presenters to consider submitting papers to the proceeding volume for publication in the journal of Palaeoworld (SCI, Elsevier).

Post-Conference Field Excursions

Three excursions were successfully led on May 26-29, 2015, to visit the spectacular Paleozoic faunas of China.

E1: Guilin, Guangxi: Devonian to Carboniferous stratigraphy and brachiopods

Led by Sun Yuanlin and Chen Xiuqin, this excursion was organized to visit the Devonian and Carboniferous sections and brachiopods around Guilin City, which is known to be one of the most beautiful places in China for its peculiar landscape and culture. Major stops included: The D/C boundary and brachiopods at the Nanbiancun Section (Fig. 2); The Lower Carboniferous Huangjin Formation and its brachiopods at Mopanshan Section; the uppermost Devonian Ertoucun, Lower Carboniferous Yaoyunling, Yingtang and Huangjing formations at the Huilong Section. The field trip also included the visit to a famous karst cave and the beautiful landscape along the Lijiang River on a boat.

E2: Kunming: Cambrian brachiopods and the Chengjiang biota

Led by Zhang Zhifei and Li Guoxiang One, the excursion visited the Neoproterozoic and Cambrian successions around Kunming of eastern Yunnan, which is famous for its diverse cultures, mildest climate, widespread flowers, as well as for yielding prolific paleontological fossils, such as dinosaurs, fishes and invertebrates of the Chengjiang Fauna. Kunming is also famous for its Stone Forest (Shilin), a 5A-class tourist site and also an International Geopark.

Key stops around the Dianchi Lake included some of the most important Chengjiang soft-bodied fossil localities, as the classic fossil site at Maotianshan Hill and the Meishucun Section that

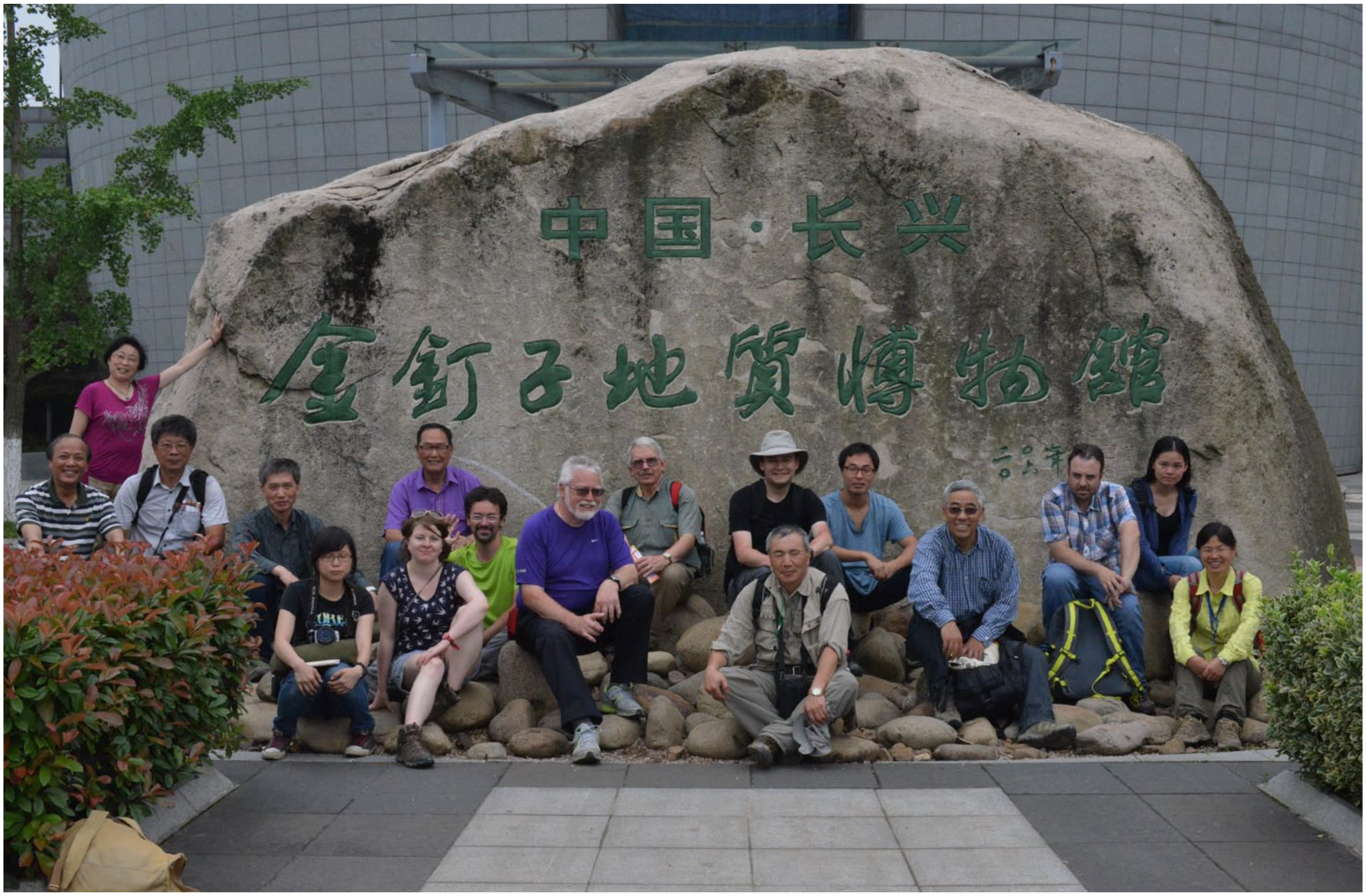

Fig. 4. Participants of the post-conference field excursion E3

was once proposed as a candidate of the Stratotype Section for Precambrian-Cambrian boundary (Fig. 3??).

E3: Zhejiang to Jiangxi: Ordovician to Permian brachiopods
Led by He Weihong, Shen Shuzhong and Zhan Renbin, the excursion was organized to visit the rocks and brachiopods of Ordovician to Permian age in central Anhui, western Zhejiang and northeastern Jiangxi provinces. Major stops included: Upper Ordovician brachiopods at Zhuzhai, northeastern Jiangxi; Wuchiapingian (Upper Permian) brachiopods at the Meishan Section and GSSPs of the Permian-Triassic boundary and end-Permian mass extinction at the Meishan sections (Fig. 4); Changhsingian (Upper Permian) deep-water small brachiopods, radiolarians, Middle Permian ammonoids and brachiopods at Chaohu, Anhui Province.

Next venue
A selection committee was named in order to select the next venue of the IBC. The next edition, 8th International Brachiopod Congress, will be held in Milano (Italy) in 2018, after the proposal by Lucia Angiolini (Università di Milano) and Renato Posenato (Università di Ferrara).

Progress report on correlation of nonmarine and marine Lower Permian strata, New Mexico, USA

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Introduction

In the southwestern USA, the state of New Mexico preserves a paleoenvironmental transect of Upper Carboniferous-Lower Permian strata from entirely nonmarine siliciclastic red beds in the northern part of the state, to mixed marine-nonmarine strata in the central part of the state to wholly marine strata in the southern part of the state (Fig. 1). This transect provides a remarkable and probably unique opportunity to correlate nonmarine and marine biostratigraphic data of the Lower Permian and, in particular, across the Carboniferous-Permian boundary.

The upper Paleozoic strata in New Mexico were deposited in equatorial western Pangea during the Ancestral Rocky Mountain (ARM) orogeny, so they range from synorogenic alluvial red beds to marine carbonates. The Hueco seaway, in southern New Mexico, was a western and northwestern extension of the famous Permian basin of West Texas. Here we present a progress report on the cross correlation of nonmarine and marine biostratigraphy across the depositional transect from ARM alluvial plains in northern New Mexico to Hueco seafloors in southern New Mexico.

Lower Permian of Central New Mexico

The older nonmarine Lower Permian strata in New Mexico encompass siliciclastic red beds of the Cutler Group, Sangre de Cristo and Abo formations and the Robledo Mountains Formation, a red-bed tongue of the upper part of the Abo Formation intercalated with Hueco Group strata in south-central New Mexico (Fig. 2) (Lucas et al., 2013e; Voigt et al., 2013). Other red-bed tongues of the Abo Formation are intercalated with the Hueco Group to the southeast, in the Sacramento Mountains of southeastern New Mexico, and in the Franklin Mountains of western Texas (Bachman and Hayes, 1958; Pray, 1961; Williams, 1963; Lucas et al., 2011c, 2014; Lucas 2014). The base of the Abo Formation correlates to the middle Wolfcampian (Nealian) Powwow Conglomerate at the Hueco Group base (Pray, 1961; Williams, 1963; Lucas et al., 2011a), and records a pulse of the ARM orogeny, the Dugout orogeny of Ross and Ross (1987). The red-bed strata yield well-known fossil assemblages of plants, tetrapod bones, vertebrate footprints and arthropod traces, as well as a few arthropod body fossils. The tetrapod footprint record is the most extensive record of Early Permian age known (Lucas and Heckert, 1995; Minter and Braddy, 2009; Lucas et al., 2011b; Voigt and Lucas, 2015).

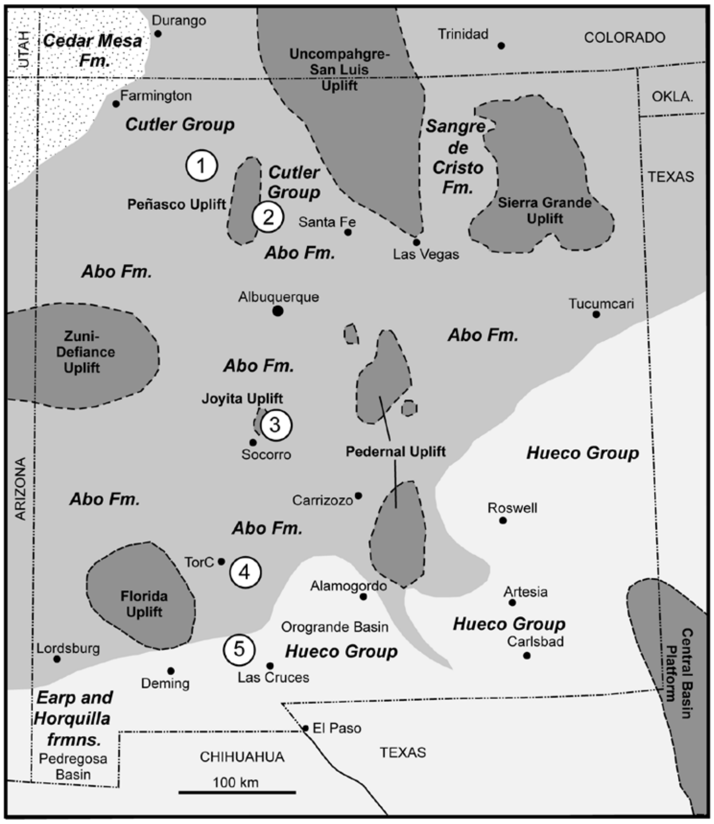

Fig. 1. Paleogeographic map of New Mexico during part of the Early Permian (~Wolfcampian) (after Kues and Giles, 2004). The numbers in circles locate the columns in the correlation chart in Figure 2.

At the base of the Permian section, and locally transgressing the Carboniferous-Permian boundary (= Wolfcampian base: Lucas, 2013a, c), is the mixed marine-nonmarine Bursum Formation. The marine biostratigraphy from Bursum carbonate beds can be directly related to tetrapod and blattid (cockroach) biostratigraphy from the intercalated nonmarine strata (see, especially, articles in Lucas and Zeigler, 2004, as well as Lucas et al., 2013c and Schneider et al., 2013). Thus, fusulinid and conodont biostratigraphy of the Bursum Formation demonstrate that it is diachronous, older (Virgilian or Virgilian/Wolfcampian) north of Socorro and younger (Wolfcampian) to the south, and that its base and/or top are unconformable in many sections (e. g., Lucas et al., 2000, 2009, 2013c; Krainer and Lucas, 2013).

The oldest Lower Permian marine strata of southern New Mexico belong to the Hueco Group and are mostly shallow marine platform carbonates (Fig. 2). They have well-studied fusulinid and brachiopod records (e. g., Thompson, 1954; Simpson, 1984; Kues, 1995; Lucas et al., 2000, 2015; Wahlman and King, 2002), a few ammonoid records (Miller and Parizek, 1948; Kues, 1995), and recent studies have developed an extensive understanding of other microfossil records, particularly of non-fusulinid foraminifers and algae (Krainer et al., 2003, 2009, 2015; Lucas et al., 2015). The most significant result for correlation to the nonmarine section is identification of the Leonardian/Artinskian age of the Robledo Mountains Formation (Fig. 3). This indicates that the base of the Leonardian is in the upper part of the Abo lithosome (below strata correlative to the Robledo Mountains Formation) to the north (Fig. 2).

Broadly overlying all of these older Permian strata is the Yeso Group, a complex array of shallow marine, sabkha, arid coastal plain and eolian strata that extend across much of New Mexico (Fig. 2) (Lucas et al., 2013b). To the northwest, the lower part of the Yeso Group is the DeChelly Sandstone, which was deposited by an erg that covered the Four Corners region. To the southeast, Yeso strata are laterally equivalent to marine strata of the Victorio Peak and Bone Spring formations in the Permian basin. In between, across most of central New Mexico, Yeso strata are composed of gypsum, siltstone, fine sandstone and thin dolomite beds that represent deposition in brine pools, sabkhas, tidal flats and eolian sand sheets on a vast coastal plain to the northwest of the Permian basin (Mack and Dinterman, 2002). Yeso strata have long been regarded as largely unfossiliferous or, at least, devoid of biostratigraphically useful fossils. However, during the last decade we have discovered tetrapod footprint and plant assemblages in the lower part of the Yeso strata (Arroyo de Alamillo Formation: Lucas et al., 2013b), and marine interbeds stratigraphically high in the Yeso Group (Los Vallos Formation) locally yield extensive microfossil assemblages (Vachard et al., 2013, 2015), though fusulinids remain undiscovered.

In central New Mexico, the Glorieta Sandstone overlies the Yeso Group and is homotaxial to the Coconino Sandstone of northern Arizona and the San Angelo Formation in the Midland basin of Texas (Fig. 2) (Lucas, 2004; Lucas et al., 2013a). Glorieta strata are mostly of eolian origin (Mack and Bauer, 2014), and the Coconino yields a well known ichnofauna, whereas the youngest Permian tetrapod body fossils from North America (Littlecrotonian LVF of

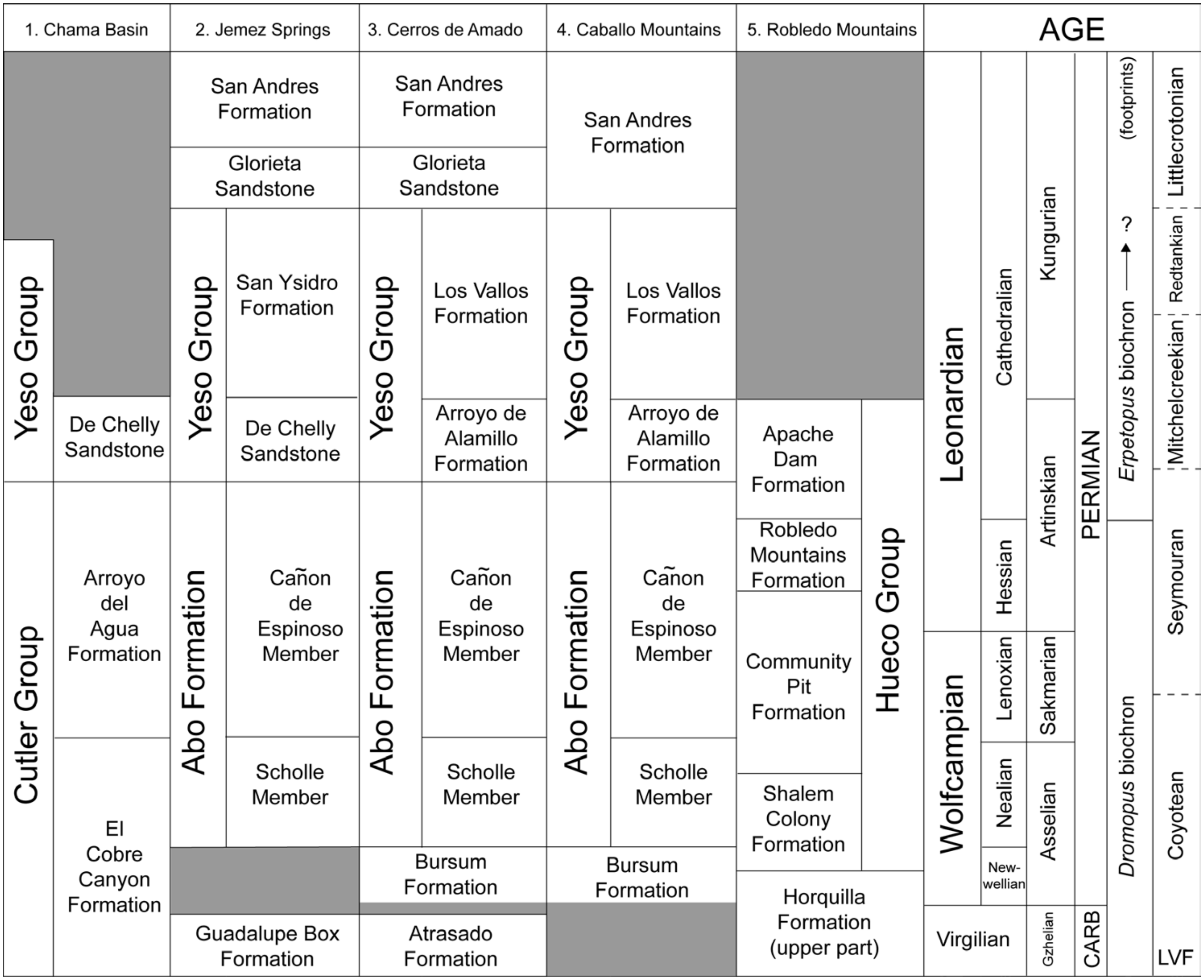

Fig. 2. Correlation of non-marine and marine strata from north to south across central New Mexico. See Figure 1 for location of columns. Modified from Lucas et al. (2013e).

Lucas, 2006) are from the San Angelo Formation in Texas and its Oklahoma equivalents, the Flowerpot and Chickasha formations (Olson, 1962; Lucas, 2004). No biostratigraphically useful fossils have been recovered from the Glorieta Sandstone in New Mexico. But, these homotaxial eolian and fluvial units are overlain by late Leonardian strata—the lower parts of the Kaibab Formation in Arizona, San Andres Formation in New Mexico-West Texas and the Blaine Formation in north-central Texas-Oklahoma (Lucas,

ZONATION	FORMATIONS		Thickness (m)	BIOMARKERS (and representative samples)		REGIONAL STAGES	INTERNATIONAL STAGES
Zone 15		SAN ANDRES FORMATION		*Olgaorlovella davydovi* *Tubiphytes epimonellaeformis* *Geinitzina indepressa*	LEONARDIAN	CATHEDRALIAN	LATE KUNGURIAN
Zone 14				*Hemigordiellina* spp.			MIDDLE KUNGURIAN
Zone 13		GLORIETA SANDSTONE		barren of foraminifers			EARLY KUNGURIAN
Zone 12		YESO GROUP		*Frondicularia* aff. *turae*			
Zone 11				*Ellesmerella rara* *Nestellorella* ? sp.			
Zone 10				*Globivalvulina novamexicana* *Orthovertellopsis protaeformis* *Glomomidiella infrapermica*			
Zone 9	HUECO GROUP	Apache Dam Formation					LATE ARTINSKIAN
Zone 8		Robledo Mountains Formation	53	*Pseudoreichelina* sp. *Geinitzina* sp. 2 (?*multicamerata*)		HESSIAN	MIDDLE ARTINSKIAN
Zone 7		Community Pit Formation	10	*Praeneodiscus* sp. *Globivalvulina novamexicana* *Globivalvulina praegraeca* DAB 13 + DAB 14/DAC 1-DAC 5			EARLY ARTINSKIAN
Zone 6			20	*Pseudovermiporella* sp. DAB 10 - DAB 12	WOLFCAMPIAN	LENOXIAN	LATEST SAKMARIAN
Zone 5			50	*Pachyphloia*? sp. *Geinitzina postcarbonica* *Nodosinelloides longissima* DAB 7 - DAB 9			LATE SAKMARIAN
Zone 4			7	*Nodosinelloides pinardae* *Globivalvulina parapiciformis* *Geinitzina postcarbonica* DAA 59 - DAA 69/DAB 2 - DAB 6			EARLY SAKMARIAN
Zone 3			50	*Hedraites* sp. DAA 53 - DAA 58		NEALIAN	LATE ASSELIAN
Zone 2			20	*Geinitzina postcarbonica* *Nodosinelloides netschajewi* DAA 45 - DAA 52			MIDDLE ASSELIAN
Zone 1		Shalem Colony Formation	65	*Leptotriticites* sp. (DAA 43) *Nodosinelloides longissima* *Tubiphytes* sp., *Geinitzina* sp. (DAA 38) *Pseudovidalina* sp., *Pseudoschwagerina* sp. DAA 42		Newwellian	EARLY ASSELIAN

Fig. 3. Foraminiferal biozonation of the marine Lower Permian of southern New Mexico (modified from Lucas et al., 2015 and Vachard et al., 2015). The column for thicknesses is for the Robledo Mountains section in southern New Mexico.

2004; Vachard et al., 2015).

Marine strata of the San Andres Formation in central New Mexico yield numerous fossils, traditionally brachiopods and cephalopods (e.g., Kottlowski et al., 1956; Krainer et al., 2012), and more recently nonfusulinid foraminifers and algae (Vachard et al., 2013, 2015) that indicate the San Andres Formation is of late Leonardian age (Fig. 3). Note that to the southeast, toward the Permian basin, younger strata of the San Andres Formation are preserved that are of Roadian age (Kerans et al., 1993), but the central New Mexico San Andres Formation appears to be a less temporally extensive unit that represents only late Leonardian time (Brose et al., 2013; Vachard et al., 2013, 2015).

The Artesia Formation encompasses the youngest Permian strata across central New Mexico (e. g., Tait et al., 1962; Kelley, 1972; Lucas and Hayden, 1991; Lucas, 2013b). These are siliciclastic red beds, dolomites and gypsum that were deposited on the vast shelf behind the great Guadalupian reefs that fringed the northwestern end of the Permian basin. In central New Mexico, the Artesia Formation is a thin clastic wedge that lacks age diagnostic fossils but is equivalent to the Grayburg and Queen formations basinward. Thus, Artesia Formation strata in central New Mexico (from San Miguel to Socorro counties) are Wordian based on stratigraphic position and basinward age determinations of correlative strata (Lucas, 2013b).

Biostratigraphy, Biochronology and Chronostratigraphy

Recent micropaleontological work in the Hueco and Yeso groups and San Andres Formation (Lucas et al., 2011a, c, 2015; Krainer et al., 2003, 2009, 2015; Vachard et al., 2013, 2015), combined with earlier work, have allowed us to construct a biozonation of these strata that can be correlated to the standard global chronostratigraphic scale (Fig. 3). This correlation places the Leonardian base in the Hueco Group.

The nonmarine red beds yield fossil vertebrate assemblages that are part of a succession of biochronological units (LVFs: land-vertebrate faunachrons) that Lucas (2006) proposed for Permian time. In terms of diversity of taxa, abundance of specimens, and quality of preservation the Lower Permian vertebrate assemblages of New Mexico clearly rank as among the most prolific in North America, which are dominated by the amphibian lepospondyls, temnospondyls (particularly dissorophoids), and anthracosaurs, the reptilian captorhinomorphs and araeoscelids, the diadectomorphs (?reptiles), and the basal synapsids ("pelycosaurs") (Berman et al., 2015). In New Mexico, tetrapod assemblages of the Cobrean, Coyotean and Seymouran LVFs are identified by stratigraphically superposed, tetrapod-dominated assemblages from the Cutler Group, Bursum Formation and the Abo Formation. In New Mexico-Texas, these and the younger Early Permian LVFs can be cross correlated to the provincial marine timescale with some fair precision (Fig. 2) (Lucas, 2006).

Tetrapod footprint assemblages from the Abo, Sangre de Cristo and Robledo Mountains formations and the lower Yeso Group can be divided into two biochrons—the latter part of the *Dromopus* biochron of Lucas (2007), which encompasses all but the uppermost Abo Formation and lower Yeso Group footprints, and the *Erpetopus* biochron of the uppermost Abo Formation and the lower Yeso Group (Fig. 2) (Voigt and Lucas, 2013, 2015). The footprint assemblages of the Abo Formation and the Robledo Mountains Formation are dominated by those of temnospondyls (*Batrachichnus*) and araeoscelids (*Dromopus*) with some eupelycosaur (*Dimetropus*) tracks (e. g., Lucas and Heckert, 1995; Lucas et al., 2011b; Minter and Braddy, 2009; Voigt and Lucas, 2013, 2015). The helical burrow *Augerinoichnus* (Minter et al., 2008) also is known only from the Abo and Robledo Mountains formations.

In contrast, ichnoassemblages of the lower part of the Yeso Group (Arroyo de Alamillo Formation) in central New Mexico are dominated by "captorhinomorph" tracks (especially of *Varanopus*), have only rare *Batrachichnus* and *Dromopus,* lack *Augerinoichnus* and include the lowest occurrence of the shallow arthropod burrow *Sphaerapus* (Lucas et al., 2013d). The change in ichnoassemblages is the boundary between the *Dromopus* (older) and *Erpetopus* (younger) biochrons (Fig. 2) (Lucas, 2007; Voigt and Lucas, 2013).

Fossil plant assemblages from the Lower Permian nonmarine red beds are of low diversity and monotonous in composition. Assemblages are dominated by walchian conifers with local dominance by the peltasperm *Supaia*. Localized occurrences of callipterids, such as *Autunia conferta* and sphenopsids, are reported (Hunt, 1983; DiMichele et al., 2007, 2013; Voigt et al., 2013). The only potentially biostratigraphically significant fossil taxon in these red-beds assemblages is *Gigantopteridium* (Read and Mamay, 1964), known only from rare occurrences; its presence in the Robledo Mountains Formation (DiMichele et al., 2015) is consistent with a Leonardian age for these strata.

Permian-Carboniferous macrofloral assemblages from strata other than the Abo Formation red beds (and equivalents) have been described from several locations and stratigraphic intervals in central New Mexico. For the most part, however, these are only of the broadest use for correlation because they preserve floras principally associated with seasonally dry climatic conditions, for which detailed biostratigraphic ranges are less well characterized within the global paleoequatorial region. Nearly all preserve some wetland elements, reflecting habitat heterogeneity, but these are most often long-ranging, broadly distributed taxa or contain rare, but significant, species for which stratigraphic ranges have not been confidently established. Macrofloras of the Bursum Formation (Tidwell and Ash, 2004; DiMichele et al., 2004), for example, indicate a mixture of typically wetland and dryland taxa, typical of the Carboniferous-Permian transition elsewhere in western Pangea (e.g., Tabor et al., 2012).

Little palynology has been undertaken of the Lower Permian strata in central New Mexico beyond studies of the Bursum Formation at Carrizo Arroyo (Traverse and Ash, 1999; Utting et al., 2004). These palynological studies are consistent with other investigations and find the Carrizo Arroyo deposits to be close to the Pennsylvanian-Permian boundary, likely earliest Permian. Conchostracans and insect fossils are rare above the Bursum interval (Martens and Lucas, 2005), so little biostratigraphy can be based on them.

Work continues on biostratigraphy and correlation in the Lower Permian nonmarine-marine depositional systems in central New Mexico. Thus, this is a progress report on a project that we hope to present in final form in the next few years.

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Range of morphology in monolete spores from the uppermost Permian Umm Irna Formation of Jordan

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Recent studies of the uppermost Permian Umm Irna Formation of Jordan showed the excellent preservation of palynomorphs obtained from thin argillaceous beds within a dominant sandstone facies (see Stephenson and Powell, 2013, 2014). As well as good preservation, the range of distinct palynological assemblages separated by only a few metres stratigraphically and geographically was particularly remarked on by Stephenson and Powell (2013). These authors considered that the thin argillaceous beds represented a series of 'snapshots' of the evolving palaeoenvironments of sandy fluvial low-sinuosity channels with deposition on point bars and in stacked small-scale braided channels, as well as localised peaty mires on the floodplain. An example from Wadi Autun (N31°32'40.1", E35°33'31.7") where two carbonaceous siltstone beds are separated stratigraphically by a few m of sandstone and siltstone (Fig. 1), yielded well-preserved assemblages, which are quite distinct from each other (despite their stratigraphical proximity), and from other assemblages recovered from the Umm Irna Formation. The lower sample yielded an assemblage containing common bisaccate pollen and the trisulcate pollen *Pretricolpipollenites bharadwajii* Balme 1970. The upper sample, 4.35 m above, contains no specimens of *Pretricolpipollenites bharadwajii*, and is dominated by well-preserved spores assigned by Stephenson and Powell (2013) to the '*Torispora-Thymospora* complex'.

Stephenson and Powell (2013) considered that the low-sinuosity channel, point bar, and small-scale braided channel environments of the Umm Irna Formation were likely to have been diverse in terms of water and nutrient availability and substrate type, which may have led to numerous small and varied plant communities across the floodplain. Larger water flows in channels would likely contain a palynomorph representation of the wider hinterland of the drainage basin of the river including these floodplain plant communities and more distant communities, and sediments deposited with this assemblage of palynomorphs would reflect in their variety something of the variety of the full drainage basin. However, where water is cut off from the river system as in water bodies like oxbow lakes or other impermanent stagnant floodplain ponds, a higher proportion of purely local palynomorphs would be preserved in associated sediments. These would be the spores and pollen of plants growing very close to the water body. At Wadi Autun, the lower sample is from a black carbonaceous, almost coaly siltstone (Fig. 1). This unit may have been deposited in a stagnant environment isolated from water flow that encouraged the plant that produced the pollen *Pretricolpipollenites bharadwaji*, possibly a cycad. Thus its pollen is well represented in the sediment. The upper sample from a carbonaceous siltstone overlying a mudstone- and siltstone-filled abandoned channel, may represent a similarly restricted local environment perhaps surrounded by a stand of plants producing ornamented monolete spores, probably tree ferns.

Fig. 2 illustrates in detail the range of morphology in monolete spores that is encountered in the upper sample from Wadi Autun. The morphology ranges from finely reticulate specimens with a well-marked monolete mark, to specimens with very well developed lateral and distal crassitudes (thickenings), to specimens with a zona, to specimens with a coarse open reticulum, rather coarse distal rugulae or distal ring-shaped crassitude. Finely reticulate specimens are well known from the Middle and Upper Permian of Oman and Saudi Arabia (see for example Stephenson, 2008; Stephenson et al., 2003), where they are assigned to *Thymospora opaqua* Singh 1964, but those with crassitudes (assignable to *Torispora*) are less commonly reported in the Arabian peninsula and certainly not in large numbers.

Permian assemblages in the Middle East with common monolete spores are often associated with a Cathaysian palaeophytogeographic affinity. Permian assemblages considered to be of Cathaysian affinity occur in Turkey (Agrali and Akyol, 1967; Akyol, 1975) and these contain abundant sculptured monolete spores. Such spores also occur commonly in undoubted Cathaysian assemblages (Gao, 1985). Later Permian assemblages in Iraq were considered to have Cathaysian affinities on the basis of common monolete spores (Nader et al., 1993).

Both palaeobotanists and palynologists report a similarity between Lower Permian floras of Cathaysia and Pennsylvanian coal measures floras of Euramerica (Cleal and Thomas, 1991; Kaiser, 1976). Kaiser (1976) suggested that the coal measures floras of

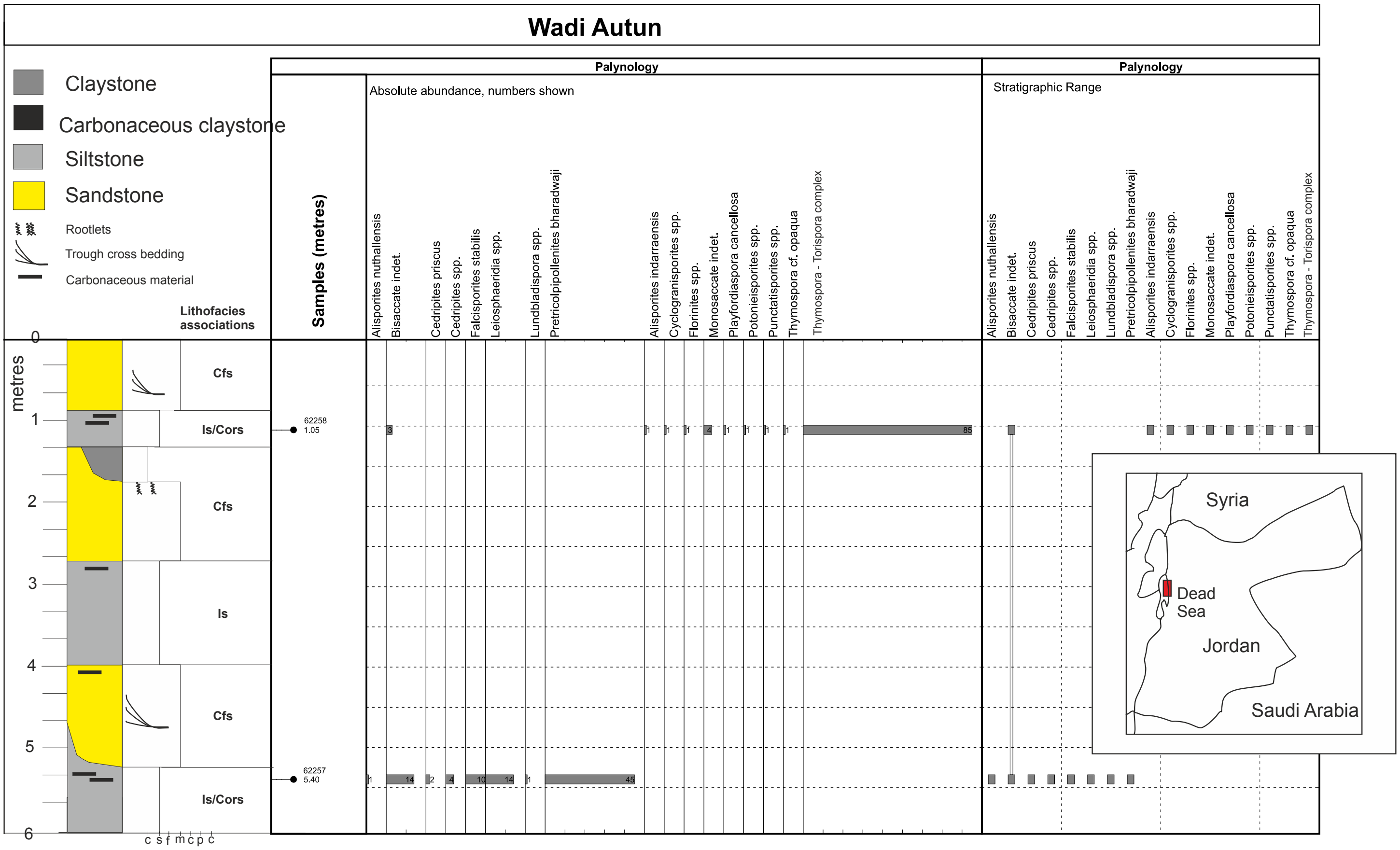

Fig. 1. Section and palynology at Wadi Autun (N31°32‘40.1”, E35°33’31.7”) with inset showing location map.

Euramerica became diachronously established further east due to the continuing palaeotropical conditions of Cathaysia which provided a refuge for the tropical vegetation of the Pennsylvanian swamps of Euramerica.

The upermost Permian monolete spore assemblages of the Umm Irna Formation are currently being investigated and will be published in a taxonomic study later, alongside comparison with other assemblages from the region.

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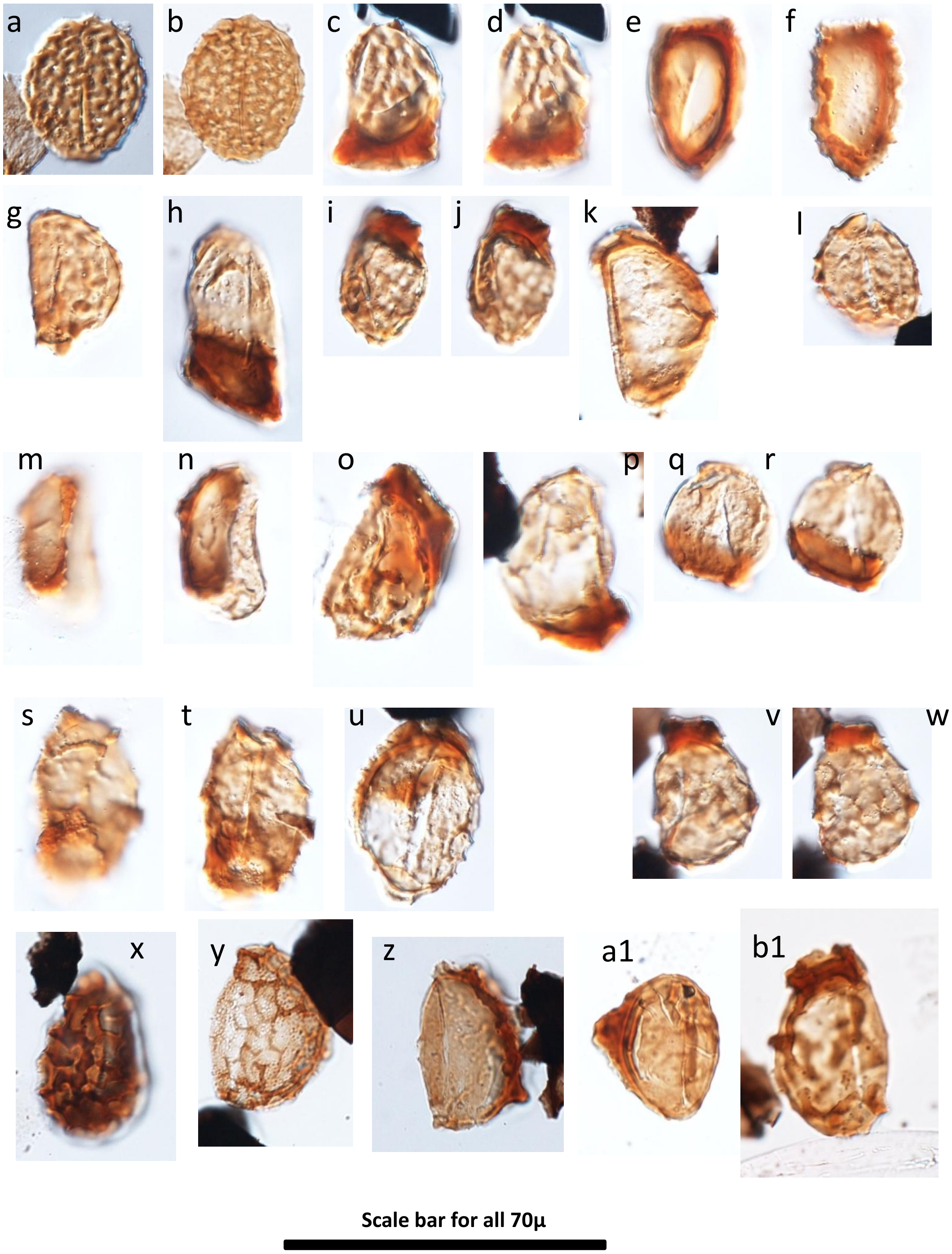

Fig. 2. Variation in morphology in monolete spores from Wadi Autun. (a) – (b) *Thymospora opaqua* J69/3, MPA 62256; (c) – (d) monolete spore with rugulae and lateral crassitude, C59/4, MPA 62258; (e) – (f) monolete spore with zona, C58, MPA 62258; (g) monolete spore with rugulae, C57/3, MPA 62258; (h) monolete spore with lateral crassitude, C57/2, MPA 62258; (i) – (j) monolete spore with reticulum and lateral crassitude, C41/2, MPA 62258; (k) monolete spore with sparse rugulae, D62/3, MPA 62258; (l) monolete spore with sparse rugulae, D62/3, MPA 62258; (m) – (n) monolete spore with distal ring-shaped crassitude, D59, MPA 62258; (o) monolete spore with rugulae and lateral crassitude, D59/3, MPA 62258; (p) monolete spore with rugulae and lateral crassitude, D55, MPA 62258; (q) – (r) monolete spore with lateral crassitude, F52, MPA 62258; (s) – (t) monolete spore with rugulae and ring-shaped crassitude, F46, 62258; (u) monolete spore with rugulae and ring-shaped crassitude, H67/2, MPA 62258; (v) – (w) monolete spore with reticulum and lateral crassitude, G60/4, MPA 62258; (x) monolete spore with reticulum, 62242-2, P57; (y) monolete spore with reticulum, 62242-2, O61/2; (z) monolete spore with distal crassitude, 62242-2, O61/2; (a1) monolete spore with sparse rugulae and large distal crassitude, 62242-2, N63; (b1) monolete spore with rugulae and lateral crassitude, 62242-2, K68/3.

Palynostratigraphy of the Permian Faraghan Formation in the Zagros Basin, Southern Iran: preliminary studies

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Introduction

A recent project on the palaeontology and biozonation of Palaeozoic sediments of Central Iran and the Zagros Basin led to the study of palynological content of the Faraghan Formation. In the Zagros region this formation crops out in several areas among which are the Dena, Faraghan and Zardkuh Mountains. The formation was also cored in several boreholes drilled by NIOC (Fig. 1). A Sakmarian-Artinskian age was originally proposed for the Faraghan Formation on the basis of stratigraphic range of some palynomorphs (Ghavidel-Syooki, 1997). In the present study a younger age is suggested on the basis of the palynoassemblage recorded, by comparison with palynozones in the Middle East. This palynological investigation was undertaken to achieve a more accurate age for the Faraghan Formation and to establish its relationships with coeval deposits in Oman, Saudi Arabia, Turkey and Iraq.

Materials and methods

Sixty samples were processed for palynological analysis. Approximately 50 g of each sample were processed following Traverse's standard technique (2007). The organic residue was concentrated using hydrochloric acid (HCl, 10%) and hydrofluoric acid (HF, 50%) and sieved with a 15 mm filter. Light microscope observations were performed on palynological slides using a Leica DM1000 microscope with differential interference contrast (DIC) techniques in transmitted light. Palynological slides are stored at the Paleontological Laboratory of the National Iranian Oil Company.

Results and discussion

The Faraghan Formation has a wide distribution in the Zagros Basin. It is composed of stromatolitic dolostones overlain by siltstones and mainly cross-bedded sandstones. The formation grades up into thick bedded carbonates of the Upper Permian Dalan Formation. The Faraghan and Dalan Formations are the major hydrocarbon reservoir in SW Iran. The thickness of the Faraghan Formation varies in the Zagros Basin, from 140 to 40 m. The present palynological study resulted from the Farghan Formation penetrated in six boreholes. Microflora recorded is generally well diversified and well preserved.

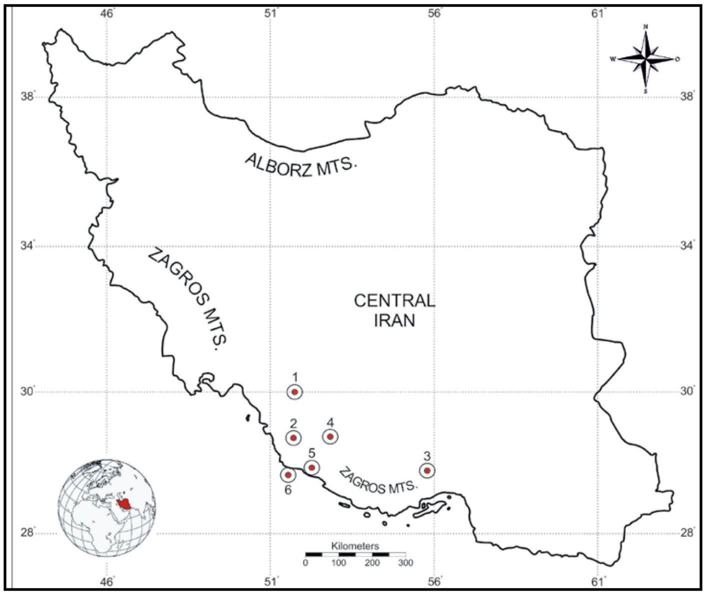


Fig. 1. Location map of the six boreholes studied.

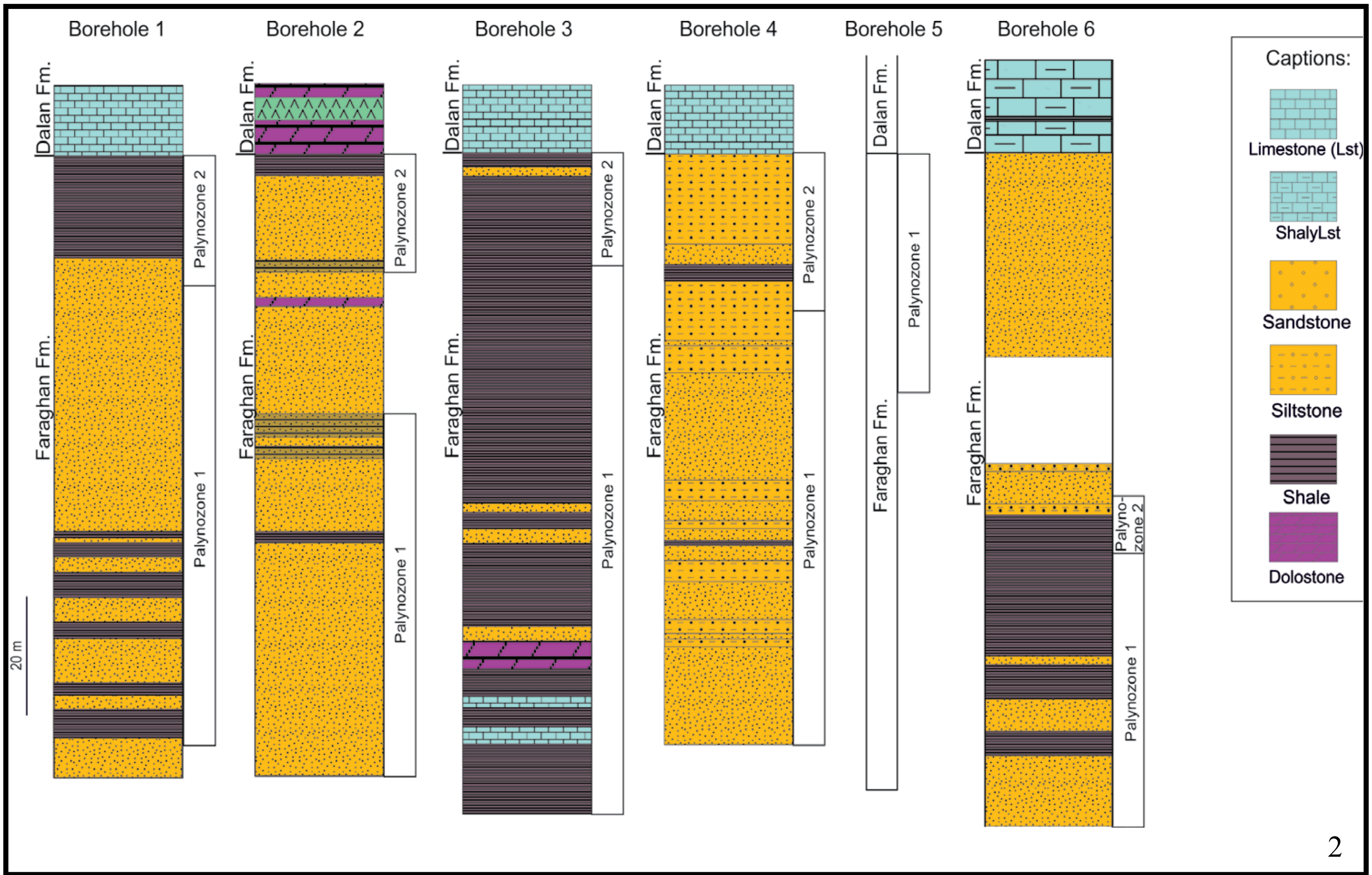
Two palynozones (Fig. 2) were recognized. The stratigraphic range of the taxa mainly refers to the palynozonal schemes for the Northern Gondwana regions (e.g. Stephenson et al., 2003; Stephenson, 2006; Stolle, 2007; Stephenson, 2008; Stolle et al., 2011).

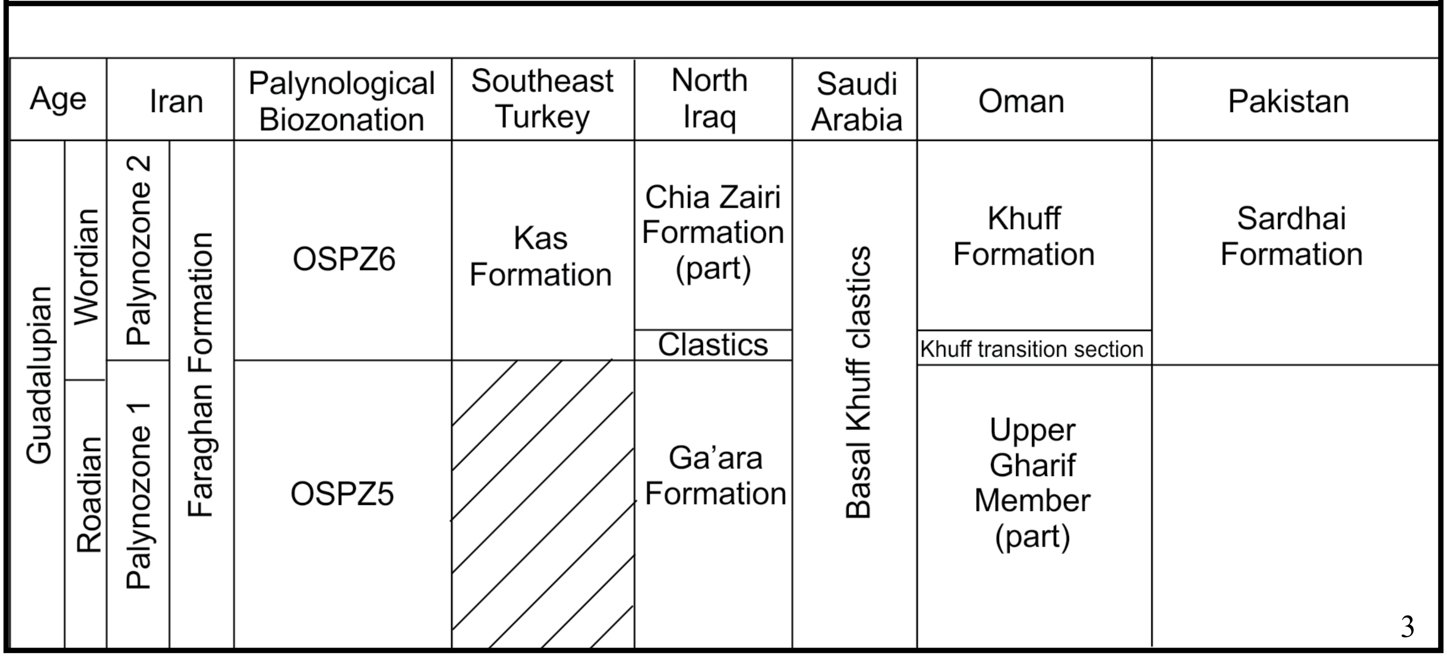
Palynozone I. This palynozone occurs in the Faraghan Formation from all boreholes of the study. The dominant taxa are monosaccate pollen such as *Plicatipollenites* spp. (among which *P. malabarensis*) and *Potonieisporites* spp. (among which *P. novicus*) and others, and taeniate bisaccate pollen such as *Protohaploxypinus* spp., *Distriatites insolitus* and *Hamiapollenites* spp. (among which *H. dettmanae*). Other taeniate bisaccate pollen such as as *Lueckisporites virkkiae* and spores such as *Indotriradites ater* and *Thymospora opaqua* are not necessarily confined in this biozone. Non taeniate pollen such as *Sulcatisporites ovatus*, *Alisporites nuthallensis* and *A. indarrensis* also occur.

Palynozone II. This biozone is marked by the first occurrence of *Indotriradites mundu*s, *Pyramidosporites cyathode*s, *Lunatisporites pellucidu*s, *?Florinites balmei* and the common occurrence o*f Reduviasporonites chalastu*s, *Alisporites nuthallensis*, *Lueckisporites virkkia*e and *Thymospora opaqua.*

Remarks

Age of palynozone I. Palynological evidence for the age of this palynozone mainly comes from the studies of Saudi Arabia and Oman microflora (Stephenson et al., 2003; Stephenson, 2006; 2008). Palynozone I shows very close similarities to OSPZ 5 documented from the Upper Gharif Member (Oman) and Unayzah Formation (Saudi Arabia, Stephenson et al., 2003; Stephenson, 2008) where miospores as *Indotriradites ater*, *Thymospora opaqua* and *Lueckisporites virkkiae* and *Distriatites insolitus* were documented. These OSPZ5 characterizing taxa were found in the palynozone 1 in assemblagewith *Potonieisporites novicus*, *Protohaploxypinus limpidus*, *Corisaccites alutas* and *Hamiapollenites* spp., *Sulcatisporites ovatus*, *Alisporites nuthallensis* and *Vittatina costabilis*.





Age		Iran		Palynological Biozonation	Southeast Turkey	North Iraq	Saudi Arabia	Oman	Pakistan
Guadalupian	Wordian	Palynozone 2	Faraghan Formation	OSPZ6	Kas Formation	Chia Zairi Formation (part)	Basal Khuff clastics	Khuff Formation	Sardhai Formation
						Clastics		Khuff transition section	
	Roadian	Palynozone 1		OSPZ5		Ga'ara Formation		Upper Gharif Member (part)	

Fig. 2. Stratigraphic logs of the Faraghan Formation and distribution of palynozone 1 and palynozone 2. The lithostratigraphy of borehole 5 is not available.

Fig. 3. Correlation of palynozones 1 and 2 from the Faraghan Formation with respectively OSPZ5 and OSPZ6 recorded in Southeast Turkey, Northern Iraq, Oman, Saudi Arabia and Pakistan (from Jan et al., 2009).

The present biozone recorded from the Faraghan Formation (Figs 2-3) is therefore assigned to the Roadian-early Wordian.

Age of palynozone II. Particular palynological taxa from the present palynozone are of stratigraphic value for correlation with the palynological record of Saudi Arabia, Oman, Southeastern Turkey and Northern Iraq. These taxa come from OSPZ6 of Stephenson et al. (2003) and were documented in Saudi Arabia and Oman (Stephenson et al., 2003; Stephenson, 2006; 2008), Southeastern Turkey (Stolle, 2007; Stolle et al., 2011) and Northern Iraq (Stolle, 2007) and Pakistan (Jan et al., 2009). The presence of stratigraphically important taxa such as ?*Florinites balmei*, *Indotriradites mundus* and *Pyramidosporites cyathodes* suggest that the present palynozone II from the upper Faraghan Formation correlates with the basal Khuff clastics in Saudi Arabia, the Khuff transition beds in Oman, the Kas Formation in Southeastern Turkey, the Chia Zairi Formation in Northern Iraq, the Sardhai Formation in Pakistan and in like manner it is assigned to the OSPZ6 indicating a Wordian age (Fig. 3).

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Towards a redefinition of the lower boundary of the *Protochirotherium* biochron

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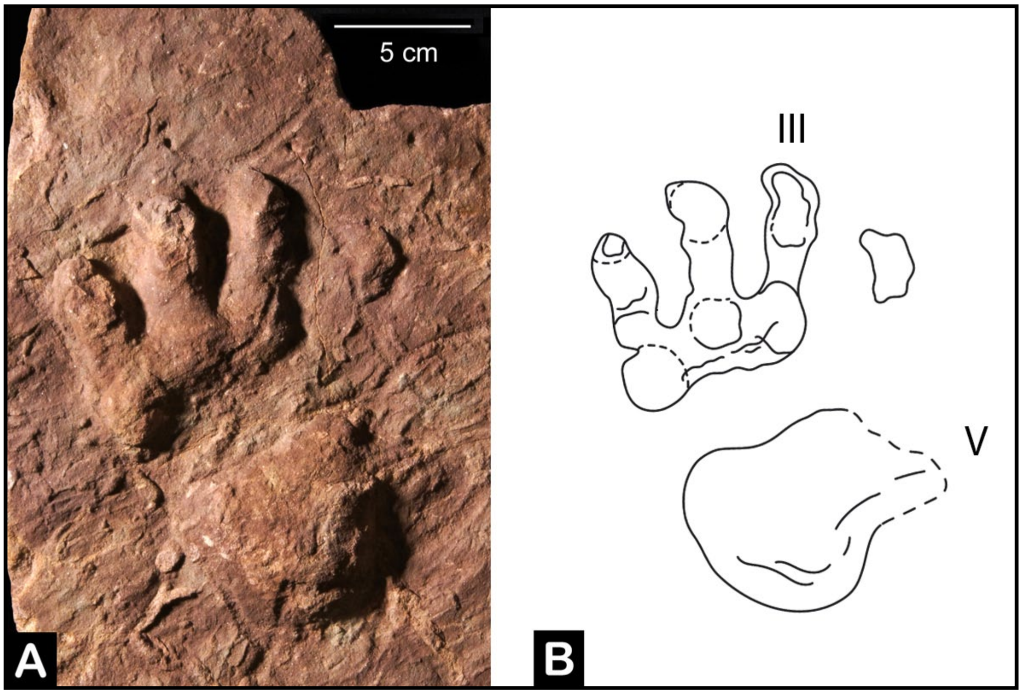
Tetrapod footprints have been shown to be useful for biostratigraphy and biochronology of the Triassic in particular in sequences where body fossils are rare (Klein and Lucas, 2010). Klein and Lucas (2010) recognized five distinct tetrapod-footprint-based biochrons in the Triassic, grounding on the land-vertebrate faunachrons (LVFs) of the tetrapod body fossil record and defined by the first appearance datum (FAD) of ichnotaxa indicated in bold: 1. **Dicynodont** tracks (Induan); 2. ***Protochirotherium*** (*Synaptichnium*), *Rhynchosauroides*, *Procolophonichnium* (Induan–Olenekian); 3. ***Chirotherium barthii***, *C. sickleri*, *Isochirotherium*, *Synaptichnium* (‘*Brachychirotherium*’), *Rotodactylus*, *Rhynchosauroides*, *Procolophonichnium*, dicynodont tracks, *Capitosauroides* (Olenekian–early Anisian); 4. ***Atreipus–Grallator*** (‘*Coelurosaurichnus*’), *Synaptichnium* (‘*Brachychirotherium*’), *Isochirotherium*, *Sphingopus*, *Parachirotherium*, *Rhynchosauroides*, *Procolophonichnium* (late Anisian – Ladinian); 5. ***Brachychirotherium***, *Atreipus – Grallator*, *Grallator*, *Eubrontes*, *Apatopus*, *Rhynchosauroides*, dicynodont tracks (Carnian–Rhaetian).

Recently a number of tetrapod tracks from the Arenaria di Val Gardena Fm. of Southern Alps have been restudied and newly described by Bernardi et al. (in press). Among these, specimen PZO 5753, collected from the Deutschnofen/Nova Levante locality (Bolzano Province, NE Italy) should be considered also for its biochronological value. The founding locality is situated just a few kilometers from the well-known Bletterbach Gorge fossil site (for a recent update see Roghi et al., 2014). The Upper Permian Arenaria di Val Gardena, also known in the literature as the Gröden Formation or Val Gardena Sandstone of the Dolomites region, crops out between the Eastern part of the Southern Alps, between the Trentino Alto-Adige and Friuli Venezia Giulia regions. It was originally described as the Grödener Sandstein by Richthofen (1860) and afterwards studied by Massari et al. (1988, 1994), Massari and Neri (1997) and Neri (2007). The Arenaria di Val Gardena is a succession of continental red beds, up to 600 meters thick. Palynology suggests a late Capitanian to Changhsingian age (Pittau, 2005) or a Lopingian age (Visscher, in Kustascher et al., 2012; Posenato, 2010).

Specimen PZO 5753 was first figured by Wopfner (1999: fig. 2), but it was never properly described. It shows a number of features, especially the shape of digit V and relative length of digit IV, that allows an assignment to cf. *Protochirotherium* sp. (Klein et al., 2013). Thus far, *Protochirotherium* was known only from Lower Triassic deposits of Germany, Austria, Poland, Morocco and USA (see Bernardi et al., in press).

Klein and Haubold (2007) and Klein and Lucas (2010) erected the “*Protochirotherium* (*Synaptichnium*) biochron” to mark the oldest biochronological unit for the Triassic. The beginning of the biochron



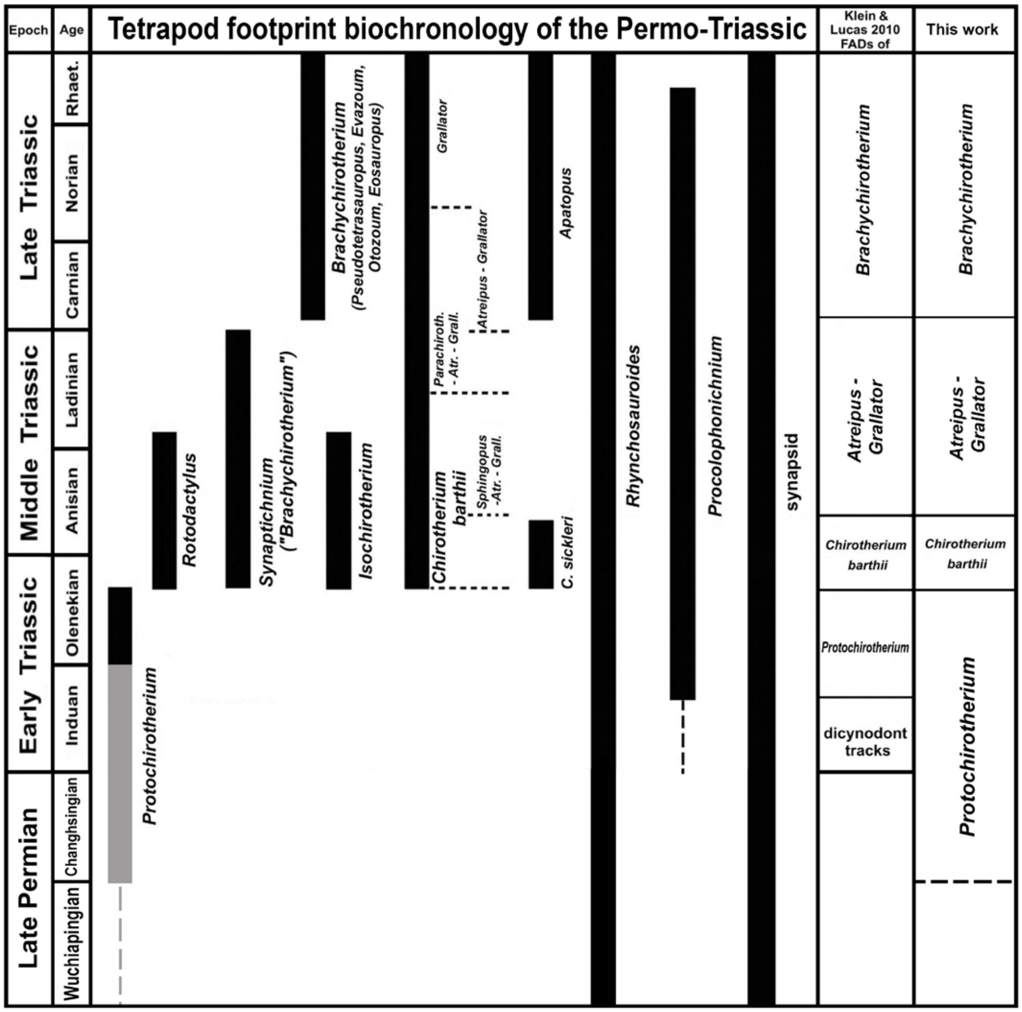


Fig. 1. A. Pes imprint of cf. *Protochirotherium* (PZO 5753) from the Arenaria di Val Gardena (Changhsingian) of the Deutschnofen/Nova Levante locality in northern Italy preserved as a natural cast. B, interpretative drawing.

Fig. 2. Tetrapod footprint biochronology of the Triassic demarcating probable shift of the FAD and lower boundary of the *Protochirotherium* biochron in the Changhsingian as suggested by the footprint record from the Southern Alps.

was defined by the FAD of *Protochirotherium* in the late Induan, and the end of the biochron defined by the FAD of *Chirotherium barthii* in the late Olenekian–early Anisian. The authors recognized *Protochirotherium* as a characteristic morphotype with wide spatial and restricted temporal distribution and therefore an ideal index ichnofossil for this biochron. The finding of cf. *Protochirotherium* in the Arenaria di Val Gardena Formation of the Southern Alps described by Bernardi et al. (in press) suggests an earlier FAD and shifts the lower boundary of the *Protochirotherium* biochron into the Late Permian (Changhsingian). More generally, the new finding confirms that Chirotheriid footprints cannot be considered exclusive of Mesozoic units.

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Preliminary report of new conodont records from the Permian-Triassic boundary section at Guryul ravine, Kashmir, India

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Conodont separates were made by standard methods on small (<1Kg) samples, collected for geochemical analysis, from the Permian-Triassic boundary section at Guryul ravine (Fig.1). Though preliminary, the results may be of some interest considering there are few conodonts previously recorded from this section (summary in Nakazawa et al., 1975; Kapoor, 1992). The present FAD of *H. parvus* remains unchanged in bed 52 at +3.1m, but *H. typicalis* is now found below this in bed 48, in association with Permian macrofauna, and in keeping with its occurrences immediately below the *H. parvus* zone at Meishan in beds 25 to 27b (Yin Hongfue et al., 2001).

Vjalovognathus is found in beds 45 and 47 (Fig. 2). This genus is considered as a cool water type with Gondwana affinities (Mei and Henderson, 2001). It ranges from the Early (Sakmarian-Artinskian) to the Late Permian (Changhsingian) (Nicoll and Metcalfe, 1998). However, it is not known from the low latitudes of the Tethys. *Vjalovognathus* is also one of the dominating genera in the Changhsingian of the Salt Range, Pakistan (e.g., Wardlaw and Pogue, 1995).

It is interesting that *Vjalovognathus* occurs only on the pre-mass extinction beds at Guryul. These beds, at Meishan, based on carbonate oxygen isotopes from conodonts, give cooler temperatures of 25^{o}C than the earliest Triassic of 30^{o}C and above (Sun et al., 2012). The change takes place in the beds between the Late Permian Event Horizon (LPEH) and the FAD of *H. parvus* at Meishan. At Guryul, the carbonate oxygen isotopes (surprisingly considering the sub-greenschist metamorphism) give the same warming trend (based on Baud et al., 1995 and current studies by us on continuous 5 cm thick samples in this interval).

Further work on larger samples will investigate in more detail the stratigraphic distribution of the conodonts and any differences between the large pebbles and the matrix of the bioclastic beds of unit E1.

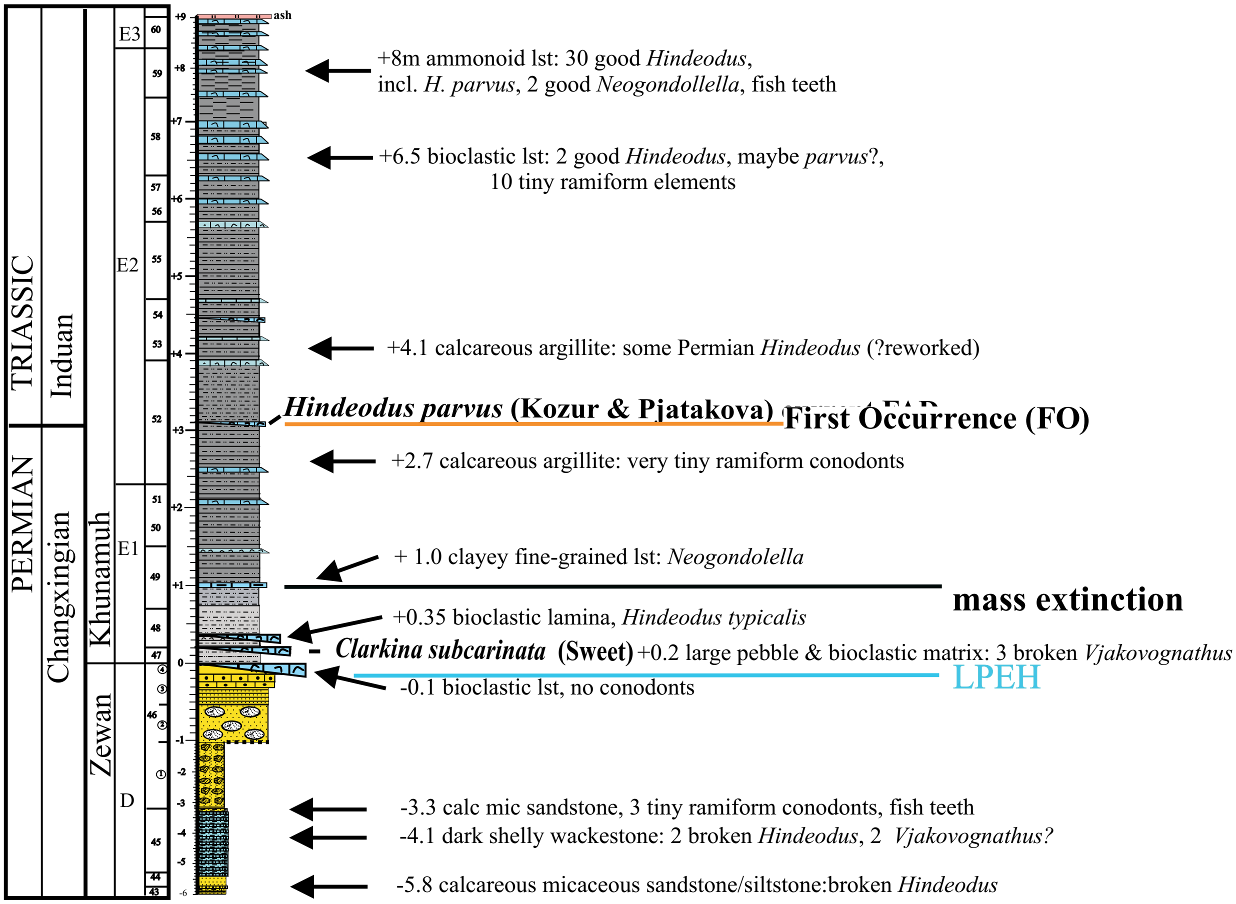

Fig. 1. Stratigraphic section at Guryul from -4 to +9 metres from top of Zewan Formation (top of first bioclastic 'tsunami' limestone). Existing conodont occurrences in bold italics. With new data in normal script. Note change scale below -1m.

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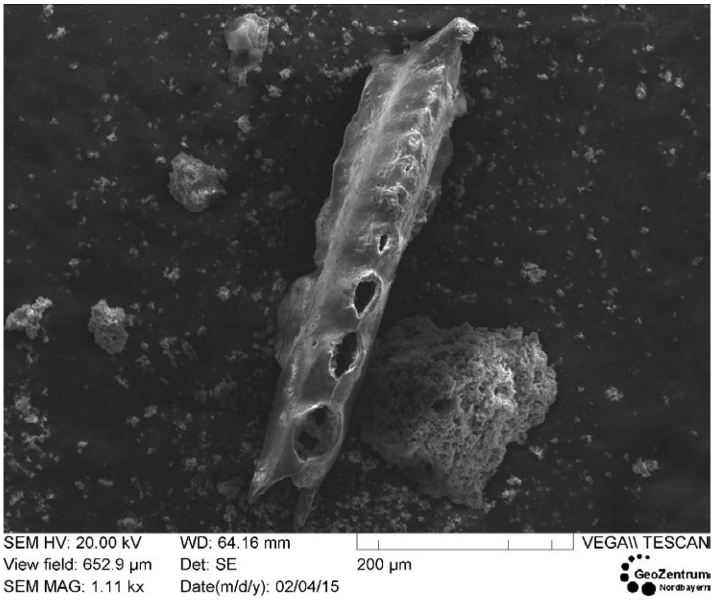

Fig. 2. A specimen of a species of *Vjalovognathus.*

The paradox of the end Permian global oceanic anoxia

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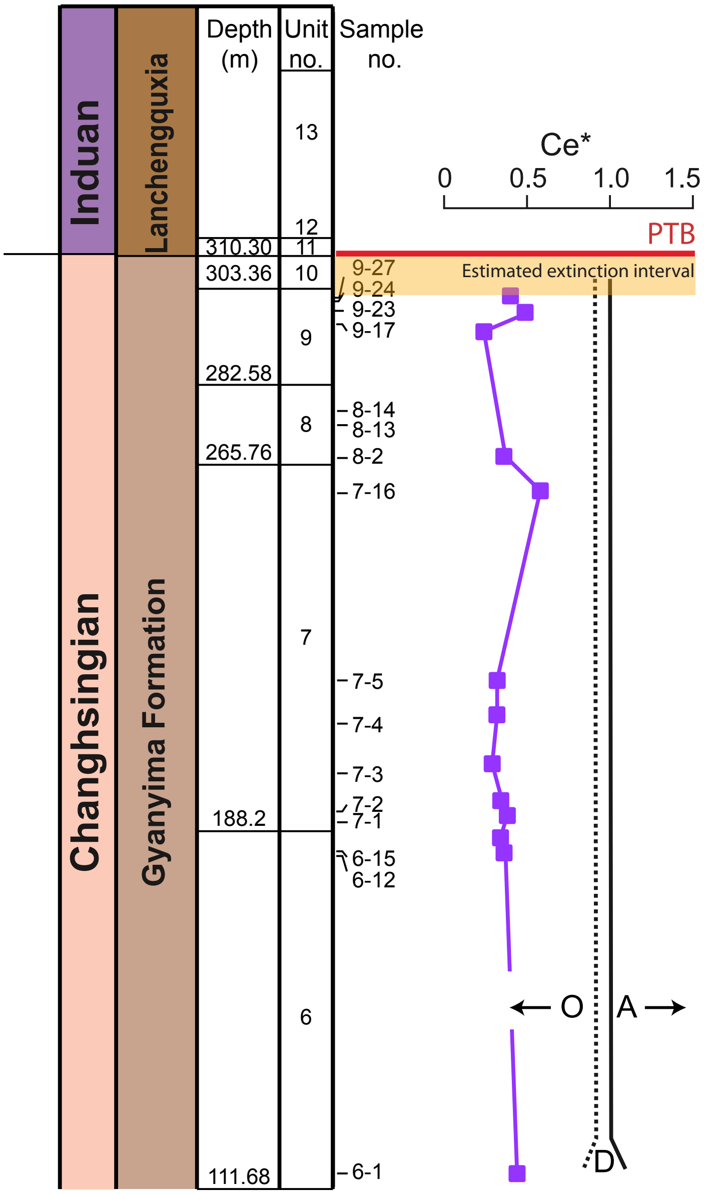

Fig. 1. Ce/Ce* anomaly from brachiopod shell material in the Gyanyima Formation; data rielaborated from Garbelli et al., in press.

It has been a consolidated opinion in many recent publications that, during the end-Permian, levels of oxygen dropped dramatically and globally to cause the main extinction. Also, low oxygen levels have been claimed as the trigger of the prolonged biotic recovery in the aftermath of the extinction (e.g., Wignall and Twitchett, 2002; Weidlich et al. 2003; and others). The reasons for the claimed global anoxia were attributed to different mechanisms from a change in ocean circulation with upwelling of anoxic waters) invading shallow water environments (Kakuwa and Matsumoto 2006; Schoepfler et al. 2013) to the ex-pansion of the oxygen minimum zone (OMZ) on shelves (Algeo et al. 2011; Hotinski et al. 2001; Kiehl and Shields 2005; Kidder and Worsley 2004). However, no concrete and direct evidence of global anoxia at the end of the Permian has been provided and the global anoxia paradigm relies on speculative arguments derived from biotic changes recorded by fossil assemblages, such as shape and size (Lilliput effect), distribution, difference in timing of extinction in deep (earlier) vs. shallow (later) waters (e.g., Payne et al. 2012; He et al. 2015; Shi et al., 2015). In addition, a number of recent studies suggest that upwelling of anoxic waters may have occurred locally during the Late Permian, and was not widespread globally and it therefore cannot be the main cause for the end Permian mass extinctions (Forel et al. 2009; Nielsen et al. 2010; Forel et al. 2013; Proemse et al. 2013; Winghut & Winghut, 2013; Hofmann et al., 2015).

To verify a globally widespread anoxic water column a multi-proxy geochemical approach has to be applied to faunal and sedimentologic sequences. Global oceanic redox conditions are recorded by Ce/Ce* anomaly and other redox sensitive elements (Mo, U) in marine carbonates (e.g., see summary in Brand et al., 2012; Proemse et al., 2013; Kendall et al., 2015).

Recent studies document values of Ce/Ce*anomaly of < 0.95 for oxic conditions, between 0.95 and 1.0 for suboxic, and >1.0 for anoxic conditions (de Baar et al., 1988; German and Elderfield, 1989; Azmy et al., 2011; Zaky et al., 2015). Ce/Ce*anomaly reported for end Permian whole rock and conodonts indicate an oxic water column and/or suboxic sediments (Algeo et al., 2007; Brand et al., 2012; Zhao et al., 2013; Loope et al., 2013; see also table 2 in Brand et al., 2012). Other redox sensitive elements (U, Mo, REY signature) in uppermost Permian-Lower Triassic microbialites also reflect oxic environments (Loope et al, 2013; Collin et al., 2015).

Our recent investigation of pristine brachiopod shells, from the extinction event beds of the Gyanyima section (Tibet) (Garbelli et al., in press), shows Ce/Ce* anomaly values ranging from 0.310 - 0.577, while whole rock data before and during the event supports dominance of oxic seawater conditions (Ce/Ce* anomaly 0.237-0.655). This suggests that subtropical southern Neotethys seawater was oxic at the onset and during the end Permian biotic crisis (Fig. 1).

In conclusion, geochemical results argue against global anoxia as a or the cause for the end Permian mass extinction. Instead, they suggest that the water column was oxic and sometimes the sediment pore water was suboxic, which is the norm. Anoxia, if present, may reflect local conditions developed in deep water settings, but that have to be supported by concrete and direct evidence.

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Late Carboniferous-Permian-Early Triassic Nonmarine-Marine Correlation: Call for global cooperation

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The Late Paleozoic to the Early Triassic is the time of full terrestrialization of life on Earth, and it bears a complete record of the climate development from the normal state of a warm earth via an icehouse earth through a warmhouse into an extreme hothouse and back to a warmhouse earth. It is the time of several biotic changes and events, such as the Late Pennsylvanian changes in tropical forests, the Permian transition from pelycosaur-dominated to therapsid-dominated vertebrate faunas, the Middle Permian biotic crises and the end-Permian mass extinction. That time has produced resources of the highest economical value worldwide – coals, hydrocarbons, salts. The understanding of these processes in time and space is therefore indispensable for basic research, applied geosciences as well as the prospecting for geological resources. As shown in the International Chronostratigraphic Chart 2014/10, the definition of stage boundaries in the Global Marine Standard Time Scale of the Carboniferous, the Permian, and the Triassic has made good progress. The opposite is the case for reliable correlations of nonmarine deposits of this time interval with the marine standard scale. Because of the Carboniferous/Permian glaciation, the Hercynian orogeny, and plate tectonics, a huge number of mixed marine-continental and especially of purely continental basins from tens to thousands of square kilometers in size emerged. During the last few decades a variety of methods was developed and they are successfully applied to correlate continental deposits locally (intra-basinal) and regionally (inter-basinal). However, intercontinental correlations, and especially correlations with the Global Marine Standard Time Scale, are still at an early stage.

To overcome this disappointing situation, in agreement between the International Subcommissions on C, P and T Stratigraphy, a Nonmarine-Marine Working Group was established (see Permophiles 60, 2014, p. 31-36). Following the example of Menning et al. (2006) “Devonian–Carboniferous–Permian Correlation Chart 2003,” a “Pennsylvanian-Permian-Early Triassic Nonmarine-Marine Correlation Chart” should be compiled by this working group. Geoscientists from all continents are requested to provide contributions covering any stratigraphic tool. Included basins should be characterized by their geotectonic and paleogeographic position, depositional environment, paleoclimate information, resources and, of course, the tie points for inter-basinal and global correlation. Besides a column in the correlation chart, a more detailed profile for each basin should be added in a layout, as exemplified in Fig. 1. All contributors will be co-authors of a common publication that should be completed by the end of 2016. To promote this cooperation, a first draft of a correlation chart of several basins from different regions is shown here (Fig. 2). We know this chart is still incorrect in many details, but it can only be improved by your contributions. The first reactions of colleagues to the publication in Permophiles 60 indicates that this will work.

The description of the Thuringian Forest basin in Germany is given here as an example for the compilation of data. In order for a wider use in geosciences the data should not be restricted to stratigraphic information only but should include information on tectonics and basin development, facies patterns, implications of paleoclimate, the development of fauna and flora, etc. Both the layout of the correlation chart as well as the content of basin descriptions, are up for discussion. The first results will be presented during the International Congress on the Carboniferous and Permian in Kazan, August 2015. The congress excursions to the well exposed and long investigated Carboniferous, Permian, and Triassic sections will surely stimulate our working group.

Hope, to see you there for further discussions!

Those colleagues who are interested in the compilation of the correlation chart should contact Joerg W. Schneider via e-mail (Joerg.Schneider@geo.tu-freiberg.de) to be included in an e-mailing list for the exchange of ideas and further discussions. The present version of the correlation chart is available as Adobe Illustrator (Ai) and CorelDraw (cdr) version under http://tu-freiberg.de/geo/palaeo/downloads: CPT nonmarine-marine correlation chart.

Example for the description of basins in the CPT Nonmarine-Marine Correlation Chart Thuringian Forest Basin, East Germany

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Geotectonic and palaegeographic position. The basin originates in the Late Pennsylvanian Gzhelian by around 303 Ma far after the peak of the Variscan orogeny (Late Devonian to Early Carboniferous Tournesian by about 340 - 320 Ma) by extensional tectonics of the Central European Extensional Province (Kroner & Romer, 2013) as an extended rift graben structure of basin-and-range character (Andreas, 2014). Sedimentation starts on deeply eroded Variscan basement of the Saxothuringian Zone in the southeast, Visean granites in the center, and the inverted Mid-German Crystalline Zone as well as the Rhenoherzynian Zone of the European Variscides in the northwest (Schneider & Romer, 2010, Lützner et al., 2012). The basin fill consists of pure continental deposits up to the Late Permian marine Zechstein transgression which flooded the remnants of the basin and the nearly peneplained Variscian morphogene. The Zechstein deposits belong to the post-Variscian platform development in Central Europe.

Size and fill. Approximately 100 km long and 50 km wide NE-SW depression in the subsurface; SW part of the Thuringian Forest–Saale basin-system; large parts exposed in the horst structure of the present Thuringian Forest Mountains; stacked thickness of sediments (without marine Zechstein) and intercalated volcanites about 5500 m.

General stratigraphy. the stratigraphy of the German Late Carboniferous and Permian is based on an about 200 year's long tradition in mapping and stratigraphy (for details see Schneider, 2001; Lützner et al., 2012; Walter, 2012). The Thuringian Forest basin belongs to the classical Rotliegend areas in Europe because of the mining activity since the 12th century of Permian Zechstein Kupferschiefer deposits along the borders of this horst, sulfide ores in Rotliegend lacustrine black shales, Stephanian and Rotliegend coals, and Mesozoic vein deposits. F.G. Gläser published in 1775 one of the worldwide oldest coloured geological maps that included parts of the Thuringian Forest Mountains. First geological descriptions and mapping activities date back to Voigt (1789) – a pupil of Abraham Gottlob Werner –, Freiesleben (1807), and von Hoff (1807), who developed here, before Lyell, ideas about the "principle of actualism". The first description of Rotliegend (Early Permian) plants where given by the coal mine owner Heyn in 1695, and the first Rotliegend plant was figured by Mylius (a lawyer of the town of Leipzig) in 1709. The wealthy illustrated publication of von Schlotheim (1804) on floras of the "Rothliegend" and the "Steinkohlen-Formation" of the Thuringian Forest mark the start of scientific palaeobotany (Barthel, 2003-2008). Nowadays, this Rotliegend basin is one of the biostratigraphically best investigated and correlated basins in the Variscan area (Schneider, 1996, 2001; Lützner et al., 2007; Andreas et al., 2005; Schneider & Werneburg, 2006, 2012; Werneburg & Schneider, 2006). Because of its stratigraphic range from Late Pennsylvanian Gzhelian up to the Late Permian Zechstein and the Permian-Triassic transitional profile in the recent Thuringian basin in the northern foreland of the Thuringian Forest it may act as a Central European Late Pennsylvanian to Early Triassic reference profile.

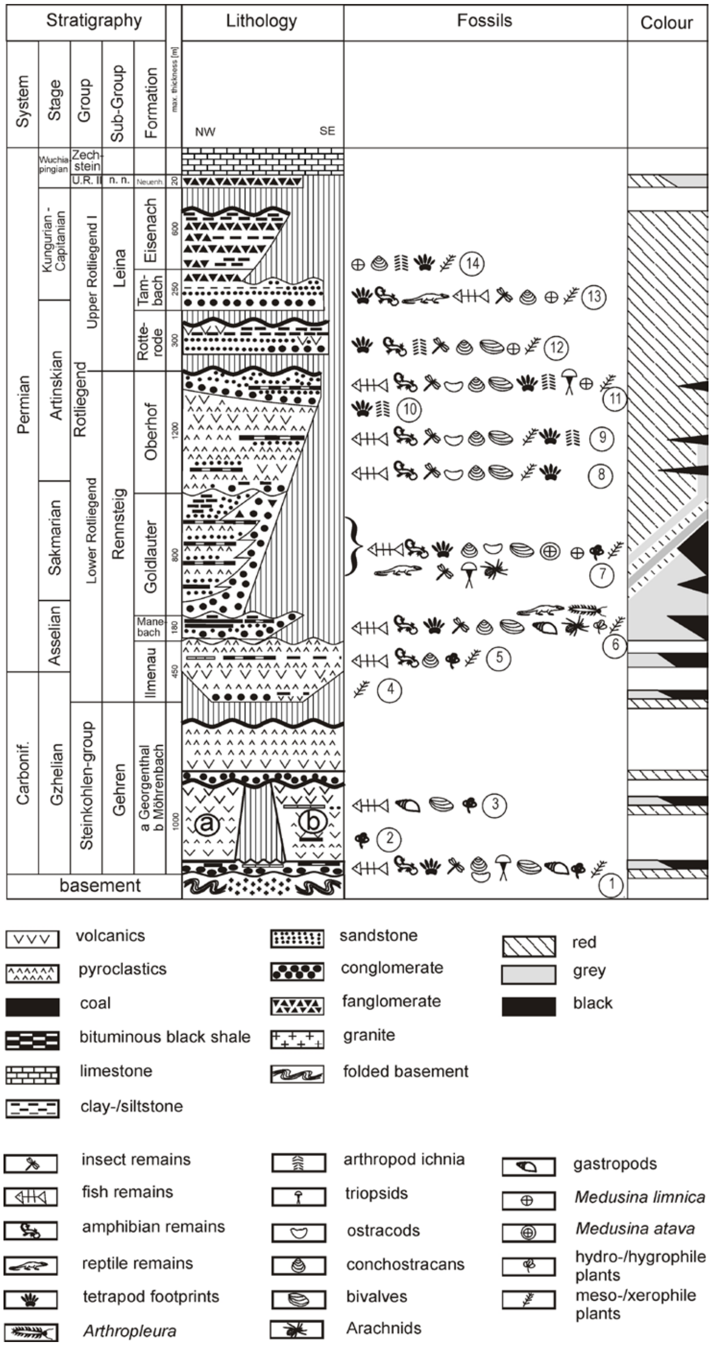

Fig. 1

Resources. Late Carboniferous and Permian volcanic rocks quarried for gritting material; economical important potash salt mines and magnesium limestone quarries in marine Zechstein deposits in the forelands of the Thuringian Mts.

Litho- and biostratigraphy (Fig. 1)

Steinkohlen-Group: This old terminus (Steinkohlen-Formation) was re-introduced by the German Stratigraphic Commission to make a clear distinction between the chronostratigraphic Carboniferous and the lithostratigraphic sequences below the Rotliegend Group which has been called traditionally "Karbon" in Germany. The base of the Steinkohlen Group is not defined so far explicitly, the top is formed by the base of the Rotliegend Group. The latter form together with the following Zechstein Group the Dyas Supergroup (Schneider, 2000).

Gehren Subgroup: Up to 1500 m thickness, mainly extrusive volcanites; subdivided into the partially contemporaneous Möhrenbach and Georgenthal formations. Sedimentation starts on deeply weathered granites and metamorphites of the Variscian basement. Mainly wet red beds with intercalated lacustrine black shales and limestones as well as grey alluvial units with minor coal seams of decimetre thickness. Vegetation consists of hygrophilous peat-forming associations in wet basinal positions with high groundwater levels and meso- to xerophilous (walchian dominated) associations of drier stands inside the basin and in basin-external regions (Barthel & Rößler, 2012). Freshwater sharks (*Orthacanthus*, *Xenacanthus*, *Bohemiacanthus*, *Sphenacanthus*, *Lissodus*) of lake horizons indicate the connection to a Central Europe-wide drainage system (Schneider & Zajic, 1994; Schneider el al., 2000, Fischer et al., 2013).

Age: Xenacanthid freshwater sharks and branchiosaurid amphibians of the *Apateon intermedius–Branchierpeton saalensis*-zone of the lImtal-lake horizon close to the base of the Gehren Subgroup give a Stephanian C, i.e. Gzhelian age (Werneburg & Schneider, 2006; Schneider & Werneburg, 2012), which is somewhat supported by vague Ar/Ar plateau ages of about 297 ± 3 to 299 ± 5 Ma (Lützner el al., 2007, 2012). The Möhrenbach and Georgenthal formations are based on insects and amphibians correlated with the Siebigerode Formation of the Saale basin in the NE prolongation of the Thuringian Forest basin. Intrusion ages of volcanites into the upper Siebigerode Formation, i.e. the Wettin Subformation, give an roughly 300 Ma for the upper boundary of those formation (Schneider et al., 2013), which was recently confirmed by an 299 ± 3,2 Ma U/Pb age of an pyroclastit in the upper Siebigerode Formation.

Rotliegend Group: The base of the group is defined by the re-organisation of former basin structures of the Steinkohlen Group often connected with a hiatus and the shedding of thick significant conglomerates. The base of marine deposits of the Zechstein and their continental equivalents form the top.

Rennsteig Subgroup: Sediments with intercalated volcanites of up to 2800 m thickness. Sedimentation starts after a basin-wide erosional disconformity caused by the Franconian movements by around 300 Ma.

Ilmenau Formation: Up to 450 m thickness, mainly extrusive volcanites with intercalated pyroclastics and alluvial grey and wet red beds as well as lacustrine black shales. The laminated black shales of the Sembachtal lake horizon close to the top of the formation represents a typical Central European Lower Rotliegend (Early Permian) lake with interchanging fish and amphibian dominated lake phases. The flora of the formation is dominated by mesophilous to xerophilous elements (*Autunia conferta, Lodevia suberosa, Odontopteris osmundaeformis*, and conifers (common walchians and rarely *Carpentieria*) (Barthel & Rössler, 1993, 2012).

The tetrapod track ichnofauna consist of *Batrachichnus*, *Limnopus*, *Amphisauropus*, *Ichniotherium*, *Dimetropus* and *Dromopus* (Voigt 2005, 2012).

Age: *Apateon dracyiensis–Melanerpeton sembachense*-zone, which is partially contemporaneous to the *Sysciophlebia ilfeldensis–Spiloblattina weissigensis*-zone (Schneider & Werneburg, 2012). Conodonts co-occurring with the latter zone species in the Bursum Formation of New Mexico give a latest Gzhelian to earliest Asselian age for this level (Lucas et al., 2013, Schneider et al., 2013).

Manebach Formation: Up to 370 m thick basin-wide grey alluvial sediments with several coal seams of maximally 1 m thickness and lacustrine black shales. No volcanites and rarely centimetre-thick pyroclastics. The Flora is dominated by hygrophilous peat-forming associations because of generally high and stable groundwater levels. Fluvial and lacustrine deposits contain eryopid amphibians, sparse indeterminable remains of branchiosaurs and rarely remains of pelycosaurs, common actinopterygians and an impoverished xenacanthid shark fauna.

Age: Insect fragments point on the *Sysciophlebia ilfeldensis*- to *S. balteata*-zones. Because of the conodont based correlation of the *S. ilfeldensis–Spiloblattina weissigenis*-zone to the Global Marine Standard Scale (see above), an Early Asselian age is confirmed. In the climate-cycle stratigraphy of Roscher and Schneider (2006) Gzhelian/Asselian wet phase C.

Goldlauter Formation: Up to 800 m sediments of an alluvial fan-alluvial plain-lake-system with transitions from wet red beds into the basin central grey facies. Intercalated into both are laminated black shales of several lake horizons. Some basin-wide pyroclastic marker horizons. The flora is generally dominated by mesophilous to xerophilous elements, mainly walchians and *Autunia*. The vegetation of lake borders may contain in places dominating hygrophilous plants. Shallow lakes and ponds are rich in temnospondyl amphibians, deeper lakes are fish-dominated, mainly by actinopterygians, *Acanthodes* and xenacanthids. Long living lakes could reveal interchanging fish and amphibian dominated phases. Lake horizons in the Lower Goldlauter Formation have delivered numerous and diverse insect remains, mainly blattids. Tetrapod tracks of the typical European Late Carboniferous/Early Permian association are common (Voigt, 2005, 2012).

Age: *Apateon flagrifer flagrifer–Branchierpeton reinholdi–Melanerpeton eisfeldi*-zone;

lowermost Goldlauter-Formation *Sysciophlebia balteata* form H–*Spiloblattina homigtalensis–Syscioblatta slusiensis*-assemblage-zone, middle to (?)upper Goldlauter Formation *Sysciophlebia balteata* form G–*Spiloblattina sperbersbachensis*-assemblage-zone (Schneider & Werneburg, 2012). In relation to the foregoing

Sysciophlebia ilfeldensis–Spiloblattina weissigenis-zone, which is dated by the co-occurrence with conodonts as Late Gzhelian to Early Asselian, a Middle to Late Asselian age could be assumed for a generalised *S. balteata*-Zone or the Goldlauter Formation respectively as discussed in Schneider et al., 2013.

Oberhof Formation: Up to 1200 m of effusive and sub-effusive volcanites as well as pyroclatics intercalated in wet red beds of an alluvial fan-alluvial plain-lake-system. Intercalated in the lower, middle and upper past are lacustrine aminated black limy lacustrine pelites, which could in places change to reddish in the upper Formation. The flora is generally dominated by mesophilous to xerophilous elements, mainly walchians and *Autunia*. The vegetation of lake borders may contain in places hygrophilous plants. The lakes are dominated by branchiosaurid amphibians. Interchanging fish and amphibian dominated phases could be present in longer living and extended lake horizons. The impoverished fish fauna is restricted to some actinopterygians and *Xenacanthus*. Tetrapod tracks of the typical European Late Carboniferous/Early Permian association are common. Insect remains are rare so fare.
Age: Lower Oberhof Formation *Apateon flagrifer oberhofensis–Melanerpeton arnhardti*-zone, upper Oberhof Formation *Melanerpeton pusillum–Melanerpeton gracile*-zone. *Melanerpeton gracile* has been proven in the upper Buxières Formation of the Bourbon l´Archambault basin in the French Massiv Central, the Lien Vert pyroclastic horizon of this formation was dated as 288 ± 4 Ma (Pb/Pb) (Schneider et al., 2004). Climate stratigraphically the *gracile*-zone marks in several European basins the level of the last perennial lakes (Roscher & Schneider, 2006). The last lake horizon of the Chemnitz basin in Germany, the Reinsdorf limestone horizon, could be dated by the Zeisigwald pyroclastit about 30 m higher in the profile as of 290.9 ± 1.5 Ma (U-Pb) (Rößler et al., 2012). Therefore, a Sakmarian to Artinskian age could be assumed.

Leina Subgroup: Exclusively wet and dry red beds of up to 1200 m thickness; volcanites only in the basal part. Sedimentation starts after the peak of volcanism by around 290 Ma linked to the last Variscian granite intrusions by a basin-wide erosional unconformity caused by the Saalian volcano-tectonic movements between 290 to 285 Ma (Schneider et al., 1995; Schneider, 2001).

Rotterode Formation: Maximally about 300 m of exclusively wet red beds of an alluvial fan-alluvial plain-system with minor (sub-)effusive volcanites and pyroclatics. Superimposed with a pronounced erosive unconformity on the Oberhof Formation. Sparse remains of meso- to xerophilous plants; invertebrate and tetrapod ichnia could be common in places (Voigt, 2005, 2012). Temporary ponds contain imprints of diplocaulid amphibians, the freshwater jellyfish *Medusina limnica* and conchostracans. Sparse insect remains, mostly of xerophilous opsiomylacrid blattoids.
Age: *Moravamylacris kukalovae*-insect zone. Based on calculations of several isotopic ages of Lippolt et al. (2009) an age of about 284 Ma is assumed by Lützner et al. (2012), i.e. Late Artinskian.

Tambach Formation: Maximally 280 m of exclusively wet red beds of an alluvial fan–alluvial plain–flood basin-system. First definitive occurrence of aeolian sandstones in the section of the Thuringian Forest basin. Sparse remains of meso- to xerophilous vegetation. Well known for his common and diverse tetrapod tracks co-occurring with well preserved and likewise diverse tetrapod skeletons, which is unique in the Early Permian not only of Europe (Voigt et al., 2007). Temporary ponds contain *Medusina limnica*, mass occurrences of conchostracans, and a wide variety of invertebrate ichnia (Voigt, 2012). Sparse insect remains, mainly xerophilous opsiomylacrids.
Age: *Moravamylacris kukalovae*-insect zone, late Artinskian to Early Kungurian. Seymouran Land-Vertebrate Faunachron (LVF) of Lucas (2006), "which straddles the Wolfcampian-Leonardian boundary", i.e. the Artinskian/Kungurian boundary.

Eisenach Formation: Up to 600 m of exclusively evaporitic dry red beds of an alluvial fan–alluvial plain–playa lake-system (Schneider & Gebhardt 1993, Lützner et al., 2012). Typical are fanglomeratic debris flows and hyperconcentrated flows. Floodplain siltstones are mainly developed as vertisols; haloturbation and gypsum are widespread. Fluvial re-deposited well sorted fine to middle grained sand strips and scattered ideally rounded coarse sand grains in distal fan deposits point on aeolian transport. The only plant fragments found so far are taeniopterid leaves (Voigt & Rössler, 2004). Arthropod ichnia and except of *Dromopus* indeterminable tetrapod ichnia could be common in places. Playa claystones contain *Medusina limnica*; siltstones of temporary ponds contain conchostracans.
Age: Magnetostratigraphically pre-Illawarra late Early to early Middle Permian (Menning et al., 1988).

Elbe Subgroup: Since the late Wordian, late Middle Permian, the huge mega-playa system of the Southern Permian basin arose in Central Europe, stretching with a length of 2,500 km and a width of ca. 600 km from the southern North Sea via the Netherlands and North Germany into Poland. The clastic part of the up to 2,500 m thick basin fill was mainly delivered via extended wadi systems from the South. The areas of the former Thuringian Forest basin and of the in the Northeast following Saale basin became at those time parts of the Hessian depression wadi system. During the Elbe Subgroup, the second and last megacycle of the Southern Permian basin, this wadi system became back stepping from North to the South increasingly filled up. Wadi fill sediments of some decametre thickness only rest with erosional disconformity, in places with an angular unconformity too on older Permian and, as in the Saale basin, on Carboniferous sediments. They are conformably overlain by marine Zechstein transgression sediments as in the Southern Permian basin. Therefore this wadi fill sediments could be regarded as equivalents of the Elbe Subgroup of the Southern Permian basin and the name of those Subgroup applied to this deposits.

Neuenhof Formation: Up to 20 m of mainly horizontal bedded alluvial sandy fine to middle grained conglomerates and pebbly sandstones of dry red bed facies; secondarily leached by descending marine Zechstein waters to gray and whitish. So far unfossiliferous. Finds of sporomorphs, reported by Kozur (1988),

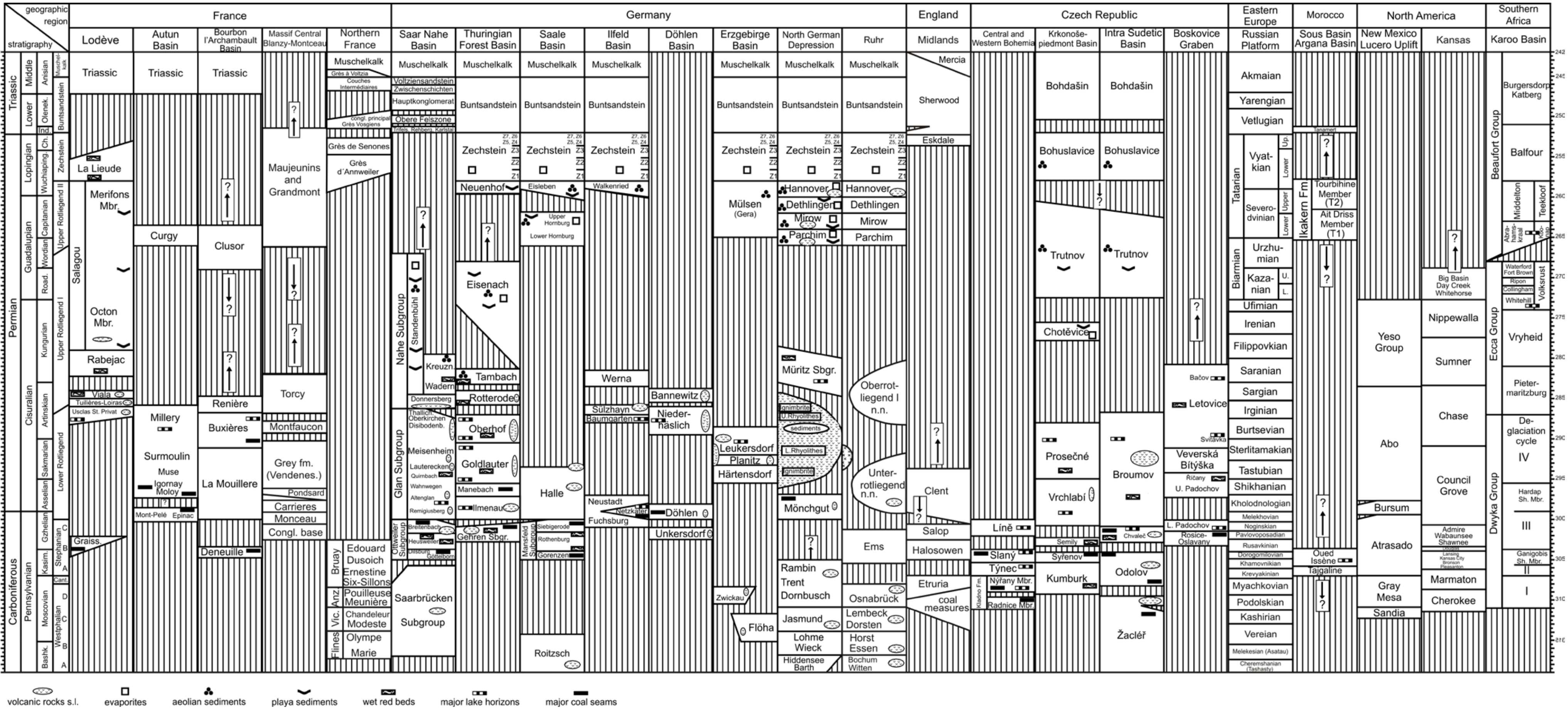

Fig. 2. Example of a correlation chart.

have later not been confirmed.

Age: Magnetostratigraphically post-Illawarra Permian (Menning et al., 1988; Menning & Bachtadse, 2012) and pre-Zechstein-transgression age, i.e. in relation to the Southern Permian basin early Late Permian Wuchiapingian (see below).

Zechstein-Group: It starts with the sudden marine flooding of the Southern Permian Basin and large areas of his southern foreland (for details see Legler et al., 2005, Legler and Schneider, 2008).The group comprise seven marine transgression cycles with restricted marine to sabkha deposits which are regarded as formations of altogether up to 2,000 m thickness (Peryt et al., 2010). The base is defined by marine reworked Rotliegend sediments and the overlaying black shales of the Kupferschiefer. Reworked sediments in the centre of the Southern Permian Basin are of centimetre to decimetre thickness only. The Zechstein conglomerate as well as the submarine bar sandstones with hummocky cross stratification of the Weissliegendes closer to the border of the marine Zechstein basin are time equivalents of different parts of the Kupferschiefer in the basin centre because of the transgressive rising sea level stepping up at the relief of basin borders.

Age: The Kupferschiefer is dated by the conodont *Mesogondolella britannica* as Early Wuchiapingian (Legler et al., 2005), which fits well with the ^{187}Re-^{187}Os
isochron age of 257.3 ± 1.6 Ma (Brauns et al., 2003).

Permian-Triassic boundary: First occurrences of the conchostracans *Euestheria gutta* and *Palaeolimnadiopsis vilujensis* from the upper part of the uppermost Zechstein Fulda Formation were reported by Kozur & Weems (2010) and Scholze et al. (2015), respectively. Based on biostratigraphic correlations with continental Permian-Triassic boundary sections in the Moscow syncline (Scholze et al., 2015) this fauna indicates an Early Triassic (Induan) age. Therefore in contrast to Kozur & Weems (2010) the Permian-Triassic boundary will be situated most possibly within the latest Zechstein Group. This is well supported by new palynological data recording the Late Permian sporomorphes *Lueckisporites virkkiae* in the lower Fulda Formation and the Early Triassic *Lundbladispora obsoleta* and *Densoisporites* sp. in the upper Fulda Formation (Scholze et al., in prep.).

Summary.

After the main folding of the Variscan orogeny in Central Europe the basin was formed after erosion of an about 7 km to 10 km pile of rocks - comparable to the Stephanian/Early Permian basins in the French Massiv Central – by extensional tectonic as a graben structure in the SW-NE stretching Kraichgau - Thuringian Forest – Unstrut – Saale basin system (Lützner, 2012) at the outer border of the orogene. The remnants of the Variscan orogone has at this time in Europe the character of low mountain ranges only, contrary to the ill-founded assumption of an alpine relief by Becq-Giraudon et al. (1996) - see Roscher & Schneider (2006). Sedimentation starts on the deeply eroded core complex of the orogene in the Early Gzhelian with wet red beds and grey lake deposits. It is followed by about 1000 m of volcanites. After a basin wide erosional hiatus leading to peneplainisation by around 300 Ma sedimentation starts again accompanied by decreasing volcanism. The volcano-tectonic activities by around 300 Ma and the hiatus are regarded as the Franconian movements in the Variscides (Schneider et al., 1995). The basin-wide grey-facies of the Manebach Formation could coincide with an interregional climatically wet phase in the European area during latest Gzhelian and the Asselian. A further volcano-tectonic activity, the so called Saalian ”phase”, resulting from granite intrusions and accompanied by sedimentary hiatuses occurs around 290 to 285 Ma. The intrusion of the NNE-SSW stretching, about 460 m thick Höhenberg dolerite sill marks the end of volcanism in the Thurigingian Forest basin by about 284 Ma (Lippolt et al. 2009). Last perennial lakes with black shales intercalated in wet red beds occur in the Late Asselian/Early Sakmarian wet phase by rougly 291 Ma to 287 Ma. During the Late Artiskian/Early Kungurian wet phase by around 284 Ma to 281 Ma temporary lakes and ponds only in wet red bed facies occur. In the following time up to the Early Wuchiapingian marine Zechstein transgression dry red beds with fanglomeratic fan and various evaporitc playa deposits dominate. The transgression is accompanied by a sudden amelioration of the climate; a maritime touch with increased precipitation is well observable in terrestrial biotas and sedimentation pattern. The Permian/Triassis boundary is most possibly situated in sabkha to playa deposits of the last Zechstein cycle 7, Fulda Formation, which continuously grade into playa deposits of the Early Triassic Buntsandstein.

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ANNOUNCEMENTS

XVIII INTERNATIONAL CONGRESS ON CARBONIFEROUS AND PERMIAN (XVIII ICCP), KAZAN, RUSSIA, August 11-15, 2015

XVIII ICCP, an international meeting of geologists and paleontologists in all fields of the Carboniferous and Permian research, will be held at Kazan Federal University, Kazan, Russia on August 11-15, 2015.

The Carboniferous and Permian successions of Russia have a long history of study and are renowned for excellent outcrops that occur over a vast territory, a considerable variety of depositional types, and abundant fossils. National and international projects have focused on documentation of candidates for global stratotypes for stage and substage boundaries, on paleogeographic reconstructions of the Uralian Ocean and the Paleo-Tethys, and on geochemical studies leading to great advances in our understanding of the paleoclimate at the end of the Paleozoic. Considerable progress was made in the study of Carboniferous and Permian successions in Siberia, the Russian Far East and the Cis-Uralian Region.

ICCP XVIII in Kazan will provide an important forum for discussion of the most relevant cutting-edge topics of Carboniferous-Permian geology and paleontology, and a unique opportunity to see and collect from exceptional geological localities in European Russia.

Organizing committee

President of the XVIII International Congress on the Carboniferous and Permian
Professor Ilshat R. Gafurov
Rector of Kazan (Volga Region) Federal University
Chairman of the Organizing Committee
Professor Danis K. Nurgaliev
Vice-Rector for Research
Director of Institute of Geology and Petroleum Technologies
Congress General Secretary
Dr. Vladimir V. Silantiev
Head of Paleontology and Stratigraphy Department
Phone/fax: 007 843 292 0819; E-mail: iccp2015@kpfu.ru

Please contact the ICCP XVIII Congress Secretariat by emailing iccp2015@kpfu.ru for all enquiries, visa support and accommodation. Please note: It is strongly recommended that you register in advance for the meeting. The website registration is free. The registration form is available on the Congress website: http://kpfu.ru/iccp2015

The fee for participation is offered at a discounted fixed rate: Regular participant – 250 Euro, Student – 125 Euro, Accompanying person – 50 Eur (all fees will be accepted onsite in cash). ATMs are widely available at aiports, banks, along main shopping streets and in malls.

Scientific Committee

Alexander S. Alekseev, Mikhail P. Arefiev, Igor V. Budnikov, Alexander S. Biakov, Zhong Q. Chen, Boris I. Chuvashov, Annette E. Goetz, Valeriy K. Golubev, Natalia V. Goreva, Giovanna Della Porta, Adrian Immenhauser, Olga L. Kossovaya, Galina V. Kotlyar, Elena I. Kulagina, Serge V. Naugolnykh, Svetlana V. Nikolaeva, Tamara I. Nemyrovska, Galina Y. Ponomareva, Barry C. Richards, Yuri V. Savitsky, Shuzhong Shen, Joerg W. Schneider.

Detailed information about the Organizing committee is available on the congress website http://kpfu.ru/iccp2015

Schedule for the XVIII ICCP

August 10: Arrival at Kazan, Registration and welcome reception.
August 11: Talk and poster sessions, workshops.
August 12: Talk and poster sessions, workshops.
August 13: Mid-Congress field excursion B1. Permian deposits and historical-cultural sites along the Volga River.
August 15: Talk and poster sessions, workshops. End of the meeting.

Sessions

1. Carboniferous stage boundaries, stratotype sections, and GSSPs
Co-Conveners: Barry C. Richards, Alexander S. Alekseev
2. Permian stage boundaries, stratotype sections, and GSSPs
Co-Conveners: Shuzhong Shen, Galina V. Kotlyar
3. Carboniferous and Permian high-resolution stratigraphy (multi-proxy correlations)
Co-Conveners: Vladimir I. Davydov, David W. Haig
4. Late Paleozoic glaciations and interglacials: impact on ecosystems and sedimentation
Co-Conveners: Alexander S. Alekseev, Arthur J. Mory
5. Carboniferous and Permian plate tectonics and orogenies
Co-Conveners: Inna Yu. Safonova, Yuriy S. Biske
6. Late Paleozoic marine macrofossils: systematics, biostratigraphy, and paleobiogeography
Co-Conveners: Svetlana V. Nikolaeva, Xiangdong Wang
7. Late Paleozoic continental biota: systematics, ecosystems, and paleobiogeography
Co-Conveners: Hans Kerp, Valeriy K. Golubev
8. Micropaleontology: systematics, phylogeny and biostratigraphy
Co-Conveners: Tamara I. Nemyrovska, Yuping Qi
9. The terrestrial late Paleozoic world: paleosols, lithofacies, and environments
Co-Conveners: Joerg W. Schneider, Sergei V. Naugolnykh
10. Sequence stratigraphy and cycles
Co-Conveners: Elena Malysheva, Edouard Poty
11. Late Paleozoic reefs, biostromes, and carbonate mounds
Co-Conveners: Giovanna Della Porta, Olga L. Kossovaya
12, 13, 14. Upper Paleozoic oceans and land: climate, evolution, extinctions and recoveries
Co-Conveners: Alexander S. Biakov, Yuriy A. Gatovsky
15. End-Permian mass extinction and Early Triassic recovery
Co-Conveners: Zhong Q. Chen, Yuri D. Zakharov
16. Carboniferous and Permian coal and mineral deposits
Co-Conveners: Annette E. Goetz, Rinat R. Khassanov
17. Eurasian conventional and unconventional hydrocarbon systems
Co-Conveners: Danis K. Nurgaliev, Giovanna Della Porta
18. Marine-Non-marine Carboniferous and Permian Correlation
Co-Conveners: Joerg W. Schneider, Shuzhong Shen

Pre-and Post-Congress excursions

A. Pre-congress excursions:
A1. Lower Carboniferous of the St. Petersburg region (north-western Russia).
http://kpfu.ru/portal/docs/F1514650990/A1.2015.02.06.FINAL.pdf
A3. Southern Urals. Deep water successions of the Carboniferous and Permian. Lower Permian GSSPS.
http://kpfu.ru/portal/docs/F1364760635/A3.2015.02.11.Engl..svn.Final._1_.pdf
A4. Middle Permian - Lower Triassic continental sequences in Vologda and Arkhangelsk regions (north of European Russia) and localities of flora, tetrapods, non-marine fishes and invertebrates.
http://kpfu.ru/portal/docs/F2140749930/A4.2015.02.11.FINAL_edGolubev2015_02_09.pdf
C. Post-congress excursions:
C1. Volga and Kama Region. Middle and Upper Permian.
http://kpfu.ru/portal/docs/F1220382687/S1.2015.02.06.FINAL.pdf
C2. Middle Urals. Carboniferous and Permian marine and continental successions.
http://kpfu.ru/portal/docs/F142458025/C2.2015.02.06.FINAL.pdf
C3. Carboniferous reference sections: potential candidates for the base of the Serpukhovian GSSP, deep-water and shallow-water sections of the eastern slope of the Southern Urals, organic buildups.
http://kpfu.ru/portal/docs/F590210485/C3.2015.02.08.Engl.vsi_svn1_kul_svn.08_02.pdf

Kazan Federal University
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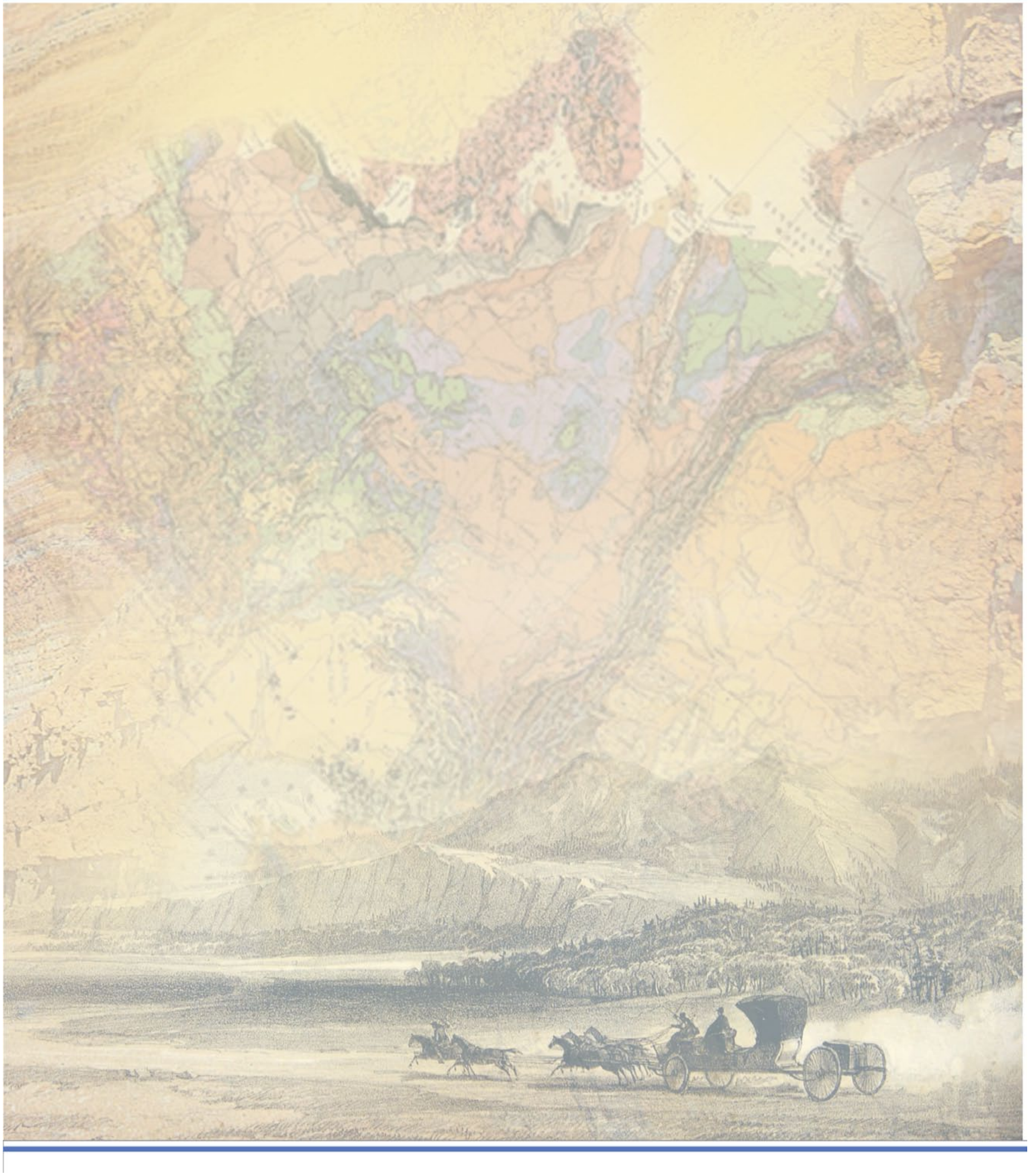

SUBMISSION GUIDELINES FOR ISSUE 62

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)
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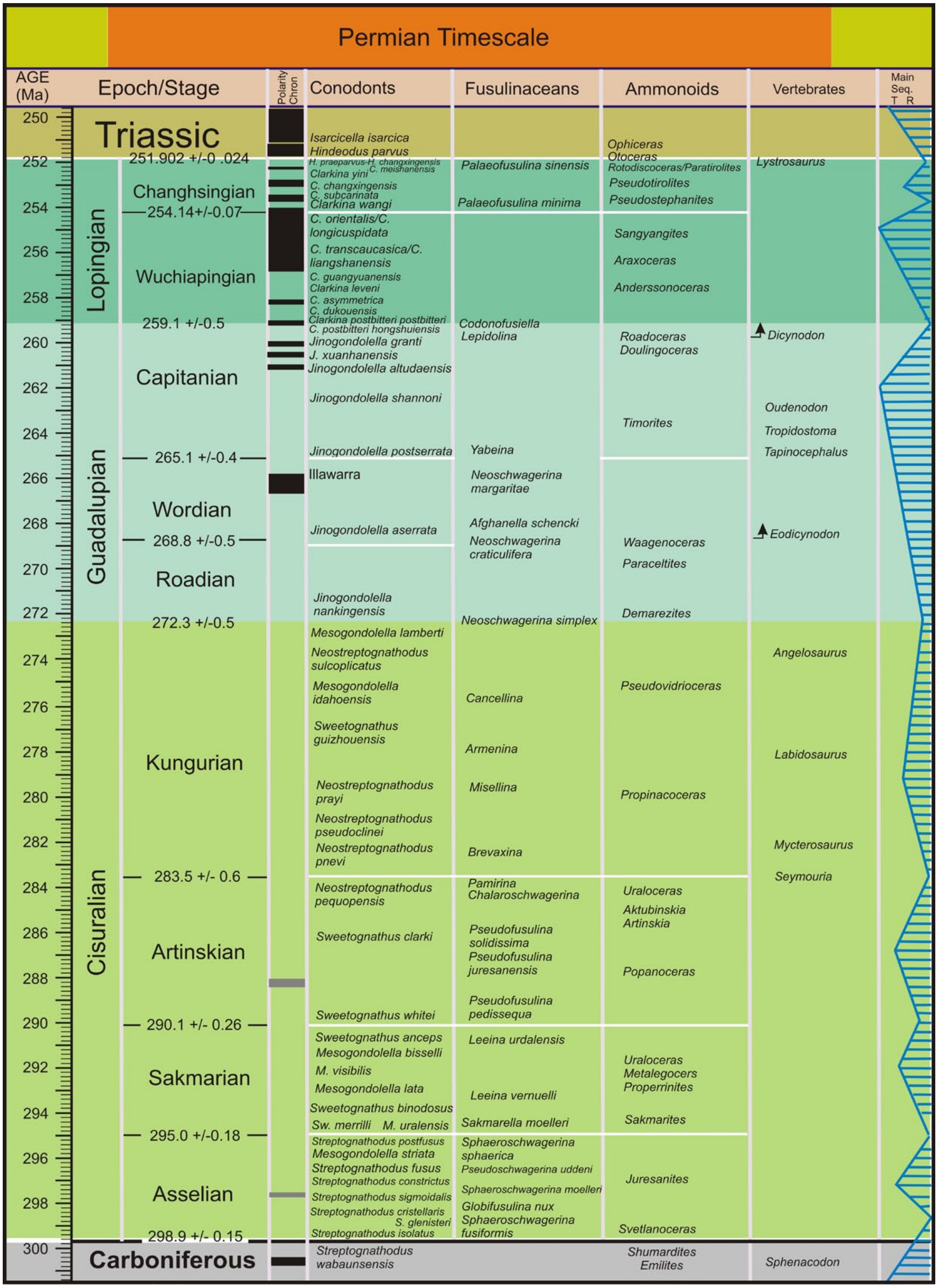
The deadline for submission to Issue 62 is November, 15th, 2015.



Note: This is the latest version of the Permian timescale which SPS recommends (Shen et al., 2013, New Mexico Museum of Natural History and Science, Bulletin 60, p. 411-416). We welcome any comments to improve it. All the information will be updated from time to time here. Geochronologic ages are combined from Burgess et al. (2014, PNAS 111, 9, p. 3316–3321); Shen et al. (2011, Science 334, p. 1367-1372) for the Lopingian; Zhong et al. (2014) for the Guadalupian-Lopingian boundary; Schmitz and Davydov, (2012, GSA Bulletin 124, p. 549-577.) for the Cisuralian, Henderson et al. (2012, The Geologic Time Scale 2012 (vol. 2), p. 653-679) for the base of Kungurian and the Guadalupian. Tetrapod biochronology is after Lucas (2006, Geological Society London Special Publications 265, p. 65-93).