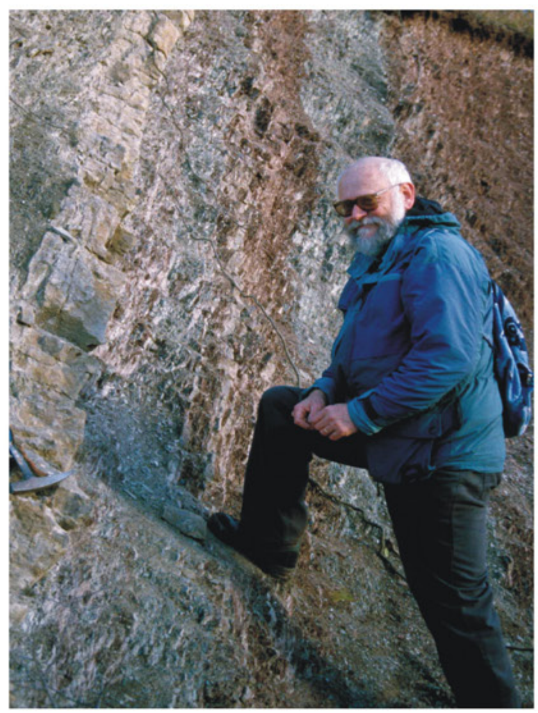
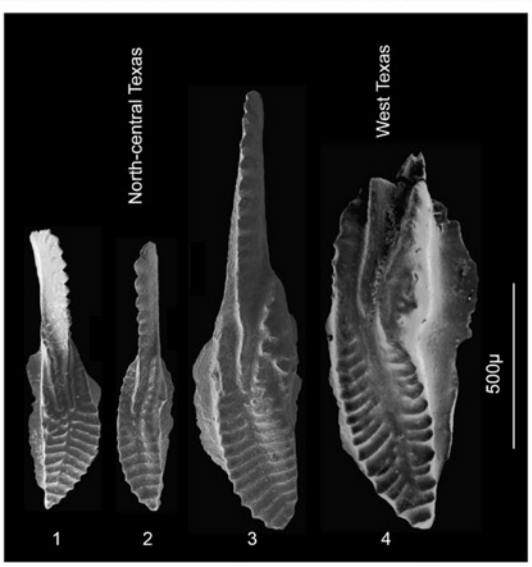
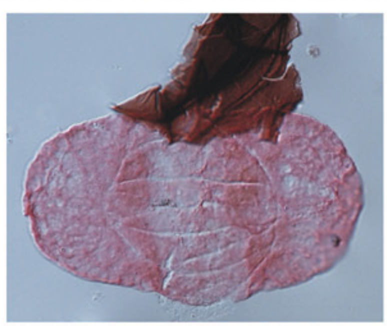
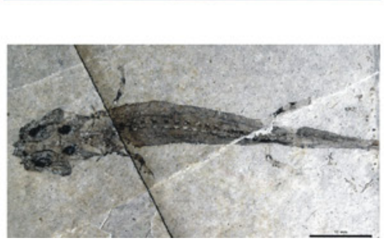
Permophiles

International Commission on Stratigraphy
International Union of Geological Sciences









Newsletter of the
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EXECUTIVE NOTES

Notes from the SPS Secretary

Lucia Angiolini

Introduction and thanks

Shuzhong Shen, Charles Henderson and I have recently visited together the very interesting sections of the P/T boundary in Sichuan, South China and while collecting fossils and rocks, we were also planning this issue of Permophiles.

During this trip (March 9-19, 2014), excellently organized by Shuzhong Shen and Dongxun Yuan, we had the opportunity to visit the Upper Permian-Lower Triassic sections of Chongqing and to sample the spectacular outcrops of Shangsi, where besides two very good PT boundary sections, richly fossiliferous beds characterize the Early Triassic recovery.

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 importat, the updated Permian timescale. Recently, there have been several request to become corresponding members of SPS by new scientists and this is very good because it keeps the Permian community active and the discussion ongoing.

In this foreword, I would like to thank Galina Kotlyar, Spencer Lucas, Mike Stephenson, Joerg Schneider, and Shuzhong Shen for having sent comments and suggestions about the proposals for GSSP for the base-Sakmarian and the base-Artinskian stages (proposals reported in Permophiles 58, p. 16 and 26). My acknowledgements also to Valery Chernykh, Boris Chuvashov and Charles Henderson for having answered to the main issues raised in the comments.

I was very happy to have received some contributions from our Permian colleagues, that make this issue rich and interesting and I want to thank Bruce Wardlaw and Merlynd Nestell, Thomas Schindler and coauthors, and Shirin Fassihi and co-authors, for their interesting contributions to this issue.

Finally I warmly thank Claudio Garbelli for his assistance in editing this and previous issue of Permophiles.

Previous and forthcoming SPS Meetings

The last business meeting held in Albuquerque, New Mexico, USA, May 20-22, 2013, along with the Carboniferous Subcommission as reported in Permophiles 58, to which reference is made for a brief comment on the meeting.

Two forthcoming SPS meetings are scheduled. The first will take place during the Field Meeting on Carboniferous and Permian Nonmarine – Marine Correlation, 21 – 27 July 2014, in Freiberg, Germany.

A second business meeting will be organized 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.

The first circulars of both meetings are available at the end of this Permophiles issue.

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This issue contains the following reports:

Positive and constructive comments about the proposals for GSSP for the base-Sakmarian and the base-Artinskian stages have been sent by Galina Kotlyar, Spencer Lucas, Mike Stephenson, Joerg Schneider, and Shuzhong Shen. These comments mainly underline the need for 1) clarifying the lineage of *Meosogondolella uralensis* in Usolka; 2) clarifying the chronomorphocline *Sw.* aff. *Sw. merrilli-Sw. binodosus-Sw. anceps-Sw.* aff. *Sw. whitei* in Dal'ny Tulkas and in particular the conodont-based primary signal (*Sw.* aff. *Sw. whitei*) which is problematic; 3) reproducing the FADs in other laboratories; 4) revising and checking the available isotopic ages; 5) trying to use also palynology to correlate the boundaries; 6) adding two comprehensive and synthetic figures, one for each section, showing all markers and fossils. Problems related to these section remain the lack of magnetostratigraphy, and the sparse and discontinuous record of macrofossils.

Valery Chernyk and Boris Chuvashov answer to some of the raised issues underlying the potentials of the two sections: Both sections, Usolka and Dal'ny Tulkas, are located close to each other; both the FAD of *Sw. merrilli* and of *M. uralensis* can be used as indicators of the lower boundary of the Sakmarian; *Sw. whitei* is a wide ranging species with global distribution. Charles Henderson provides a thoughtful answer to all the comments and a very incisive and clear synthesis of the main systematic issues.

Bruce Wardlaw and Merlynd Nestell report the occurrence of specimens of *Streptognathodus isolatus* (the primary criterion used for the base of the Permian) from the Stockwether Limestone Member of the Pueblo Formation in north-central Texas and the Neal Ranch Formation from the Glass Mountains, West Texas, confirming that its occurrence in Texas is not just inferred. Sampling by the authors has yielded several collections with common to abundant *Streptognathodus* species that can be used to tie the Texas section to Aidaralash and Kansas. This contribution thus continues the discussion started in Permopiles 58 by the Q & A of Spencer Lucas and Valdimir Davydov on the GSSP section at Aidaralash Creek.

Tomas Schindler and co-authors describe the tetrapod body fossil record from the middle part of the Lower Permian (Asselian) Meisenheim Formation deposited in a lake system. Temnospondyl amphibians from the studied section comprise Branchiosauridae [*Apateon pedestris* and a new species of *Leptorophus* (Schoch, in press)] and Sclerocephalidae (*Sclerocephalus haeuseri*). This record is of special interest as it comprises the first occurrence of *Leptorophus* in the middle part of the Meisenheim Formation, suggesting immigration of other aquatic vertebrate taxa from adjacent Late Palaeozoic basins into the Saar-Nahe Basin (Raumbach invasion).

Shirin Fassihi and co-authors introduce a research they are undertaking on the Carboniferous/Permian boundary in the Banarizeh and Tang-e-Darchaleh sections, in the Sanandaj-Sirjan terrane. This is important not only for correlation of the base-Permian, but also for the debated palaeogeographic setting of the Iranian microplates.

Finally, an obituary by Spencer Lucas, Gerhard Bachman, and Charles Henderson remember the charismatic figure of Heinz Kozur, a conodont specialist famous amongst Permian and Triassic researchers, who sadly passed away on 20 December 2013.

At the end of the issue un updated version of the Permian Timescale is provided.

Future issues of Permophiles

The next issue of Permophiles will be the 60th 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 to move Permian studies forward.

The deadline for submission to **Issue 60** is a **15th November, 2014**. Manuscripts and figures can be submitted via email address (lucia.angiolini@unimi.it) as attachments. To format the manuscripts, please follow the TEMPLATE that you can find on the new SPS webpage at http://permian.stratigraphy.org/ under Publications.

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

Notes from the SPS Chair

Shuzhong Shen

It is very sad to know that one of our distinguished palaeontologists, Dr. Hein Kozur, passed away on December 20, 2013. Dr. Heinz Kozur had a broad range of research in palaeontology and stratigraphy, with a strong focus on the Permian and Triassic conodonts, radiolarians and conchostracans. We have lost one of the most active experts in the Permian community. I would thank Spencer Lucas, Gerhard H. Bachman and Charles Henderson for presenting the obituary for Hein Kozur in this issue.

I would like to thank Lucia Angiolini and Charles Henderson for numerous discussions in the joint field work in South China to organize Permophiles 59. Lucia and I completed the editing of this issue through email communications.

This issue is relatively short, but contains important notes from a few colleagues for the potential Cisuralian GSSPs. In the last issue (#58), the Cisuralian Working Group published two proposals for two potential GSSPs (Sakmarian-base and Artinskian-base) based on the Usolka section and the Dal'ny Tulkas section in southern Urals (Chernykh et al., 2013; Chuvashov et al., 2013). We received some comments and suggestions from our collegues which are very useful to improve the proposals. All those comments and the responses from Valery Chernyk, Boris Chuvashov and Charles Henderson are presented in this issue. We hope that all the voting and corresponding members and other colleagues present their opinions about the quality of the sections and proposals. We also hope that the Cisuralian Working Group has sufficient time to revise and improve the proposals, as we postponed the voting process in the Permian Subcommission. The current practice for establishing new GSSPs typically includes an examination of several fossil groups, together with magnetostratigraphy, isotope stratigraphy (oxygen, carbon, and strontium isotopes) and astrochronology where possible, as well as geochronology (Smith et al., 2014). It appears more and more important that a GSSP should be defined based on multiple markers in addition to the basic requirement of a clear short-range index fossil lineage (Finney, 2013; Smith et al., 2014). The longer an index species ranges, the worse it is to be used for the definiton of a GSSP. Both Ulsoka and Dal'ny Tulkas have good secondary multiple markers including high-precision radiometric dates (Schmitz and Davydov, 2012) and geochemical signals (Zeng et al., 2012). High-resolution radiometric ages and geochemical signals have revealed the limits of biostratigraphical discriminations and common diachronism of fossils (e.g., Rong et al., 2008; Kaiser and Corradini, 2011; Zhang et al., 2014). However, we must be also cautioned to choose clear good short-range index fossil species for the GSSPs.

I would like to thank Bruce Wardlaw and Merlynd Nestell for publishing additional conodont information from the basal part of the Permian System in USA in this issue. The problems of the base of the Permian System were recently discussed by Spencer Lucas in the last issue. I would also thank Tomas Schindler, Shirin Fassihi and their co-authors to contribute their reports on the Lower Permian amphibians in Germany and the Carboniferous-Permian boundary in Iran.

The correlation between marine and non-marine sequences of the Permian System has increasingly becoming a topic which we want to focus on. A large international Carboniferous-Permian working group has been initiated by SPS Vice-Chair Jorg Schneider. An international meeting is planned to be organized in July 21-22, 2014, followed by 5-day field excursion in East Germany, Czech Republic and Belgium. An SPS business meeting will be held during this meeting to discuss the progress of the remaining GSSPs of the Permian System. We cordially invite all colleagues, especially those who are interested in Carboniferous and Permian marine and non-marine sequences, to participate in the meeting. Jorg Schnieder has sent the final announcements to many colleagues and this anouncement is also availabe in this issue and on the SPS webpage.

References

Chernykh, V.V., Chuvashov, B.I., Shen, S. and Henderson, C.M., 2013. Proposal for the Global Stratotype Section and Point (GSSP) for the base-Sakmarian Stage (Lower Permian). Permophiles, v. 58, p. 16-26.

Chuvashov, B.I., Chernykh, V.V., Shen, S. and Henderson, C.M., 2013. Proposal for the Global Stratotype Section and Point (GSSP) for the base-Artinskian Stage (Lower Permian). Permophiles, v. 58, p. 26-34.

Finney, S.C., 2013. The reality of GSSPs. Ciências de Terra (UNL), v. 18, p. 9-12.

Kaiser, S.I. and Corradini, C., 2011. The early siphonodellids (Conodonta, Late Devonian-Early Carboniferous): overview and taxonomic state. Neues Jahrbuch für Geologie und Paläontologie - Abhandlungen, v. 261, 19-35.

Rong, J.Y., Melchin, M.J., Henry, W.S., Koren, T.N. and Verniers, J., 2008. Report of the restudy of the defined global stratotype of the base of the Silurian System. Episodes, v. 31, p. 315.

Schmitz, M.D. and Davydov, V.I., 2012. Quantitative radiometric and biostratigraphic calibration of the Pennsylvanian–Early Permian (Cisuralian) time scale and pan-Euramerican chronostratigraphic correlation. Geological Society of America Bulletin, v. 124, p. 549-577.

Smith, A.G., Barry, T., Bown, P., Cope, J., Gale, A., Gibbard, P., Gregory, J., Hounslow, M., Kemp, D., Knox, R., Marshall, J., Oates, M., Rawson, P., Powell, J. and Waters, C., 2014. GSSPs, global stratigraphy and correlation. Geological Society, London, Special Publications, v. 404. DOI: 10.1144/sp404.8

Zeng, J., Cao, C.Q., Davydov, V. I. and Shen, S. Z., 2012. Carbon isotope chemostratigraphy and implications of palaeoclimatic changes during the Cisuralian (Early Permian) in the southern Urals, Russia. Gondwana Research, v. 21, p. 601-610.

Zhang, Y., Zhang, K. X., Shi, G. R., He, W. H., Yuan, D. X., Yue, M. L. and Yang, T. L., 2014. Restudy of conodont biostratigraphy of the Permian–Triassic boundary section in Zhongzhai, southwestern Guizhou Province, South China. Journal of Asian Earth Sciences, v. 80, p. 75-83.

Officers and Voting Members since August, 2012

Prof. Lucia Angiolini (Secretary)
Dipartimento di Scienze Terra "A. Desio"
Via Manngiagalli 34, 20133, Milano, Italy
E-mail: lucia.angiolini@unimi.it

Dr. Alexander Biakov
Northeast Interdisciplinary Scientific Research Institute
Far East Branch, Russian Academy of Sciences,
Portovaya ul. 16, Magadan, 685000 Russia
E-mail: abiakov@mail.ru

Dr. Valery Chernykh
Institute of Geology and Geochemistry
Urals Baranch of Russian Academy of Science
Pochtovy per 7,
Ekaterinburg 620154 Russia
E-mail: vtschernich@mail.ru; chernykh@igg.uran.ru

Dr. Nestor R. Cuneo
Museo Paleontologico Egidio Feruglio
(U9100GYO) Av. Fontana 140,
Trelew, Chubut, Patagonia Argentina
E-mail: rcuneo@mef.org.ar

Dr. Vladimir Davydov
Department of Geosciences, Boise State University
1910 University Drive, Boise ID 83725 USA
E-mail: vdavydov@boisestate.edu

Dr. Clinton B. Foster
Australian Geological Survey Organization
G.P.O. Box 378, Canberra 2601 Australia
E-mail: clinton.foster@ga.gov.au

Prof. Charles M. Henderson
Dept. of Geoscience, University of Calgary,
Calgary, Alberta, Canada T2N1N4
E-mail: cmhender@ucalgary.ca

Dr. Galina Kotlyar
All-Russian Geological Research Institute
Sredny pr. 74,
St. Petersburg 199026 Russia
E-mail: Galina_Kotlyar@vsegei.ru

Dr. Ausonio Ronchi
Dipartimento di Scienze della Terra e dell'Ambiente
Università di Pavia - Via Ferrata 1, 27100 PV, ITALY
E-mail: ausonio.ronchi@unipv.it

Dr. Tamra A. Schiappa
Department of Geography, Geology and the Environment
Slippery Rock University
Slippery Rock, PA 16057 USA
E-mail: tamra.schiappa@sru.edu

Prof. Joerg W. Schneider (Vice-Chair)
Freiberg University of Mining and Technology
Institute of Geology, Dept. of Palaeontology,
Bernhard-von-Cotta-Str.2
Freiberg, D-09596, Germany
E-mail: Joerg.Schneider@geo.tu-freiberg.de

Prof. Shu-zhong Shen (Chair)
Nanjing Institute of Geology and Paleontology,
39 East Beijing Rd. Nanjing, Jiangsu 210008, China
E-mail: szshen@nigpas.ac.cn

Prof. Guang R. Shi
School of Life and Environmental Sciences,
Deakin University
Melbourne Campus (Burwood), 221 Burwood
Highway, Burwood
Victoria 3125, Australia
E-mail: grshi@deakin.edu.au

Prof. Ueno Katsumi
Department of Earth System Science
Fukuoka University, Fukuoka 814-0180 JAPAN
E-mail: katsumi@fukuoka-u.ac.jp

REPORTS

Received comments about the proposals for GSSP for the base-Sakmarian and the base-Artinskian stages (Permophiles 58)

Comment from G. Kotlyar

Galina Kotlyar
All-Russian Geological Research Institute
Sredny pr. 74
St. Petersburg 199026 Russia;
email: Galina_Kotlyar@vsegei.ru

I think the quality and the correlation potential for the base-Sakmarian and the base-Artinskian GSSPs correspond to necessary requirements and they are complete. Even the biostratigraphic framework (conodonts, fusulinids, ammonoids and radiolarians) in the transitional intervals for the base-Sakmarian and base-Artinskian GSSPs provide sufficiently reliable correlation of the base-Sakmarian and the base-Artinskian GSSPs in the broad-facies spectrum. Besides the geochronologic age, strontium isotopic values and carbon isotopic data serve as additional methods to correlate the lower Sakmarian and Artinskian boundaries.

Comment from S.Z. Shen

Shuzhong Shen
Nanjing Institute of Geology and Palaeontology,
39 East Beijing Rd. Nanjing, Jiangsu 210008, China;
email: szshen@nigpas.ac.cn

Here are the requirements for a GSSP (Global Stratotype Section and Point) as required by ICS:

1) Must be selected in a section representing essentially continuous deposition. The worst possible choice is at an unconformity.
2) Should be in a marine, fossiliferous section without major vertical lithofacies or biofacies changes.
3) The fossil content should be abundant, distinctive, well preserved, and represent a fauna and/or flora as cosmopolitan and as diverse as possible.
4) The section should be well exposed in an area of minimal structural deformation or surficial disturbance, metamorphism and diagenetic alternation, and with ample thickness of strata below, above and laterally from the selected boundary-stratotype.
5) Should be selected in an easily accessible section that offers reasonable assurance of free study, collection, and long-range preservation. A permanent field marker is desirable.

6) The selected section should be well studied and collected and the results of the investigations published, and the fossils collected from the section securely stored and easily accessible for study in a permanent facility.
7) Where possible, the selection should take account of historical priority and usage and should approximate traditional boundaries.
8) To insure its acceptance and use in the Earth sciences, a boundary stratotype should be selected to contain as many specific marker horizons or other attributes favourable for long-distance time correlation as possible.

My comments:

Both the Usolka and Dal'ny Tulkas sections meet some of the above-mentioned requirements as GSSP sections, and both have historical priority following the scheme of previous Permian timescales (Jin et al., 1997).

As for the Usolka section for the Sakmarian-base GSSP, the section is very well exposed and easily accessible. The section has been well studied and possesses multiple markers for correlation. The Usolka section contains both conodonts and fusulinids as well as multiple ash beds. A series of high-precision geochronologic ages have been published (Ramezani et al., 2007; Schmitz and Davydov, 2012). High-resolution carbon isotope geochemistry with potential excursions and strontium isotope based on conodonts are both available at the Usolka section (Chernykh et al., 2013; Zeng et al., 2012). Some improvements are necessary.

1) The lineage of *Meosogondolella uralensis* has not been sufficiently displayed. The problem is that this lineage has not been found in other regions (*e.g.*, South China and any other area). Although similar *Mesogondolella* species (*e.g.*, *Mesogondolella bisselli*) have been reported in many regions, taxonomic relationships between *Mesogondolella* "*bisselli*" and the Ural *Mesogondolella uralensis* lineage needs to be clarified. It is still not clear yet how to use this lineage to correlate among different regions. So this lineage needs more review and comparison. I would suggest Charles and Valery figure more specimens of each species of *Meosogondolella* from Usolka. The correlation of this conodont lineage has not been fully discussed. In particular, the potential for global correlation.
2) The Usolka section is characterized by a series of clastic deposits alternated with carbonates and ash beds. So fossil distributions are not uniform. Some clastic beds do not have fossils.
3) The conodont succession has not been fully confirmed by other labs. I have processed a few samples from the Usolka section; some samples do contain abundant conodonts, but it is better that the whole lineage used for the definition can be confirmed by another lab. Previously we did not confirm the FAD conodonts from the Mechetlino section (for the Kungruian base) and the Kondurovsky section for the Sakmarian-base GSSP. This is also the reason why we want to move the Sakmarian-base GSSP candidate to Usolka.
4) A comprehensive figure showing all markers and fossils is necessary for the proposal.

As for the Dal'ny Tulkas section, it contains better megafossils with high-precision ages, especially some ammonoids were found from a limestone bed slightly above the potential GSSP. The conodonts have been confirmed by different labs. Strontium isotope data are available. Some improvements and problems are also present in the Dal'ny Tulkas section:

1) The section is not well outcropped. In particular, the strata immediately below the limestone breccia are basically covered. People have difficulties to collect samples if the section is not excavated. The section contains less carbonate.
2) The conodont lineage needs to be described more clearly, and more specimens need to be figured. The global correlation potential of the lineage needs to be discussed in more detail.
3) The section is also dominated by clastic deposit, many rocks are organic-rich and do not contain fossils.
4) Carbon isotope geochemistry based on bulk samples is likely affected by diagenesis, therefore probably not very helpful for global correlation.
5) A comprehensive figure showing all markers and fossils is necessary for the proposal.

Nevertheless, no section is perfect to meet all requirements as a GSSP. I would welcome any discussion how to improve the quality of the two sections and proposals.

References

Chernykh, V.V., Chuvashov, B.I., Shen, S.Z. and Henderson, C.M., 2013. Proposal for the Global Stratotype Section and Point (GSSP) for the base-Sakmarian Stage (Lower Permian). Permophiles, v. 58, p. 16-26.

Jin, Y.G., Wardlaw, B.R., Glenister, B.F. and Kotlyar, C.V., 1997. Permian chronostratigraphic subdivisions. Episodes, v. 20, p. 6-10.

Ramezani, J., Schmitz, M.D., Davydov, V.I., Bowring, S.A., Snyder, W.S. and Northrup, C.J., 2007. High-precision U-Pb zircon age constraints on the Carboniferous-Permian boundary in the southern Urals stratotype. Earth Planet. Sc. Lett., v. 256, p. 244-257.

Schmitz, M.D. and Davydov, V.I., 2012. Quantitative radiometric and biostratigraphic calibration of the Pennsylvanian–Early Permian (Cisuralian) time scale and pan-Euramerican chronostratigraphic correlation. Geol. Soc. Am. Bull., v. 124, p. 549-577.

Zeng, J., Cao, C.Q., Davydov, V.I. and Shen, S.Z., 2012. Carbon isotope chemostratigraphy and implications of palaeoclimatic changes during the Cisuralian (Early Permian) in the southern Urals, Russia. Gondwana Research, v. 21, p. 601-610.

Comment from J. Schneider

Joerg W. Schneider
Freiberg University of Mining and Technology
Institute of Geology, Dept. of Palaeontology,
Bernhard-von-Cotta-Str.2
Freiberg, D-09596, Germany;
email: Joerg.Schneider@geo.tu-freiberg.de

Here my comments to the GSSP proposals for the base of the Sakmarian and Artinskian. First some formal notations:

1. Both proposals should be completed by synoptic graphics, which give all important information in one figure. In Chernykh et al. (2013) fig. 2 shows the profile up to the top of bed 26; fig. 9, left side, shows a much longer profile modified from Schmitz and Davydov (2012) and fig. 10 (again longer) the position of the cited ash beds, several other fossil groups besides the conodonts in fig. 2, as well as the isotopic curves. In the text, the position of samples, ash beds *etc*. is given in metres above the base of the whole Usolka profile, but fig. 2 shows only individual thicknesses of the beds. For the absolute distance from the base of the Usolka section you have to refer to fig. 9 and 10.

2. Similarly, in Chuvashov et al. (2013), the information contained in fig. 7 should be integrated in fig. 2; in fig. 2 the symbol for ammonoids is missing from bed 8; the Bursevskian suite in the stratigraphic column is partially written in Russian letters ("Burcebskian"). All ash beds should be added in fig. 2 with indication of which ash beds are dated. The sentence at p. 27, right side, second line, "The overlying deposits of the Sterlitamak horizon…" should be checked – do the authors mean the Bursevskian horizon in reality?

For the content of the proposals I agree with the comments of Spencer Lucas and Shuzhong Shen. But I agree with Charles Henderson too: "If we are looking for perfection we will never achieve our goal." Anyway, both proposals need the discussed improvements.

As a continental worker and busy in non-marine – marine correlations I look for signatures in marine profiles that could be potentially correlative to non-marine profiles. Magnetostratigraphy could be a good tool if the continental sections are long enough and more or less continuous (which is rarely the case) – but these data are missing in both proposed stratotype sections. However, the most useful data are isotopic ages.

Base Sakmarian stage: The age for the base is extrapolated from a Middle Asselian age data in the Usolka section and another ash bed 25 m higher in the profile, which is roughly 6 Myrs younger. Six million of years is nearly the mean duration of the Permian stages. Anyway, the extrapolated age is better than nothing. But in fig. 10 (from Zeng et al., 2012) of Chernykh et al. (2013) there are two ash beds indicated in bed 26 – only about 4 to 5 metres above the proposed base of the Sakmarian in bed 25! Why haven't these ash beds been dated? The authors should carefully answer to this crucial question.

Base Artinskian stage: The proposed base is well framed by dated ash beds from 4 m below the proposed base to 10.5 m and 12.5 m above the base. The thickness difference of 16.5 m and the time difference of 2.6 Myrs between the oldest age and the youngest age around the extrapolated age of 290.1 Ma for the Artinskian base (Schmitz and Davydov, 2012) are excellent for correlations to the non-marine realm (as we have actually done for the world-famous Chemnitz petrified forest and continental ecosystem in Rößler et al. (2012)!

References

Rößler, R., Zierold, T., Feng, Z., Kretzschmar, R., Merbitz, M., Annacker, V. and Schneider, J.W., 2012. A snapshot of an Early Permian ecosystem preserved by explosive volcanism: new results from the petrified forest of Chemnitz, Germany. Palaios, v. 27, p. 814–834.

Comment from S. Lucas
Two Recently Proposed Lower Permian GSSPs

Spencer G. Lucas
New Mexico Museum of Natural History, 1801
Mountain Road N. W., Albuquerque,
New Mexico 87104 USA;
email: spencer.lucas@state.nm.us

The recent proposals of GSSPs of the base of the Sakmarian and Artinskian stages by Chernykh et al. (2013) and Chuvashov et al. (2013), respectively, merit comment. The GSSP for the base of the Sakmarian Stage is proposed as the Usolka section in southern Russia, with its primary signal for correlation the FAD of the conodont *Mesogondolella uralensis* in the supposed evolutionary lineage *M. pseudostriata-M. arcuata-M. uralensis-M. monstra* (Chernykh et al., 2013, fig. 5). Evidently, there are no other correlation signals (proxies) for this GSSP level other than those based on conodonts: the primary signal, the apparent extinction of *Streptognathodus* and the FAD of a *Sweetognathus* morph referred to as *S.* aff. *S. merrilli*.

Chernykh et al.'s (2013) proposal of this GSSP makes no mention of macrofossils (especially ammonoids) in the Usolka section, and it does make it clear that the fusulinid record of this section is sparse—the first lower Sakmarian (Tastubian) fusulinids are well above the GSSP level. The Usolka section does have strontium and carbon isotope records across the proposed level for the base of the Sakmarian. However, the basis for assigning a $^{87}Sr/^{86}Sr$ ratio value to the base of the Sakmarian has only been published in an abstract. And, the small shifts in oxygen and carbon values close to this level are well within the noise of the underlying Asselian curves (Chernykh et al., 2013, fig. 10). It thus seems that isotope-based proxies for correlating the proposed base of the Sakmarian are weak to nonexistent.

The claim by Chernykh et al. (2013, p. 25) that an "extrapolated geochronologic age of 295.5 Ma" serves as a marker for correlation is a bit misleading. Such an extrapolated numerical age can be derived for any point in the geological timescale (with varying degrees of precision), so it presents no more data than are available for correlating any proposed GSSP. It is a good feature of the Usolka section that it has dated ash beds, but they only bracket the base of the Sakmarian between ~ 291-297 Ma. The "extrapolated geochronologic age" is based on assumptions about sedimentation rates over 6 million years of sedimentation; it is not a precise age determination.

The proposed base Sakmarian GSSP level thus can only be correlated by changes in hypothesized conodont chronomorphoclines. Documentation of these chronomorphoclines is incomplete.

Thus, unlike chronomorphoclines proposed in the paleontological literature for some other taxa, such as fossil mammals or foraminifers, Chernykh's conodont chronomorphoclines are known only from photographs of representative steps in the lineage. There are no data on sample sizes, no documentation of variation in samples, no metric data, indeed, none of the detailed information and analyses we should see to convince us that the data robustly support the hypothesized chronomorphoclines. Instead, all we are shown is a succession of ideal morphotypes that may capture the actual chronomorphocline, but without other data and analysis the chronomorphocline must be considered incompletely documented. *I urge Chernykh and colleagues to document their conodont chronomorphoclines more extensively and more rigorously before they are considered for use in chronostratigraphy.*

Indeed, the supposed evolutionary lineages of *Sweetognathus* illustrated by Chernykh et al. (2013, figs. 7-8) are characterized by dramatic morphologic jumps in the shape of the carinae that do not suggest transition to me—note, for example, the difference between their figs. 7.2 and 7.3. Furthermore, problems with the lineages of *Sweetognathus* discussed by Chernykh et al. (2013, p. 22) raise real questions about the evolution of species within this genus (see below).

The proposed GSSP for the base of the Artinskian Stage is the Dal'ny Tulkas section in southern Russia, with its primary signal for correlation the FAD of the conodont *Sweetognathus* aff. *Sw. whitei* in the supposed chronomorphocline *Sw.* aff. *Sw. merrilli*-*Sw. binodosus*-*Sw. anceps*-*Sw.* aff. *Sw. whitei*. This GSSP has better fusulinid and ammonoid records than does the proposed base Sakmarian GSSP at Usolka, though these records provide no proposed proxies for correlation.

The proposed level of the Artinskian GSSP is close to sharp inflections in the carbon and oxygen isotopic curves, which can serve as proxies for correlation. Nevertheless, the conodont-based primary signal is highly problematic given that the type of *S. whitei* (from Wyoming, USA, Rhodes, 1963) is evidently Asselian. This, of course, raises the question of what is the taxonomic and evolutionary status of what Chuvashov et al. (2013) are calling *Sw.* aff. *S. whitei*? Is it a homeomorph of *Sw. whitei*, or is it *Sw. whitei* first appearing at Dal'ny Tulkas long after its earlier appearance in the USA? This problem needs resolution before the supposed chronomorphocline can be used for chronostratigraphy.

Thus, the proposed GSSPs for the bases of the Sakmarian and Artinskian have as their primary signals for correlation incompletely documented conodont chronomorphoclines, and the chronomorphocline that supposedly resulted in the FAD of *S.* aff. *S. whitei*, which is being proposed as the primary correlation signal for the base of the Artinskian, is particularly problematic. Both GSSP localities also suffer from limited outcrop and a relative lack of other fossil records (especially of fusulinids and ammonoids) by which to correlate them. Both the Sakmarian and Artinskian Stages were originally defined by ammonoid and fusulinid biostratigraphy, and little effort is made in either GSSP proposal to explain how the newly defined stages correlate to their original definitions, so neither proposal contains a necessary discussion of priority.

In am thus concerned that these two proposals may give us two more Permian GSSPs that have many (or all) of the defects of the Aidaralash GSSP for the base of the Asselian that I have already critiqued at length---correlation by one poorly documented conodont-based signal rooted in an incompletely documented chronomorphocline, few and poor proxies for correlation, limited outcrops and an absence of an effort to preserve priority (Lucas, 2013). At this point, much more work should be done to convince the Permian timescale community that the recently published proposals of the GSSPs of the base of the Sakmarian and base of the Artinksian merit approval.

References

Chernykh, V.V., Chuvashov, B.I., Shen, S. and Henderson, C.M., 2013. Proposal for the Global Stratotype Section and Point (GSSP) for the base-Sakmarian Stage (Lower Permian). Permophiles, v. 58, 16-26.

Chuvashov, B.I., Chernykh, V.V., Shen, S. and Henderson, C.M., 2013. Proposal for the Global Stratotype Section and Point (GSSP) for the base-Artinskian Stage (Lower Permian). Permophiles, v. 58, 26-34.

Lucas, S.G., 2013. We need a new GSSP for the base of the Permian. Permophiles, v. 58, p. 8-13.

Rhodes, F.H.T., 1963. Conodonts from the topmost Tensleep Sandstone of the eastern Big Horn Mountains, Wyoming. Journal of Paleontology, v. 37, p. 401-408.

Additional comment (answer by S. Lucas to S.Z. Shen)

Let me just emphasize two points I made in my previous comment:

1. We do need more rigorous and explicit published documentation of the conodont chronomorphoclines (and taxonomies) of the lineages being proposed to act as primary correlation signals for both GSSPs.

2. There should be some explicit explanation (or reference to such an explanation already published) of how the proposed Sakmarian and Artinskian bases are related to their historic (and original) definitions, which were by ammonoids and fusulinids, not by conodonts.

Comment from M. Stephenson

Comment on Dal'ny Tulkas section as the site of a possible GSSP for the lower boundary of the Artinskian Stage – and some reflections on palynology in Permian correlation

Mike H. Stephenson
British Geological Survey
Keyworth
NG12 5GG Nottingham, UK;
email: mhste@bgs.ac.uk

I read with interest the proposal to institute the base of bed 4b at the Dal'ny Tulkas section, near Krasnousol'sky, Bashkortostan as the base of the Artinskian Stage. This boundary can be established on conodonts, fusulinaceans and ammonoids. The occurrence of the evolutionary lineage *Sw. binodosus-Sw. anceps-Sw.* aff. *whitei* with transitional forms between the named species establishes continuous sedimentation in the Sakmarian- Artinskian. The presence of ash tuffs, the accessibility of the section and the possibility of global correlation of the established boundary all make the FAD of *Sw.* aff. *whitei* at 1.8 m above the base of bed 4 at the Dal'ny Tulkas section an ideal GSSP for the base of the Artinskian, and I am broadly supportive of the proposal.

The palynology of the section was also reported by me (shortly after the field sampling workshop was conducted between June 25 and July 4, 2007) in Permophiles 50 (Stephenson, 2007). The main purpose of my study was to investigate the possibility that the palynological succession may help to correlate the proposed GSSP.

The palynological samples were found to be dominated by indeterminate non-taeniate and taeniate bisaccate pollen, *Cycadopites* (mainly *C. ?glaber* (Luber and Valts) Hart) and *Vittatina* spp. (mainly *V. minima* Jansonius, *V. vittifera* (Luber and Valts) Samoilovich and *V. subsaccata* Samoilovich) (see details in Stephenson 2007). Algal (?) forms such as *Azonaletes* cf. *compactus* Luber and 'Algal palynomorph sp. A' were also locally common (see fig. 1, Stephenson, 2007).

At the time, it was difficult to be sure whether palynology could be used to correlate the boundary partly because of the rather poor preservation, and partly because my knowledge of the whole Russian Cisuralian palynological sequence was not complete enough to determine where there was something palynologically unique about the section in Dal'ny Tulkas (particularly at the level of the proposed GSSP) to distinguish and correlate it. However the taxa that I called *Azonaletes* cf. *compactus* and 'Algal palynomorph sp. A' (see Stephenson, 2007) hold some promise. Further palynological work might allow palynology to contribute to the correlation of this and other Cisuralian GSSPs in palynological terms.

It was interesting to note, however, that my small article in Permophiles 50 wasn't mentioned by Chuvashov et al. (2013). I have not written this comment to particularly draw attention to this fact - or to be critical - but sadly I think the omission is rather symptomatic of the general lack of attention paid to palynology in Permian correlation. This is odd because palynology is so very important in the Permian! The dominantly non-marine, cold-climate sediments of the Late Carboniferous and Cisuralian of Gondwana are poor in marine fossils (*e.g.*, foraminifera and corals), and crucially in conodonts; thus, historically, correlation has relied mainly on palynology. Palynological research for this period is extensive, being partly driven by exploration for coal (*e.g.*, in India and Australia) and oil and gas (*e.g.*, in the Middle East, South America, and Australia; See Stephenson, 2008 for details). There are literally thousands of papers on palynological correlation of these sediments emanating from palynologists in India, South America, Arabia, Australia and South Africa. There are several local correlations set up by Indian and Australian palynologists and in the many oil, gas and coal companies operating in these areas there must be many tens of palynologists working away with local palynological schemes. The rocks that they correlate are amongst the most valuable in the world in terms of their oil, gas and coal. The Cisuralian to Triassic Khuff Formation in Arabia, for example, is the largest non-associated gas reservoir in the world in the supergiant North Dome / South Pars Field in the Arabian Gulf. Nearby in Saudi Arabia the Cisuralian Unayzah Formation contains several giant oil fields. In Oman to the south there are many large and giant oil fields in the Carboniferous - Permian Al Khlata Formation. In the Cisuralian of South America, South Africa and Australia there are huge coal fields. Almost all of these deposits are correlated regionally and locally by palynology and the scientific and economic value of the palynology done there is huge. Yet palynologists are very rarely represented in the community that develops correlation from GSSPs or in the establishment of GSSPs themselves.

I know that we palynologists can sometimes be a bit complacent and insular, but it's not all our fault! Let's have better representation of the palynological community in the development of Permian correlation!

References

Chuvashov, B.I., Chernykh, V.V., Shen, S. and Henderson, C.M., 2013. Proposal for the Global Stratotype Section and Point (GSSP) for the base-Artinskian Stage (Lower Permian). Permophiles, v. 58, 26-34.

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

Stephenson, M.H., 2008. A review of the palynological biostratigraphy of Gondwanan Late Carboniferous to Early Permian glacigene successions. Geological Society of America Memoir, v. 441, p. 304-320.

Response and Comments by V. Chernykh and B. Chuvashov

Uralian stratotypes of the stage boundaries of the Lower Series of the Permian System

Valery V. Chernykh
Zavaritskii Institute of Geology and Geochemistry
Ural Branch, Russian Academy of Sciences
Pochtovyi per. 7, Yekaterinburg, 620075 Russia;
e-mail: chernykh@igg.uran.ru

Boris I. Chuvashov
Zavaritskii Institute of Geology and Geochemistry
Ural Branch, Russian Academy of Sciences
Pochtovyi per. 7, Yekaterinburg, 620075 Russia

We consider that with the selection of the standard section of the Stage boundary (GSSP), priority should be given to sections located in the stratotype area, because detailed stratigraphic work on the establishment of this Stage and its subdivisions in this region have been performed for a long time. As a rule, detailed zonal scales are necessary for the designation of the boundary at a fixed point of a section and these are chosen according to data generated by the study of sections in the stratotype area.

Questions about the lower boundary of the stages of the Lower Permian cannot be given separately from the results of the long standing study of the Uralian stratigraphy of the Lower Series of the Permian System. All stages of the Lower Series of the Permian were established in the Urals. To establish and determine the lower boundary, for example, of the Sakmarian Stage, we do not take the first discovered section, but we go to the area where historically prevailing ideas about the location of sections of Asselian and Sakmarian strata have been studied. These investigations are made step by step by using corals, brachiopods,

Stage	Horizon	Foraminifera (Chuvashov)	Conodonta (Chernykh)		Radiolaria (Amon)
Kungurian	Irenian	*Parafusulina aff. solidissima – Nodosaria sexangulata*	*Neostreptognathodus imperfektus*		*Ruzhencevispongus uralicus*
	Philippovskian	*Nodosaria pugioidea*	*Neostreptognathodus clinei*		
	Saraninskian	*Hemigordius saranaensis*	*Neostreptognathodus pnevi*		
Artinskian	Sarginskian	*Parafusulina solidissima*	*Neostreptognathodus pequopensis*		*Polyentactinia lautitia*
	Irginskian	*Pseudofusulina juresanensis – Eoparafusulina lutugini*	*Sweetognathus clarki – S.aff. ruzhencevi*		*Tetracircinata reconda*
	Burtsevskian	*Pseudofusulina pedissequa – Pseudofusulina concavuta*	*Sweetognathus whitei*		*Entactinosphaera crassicalthrata – Quinqueremis arundinea*
Sakmarian	Sterlitamakian	*Pseudofusulina urdalensis*	*Sweetognathus anceps*	*Mesogondolella bisselli*	*Rectotormentum fornicatum*
				M. visibilis	*Camptoalatus monopterygius*
				M. lata	*Entactinia pycnoclada – Tormentum circumfusum*
	Tastubian	*Pseudofusulina verneuili – Eoparafusulina tschernyschewi*	*Sweetognathus binodosus*	*Mesogondolella . uralensis*	*Helioentactinia ikka – Haplodiacanthus perforatus*
		Pseudofusulina moelleri	*Sweetognathus merrilli*		*Tetragregnon vimineum – Copiellintra diploacantha*
Asselian	Shikhanian	*Sphaeroschwagerina sphaerica – Globifusulina firma*	*S. postfusus – S. barskovi*	*Mesogondolella pseudostriata*	
				Mesogondolella striata	*Haplodiacanthus anfractus*
	Kholodnolozhian	*Pseudoschwagerina uddeni*	*S. fusus*	*Mesogondolella simulata*	
		Sphaeroschwagerina moelleri-Globifusulina fecunda	*S. constrictus*	*Mesogondolella belladontae*	
		Globifusulina nux	*S. sigmoidalis*		
			S. cristellaris		
		Sphaeroschwagerina fusiformis	*Streptognathodus glenisteri – S. isolatus*		

Table 1. Conodont zones of the Lower Permian and their correlation with fusulinid and radiolarian zones (after Chuvashov et al., 2004, with the additions).

fusulinids and ammonoids. At the present time, most sections could be subdivided by using these faunas in different regions, but the best correlations can be made by using conodonts. We subdivide the strata of these stages on the basis of conodonts, and among them we look for species that could be used as global biochronologic markers.

Long standing paleontological and stratigraphic research of the study of the Lower Permian stratigraphy that has continued for many decades is the basis of all of such investigations. At the present time, the zonal conodont scale of the Lower Permian is based on Uralian materials (Table 1).

In cases when ideas to move the stratotype from the stratotype area to remote regions appear, such ideas are based on the already established evolutionary sequence of the fauna from the stratotype area. For example, the proposal to select the lower boundary of the Kungurian in Nevada (USA) uses the established lineage of the cosmopolitan conodonts *N. pequopensis* - *N. pnevi* - *N. clinei* in the Urals and then uses the Uralian succession to draw the lower boundary of the Kungurian at the level of the appearance of the species *N. pnevi* (base of the Saraninskian horizon). We consider that the original stratotype area is an important consideration for the correct selection of the standard section in accordance with the concept of the GSSP.

Now, after these observations, we present specific comments on the sections proposed by us as the stratotypes of the boundaries of the Sakmarian and Artinskian Stages (Chernykh et al., 2013; Chuvashov et al., 2013).

1. Both sections, Usolka and Dal'ny Tulkas, are located close to each other. The section located on the stream Dal'ny Tulkas significantly duplicates the section at Usolka. The Asselian-Sakmarian part of the section is exposed better in the Usolka section and this section is proposed as the stratotype of the lower boundary of the Sakmarian. The historical stratotype of the Sakmarian Stage is located a short distance to the south and was established by V. E. Ruzhentsev in the Kondurovka section. Ammonoids and fusulinids are more fully represented in the latter section. However, the significant reworking of sediments and fauna in the Kondurovka section makes it more preferable to choose the Usolka section. The Kondurovka section can be proposed as an auxiliary section for the lower boundary of the Sakmarian.

2. The section on the stream Dal'ny Tulkas has the lower boundary of the Artinskian somewhat exposed, but additional mining operations will be required to be able to complete the study of the stratigraphic sequence. This work will be carried out by the time of the XVIII International Congress on the Carboniferous and Permian that will be held August 11- August 15, 2015 at the Kazan Federal University in Kazan, Russia. The renovated section will be shown to participants on the field excursions.

3. We want to make the following comments concerning Shuzhong Shen's remark about the lineage of *Mesogondolella uralensis*. Until very recently, the determination of the lower boundary of the Sakmarian was proposed by us to be placed at FAD of *Sw. merrilli* in the lineage *Sw. expansus* - *Sw. merrilli* - *Sw. binodosus* (Chernykh, 2005, 2006, and others). However, Charles Henderson, relying on collections obtained during the study of conodonts in Bolivia, placed under doubt the reliability of *Sw. merrilli* as the indicator of this boundary and asked us to use the *Mesogondolella* lineage instead. He promised to publish the available arguments, but has not done this at the present time. We agreed with the proposal of Charles Henderson, taking into account that the FAD of *Sw. merrilli* and FAD of *M. uralensis* are very close (the first species appears within the limits of the *M. uralensis* zone) and both species can be used as the indicator of the lower boundary of the Sakmarian (fig. 1).

Because the Bolivian material of C. Henderson is not published yet, we would like to introduce to the voting members the letter, which V. Chernykh sent in 2009 to C. Henderson after the examination of the images of conodonts from Bolivia that were sent to him by C. Henderson. Here is this letter.

"Dear Charles,

After the careful analysis of the images of conodonts from the Apillapampa section (sample # 05) I can report to you the following.

1. The general appearance of the *Sweetognathus* forms supports their late Sakmarian – early Artinskian age. In the Tastubian *Sw. merrilli*, *Sw. binodosus*, the carina consists of 4 - 5 nodules, in the Artinskian *Sweetognatus* there are 6-8 nodules.
2. Forms 05 and 08 are similar to *Sw. binodosus,* but they are Artinskian *Sw. binodosus.* Similar forms are illustrated in my monograph (2006, plate XV, fig. 11, 12). They differ from the Tastubian ones by the higher number of nodules, their more regular construction, and also the presence of a weak ridge on the upper surface.
3. Form 09 – is a transitional form from *Sw. anceps* to *Sw. whitei*, but is more close to the latter one.
4. Form 12 – is a juvenile form and probably the same species as form 08.
5. Form 07 – is a new species from the group *Sw. expansus.* From the type species it differs by a wider and elongate rhomboidal carina with very weak differentiation and the presence of a median ridge. I have not seen such forms in the Uralian sections.
6. Form 18 – it is no doubt *Streptognathodus paraisolatus* (Chernykh, 2006, plate III, fig.1). This species is from the lower Asselian (*glenisteri* zone that is, the next zone after the *isolatus* zone).
7. Form 25 – it is *Str. longus* (Chernykh, 2006. Pl. III, fig. 7). This species is present almost through the entire Asselian. But, judging by the presence of relict nodules on the internal side of the platform, it is more probable that it is also an early Asselian form from the *glenisteri* zone.

I think that forms 18 and 25 are reworked early Asselian forms, which very often can be seen among early Artinskian sweetognathids in the Uralian sections as well.

I do not want to discuss herein the isotopic age of tuffs (295.2), but the Artinskian (or late Sakmarian) age of the conodont assemblage gives a possibility for the conclusion that the isotopic data could be wrong.

With best wishes!
Valery

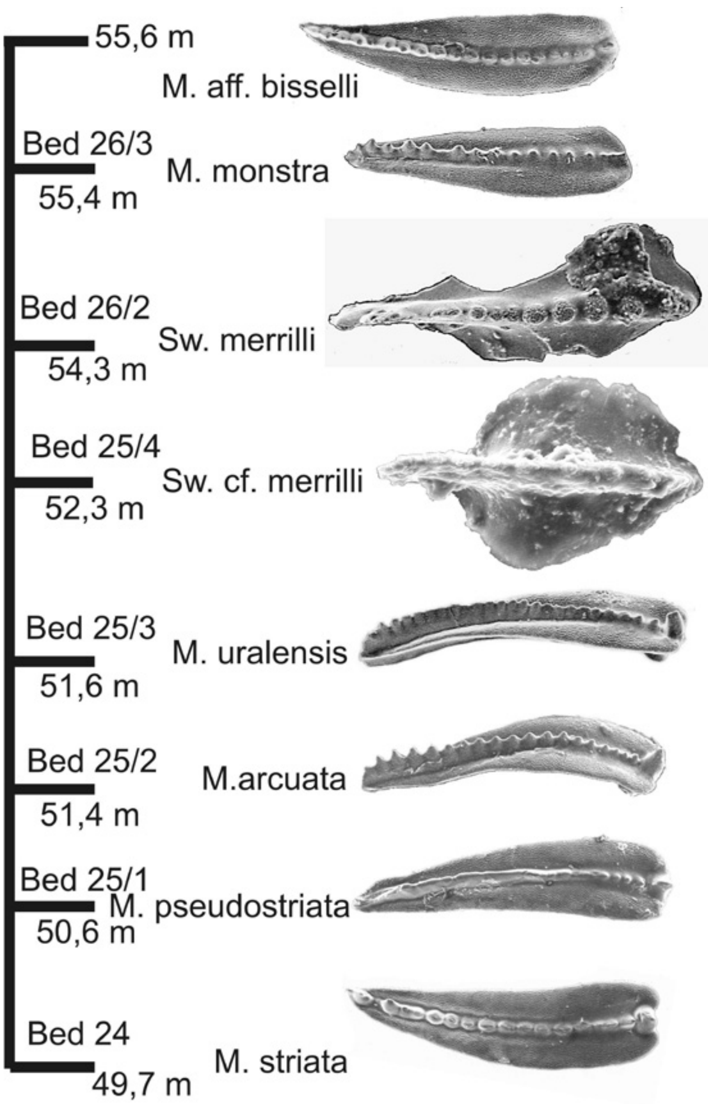


Fig.1. Distribution of conodonts of the lineage Mesogondolella and the level of the first appearance of the conodonts Sweetognathus merrilli Kozur in the Usolka section (the number of beds, distance in the meters from the base of the section is indicated to the left).

P.S. All above mentioned conclusions were discussed by the members of the Russian Commission on the Permian System during the meeting on September 30 of this year (Kazan City). The official document will be sent to you by the chairperson of the Permian Commission of Russia, Dr. Galina Kotlyar.
September 23, 2009.

Our point of view concerning of age of the Bolivian conodonts remains unchanged at the present time.

In addition to this, we want to note herein that conodonts from the Urals identified by us as "*Sw. merrilli*", were assigned by C. Henderson to this species with the sign "aff." and with such a designation they appeared in our paper in Permophiles (Chernykh et al., 2013; Chuvashov et al., 2013), without us agreeing to this correction. The same also happened with the species *Sw. whitei*, which was named by C. Henderson as *Sw.* aff. *whitei* without any preliminary discussion with us. We consider this correction of our determinations to be incorrect and we insist our original point of view be followed.

Returning to the lineage *M. uralensis* and taking into consideration S. Shen's wish to indicate the relation of this species (the time appearance - Tastubian) to the later form *M. bisselli* (the time of appearance – Sterlitamakian), we will give the entire sequence of the forms of *Mesogondolella*, beginning from the Asselian forms and ending at *M. bisselli* in the Usolka section (Fig. 1). In layer 24, the most evolutionary advanced specimens of *M. striata* are present, whose carina consists of closer (which is atypical for this species), but clearly self-contained accessory teeth.

The representatives of the species *M. pseudostriata* appear at the base of bed 25. Almost all carinal teeth in these forms merge and 4-5 posterior teeth remain free. A unique morphotype of *Mesogondolella* appears 0.8 m above in bed 25/2. The teeth of this morphotype are laterally compressed and fused for the larger elongation of carina, and the platform appears bent in side view. We described such forms as *M. arcuata*. The following species after *M. uralensis* are characterized by an even more expressed curvature of the platform, less wide basal cavity and almost complete fusing of the carinal teeth for the entire elongation of carina. Then the tendency of changing in the structure of the morphotypes of *Mesogondolella* is changed to the reverse. This change leads to the appearance at first of *M. monstra* with a flattened platform and with self-contained posterior carinal teeth, and then in the upper part of the Tastubian horizon, morphotypes very similar to *M. bisselli* appear together with *Sw. binodosus*. Typical *M. bisselli* with 3-4 noticeably separated anterior teeth appear somewhat above, in the Sterlitamakian horizon together with *Sw. anceps* (Chernykh, 2005).

The correlation of the levels of the appearance of *M. uralensis* and *Sw. merrilli* is also shown in Fig. 1. The first representatives of the latter species are known from bed 25. Unfortunately, in this layer we have specimens of this species only of poor preservation, which can be identified only in open nomenclature. However, a specimen of typical *Sw. merrilli*, very similar to our forms from bed 25/4, was found by Bruce Wardlaw also in bed 25 of the Usolka section and it was shown to us in 2002 in Boise. Thus, the levels of the first appearance of *Sw. merrilli* and *M. uralensis* are divided by an interval of only more than half metre in the Usolka section, and 6 metres in the Kondurovka section.

The Asselian-Sakmarian mesogondolellas are most studied in the Urals, but they are little known beyond the Ural region. In this connection, we want to note again the possibility of the use of the cosmopolitan conodont species *Sw. merrilli* as the indicator of the lower boundary of the Sakmarian Stage. The lineage of *Sweetognathus* is well studied in the Urals in the Asselian, Sakmarian and Artinskian sections. It is represented by *Sw. expansus* (Perlmutter) in the Asselian interval; *Sw. merrilli* appears at the beginning of the Sakmarian, then the morphotype of *Sw. binodosus* appears in the second half of the Tastubian, the species *Sw. anceps* appears in the Sterlitamakian, and the species *Sw. whitei* appears at the very beginning of the Artinskian. The latter species we proposed as the marker of the lower boundary of the Artinskian Stage.

Sw. merrilli is known from several sections in the territory of the USA: Kansas (Ross, 1963), Texas (Wardlaw, Davydov, 2000) and California (Stevens et al., 2001).

The following member of the lineage, *Sw. binodosus*, is known from the sections of the Sakmarian Stage in Canada (Beauchamp and Henderson, 1994; Orchard, 1984; Orchard and Forster, 1988) and also in China (Ding Hui and Wang Shilu, 1990). We hope that more thorough work on these sections will make possible to find *Sw. merrilli*.

The species *Sw. whitei* proposed by us as the marker of the lower boundary of the Artinskian has wide distribution. It was first described by Rhodes (1963) from the topmost bed of the Tensleep Sandstone of the Eastern Big Horn Mountains, Wyoming, USA. Ritter (1986) studied the distribution of the species of the genus *Sweetognathus* in the Sakmarian-Artinskian sections of eastern Kansas (Chase Group), of western Utah and Nevada (Riepetown Formation). Boardman et al. (2009) established the joint presence of *Sw. whitei* and *Sw. anceps* in the basal part of the Florence Limestone which is, therefore, early Artinskian.

Henderson and McGugan (1986) noted the finding of *Sw. whitei* and *M. bisselli* in the lower part of the Ross Creek Formation (Ishbel Group, southwestern Alberta and southeastern British Columbia).

Orchard (1984), and Orchard and Forster (1988) described a "*Sweetognathus whitei* fauna" from the deposits of the Harper Ranch Formation (south-central British Columbia, Canada).

Henderson (1999) indicated an assemblage of conodonts characteristic for the Artinskian (*Sw. whitei*, *M. bisselli*) from the upper part of the Raanes Formation and the lower part of the Great Bear Cape Formation (Canadian Arctic archipelago).

The species *Sw. whitei* and *M. bisselli* are found in Bolivia (Riglos Suárez et al., 1987). We determined among the conodonts of this assemblage the transitional forms from *Sw. binodosus* to *Sw. anceps* (pl. 19.2, fig. 10) and *M. lacerta* (pl. 19.2, fig. 14); these findings support the early Artinskian age of the enclosing deposits.

Wang Zhi-hao (1994, 2003) notes the presence of *Sw. whitei* at 316 m higher than the base of the Nashui section (Luodian, Guizhou, China).

An assemblage of conodonts with *Sw. whitei* is known also in Korea in the limestone of the Unamasa Formation (Soo-in Park, 1989). This assemblage does not differ from the conodont assemblage of the Tensleep Sandstone, Wyoming, discovered by Rhodes (1963).

We could continue the list of *Sw. whitei* locations, but the already mentioned above data supports the global distribution of this species.

4. "We do need more rigorous and explicit published documentation of the conodont chronomorphoclines (and taxonomies) of the lineages being proposed to act as primary correlation signals for both GSSPs". Spencer Lucas made this observation in a discussion in connection with our proposals in Permophiles 58. It seems a somewhat unexpected comment from him. In the past year, S. Lucas obtained the monograph of Chernykh (2005), in which all stratigraphically important species are described, and the information about the correlation of the established conodont zones is given. S. Lucas noted to us, that he understands Russian text well, and therefore he has the capability to satisfy any of his questions entirely.

We admit that a large part of information concerning the systematics of Upper Carboniferous and Lower Permian conodonts, zonal subdivisions of the Uralian sections and other information about Uralian biostratigraphy of the Lower Permian is published in Russian, that this fact creates an inconvenience for the wide acquaintance with this information. In 2007, on the request of C. Henderson, V. Chernykh gave him the descriptions of all forms of the Permian conodonts from the Uralian sections to be translated into English (preliminary translations have been made by V. I. Davydov). But, there is no information at the present as to how this work progresses. Probably, soon we will search for a satisfactory solution for this problem independently.

We assume that our proposed sections, Usolka and Dal'ny Tulkas, and the species-indicators (conodonts) of the lower boundary of the Sakmarian (*M. uralensis*, and *Sw. merrilli*), the lower boundary of the Artinskian (*Sw. whitei*) and lower boundary of the Kungurian (*N. pnevi*) completely satisfy the main requirement that they provide the possibility of the identification of these boundaries in the Urals, USA, Canada, China, partly in South America, Korea and Japan. Wider correlation will become possible after biostratigraphic studies with the necessary completeness that will be carried out in South America and other regions, where Lower Permian strata are known. In the Urals, these works, as it seems to us, are somewhat advanced in comparison to similar studies in other regions.

References

Beauchamp, B. and Henderson, C.M., 1994.The Lower Permian Raanes, Great Bear Cape and Trappers Cove formations, Sverdrup Basin, Canadian Arctic: stratigraphy and conodont zonation. Bulletin of Canadian Petroleum Geology, v. 42 (4), p. 562-597.

Boardman, D.R., Wardlaw, B.R. and Nestell M.K., 2009. Stratigraphy and Conodont Biostratigraphy of Uppermost Carboniferous and Lower Permian from North American Midcontinent. Kansas Geological Survey Bulletin 25, 42 pp.

Chernykh, V.V., 2005. Zonal Methods and Biostratigraphy – Zonal scheme for the Lower Permian of the Urals according to conodonts. Institute of Geology and Geochemistry, Urals Branch of RAS. Ekaterinburg, 217 pp. (In Russian).

Chernykh, V.V., 2006. Lower Permian conodonts of the Urals. Institute of Geology and Geochemistry, Urals Branch of RAS. Ekaterinburg, 130 pp. (In Russian).

Chernykh, V.V., Chuvashov B. I., Shen, S. and Henderson, C.M., 2013. Proposal for the Global Stratotype Section and Point (GSSP) for the base - Sakmarian Stage (Lower Permian). Permophiles, v. 58, p. 16-26.

Chuvashov, B.I., Chernykh, V.V., Shen, S. and Henderson C.M., 2013. Proposal for the Global Stratotype Section and Point (GSSP) for the base-Artinskian Stage (Lower Permian). Permophiles, v. 58, p. 26-34.

Chuvashov, B.I., Chernykh, V.V and Amon, E.O., 2004. Sakmarian stage of Cis-Uralian division of Permian system: biostratigraphy and correlative potential. Permophiles, v. 44, p. 10-11.

Ding Hui and Wan Shilu, 1990. The Carboniferous-Permian conodont event-stratigraphy in the South of the North China Platform. Cour. Forschungsinst. Seckenberg, v. 118, p. 131-155.

Henderson, C.M., 1999. Correlation of Cisuralian and Guadalupian stages in the Sverdrup Basin, Canadian Arctic archipelago. XIV ICCP. Pander Society. Can. Paleontol. Conf. Abstrs. Calgary, p. 57-58.

Henderson, C.M. and McGugan, A., 1986. Permian conodont biostratigraphy of the Ishbel Group, southwestern Alberta and southeastern British Columbia. Contribution to Geology, University of Wyoming, v. 24, p. 219-235.

Orchard, M.J., 1984. Early Permian conodonts from Harper Ranch Beds, Kamloops area, southern British Columbia Current Research. Part B. Geological Survey of Canada Paper, v. 84 (1B), p. 207-215.

Orchard, M.J. and Forster, P.J.L., 1988. Permian conodont Biostratigraphy of the Harper Ranch beds, near Kamloops, southern-central British Columbia. Geological Survey of Canada Paper, v. 88 (8), p. 1-27.

Rhodes, F.H.T., 1963. Conodonts from the topmost Tensleep sandstone of the Eastern Big Horn Mountains, Wyoming. Journal of Paleontology, v. 37 (2), p. 401-408.

Riglos Suárez, M., Hünicken, M.A. and Merino, D., 1987. Conodont biostratigraphy of the Upper Carboniferous-Lower Permian rocks of Bolivia. In Austin, R.L., ed. Conodonts: investigative techniques and applications. British Micropalaeontological society, Ellis Horwood Publishers, London, p. 317-325.

Ritter, S.M., 1986. Taxonomic revision and Phylogeny of post-early crisis bisselli-*whitei* Zone conodonts with comments on Late Paleozoic diversity. Geologica et Palaeontologica, v. 20, p. 139-165.

Ross, C.A., 1963. Standard Wolfcampian Series (Permian), Glass Mountains, Texas. Geol. Soc. Am. Mem., v. 88, 205 pp.

Stevens, C.H., Stone, P., Ritter, S.M., 2001. Conodont and Fusulinid Biostratigraphy and History of the Pennsylvanian to Lower Permian Keeler Basin, East-Central California. Byu Geology Studies, v. 46, p. 99-142.

Soo-In Park, 1989. Microfossils of the Permo-Carboniferous Strata of Nongam Area in Mungyeong Coalfield. Journal of Korean Earth Science Society, v. 10 (1), p. 102-110.

Wang Zhi-hao, 1991. Conodonts from Carboniferous-Permian boundary strata in China with comments on the boundary. Acta Palaeontologica Sinica, v. 30 (1), p. 6-41.

Wang Zhi-hao and Qi Yu-ping, 2003. Upper Carboniferous (Pennsylvanian) conodonts from south Guizhou of China. Rivista Italiana di Paleontologia e Stratigrafia, v. 109, p. 379-397.

Wardlaw, B.R. and Davydov, V.I., 2000. Preliminary Placement of the International Lower Permian Working Standard to the Glass Mountains, Texas. Permophiles, v. 36, p. 11-14.

Response and Comments by C.M. Henderson
The GSSP Process and the GSSPs proposed for base-Sakmarian and base-Artinskian stages

Charles M. Henderson
Department of Geoscience,
University of Calgary, 2500 University Drive, NW Calgary, Alberta, Canada T2N 1N4;
email: cmhender@ucalgary.ca

Introduction

So where do I begin? At the beginning - and then there were conodonts…seemingly the best biostratigraphic index fossil for correlation of the Permian. As a conodont worker I wish this to be true. It turns out though that sometimes conodonts, or at least the people interpreting those conodonts, can be wrong. The two volumes of GTS 2012 make a tremendous leap forward in our understanding of the Geologic Time Scale, not because of detailed biostratigraphic study in traditional areas, but because it integrates the studies of many workers utilizing all available chronocorrelation techniques. Occasionally during such collaborative efforts a few busts (potential errors) in the biostratigraphic zonation become apparent. At such a time, geoscientists have a choice. We can ignore these new data and suggest that, for example, the U-Pb geochronologic system is wrong, or we can scientifically investigate further and determine whether some refinement is necessary.

There are many critics of the GSSP process, among them S. Lucas, who I respect very much. His criticisms however will serve only to force those of us contributing to these proposals to work harder and more completely so as to produce better proposals. These improved proposals will not be infallible and they will not be perfect. That is simply the nature of the stratigraphic record. The purposes of these proposals are two-fold: 1) they serve to define a point at a single section, and 2) they propose a means to correlate that level elsewhere. The first step, in my view, must be a single definition, for example a conodont species FAD, but it could be some other criterion. The second step is to propose as many ways in which to correlate that level, or more often, proximity to that level. It is best if some of these tools could be utilized in both marine and terrestrial realms. U-Pb isotopic age determination is one such tool and palynology is another. I apologize to M. Stephenson that the proposals did not mention his palynologic work. The final proposals must, and I challenge palynologists to contribute more, as this will become increasingly important for integration of the marine and terrestrial realms into a single time scale. What we don't need are more tethyan stages like the Hermagorian Stage proposed by Davydov et al. (2013). Instead we need good taxonomy (their *anceps*_1 is *binodosus* and transitional forms to *anceps* and *anceps*_2 is actually *anceps*), good correlations, and the willingness to redefine or refine our current stage boundaries

Let's look at two such conodont species FADs – *Sweetognathus merrilli* and *Sweetognathus whitei*. The type locality of *Sw. merrilli* is in the Eiss Limestone in Kansas and this has been compared to the Uralian rare occurrences of so-called *Sw. merrilli* (Chernykh, 2005, 2006). Therefore the occurrences of these forms are correlated with the lowermost Sakmarian. V. Chernykh and B. Chuvashov in their reply (above) suggested that they would like to return to that definition for correlation of the base-Sakmarian and indicated that it was me, without their permission that designated the Uralian specimens as *Sw.* aff. *merrilli*. I had their permission to revise and add to the proposal (not the taxon necessarily) for the previous issue of Permophiles and in my view it was necessary to designate these forms differently (also for *Sw. whitei*) – otherwise there would be a major bust in correlation. By including an earlier correspondence between us in their comments, V. Chernykh and B. Chuvashov inadvertently prove my point. I showed them specimens from Bolivia hoping to get an opinion to assist me in determining how to deal with the considerable morphologic variability in the populations I was finding as well as the apparent overlap of *Sweetognathus* and *Streptognathodus*. It was V. Chernykh during a discussion at a 2007 southern Urals workshop that alerted me to the fact that *Sweetognathus* appeared to be an ecologic replacement for *Streptognathodus* because they overlap only briefly and rarely in the earliest Sakmarian of the Urals. However, in a few locations like the mid-west USA these two taxa overlap for a considerable range – leaving the classic biostratigraphic dilemma. Did *Sweetognathus* appear earlier in this region or did *Streptognathodus* range higher? They argued that my Bolivia material included Artinskian *Sw. binodosus* (I am not convinced that they can be differentiated from Sakmarian representatives of that species since number of row ridges in my experience increase during the lifetime of an individual) and a transitional form between *Sw. anceps* and *Sw. whitei* (closer to the latter). Thus they argued that the sample was earliest Artinskian, but that it included reworked species of Asselian *Streptognathodus*. Furthermore, they chose to suggest that the Asselian geochronologic ages must also be wrong. One age can be wrong, but when several occur in succession in the right order then this possibility is negligible. In the proposals of Permophiles 58, I argued that there is a very simple and compelling way to see that evolution has essentially repeated itself – namely, sequence biostratigraphy. The type specimen of *Sw. merrilli* is from the glacial eustatic cyclothems of Kansas in the Eiss Limestone and specimens identified as *Sw. whitei* from the Florence Limestone are also from the same cyclothem succession. Furthermore, my "Artinskian with reworked Asselian specimens" from Bolivia are also from a very cyclic succession. This is not true of *Sweetognathus* from the Urals or from the Canadian Arctic, where the genus appears above these highly cyclic deposits driven by glacial eustacy – I tried to show this in Permophiles 58. If this is not enough, M. Schmitz (unpublished data) has shown that the Eiss Limestone *Sw. merrilli* have a strontium isotopic signature close to the base-Permian and topotype specimens of *Sw. whitei* from the Tensleep Sandstone of Wyoming have a strontium isotopic signature within the Asselian. Schmitz and Davydov (2012) expected twenty two 400 Kyrs duration cyclothems to occur within the 8.8 Myrs of Asselian and Sakmarian in the mid-west USA (their fig. 13). But instead of 22 there are only 10 cyclothems; they made a very valid assumption that most of the time was missing within the paleosols separating the cyclothems. However, given the new biostratigraphy argued herein, these 10 cyclothems (4 Myrs) fit perfectly into the Asselian and earliest Sakmarian interval. I am presently processing samples from the Florence Limestone for further analysis. Given the memorial in this issue, it is of special interest that H. Kozur at an Albuquerque meeting actually told me to go and collect some topotype material from Wyoming because in his view "the type *Sweetognathus whitei* is different from the Uralian specimens, but he was not sure how". The Tensleep material, just as indicated by Rhodes (1963), is dominated by *Streptognathodus* – species that I would now attribute to *S. fusus* and/or *S. postfusus* (Upper Asselian). Strontium analyses have been performed on *Sweetognathus*, *Streptognathodus* and *Hindeodus* individually and they indicate the same values. These are not reworked Asselian *Streptognathodus* with Artinskian *Sweetognathus*. At least one of these age correlations must be wrong. Given the strontium isotopic values, their occurrence within cyclothems, and the U-Pb ages from Bolivia it is my contention that these *Sweetognathus* forms from Bolivia and mid-west USA are all Asselian (or earliest Sakmarian). Three strikes against the Artinskian age indicates that this correlation is out!

Comments on the other Comments

I agree with S. Lucas, as does V. Chernykh and B. Chuvashov that the chronomorphoclines need to be better documented. Below I will discuss briefly how to differentiate *Sweetognathus whitei* (the type material of Asselian age) and *Sweetognathus* aff. *whitei* (the defining material from the Urals for base-Artinskian. I am also preparing a paper for Palaeoworld that will name this new taxon to hopefully lend further confidence to the final proposal. Conodont species typically do exhibit considerable morphologic plasticity so it is important to illustrate sample populations of these species and this is becoming a more typical practice recently. However, Chernykh (2005, 2006) has illustrated numerous specimens in his books from a number of levels that collectively document these chronomorphoclines to a reasonable extent – it would be even better if V. Chernykh took a more sample population approach to his material. As V. Chernykh points out most of these taxa are published in Russian and that we are working on a translation. Much of this work is complete, but it seems that publishing this work will be difficult because journal opinions have indicated to me that the work is already published. I propose that these translations and the illustrations provided to me by V. Chernykh be prepared for the next issue of Permophiles (with his agreement of course). How many additional specimens need to be illustrated to make the community happy?

I have indicated that *Mesogondolella* would be a better taxon for defining and correlating the base-Sakmarian. This is because neither *Sweetognathus merrilli* nor *Sw.* aff. *merrilli* have been recovered from the Urals. The specimens illustrated by Chernykh (2005, 2006) are very rare "transitional forms" within a "population" leading to *Sweetognathus binodosus* and I would now attribute them to the latter species (but as transitional). This is exactly the nature of my Canadian Arctic material (my PhD thesis in 1989; Beauchamp and Henderson, 1994) – *Sweetognathus binodosus* represents the initial species

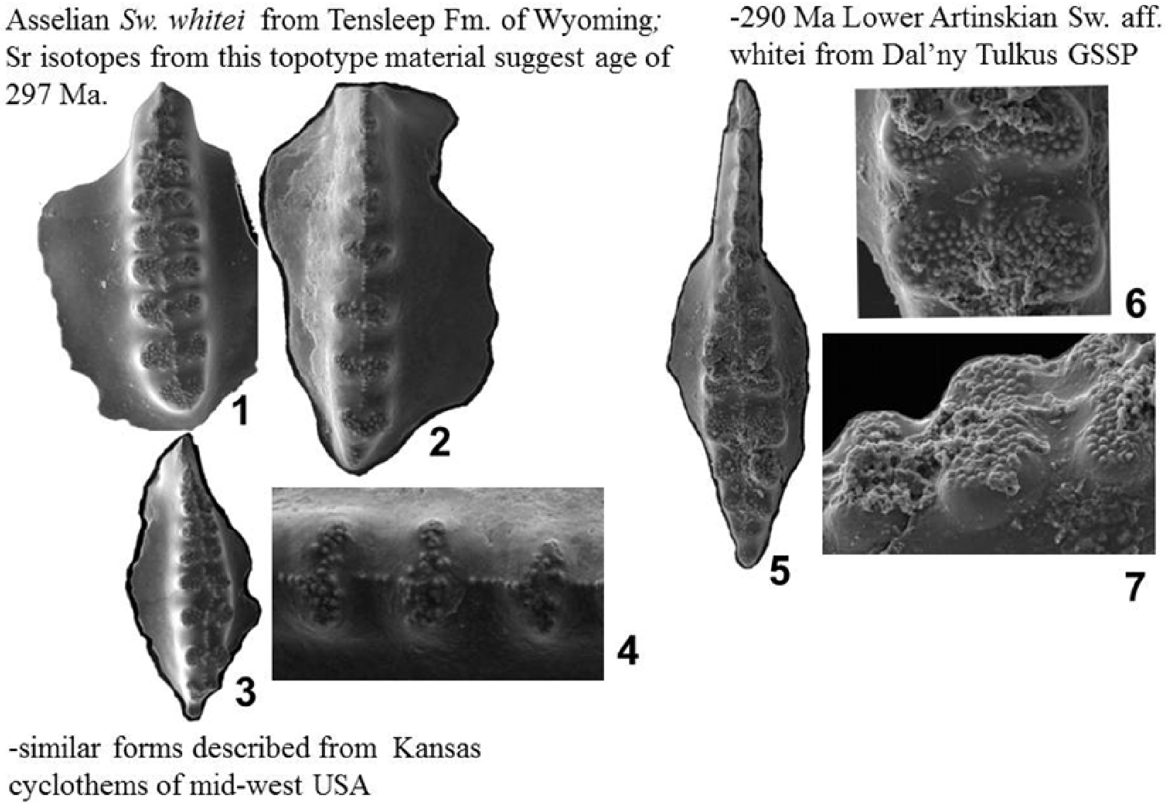


Fig. 2. 1-4 are from the Tensleep Sst of Wyoming. This locality is exactly the same as that indicated by Rhodes in 1963 and thus represents topotype material of *Sw. whitei*. 5-7 are from Dal'ny Tulkas section and represent specimens from the GSSP level and identified currently as *Sw.* aff. *whitei*. Strontium isotopic remarks are unpublished from Mark Schmitz and presented at a workshop in Wells Nevada.

migration of this genus during the major transgression following the Gondwana glacial meltdown that shut down the "cyclothem system". *Sweetognathus merrilli* from the mid-west USA may in fact more closely approximate the base-Permian; it has very irregular nodes and pustulose development on those nodes. Many reports of *Mesogondolella* (including my earlier studies) have misidentified most Sakmarian occurrences of *Mesogondolella* species as *M. bisselli*. In fact, it was the insights and good material illustrated by Chernykh (2005, 2006) that has provided the basis to recognize this succession of species. Work in progress with my Chinese colleagues (Shuzhong Shen and Jun Chen) document a number of Sakmarian levels with *Mesogondolella*, but *M. uralensis* is not among them. In western Canada we have recently documented occurrences of *Mesogondolella monstra*. As shown by V. Chernykh, this species with its more discrete carinal denticles appears very soon after *M. uralensis*. I have previously suggested that discrete denticulation typically are associated with significant flooding or major transgressive events and this could account for the more widely distributed forms like *M. monstra* compared to *M. uralensis*. I chose *M. uralensis* because it is very distinctive and seems to correlate best to a "traditional" level, but perhaps this is a mistake. I still think that this is a good definition and we have geochronology, strontium isotopes (Asselian and Early Sakmarian values come from specimens from the Usolka section), carbon isotopes, sequence biostratigraphy, first appearance of the younger *Sweetognathus* lineage and other species of *Mesogondolella* to correlate the boundary or proximity to the boundary. In my view, that is a significant list of correlation proxies making this a very viable GSSP!

It was suggested that another lab should confirm the succession at Usolka. In fact, in the proposal there are specimens illustrated that were prepared in my laboratory. My laboratory has also duplicated the Sr isotopic values for these levels (BSc thesis in my research group). I agree with G. Kotlyar above that the quality and correlation potential for the base-Sakmarian proposed GSSP corresponds to the necessary requirements and is complete. I agree that a comprehensive and consistent figure be produced that document all data from each of these localities in the final proposals.

The primary objections to the base-Artinskian proposed GSSP relate to the taxon used for definition and the quality of the outcrop at the Dal'ny Tulkas section. Below I will provide preliminary ways in which to differentiate this taxon and, as noted above, I am preparing a paper for Palaeoworld. Furthermore, when excavated this section does meet requirements. V. Chernykh and B. Chuvashov above do indicate that this section will be better exposed prior to the ICCP meeting in Kazan in 2015.

Differentiating *Sweetognathus whitei* from *Sweetognathus* aff. *whitei*

Sweetognathus whitei was described by Rhodes in 1963 from the

Tensleep Formation of Wyoming. The scaphate platform element bears a series of transverse ridges that are roughly dumbbell-shaped and widest in the central part of the platform. All of these transverse ridges are ornamented by pustulose microornament. A pustulose series of nodes forms a ridge that connects each of these transverse ridges along the central axis for the entire length of the platform (Figs. 2.1 to 2.4). The transverse ridges are somewhat irregular in form and the borders slope into the platform below; pustulose microornament is irregularly distributed and occurs on the top and slope of the transverse ridges (Fig. 2.4). Associated taxa include abundant specimens of *Streptognathodus* including *S. fusus* and *S. postfusus*, which are typical of Upper Asselian. Irregular shaped transverse ridges and irregularly distributed pustulose microornament are also characteristic of *Sw. merrilli*. This lineage or parts of it seem to be restricted to Bolivia (Riglos-Suarez *et al*., 1987) to Western Canada and with mid-west USA (Boardman *et al*., 2009) in the centre (Fig. 3; dashed yellow ellipse).

The above characters are also diagnostic of Artinskian *Sweetognathus* aff. *whitei* (Fig. 2.5 to 2.7) including transverse ridges and pustulose microornament. The difference however is that the transverse ridges are regular in shape and the borders drop vertically toward the platform (Fig. 2.7); pustulose microornament is regularly distributed, closely packed and restricted to the upper surface only. Associated conodont taxa typically include species of *Mesogondolella* and no specimens of *Streptognathodus* co-occur because the genus is extinct. These morphologic features are also characteristic of *Sw.* aff. *merrilli* (actually transitional forms to *Sw. binodosus*), *Sw. binodosus*, and *Sw. anceps* from the Urals. This lineage seems to be nearly global in distribution (Fig. 3; solid yellow ellipse). V. Chernykh and B. Chuvashov in their comments point out many of these locations.

Conclusion

In my view these two GSSPs for the base-Sakmarian and base-Artinskian are basically ready for a vote. I am not certain what additional material, beyond the few recommendations below, will significantly improve these proposals – any improvements will be incremental. A paper is needed to better describe the key taxa and this is in progress and will be submitted to Palaeoworld this summer. It is also recommended that the Dal'ny Tulkas section be better exposed and this is planned as indicated by V. Chernykh and B, Chuvashov. Finally, consistent figures should be produced to show the stratigraphy, biostratigraphy and key events. I agree with G. Kotlyar, V. Chernykh and B. Chuvashov that the proposals

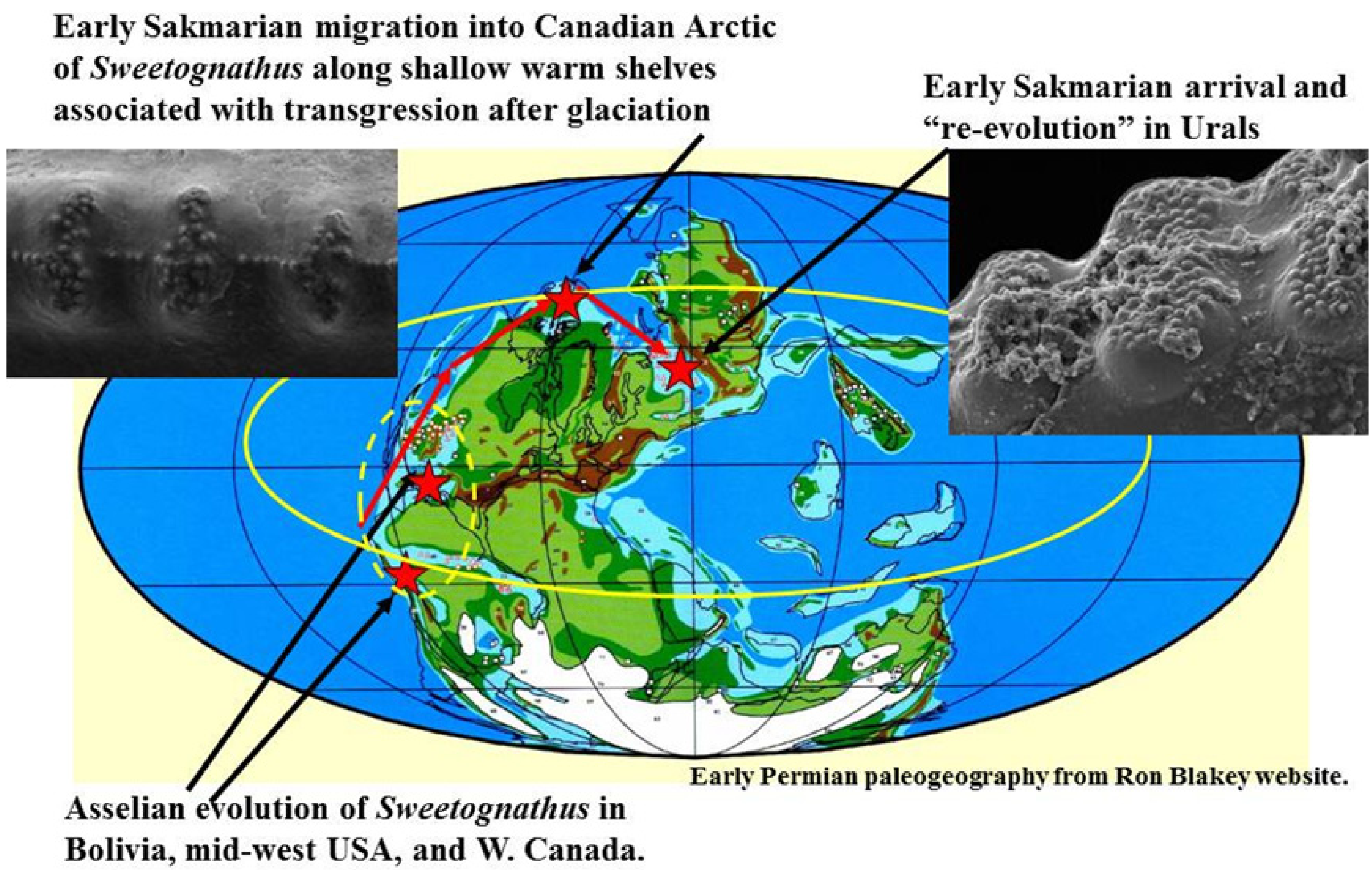


Fig. 3. Possible paleogeography of the evolution of these *Sweetognathus* lineages. The older lineage is restricted in distribution (yellow dashed ellipse) and centred on the mid-west USA during the Asselian. Migration of latest Asselian-earliest Sakmarian taxa was affected by a major marine transgression at this time that was presumably associated with the termination of Gondwana glaciation. This younger lineage is nearly global in distribution and serves as a good reference for global correlation.

are more or less complete according to the principles of GSSPs as outlined by ICS. It is certainly possible that future work will identify sections with additional ash beds, or sections less altered in terms of carbon isotopes, but this will always be true. At some point it is important to simply define. In so doing, we can set in motion new avenues of stratigraphic research to better understand how to correlate these rocks into the terrestrial realm or better understand cyclicity or better understand the evolutionary process of various taxa…This work cannot begin before there is actually a definition to test.

References

Beauchamp, B. and Henderson, C.M., 1994.The Lower Permian Raanes, Great Bear Cape and Trappers Cove formations, Sverdrup Basin, Canadian Arctic: stratigraphy and conodont zonation. Bulletin of Canadian Petroleum Geology, v. 42 (4), p. 562-597.

Boardman, D.R., Wardlaw, B.R. and Nestell M.K., 2009. Stratigraphy and Conodont Biostratigraphy of Uppermost Carboniferous and Lower Permian from North American Midcontinent. Kansas Geological Survey Bulletin 25, 42 pp.

Chernykh, V.V., 2005. Zonal Methods and Biostratigraphy – Zonal scheme for the Lower Permian of the Urals according to conodonts. Institute of Geology and Geochemistry, Urals Branch of RAS. Ekaterinburg, 217 pp. (In Russian).

Chernykh, V.V., 2006. Lower Permian conodonts of the Urals. Institute of Geology and Geochemistry, Urals Branch of RAS. Ekaterinburg, 130 pp. (In Russian).

Davydov, V., Krainer, K., and Chernykh, V., 2013. Fusulinid biostratigraphy of the Lower Permian Zweikofel Formation (Rattendorf Group; Carnic Alps, Austria) and Lower Permian Tethyan chronostratigraphy. Geological Journal, 48, p. 57-100.

Rhodes, F.H.T., 1963. Conodonts from the topmost Tensleep sandstone of the Eastern Big Horn Mountains, Wyoming. Journal of Paleontology, v. 37 (2), p. 401-408.

Riglos Suárez, M., Hünicken, M.A. and Merino, D., 1987. Conodont biostratigraphy of the Upper Carboniferous-Lower Permian rocks of Bolivia. In Austin, R.L., ed. Conodonts: investigative techniques and applications. British Micropalaeontological society, Ellis Horwood Publishers, London, p. 317-325.

Schmitz, M.D. and Davydov, V.I., 2012. Quantitative radiometric and biostratigraphic calibration of the Pennsylvanian–Early Permian (Cisuralian) time scale and pan-Euramerican chronostratigraphic correlation. Geol. Soc. Am. Bull., v. 124, p. 549-577.

Conclusive remarks by L. Angiolini and S.Z. Shen

In thanking all the Permian specialists who have contributed to this very interesting discussion, we would like to focus the attention of our colleagues on the main problems which remain open in the proposals for GSSP for the base-Sakmarian and the base-Artinskian stages. If an index species ranges from Asselian to Artinskian or if our conodont specialists have obvious inconsistencies about the taxonomy of the index species, the species is hardly to be adopted as the index species of a GSSP. We suggest that the reliability of *Sw. merrilli* as the indicator of the base-Sakmarian should be better investigated. The same holds true for the conodont-based primary signal (*Sw.* aff. *Sw. whitei*) in Dal'ny Tulkas. Is it a *Sw. whitei* (type from the Asselian of Wyoming, USA) OR another species *affinis* to *Sw. whitei*? If the first case is true, then *Sw. whitei* appears to be a long-ranging and wide-ranging species, ranging from Asselian to Artinskian, and counteracting one of the prerequisites of a species to be a good GSSP marker. If, instead, the selected marker for the base Artinskian is a new species, then its taxonomy should be published soon with great details and all the correlation revised. No matter which species we will use, the taxonomy and its correlation value must be clarified. C. Henderson has acknowledged that a paper is needed to better describe these taxa, a paper which is already in progress for Palaeoworld. We look forward for it and we hope in a quick resolution of these taxonomic problems as Usolka and Dal'ny Tulkas are good sections; they just need clear short-range index fossil lineages to be described, constrained and correlated.

The first appearance of *Streptognathodus isolatus* in the Permian of Texas

Bruce R. Wardlaw
U.S. Geological Survey
926A National Center
Reston, VA 20192 USA;
email: bwardlaw@usgs.gov

Merlynd K. Nestell
Department of Earth and Environmental Sciences
University of Texas at Arlington
Arlington, TX 706019;
email: nestell@uta.edu

The FAD (First Appearance Datum) of *Streptognathodus isolatus* at the Aidaralash section, Kazakhstan, defines the base of the Permian. *Streptognathodus isolatus* is not a rare species and the general interpretation of the species evolution within the *Streptognathodus* clade is ever improving with an increasing knowledge base. Its presence in Texas is not just inferred as reported by Lucas (2013) and here we illustrate specimens from the Stockwether Limestone Member of the Pueblo Formation in north-central Texas and the Neal Ranch Formation from the Glass Mountains, West Texas (Fig. 1). *Streptognathodus isolatus* was first proposed in 1997 (Chernykh et al., 1997) and the distinctions of this species have steadily become sharper since that time as evidenced in the monographic study of Boardman et al. (2009).
The uppermost Pennsylvanian-Lower Permian strata in north-central Texas consist of interbedded and laterally variable thin limestone, shale, mudstone and sandstone comprising the Harpersville, Pueblo, Moran, and Putnam Formations (Fig. 2). The complex lithostratigraphy contributed to a checkered history for the placement of the local Pennsylvanian-Permian boundary

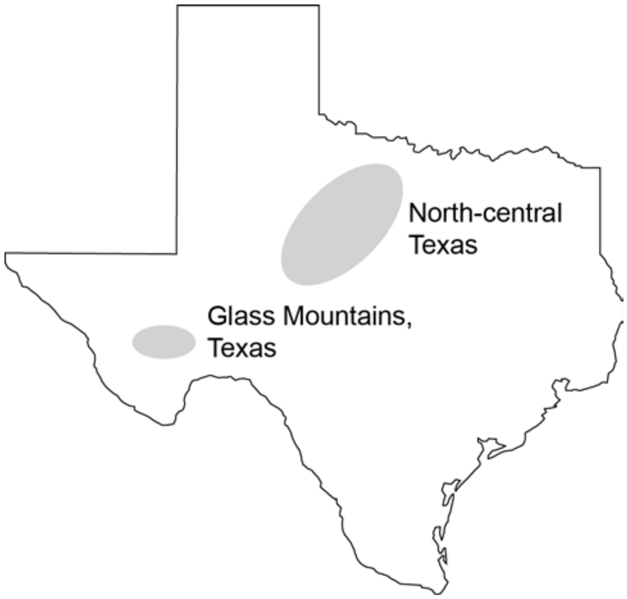


Fig. 1. Areas of *Streptognathodus isolatus* bearing sections: north-central Texas, Glass Mountains, West Texas.

in the mid twentieth century (Wilde, 1975). It had come finally to rest at the first appearance of the fusulinacean genus *Schwagerina* (*Pseudofusulina* of some authors), which first occurs in the Waldrip #3 Limestone (Harpersville Formation). Then Skinner and Wilde (1965) subtly moved the boundary slightly lower with the erection of a new subgenus, the fusulinacean *Triticites (Leptotriticites),* by stating its age and distribution to be "Lower Permian (Wolfcampian) of south-central and southwestern United States". *Leptotriticites,* now considered as a genus, first appears in the Waldrip #1 Limestone in the Colorado River Valley of north-central Texas. Unfortunately, *Leptotriticites* is not widespread geographically, limiting its usefulness, and species of *Schwagerina* (or *Pseudofusulina*) in Waldrip #3 are not sufficiently diagnostic for precise correlation.

In the earliest Permian of north-central Texas only one ammonoid, a single specimen of *Artinskia,* is known from the Camp Creek Shale (Pueblo Formation).

Conodonts occur in most limestone and marine shale/mudstone beds, and show significant changes from each major limestone allowing these limestone intervals to be identified by their contained conodont fauna. The authors have collected and processed many samples for conodonts in the interval from the Waldrip # 1 Limestone through the Coleman Junction Limestone and are preparing a comprehensive paper discussing the conodont distribution.

Most conodonts recovered represent shallow-water facies dominated by *Sweetina, Hindeodus,* and *Adetognathus.* However, sampling over a wide area and collecting large samples has yielded several key collections with common to abundant *Streptognathodus* species that can be used to tie the section to Aidaralash and Kansas; two well-studied sections for the *Streptognathodus* succession through the Pennsylvanian-Permian boundary. The Aidaralash section was chosen as a type section for the Carboniferous-Permian boundary because it was

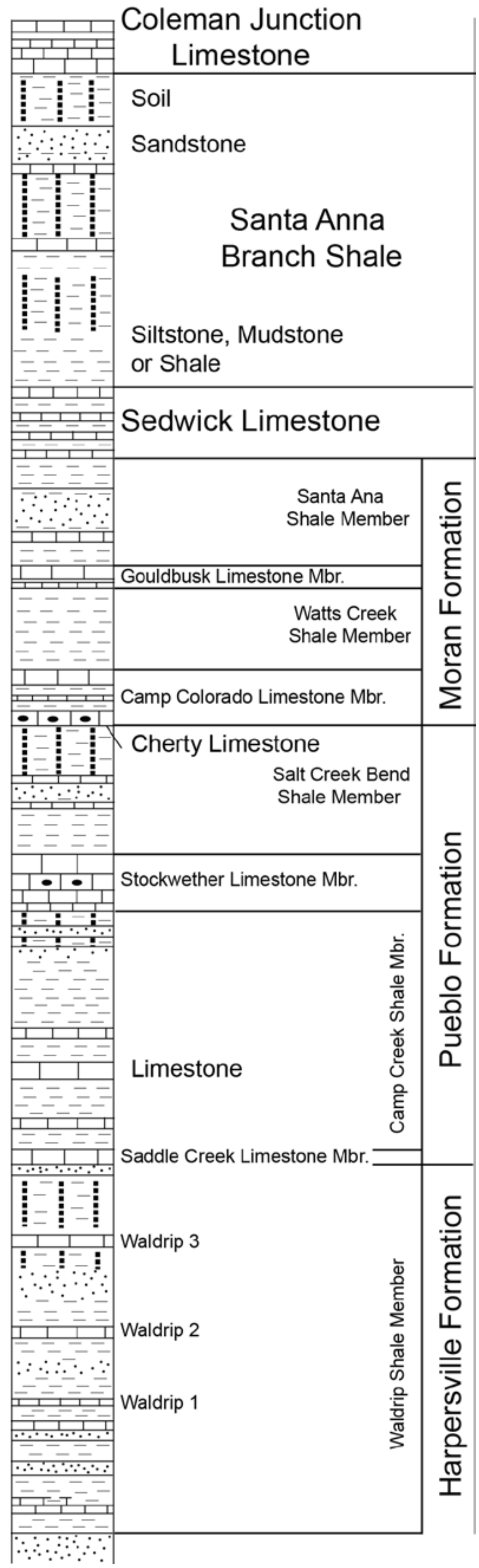


Fig. 2. General section of the Lower Permian strata in north-central Texas showing stratigraphic relations of the units of interest.

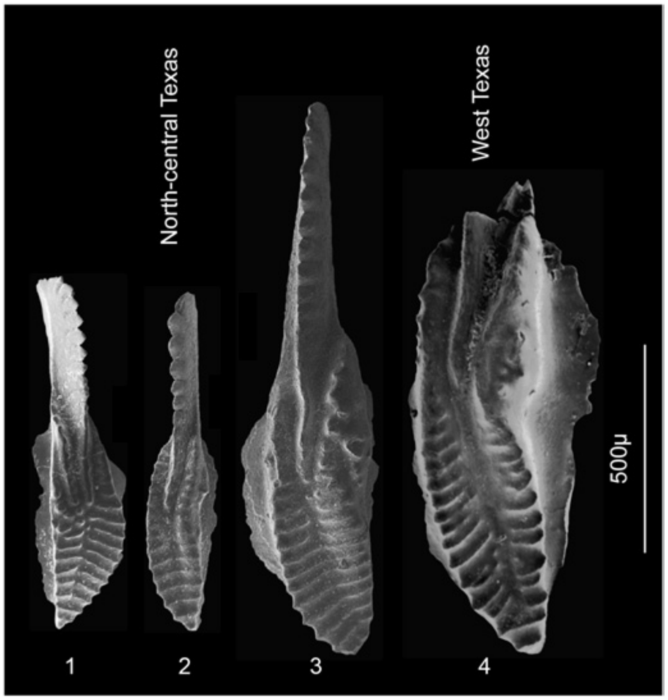


Fig. 3. 1-*Streptognathodus binodosus* transitional to *S. isolatus* from the Camp Creek Shale; 2-juvenile and 3-adult *Streptognathodus isolatus* from the Stockwether Limestone; 4-*Streptognathodus isolatus* from the Neal Ranch Formation, Geologist Canyon Section, Glass Mountains, West Texas.

well represented by the groups that traditionally had been used to define the base, both ammonoids and fusulinids, along with conodonts. In that decision, the basinal section of Usolka was utilized as a primary reference and it was actually advocated by one of us (BRW) that it should be the type section with its nearly continuous conodont succession.

In addition, *Streptognathodus isolatus* occurs from the lower part of the Neal Ranch Formation in the North American Regional Stratotype for the Wolfcampian (Fig. 3).

First appearances of conodont species in the Midcontinent successions are at maximum flooding implying that species did not evolve in the Midcontinent but migrated during highstands (Boardman et al., 2009). The same pattern appears to be true in north-central Texas. The succession of *Streptognathodus* species (Table 1) matches well the succession detailed by Boardman et al. (2009), for Kansas, most importantly, including a transitional morphotype from *S. binodosus* to *S. isolatus* in the Camp Creek Shale (Fig. 3). Also, *S. isolatus* first appears with *S. nevaensis* and *S. constrictus* which occur with the Neva cycles above the Red Eagle cycles which mark the boundary in Kansas (Table 1). *Streptognathodus isolatus* occurs in the lowermost bed of the Stockwether (Fig. 4). *Streptognathodus nevaensis, S. constrictus,* and *S. isolatus* co-occur in the second bed of the Stockwether (Fig. 3). This occurrence implies that the Pennsylvanian-Permian boundary is well constrained within the soils at the top of the Camp Creek or the very base of the Stockwether.

Streptognathodus isolatus along with a plethora of other conodont species shows that the polyphyletic group of inflated schwagerinid fusulinids is highly diachronous.

Waldrip #1	Waldrip #3	Saddle Creek	Camp Creek	Stockwether	Camp Colorado	Conodont
				X	X	*Streptognathodus translinearis*
				X	X	*Streptognathodus minacutus*
				X		*Sreptognathodus nevaensis*
				X		*Streptognathodus constrictus*
				X		*Streptognathodus invaginatus*
				X		*Streptognathodus isolatus*
			X		X	*Streptognathodus fusus*
			X	X		*Streptognathodus bipartitus*
			X			*Streptognathodus fuchengensis*
			X			*S. binodosus transitional to S. isolatus*
		X	X			*Streptognathodus binodosus*
		X				*Steptognathodus conjunctus*
	X	X				*Streptognathodus elongatus*
	X					*Streptognathodus farmeri*
	X					*Streptognathodus wabaunsensis*
X						*Streptognathodus flexuosus*
X						*Streptognathodus brownvillensis*

Table 1.The distribution of *Streptognathodus* species in the uppermost Pennsylvanian and lowermost Permian of north-central Texas constraining the Pennsylvanian-Permian boundary.

References

Boardman, D.R., II, Wardlaw, B.R. and Nestell, M.K., 2009. Stratigraphy and conodont biostratigraphy of the uppermost Carboniferous and Lower Permian from North American Midcontinent. Kansas Geological Survey Bulletin, v. 255, 253 p.

Chernykh, V.V., Ritter, S.M. and Wardlaw, B.R., 1997. *Streptognathodus isolatus* new species (Conodonta)—Proposed index for the Carboniferous-Permian boundary. Journal of Paleontology, v. 71, p. 162-164.

Lucas, S.G., 2013. We need a new GSSP for the Base of the Permian. Permophiles, v. 58, p. 8-13.

Skinner, J.W. and Wilde, G.L., 1965. Lower Permian (Wolfcampian) fusulinids from the Big Hatchet Mountains, southwestern New Mexico. Contributions from the Cushman Foundation for Foraminiferal Research, v. 16, n. 3, p. 95-105.

Wilde, G.L., 1975. Fusulinid evidence for the Pennsylvanian-Permian boundary. In Barlow, J.H., ed. The age of the Dunkard.

Proceedings of the First I. C. White Memorial Symposium, Morgantown, W.Va., 1972. West Virginia Geological and Economic Survey, p. 123-141.

Fig. 4. Stockwether Limestone as exposed 10 km northwest of Cisco, Texas on Texas State Highway 6 and 1 km north of TX 6 on the east side of Texas FM road 1853 (Lat: 32°28' 40.62" W; Long: 99° 02' 15.53" N). Note the two limestone beds exposed at this locality. Hammer ruled in 10 cm intervals. *Streptognathodus isolatus* first occurs in the lower limestone bed.

Lower Permian amphibians from the construction pit of a German wind power station: ecological and biogeographical inferences

Thomas Schindler
Generaldirektion Kulturelles Erbe Rhineland-Palatinate
Direktion Landesarchäologie
Referat Erdgeschichte
Große Langgasse 29
D-55116 Mainz
Email: thomas.schindler@gdke.rlp.de

Markus Poschmann
Generaldirektion Kulturelles Erbe Rhineland-Palatinate
Direktion Landesarchäologie
Referat Erdgeschichte
Große Langgasse 29
D-55116 Mainz
Email: markus.poschmann@gdke.rlp.de

Rainer R. Schoch
Staatliches Museum für Naturkunde
Rosenstein 1
D-70191 Stuttgart
Email: schoch.smns@naturkundemuseum-bw.de

Dieter Uhl
Senckenberg Forschungsinstitut und Naturmuseum
Senckenberganlage 25
D-60325 Frankfurt am Main
Email: dieter.uhl@senckenberg.de

Sebastian Voigt
Urweltmuseum GEOSKOP
Burg Lichtenberg (Pfalz)
Burgstraße 19
D-66871 Thallichtenberg
Email: s.voigt@pfalzmuseum.bv-pfalz.de

Amphibians are common fossil remains in Upper Carboniferous and Lower Permian deposits of the Saar-Nahe Basin, SW Germany (Boy, 2007). This is due to the presence of numerous and extended lakes that provided favourable conditions for the development of a diverse amphibian fauna during basin evolution. In 2013, construction work for a commercial wind power station in the eastern part of the basin exposed a 29 m thick succession of greyish fossiliferous beds that we correlate with the middle part of the Lower Permian (Asselian) Meisenheim Formation (informal unit M5 sensu Boy et al., 2012; Fig. 1). The rock column of this artifical outcrop starts with interbedded sandstone, siltstone and claystone deposits which yielded a moderately diverse assemblage of arthropod and tetrapod trackways of the *Scoyenia*-ichnofacies. This fluvial sequence is overlain by a 2.9 m thick horizon of laminated silty to clayish mudstone we attribute to a transgressive lake system. Its beds predominantly contain amphibians with minor plant and insect remains. The sequence is topped by an intrusive andesitic sill that thermally overprinted the underlying lacustrine strata (Fig. 1).

The fossil content of the section was systematically studied by several excavations conducted in 2013 and 2014 under the supervision of the General Department of Cultural Heritage Rhineland-Palatinate, Department Archaeology, Section Geological History of the Earth.

This short communication is dedicated to the tetrapod body fossil record of the outcrop because it includes a new taxon. Temnospondyl amphibians from the studied section are attributed to two families and three genera:

(1) Branchiosauridae with *Apateon pedestris* von Meyer and a new species of *Leptorophus* (Schoch, in press); and
(2) Sclerocephalidae with *Sclerocephalus haeuseri* Goldfuss.

Remarkable are the differences in the vertical distribution of these amphibians. The lake stage I (Fig. 1) contains only few plant remains with questionable amphibian bones at the top.

Articulated amphibians first occur in an 8 cm-thick laminated calcareous claystone layer (lake stage II). This bed is characterized by abundant specimens of *Apateon* with very few remains of juveniles of *Sclerocephalus*. Other aquatic fauna is represented by two conchostracan valve finds. Notably, fishes are missing, as well as coprolites. The amphibians are excellently preserved, showing full articulation with skin shadows, eye pigments and

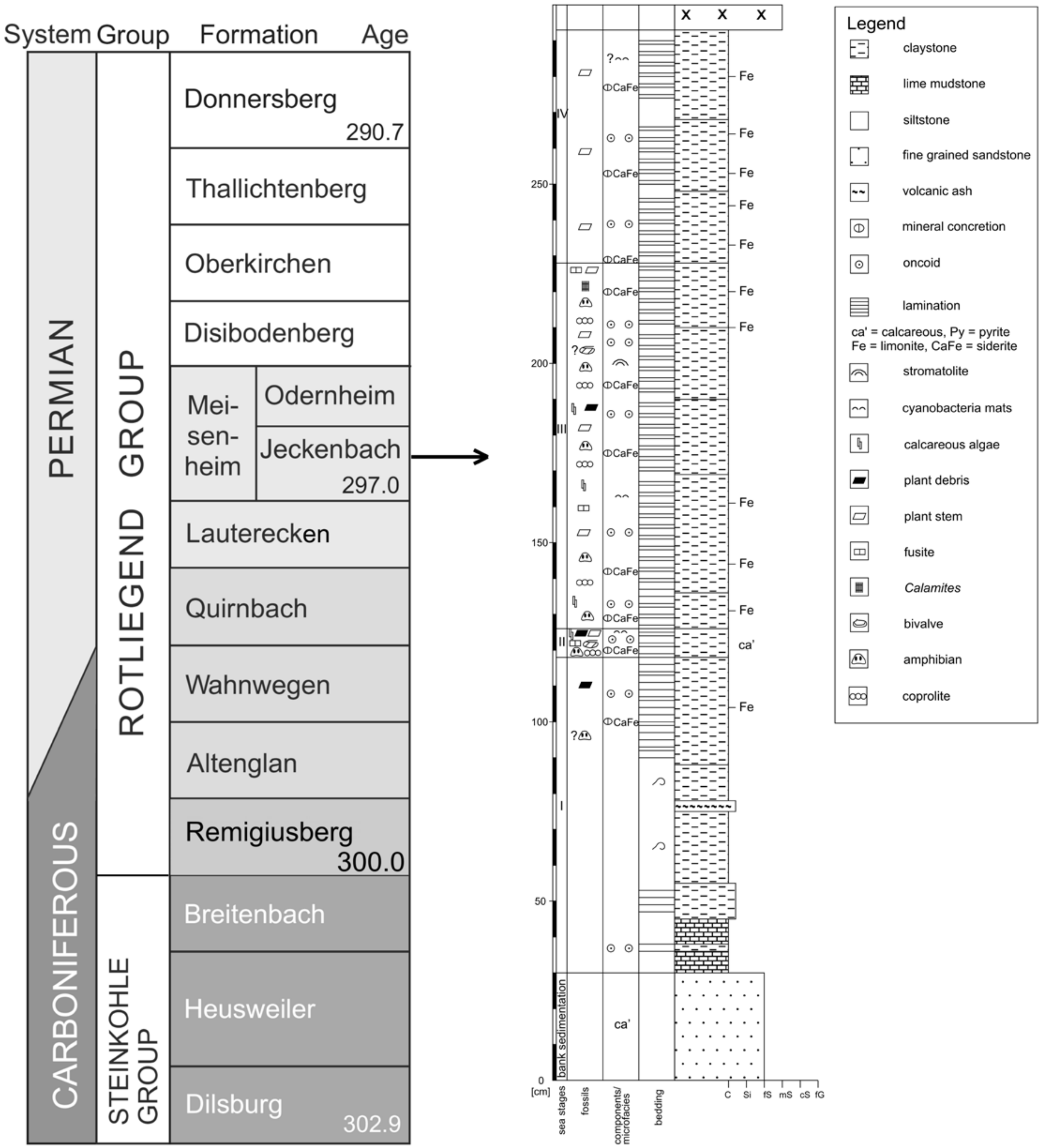


Fig. 1. Stratigraphic framework of the Rotliegend in the Saar-Nahe Basin (adapted from Fröbisch et al. 2011), with detailed section of the lacustrine succession of the described outcrop at the wind power station at Obermoschel/Saar-Nahe Basin (Schindler et al. in prep.)

Fig. 2. *Apateon pedestris* with skin preservation from lake stage II; scale bar = 10 mm (Rhineland-Palatinate State Collection for Natural History, PW2013-5162a-LS; photograph: Kai Nungesser).

Fig. 3. *Leptorophus* sp. with skin preservation from lake stage III (Schoch, in press); the white colour of the bones is a result of thermal overprinting by Palaeozoic subvolcanic intrusion; scale bar = 10 mm (Rhineland-Palatinate State Collection for Natural History, PW2014-5143a-LS; photograph: Markus Poschmann).

external gills (Fig. 2). Fragmentary specimens or even isolated bones are remarkably rare.

Lake stage III is different from the underlying stages: filter feeding *Apateon pedestris* is less abundant, contrasted by the occurrence of the larger carnivorous *Leptorophus*. The latter is present with large specimens only, suggesting that larvae grew up in a different habitat. The putative top predator *Sclerocephalus* remains rare (few individuals, juveniles as before), but coprolites indicate that larger carnivores, maybe adult individuals of *Sclerocephalus*, have been around as well. The number of disarticulated temnospondyl amphibians and isolated bones increases, although some articulated individuals still show skin preservation (Fig. 3).

The topmost lake stage, stage IV, is characterised by some plant remains (Equisetophytes and others), but there is no evidence for aquatic fauna.

The differences in the vertical distribution of the amphibians is probably caused by different ecological preferences of the discerned taxa considering specific adaptations on nutrition, habitat, sediment input, and water chemistry (salinity, oxygen content). Due to the probably taphonomic lack of invertebrates as potential prey for the almost equally-sized amphibians (recorded body length up to 14 cm), the first ecological variable cannot be evaluated. The habitat (lake diameter, water depth, bottom currents) is assumed to have been consistent within the studied section. Changes in water chemistry could be proven by geochemical analyses of calcareous algae and cyanobacterial precipitate (microoncoids etc.). It is a task for future investigation. The sediment input ranged from a starving sedimentation in the calcareous claystone to a clayey to silty sedimentation in the upper layers and therefore seems to be of minor importance. Consequently, the different faunistic composition of the lake stages cannot be resolved at the moment (Schindler et al. in prep). The studied section is of special interest as it comprises the first occurrence of *Leptorophus* in the Saar-Nahe Basin (Schoch, in press). The occurrence of this taxon in the middle part of the Meisenheim Formation is in agreement with observations that point to the immigration of other aquatic vertebrate taxa from adjacent Late Palaeozoic basins into the Saar-Nahe Basin (Raumbach invasion; Boy and Schindler, 2012). This may be due to temporarily enhanced fluvial connections between contemporary freshwater basins of central Europe (Boy and Schindler, 2012).

References

Boy, J.A., 2007. Als die Saurier noch klein waren: Tetrapoden im Permokarbon. In Schindler T. and Heidtke U.H.J., eds. Kohlesümpfe, Seen und Halbwüsten. Dokumente einer rund 300 Millionen Jahre alten Lebewelt zwischen Saarbrücken und Mainz; POLLICHIA-Sonderveröffentlichung, v. 10, p. 258-286.

Boy, J.A., Haneke, J., Kowalczyk, G., Lorenz, V., Schindler, T., Stollhofen, H. and Thum, H., 2012. Rotliegend im Saar-Nahe-Becken, am Taunus-Südrand und und im nördlichen Rheingraben. In Deutsche Stratigraphische Kommission, ed. (coordination and redactorial office: H Lützner and G Kowalczyk for the subcommission Perm-Trias) Stratigraphie von Deutschland X. Rotliegend. Part I: Innervariscische Becken; Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften, v. 61, p. 254-377.

Boy, J.A. and Schindler, T., 2012. Ökostratigraphie des Rotliegend. In Deutsche Stratigraphische Kommission, ed. (coordination and redactorial office: H Lützner and G Kowalczyk for the subcommission Perm-Trias) Stratigraphie von Deutschland X. Rotliegend. Part I: Innervariscische Becken; Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften v. 61, p. 143-160.

Fröbisch, J., Schoch, R.R., Müller, J., Schindler, T. and Schweiss, D.J., 2011. The oldest amniote from Germany: a sphenacodontid synapsid from the Saar-Nahe Basin. Acta palaeontologica polonica, v. 56, p. 113-120.

Schindler, T., Poschmann, M., Schoch, R.R., Uhl, D. and Voigt, S., in prep. Cyclic sedimentation and corresponding biofacies in the Lower Permian: An example from the Saar-Nahe Basin (Germany).

Schoch, R.R., 2014 in press. First evidence of the branchiosaurid temnospondyl *Leptorophus* in the Early Permian of the Saar-Nahe Basin (SW Germany). Neues Jahrbuch für Geologie und Paläontologie Abhandlungen.

The Carboniferous–Permian Boundary in the Sanandaj–Sirjan Terrane, Central Iran: Preliminary report

Shirin Fassihi
Department of Geology,
Faculty of Science,
University of Malaya,
50603 Kuala Lumpur, Malaysia.
Email: shirin.fassihi@gmail.com

Masatoshi Sone
Department of Geology,
Faculty of Science,
University of Malaya,
50603, Kuala Lumpur, Malaysia.
E-mail: masatoshi.sone@gmail.com

Fariba Shirezadeh Esfahani
Department of Geology,
Faculty of Basic Science,
Azad University of Tehran, North Branch,
Postal Code: 1667934783
Tehran, Iran.
E-mail: iran_1040@yahoo.com

Vachik Hairapetian
Department of Geology,
Azad University, Khorasgan Branch,
PO Box 81595-158,
Esfahan, Iran.
E-mail:vhairap@gmail.com

In terms of paleogeography, Iran is composed of several microcontinents including the Alborz, Central–East Iran and Sanandaj–Sirjan Terrane of Middle to Late Paleozoic basements (*e.g.*, Torsvik and Cocks, 2004; Ruban *et al.,* 2007; Arfania and Shahriari, 2009). Most paleogeographic reconstructions show the Sanandaj–Sirjan Terrane in close proximity to the northern Gondwana margin, forming a Peri–Gondwana Cimmerian shallow continental shelf at 30° S–45° S during the Late Carboniferous (*e.g.*, Berberian and King, 1981; Stampfli and Borel, 2002; Torsvik and Cocks, 2004, 2013).

During last decades, Carboniferous and Permian fusulinids and biostratigraphy in Central and East Iran and the Sanandaj–Sirjan Terrane have been investigated by several researchers. Taraz (1974) was the first to describe the beds located under several unnamed lithostratigraphic 'groups' or units (Iranian Japanese Research Group, 1981). Carboniferous strata were subdivided into two informal 'Limestone' and 'Sandstone groups'. The lower contact of the 'Limestone group' with the underlying beds of a Late Devonian (Famenian) age is unexposed, or is likely faulted.

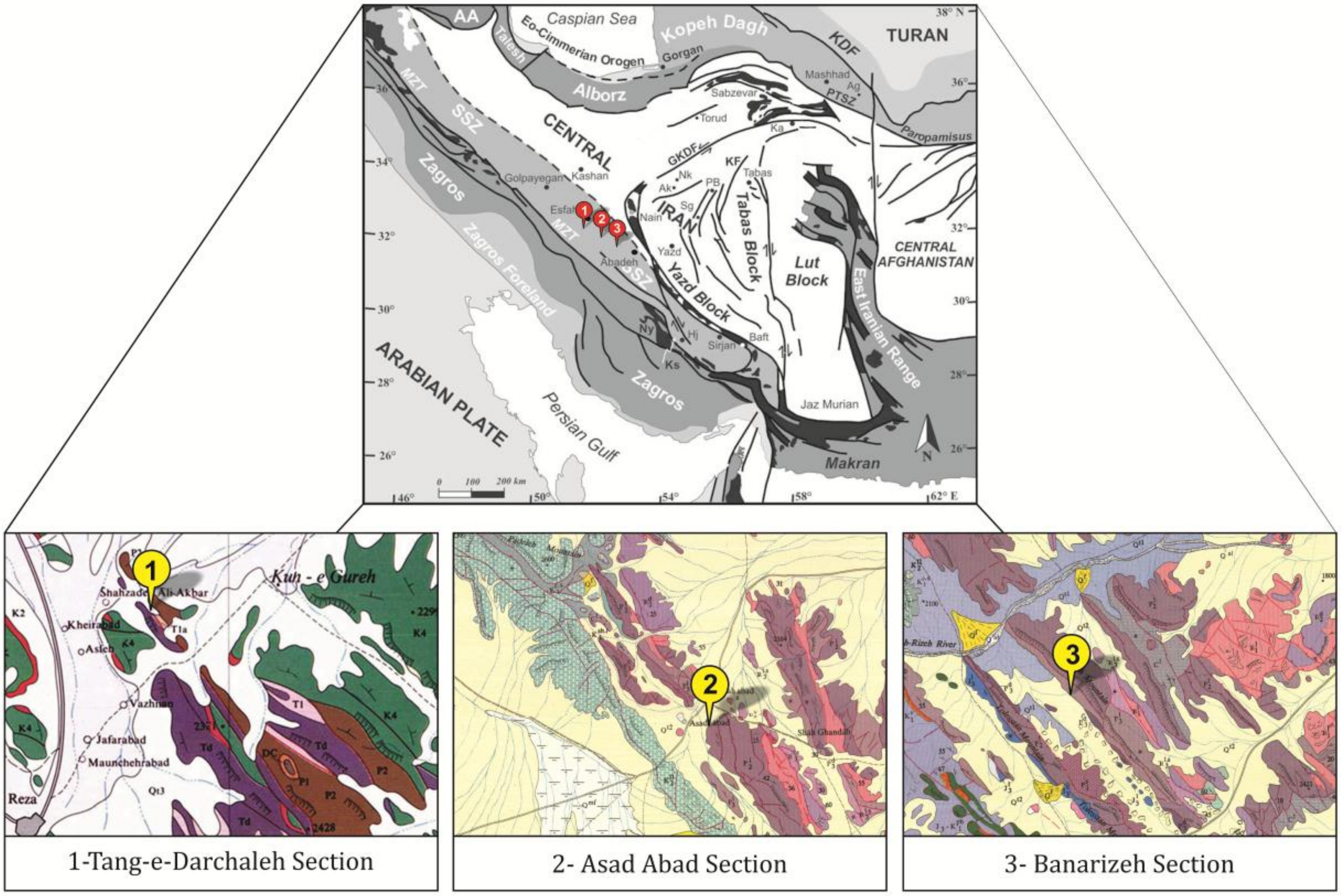


Fig. 1. Tectonic scheme of Iran with the main tectonic subdivisions, modified from Angiolini et al. (2007) and the geological maps of localities of the under studied sections. **AA**, Araxian-Azarbaijanian Zone; **Ag**, Aghdarband Basin; **Ak**, Anarak; **GKDF**, Great Kavir-Doruneh fault System; **Hj**, Hajiabad metamorphic complex; **KDF**, Kopeh Dagh Foredeep; **KF**, Kalmard Fault; **KS**, Kor-e-Sefid metamorphic complex; **MZT**, Main Zagros Thrust; **NK**, Nakhlak Basin; **Ny**, Neyriz ophiolites; **PB**, Posht-e-Badam; **PTSZ**, Palaeotethys Sutur Zone; **Sg**, Saghand; **SSZ**, Sanandaj-Sirjan Zone.; 1:Tang-e-Darchaleh Section; 2: Asad Abad Section; 3: Banarizeh Section

Its upper part is disconformably covered by a basal conglomerate bed of the 'Sandstone group' which was later, considered by Baghbani (1993) as the lowermost part of his Vazhnan Formation in its type section in the Tang–e–Darchaleh section in about 18 km NE of the town of Shahreza. However, the underlying 'Limestone group' of Taraz has generally been left in open lithostratigraphic nomenclature, often referred to as 'Carboniferous beds' (*e.g.,*Baghbani, 1993). Based on the fusulinids, Baghbani (1993) assigned a Sakmarian age to the Vazhnan Formation, although a large part (units 3–7) of the formation was reported to be almost barren of diagnostic fossils. This age determination was partly revised by Leven and Gorgij (2008, 2011a,b). It means, the Vazhnan Formation is now shown to be of the Gzhelian– Asselian age rather than the Sakmarian (Leven and Gorgij , 2011b).

There are several recent works which indicate more detailed stratigraphic and paleontologic data on the Carboniferous and Permian deposits in Iran including Central and East Iran, Sanandaj–Sirjan Terrane and Alborz Mountains (*e.g.,* Gaetani *et al.,* 2009; Leven and Gorgij, 2011b). The fusulinids of the Khan Formation in East Iran and some problems of their paleobiogeography have been investigated by Leven and Gorgij (2007). New Moscovian fusulinids were reported and the Bolorian and Kubergandian stages were described from the Sanandaj–Sirjan Terrane in Central Iran (Leven and Gorgij, 2008a,b). The Permian deposits and fusulinids of the Halvan Mountain in Central Iran have been studied by Leven and Gorgij (2009, 2011a). Lately, the results of an extensive research on the Pennsylvanian–Early Triassic stratigraphy of Central and East Alborz were published by Gaetani *et al.,* (2009). Moreover, the new findings of Permian fauna have been reported by Davydov and Arefifard (2007) and Leven and Gorgij (2011c) from the Kalmard Block of Central Iran. These data are of main importance for tectonic and paleogeographic reconstructions of the region.

Despite decades of study on the Carboniferous–Permian boundary in many sections of the world using fusulinids, the Gzhelian deposits were unknown in Iran till recently, and the Asselian strata were only described in sections of the Alborz Mountains and of Anarak in Central Iran (Lys *et al.,* 1978). This is why till recently, it was believed that, in the Late Pennsylvanian (Kasimovian–Gzhelian), major parts of Iran were emerged (uplifted) and the sea transgression occurred only in the late Early Permian (Leven and Gorgij, 2011). However, the new results from the Late Carboniferous and Early Permian deposits in Central and East Iran, the Alborz Mountains, and the Sanandaj–Sirjan

Terrane reveal that there are several sections which have yielded data indicating the presence of the Carboniferous–Permian boundary in Iran. The Zaladou Formation in Central and East Iran (Leven and Taheri, 2003; Leven and Gorgij, 2006a, 2006b), the Toyeh Formation in the Alborz Mountains (Gaetani *et al*., 2009) and the Vazhnan Formation in the Sanandaj–Sirjan Terrane (Leven and Gorgij, 2011b) have now been considered as the most prospect sections for locating the Carboniferous–Permian boundary, as they all display strata ranging from the Gzhelian to Asselian (Leven and Gorgij, 2011b).

Besides the aforementioned formations, it seems that there are other localities which comprise strata ranging from the Late Carboniferous to Early Permian deposits. The Banarizeh section located 40 km NE of the town of Abadeh is one of such (Fig. 1). Its sedimentary succession includes alternating shale, thin bedded limestone, sandstone, sandy limestone with intercalations of sandstone. According to our preliminary studies, fusulinids from the middle part of this section range from Gzhelian? through to the Asselian. Late Carboniferous conodonts were also reported from the Banarizeh section. They include *Streptognathodus oppletus* Ellison, 1941, that ranges from the Kasimovian to the Early Gzhelian (Nouradiny et al., 2010). Moreover, based on the unpublished data by Leven (2011), Gzhelian to Asselian marine deposits have recently been discovered in the Abadeh area in the Sanandaj–Sirjan Terrane. We, therefore, consider that the Banarizeh section probably includes the Carboniferous–Permian transition.

Furthermore, approximately 60.9 km SW of the Banarizeh section, the Tang–e–Darchaleh section, the type section of the Vazhnan Formation is located (Baghbani, 1993) (Fig. 1). Its sedimentary succession consists of alternating thin to medium limestone, sandstone, sandy detrital limestone and limestone with shaley interbeds. Compared with the Banarizeh section, the Tang–e–Darchaleh section has noticeably less fusulinids. Up to now, it is unknown whether the Carboniferous–Permian transition is present in the Tang–e–Darchaleh section. However, the Asselian fusulinids that we have found in the upper part of the section, suggest the possible presence of the Carboniferous–Permian boundary. We need more detailed investigations on our material collected from this section and further sampling will be carried out in near future.

About 25.6 km SW of the Tang–e–Darchaleh section, there is another section called the Asad Abad section (Fig. 1), where the first records of the Gzhelian and Asselian fusulinids have been reported by Leven and Gorgij (2011b). It shows a stratigraphic range from the Gzhelian to the Asselian (Leven and Gorgij, 2011b). In this section, we have currently carried out a systematic sampling to find the Carboniferous–Permian boundary. The boundary between the Vazhnan and Surmaq formations and also the Middle Permian deposits in this section will next be studied.

We have currently investigated the Carboniferous–Permian boundary in the Banarizeh, Tang–e–Darchaleh and Asad Abad sections, all in the Sanandaj–Sirjan Terrane. This is part of Shirin Fassihi's Ph.D Project, under the supervisions of Masatoshi Sone and Vachik Hairapetian at University of Malaya.

References

Angiolini, L., Gaetani, M., Muttoni, G., Stephenson, M.H and Zanchi, A. 2007. Tethyan oceanic currents and climate gradients 300 m.y. ago. Geology, v. 35, p. 1071-1074

Arfania, R and Shahriari, S., 2009. Role of Southeastern Sanandaj-Sirjan Zone in the tectonic evolution of Zagros Orogenic Belt, Iran. Island Arc, v. 18, p. 555-576.

Baghbani, D., 1993. The Permian Sequence in the Abadeh Region, Central Iran. In Koroteev, A.V., ed. Contributions to Eurasian Geology. Occasional Publ. Earth Sci. Res. Inst., Univ. South California, N.S., 1993, v. 913, p. 7-22.

Berberian, M. and King, G.C.P., 1987. Toward a paleogeography and tectonic evolution of Iran. Canadaian Journal. Earth Sci., v. 18, p. 210-265.

Davydov, V.I. and Arefifard, S., 2007. Permian Fusulinid Fauna of Peri-Godwana Affinity from the Kalmard Region, East- Central Iran and Its Significance for Tectonics and Paleogeography. Palaeontologia Electronica, v. 10 (2), p. 1-40.

Gaetani, M., Angiolini, L., Ueno, K., Nicora, A., Stephenson, M. H., Sciunnach, D., Rettori, R., Price, G.D. and Sabouri, J., 2009. Pennsylvanian Early Triassic stratigraphy in the Alborz Mountains (Iran). In Brunet M.-F., Wilmsen M. and Granath J.W., eds. South Caspian to Central Iran Basins. Geological Society, London, Special Publications, v. 312, p. 79-128.

Iranian-Japanese Research Group, 1981. The Permian and the Lower Triassic Systems in Abadeh Region, Central Iran. Memoris of the Faculty of Science, Kyoto University, Ser. Geol. Mineral, 47 (2), p. 133.

Leven, E.Ja. and Taheri, A., 2003. Carboniferous-Permian Stratigraphy and Fusulinids of East Iran. Gzhelian and Asselian Deposits of Ozbak-Kuh Region. Rivista Italiana di Paleontologia e Stratigrafia, v. 109 (3), p. 399-415.

Leven, E.Ja. and Gorgij, M.N., 2006a. Gzhelian Fusulinids First Discovered in Central Iran. Stratigraphy and Geological Correlation, v. 14 (1), p. 19-29.

Leven, E.Ja. and Gorgij, M.N., 2006b. Upper Carboniferous-Permian Stratigraphy and Fusulinids from the Anarak Region, Central Iran. Russ. J. Earth Sci., v. 8, ES2002.doi: 10.2205/2006ES000200, p. 1-25.

Leven, E. Ja. and Gorgij, M.N., 2007. Fusulinids of the Khan Formation (Kalmard Region, Eastern Iran) and some problems of their Paleobiogeography. Russ. J. Earth Sci., v. 9, 10 p.

Leven, E.Ja. and Gorgij, M.N., 2008a. New Fusulinids of the Moscovian Stage Found in Iran. Stratigraphy and Geological Correlation, v. 16 (4), p. 164-173.

Leven, E.Ja. and Gorgij, M.N. 2008b. Bolorian and Kubergandian Stages of the Permian in the Sanandaj-Sirjan Zone of Iran. Stratigraphy and Geological Correlation, v. 16 (5), p. 455-466.

Leven, E.Ja. and Gorgij, M.N. 2009. Section of Permian Deposits and Fusulinids in the Halvan Mountains, Yazd Province, Central Iran. Stratigraphy and Geological Correlation, v. 17 (2), p. 155-172.

Leven, E.Ja. and Gorgij, M.N. 2011a. The Kalaktash and Halvan Assemblages of Permian Fussulinids from the Padeh and

Sang-Variz Sections (Halvan Mountains, Yazd Province, Central Iran). Stratigraphy and Geological Correlation, v 19 (2), p. 141-159.

Leven, E. Ja. and Gorgij, M.N., 2011b. First Record of Gzhelian and Asselian Fusulinids from the Vazhnan Formation (Sanandaj-Sirjan Zone of Iran). Stratigraphy and Geological Correlation, v. 19 (5), p. 486-501.

Leven, E. Ja. and Gorgij, M.N., 2011c. New Findings of Permian Marine and Terrestrial Fossils in Central Iran (the Kalmard Block) and their significance for Correlation of the Tethys, Uralian and West European Scales. Rivista Italiana di Paleontologia e Stratigrafia, v. 117 (3), p. 355-374.

Leven, E. Ja. and Gorgij, M.N., 2011. Fusulinids and Stratigraphy of the Carboniferous and Permian in Iran, Stratigr. Geol. Correlation, vol. 19, No. 7, pp. 687-776.

Lys, M., Stampfli, G. and Jenny, J., 1978. Biostratigraphie du Carbonifere et du Permian de I'Elbourz oriental (Iran du N.E.), Notes Lab. Paleont. Univ. Geneve, v.10, p. 63-78.

Nouradiny, M., Rahmati, S. and Yazdi, M., 2010. Correlation of the Late Carboniferous-Permian Conodont Fauna in the Abadeh area with the Adjacent Regions. Iranian. J. Earth Sci., v. 77, p.175-180.

Ruban, D., 2007. Major Paleozoic-Mesozoic unconformities in the Greater Caucasus and their tectonic re-interpretation: a synthesis. GeoActa, v. 6, p. 91-102.

Stampfli, G.M., Raumer, J.F. and Borel, G.D., 2002. Paleozoic evolution of pre-Variscan terranes: From Gondwana to the Variscan collision. In Martínez Catalán, J.R., Hatcher, R.D., Jr., Arenas, R., and Díaz García, F., eds. Variscan-Appalachian dynamics: The building of the late Paleozoic basement: Boulder, Colorado, Geological Society of America Special Paper, v. 364, p. 263–280.

Torsvik, T.H. and Cocks, R. M., 2004. Earth Geography from 400 to 250 Ma: a palaeomagnetic, faunal and facies review. Journal of the Geological Society, London, v. 161, p. 555-572.

Torsvik, T.H. and Cocks, R. M., 2013. Gondwana from top to base in space and time. Gondwana Research, v. 24, p. 999-1030.

OBITUARY

HEINZ W. KOZUR (1942-2013)

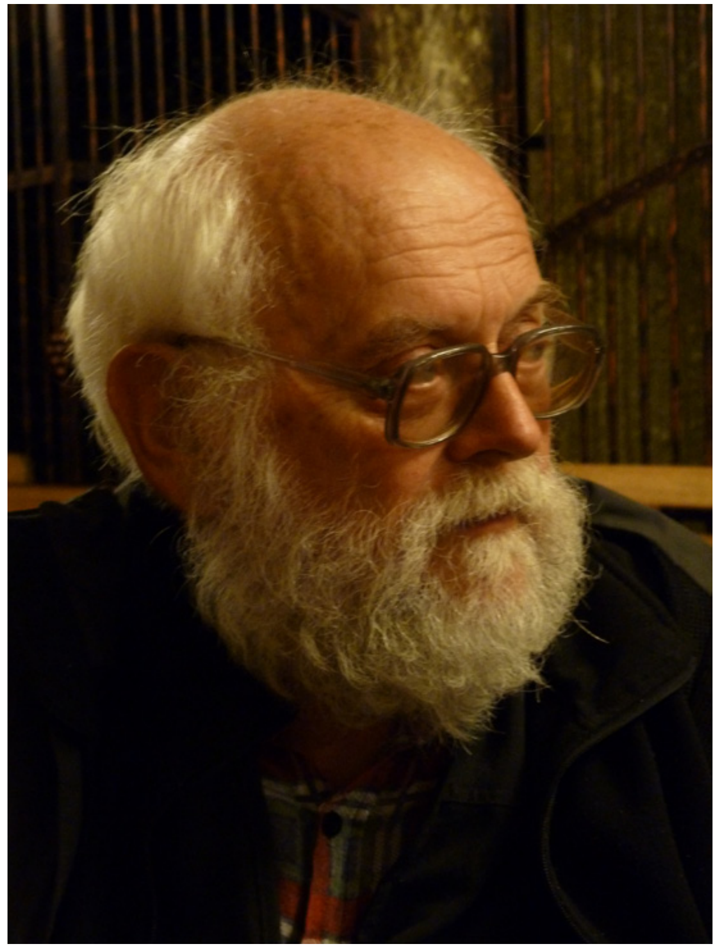


Fig. 1. Portrait photo of Heinz Kozur after receiving his medal in 2012. Photo supplied by Gerhard Bachmann.

On 20 December 2013, Heinz W. Kozur died in Budapest, Hungary, after a long struggle with illness. Born in Hoyerswerda (Sachsen), Germany, on 26 March 1942, Heinz began his studies of geology at the Bergakademie Freiberg/Sachsen in 1961. There, he completed a diploma thesis in 1967 on conodonts and scolecodonts of the Upper Muschelkalk of Europe under the supervision of Professor Dr. A. H. Müller. For this, and his other student accomplishments, Heinz was awarded the Agricola Medal.
Postgraduate study at Freiberg under the direction of Müller followed. In 1971, Heinz received his doctoral degree (Dr. rer. nat. geol.) for his dissertation (awarded *summa cum laude*) on the micropaleontology, biostratigraphy and biofacies of the German Middle Triassic. By the time he received this degree, he had begun employment as the Chief of the Department of Natural Science at the Staatliche Museen Meiningen/Thüringen, a position Heinz held until 1981. In 1975, Heinz finished his Habilitation at Freiberg, again under the direction of Prof. Müller, on the biostratigraphy, facies and paleogeography of the Triassic.
Outspoken and headstrong, Heinz came into conflict with the socialist authorities in the former German Democratic Republic (GDR or East Germany). Thus, when the socialist establishment seriously impeded his scientific career in East Germany, he went into exile to Hungary in 1981. Employment at the Geological Survey of Hungary in Budapest followed (1981-1985), which led to Heinz's election to the Hungarian Academy of Science. However, in 1985, political problems resurfaced due to the long arm of GDR authorities, and Heinz lost his position in Budapest. He was banned from his profession and had his scientific notes, documents and specimens confiscated.
Thus began the remainder of Heinz's professional career, during which regular, full-time employment was replaced by part-time or short-term employment as a visiting professor or by funds supplied by research stipends, grants and professional consulting.

Fig. 2. Guadalupian meeting at Alpine: Jerry Lewis, Tatyana Leonova, Galina Kotlyar, Bruce Wardlaw, Garner Wilde, and Heinz Kozur.
Heinz didn't have a hawaiian shirt so he dressed in arab garb (which he thought was his most outrageous ware). Even though he didn't drink, he had a wonderful time at the BBQ. Photo provided by Bruce Wardlaw

Heinz thus undertook most of his professional work and achieved his remarkable and extensive research results of the last three decades as a private citizen without long-term institutional support.
During the 1980s and 1990s, Heinz was a visiting professor at several universities, including Yarmouk University in Jordan, Northern Arizona University in the USA, the University of Palermo in Italy, the University of Lausanne in Switzerland, the University of Salzburg and Innsbruck University, both in Austria, and (after the collapse of the GDR) at the University of Halle in Germany. Long-term research stipends came from Middle East University in Turkey, the Geological Survey of Japan and Innsbruck University. Additionally, Heinz received many research grants from diverse sources.
The research of Heinz Kozur covers a broad range of topics in historical geology, with a strong focus on the Permian and Triassic timescales. Heinz served as a voting member of the IUGS Subcommission on Permian Stratigraphy from 1976 to 2007, and remained a honourary member until his death. From 1969 until his death, Heinz was also a voting member of the IUGS Subcommission on Triassic Stratigraphy. Within these subcommissions, Heinz participated in the research and deliberations of many of the key working groups devoted to defining geological time boundaries, including the Carboniferous-Permian, the Permian-Triassic and the Triassic-Jurassic boundaries. He was also an integral member of the groups that defined the Guadalupian, that deciphered the Tethyan Triassic and that worked to develop the chronology of nonmarine Triassic strata. He was also active in the Permian-Triassic Subcommission of the German Stratigraphic Commission.
Many of the major advances that have been achieved in refining and defining the Permian and Triassic timescales of the last 30-40 years were influenced by Heinz Kozur. For example, the defining criterion of the base of the Triassic System is the first appearance of the conodont species *Hindeodus parvus*, a species named by Kozur and Pjatkova in 1975.
In his curriculum vitae, Heinz divided his research contributions into six areas: stratigraphy, paleoecology, bioevents, tectonics, paleogeography/paleoclimatology and paleontology/biostratigraphy. In the area of stratigraphy, Heinz contributed much to the marine and nonmarine stratigraphy of Carboniferous-Triassic rocks, especially in central Europe. In paleoecology, our understanding of the complex ecosystems of the Permian and Triassic and how they responded to the end-Permian extinctions owe much to Heinz's insight. With regard to bio-events, Heinz contributed much to the analysis and timing of biotic crises, especially at the Permian-Triassic and Triassic-Jurassic boundaries. It is fair to say that it is in paleontology and biostratigraphy that Heinz's greatest contributions were made, as his nearly 600 published articles indicate.
As a paleontologist, Heinz worked on diverse fossil groups. But, perhaps his largest contributions were to conodonts, radiolaria and conchostracans. In all three groups, many of new taxa described by Heinz and his collaborators were used to build landmark understandings of the evolution and biostratigraphy of these

Fig. 3. Bruce Wardlaw and Heinz Kozur at stratotype canyon in Guadalupe National Park; they are sitting on the base-Roadian GSSP. Photo provided by Charles Henderson.

groups. Indeed, the work of Heinz Kozur on Triassic conodonts in his doctoral dissertation was the beginning of modern Triassic conodont taxonomy and biostratigraphy. His Muschelkalk conodont zonation is still standard, and many of the key taxa used in Triassic correlations were first identified and analyzed by Kozur. He published many of the pioneering studies on Permian conodonts that continue to be important sources. The radiolaria tell a similar story, with Kozur early on recognizing the value of these microfossils to the subdivision of Triassic time. And, in the terrestrial Triassic, the last eight years saw Heinz, in collaboration with Rob Weems, elaborate on earlier work to present a Triassic conchostracan zonation built largely on the records from the Germanic basin and the Newark Supergroup basins of eastern North America. Among other noteworthy results here was the first demonstration by conchostracan biostratigraphy that the beginning of the Jurassic was in fact during the episode of CAMP volcanism that accompanied the rifting that opened a nascent Atlantic Basin, not prior, as suggested earlier. It is fair to say that nobody can review the biostratigraphy and chronology of the Permian and Triassic without considering the work of Heinz Kozur.

Throughout much of his career, Heinz was a member of several scientific societies, among them the Deutsche Gesellschaft für Geowissenschaften (since 1990), the Ungarische Geologische Gesellschaft (since 1982), the Deutsche Paläontologische Gesellschaft (since 1990) and he was elected to the Ungarische Akademie der Wissenschaften (in 1984) and the New York Academy of Science (in 1996).

Each of us met Heinz in the early 1990s. Since then he was a valued collaborator to SGL and GHB on various projects; to CMH he was a valued colleague, but we actually never collaborated on any papers. However, it is fair to say that he influenced me (CMH) very much and there are many debates on record in the pages of past Permophiles; despite a number of disagreements, there was respect. I (CMH) will always be grateful to Heinz for supporting as a referee my application for Full Professor. I (CMH) remember meeting Heinz for the first time in 1991 at the Permian meeting at Perm, Russia. After a long day on a southern Ural field trip I fell asleep talking to Heinz and when I woke the next morning Heinz was talking to me still. Heinz was clearly a person of great energy – a tireless worker on the outcrop, at the museum, in the laboratory as well as behind the microscope and the computer. A polyglot, he moved freely from his native German to fluent English and Russian or on to a working technical knowledge of several other languages, not to forget Hungarian, the language of his adopted country and his wife Dr. jur. Zsuzsánna Tömpe. He never learned how to drive, so to drive Heinz to the outcrop was to transport an encyclopedia of Pangea – an earth scientist who had been all over the globe and knew its Triassic outcrops and biostratigraphic problems as well as any and better than most. When other people had to check their notes – Heinz simply *knew* it.

When Heinz turned 70, at its Annual Meeting at Hannover in October 2012, the Deutsche Gesellschaft für Geowissenschaften awarded him the Leopold-von-Buch-Plakette to honour his scientific contributions. In 2013, New Mexico Museum of Natural History and Science Bulletin 61, *The Triassic System: New developments in stratigraphy and paleontology*, was dedicated to Heinz; his complete scientific bibliography through early 2013 is published there.

With the death of Heinz Kozur we have lost one of the great experts on paleontology and the geological timescale, particularly of the Permian and Triassic Periods.

Spencer G. Lucas, Gerhard H. Bachmann, Charles M. Henderson

ANNOUNCEMENTS

BERGAKADEMIE TECHNISCHE UNIVERSITÄT FREIBERG

CPC-2014

First Circular

Field Meeting on Carboniferous and Permian Nonmarine – Marine Correlation
21 – 27 July 2014, Freiberg, Germany

Best exposed continuous late Permian (Zechstein) - Early Triassic (Bunter) section in Europe!

Note: deadline for abstract submission and fee transfer extended to May, 10th

Objectives

A look at the current *International Geological Time Scale* shows that nearly all marine stage boundaries of the Carboniferous and the Permian are ratified or will be ratified in the very near future. But nearly nothing is known about the correlation of the system and stage boundaries into the vast continental deposits on the CP Earth. However, the Late Carboniferous and Permian was a time of extreme continentality because of an exceptional low sea level in Earth's history, comparable only to the Pleistocene and post-Pleistocene modern world. Of the two largest components of the Palaeozoic supercontinent Pangea, Gondwana covered an area of about 73 million km^2, but was capped by epicontinental seas for only about 15%, while Laurasia had about 65 million km^2 and about 25% coverage by epicontinental seas. This means that most of the preserved deposits of this time with many economically interesting resources (mainly coal, natural gas, salt and other minerals) are in continental successions. It was the time of full terrestrialisation of life and the time when by the end of the Middle and the Late Permian the most severe mass extinction occurs in both the marine and terrestrial ecosystems. To understand the processes and their interrelations in the geo- and biosphere of this time, we need an exact stratigraphic control and an exact correlation of marine and nonmarine deposits. Consequently, there is an urgent need to focus future activities of both the subcommissions on marine – nonmarine correlation. Therefore, last year, during the *International meeting on the Carboniferous and Permian Transition* in Albuquerque, New Mexico, the chairs of the Subcommissions on Carboniferous and on Permian Stratigraphy, Barry Richards and Shuzhong Shen, agreed to organize a joint working group on the global correlation between Carboniferous and Permian marine and nonmarine deposits. As the kickoff for this working group, a **Field Meeting on Carboniferous and Permian Nonmarine – Marine Correlation** will be held at the TU Bergakademie Freiberg in Germany from July 21 to July 27, 2014.

Topics

The aim of the meeting is to bring together all colleagues who are interested in the correlation of Carboniferous, Permian and Early Triassic continental deposits with the global marine scale. The subject of the meeting will be the use of any and all correlative age-relevant data from marine and nonmarine deposits for the solution of the above mentioned problem. In particular, the workers from the various continental basins are asked to promote their detailed local and regional knowledge toward our global aims. Reports about methods, results and perspectives of nonmarine as well as nonmarine – marine intra-basinal and inter-basinal correlation as well as of global correlation are requested. First of all, we will use the meeting to develop cooperative research projects for the solution of central problems, which are suited to raise funds from various national and international sources for the realisation of our aims.

Program

July 20, 2014 arrival in Freiberg, icebreaker
July 21 and July 22, 2014: Scientific Sessions
July 23 until July 27, 2014: 5 days field excursion to the most important Carboniferous and Permian outcrops in eastern Germany and the Czech Republic, including Permian–Triassic transitional profiles. The meeting will be accompanied by a *SPS* business meeting as well as by a meeting of the *Sino-German Cooperation Group on Late Palaeozoic Palaeobiology, Stratigraphy and Geochemistry.*

Organizers

Jörg W. Schneider: Joerg.Schneider@geo.tu-freiberg.de
Spencer G. Lucas: spencer.lucas@state.nm.us
Olaf Elicki: Olaf.Elicki@geo.tu-freiberg.de

Scientific organizing committee

Shuzhong Shen (China, Chairman of the Subcommission on Permian Stratigraphy),
Barry Richards (Canada, Chairman of the Subcommission on Carboniferous Stratigraphy), Lucia Angiolini (Italy, Secretary of the Subcommission on Permian Stratigraphy),
Manfred Menning (Chairman of the German Commission on Stratigraphy),
Hans Kerp (Germany, Co-leader of the Sino-German cooperation project),
Ralf Werneburg (Germany), Sebastian Voigt (Germany), Ronny Rößler
(Germany), Stanislav Oplustil (Czech Republic), Ausonio Ronchi (Italy; voting member SPS), Hafid Saber (Morocco), Valeryi Golubev (Russia)

Local organizers

Frank Scholze and Frederik Spindler (Freiberg / Germany), Karel Martinek and Richard Lojka (Prague / Czech Republic)

Registration fee

The meeting registration fee will cover costs of reception, coffee and tea breaks, and lunch during the scientific sessions and conference materials. The field-excursion fee will cover costs of transportation, accommodation, packed lunches, and guidebook. Participants are required to pay registration fee by bank transfer until May, 10th, 2014 (for transfer data see below). Only in exceptional case, it will be accepted to pay the registration fee at the meeting registration desk with a supplementary surcharge (in such cases, please, consult the organizers before).

Fee for the scientific session in Freiberg (20.07. – 22.07.2014): 60.00 €
Excursion fee eastern Germany – Czech Republic (23.07. – 27.07.2014): 360.00 €

Transfer the fee to:
Förderkreis Freiberger Geowissenschaften e.V.
IBAN: DE12870520003115015010
BIC: WELADED1FGX
(Sparkasse Mittelsachsen)
Please indicate for purpose: **Freiberg Field Meeting 2014**

Registration

- pre-registration deadline: 01.04.2014
- registration deadline and payment of fees extended to: 10.05.2014

Accommodation

Hotel reservation in Freiberg for the 20th to the 23rd of July, 2014, has to be arranged by yourself!
We have the option for accommodation (pre-reservation) with special discount at four-star *Hotel Kreller (*http://www.hotel-kreller.de, Fischerstrasse 5, D-09599 Freiberg:
kontakt@hotel-kreller.de, booking code: Prof. Schneider)
- double room: 70 € (15 pre-reserved but more are available)
- single room: 55 € (5 pre-reserved)
- pre-reservation deadline: 30. May 2014
- e-mail: kontakt@hotel-kreller.de ***Code Name:*** Prof. Schneider
(room payment is not included in the meeting fee)

Excursion program (preliminary, details follow in the second circular)

July, 23-24, 2014 - Czech Republic – classical outcrops of the Central European continental Late Carboniferous and Early Permian in the well-studied Krkonoše Piedmont basin and Bohemian basin: basin development, palaeoclimate and fossil content of Late Westphalian (Moscovian) to early Permian (Asselian–Artinskian) continental gray and red beds.

July, 25-27, 2014 - Germany – classical outcrops of the Central European Late Carboniferous and Permian as well as the Early Triassic of the Thuringian basin and the Thuringian Forest Mountains: Late Carboniferous (Stephanian, Gzhelian) to Late Permian and earliest Triassic (Lopingian to Induan, Zechstein, Bunter with the prognostic PT-boundary in a fossiliferous continental sabkha-playa transition), classical outcrops of the Saale basin in Saxony-Anhalt, continental fossiliferous gray and red beds of late Carboniferous (Gzhelian) to Late Permian Lopingian.

Abstracts / Publications

Abstracts of oral or poster presentation are welcome. Please indicate your preference when submitting. Abstracts, please, submit by e-mail (attached file in Word format) to: Joerg.Schneider@geo.tu-freiberg.de. Deadline for submission is May, 10th, 2014. Official language of the meeting is English. All submissions will be peer-reviewed and published in an abstract volume.

Format: Abstracts are limited to two A4-sized pages including text, figures and tables; *margins* (top, bottom, left, right): 25 mm; *title*: upper and lower case, left justified; Arial, 14 pt bold; *contributor's names*: upper and lower case, left justified, first name first, surname last, Arial, 12 pt.; *affiliation*: upper and lower case, left justified, Arial, 10 pt.; numbered superscripts should be used to indicate the affiliation of each contributor; *e-mail address* should be added in parentheses at the end of the corresponding contributor's affiliation; *main text*: single-spaced text, Arial 12 pt, no section headings.

Additional to the abstract-volume, a meeting-volume including (peer-reviewed) extended abstracts and further short related contributions (10 to 20 print-pages; for more extended contributions contact O.E.) will be published in the *psf*-Journal of Freiberg University after the conference. Contributions to this meeting volume should be submitted electronically until August, 31st, 2014 to Olaf.Elicki@geo.tu-freiberg.de. For instruction for authors consult the journal website at http://tu-freiberg.de/geo/psf.

Important Dates

Opening of e-mail registration: **01.03.2014**
Abstract submission Deadline: **10.05.2014**
Final registration deadline and payment of fees by bank transfer extended to: **10.05.2014**
Hotel reservation in Freiberg for 20.–23.7.2014 up to: **30.05.2014**

How to reach Freiberg?

Freiberg is quite easy to access by public transport. The easiest way is to go to Dresden first (the nearby capital of Saxony State) and then to use railway to Freiberg (trains run every hour). Airports with international connections are closely situated in Dresden (DRS, 50 km away) and Leipzig (LEJ, 120 km away); both airports also have domestic flights from/to Frankfurt International Airport. Alternatively, you can also use one of the Berlin airports (Schönefeld: SXF, Tegel: FBB). From all mentioned airports regular railway connections to Freiberg are available (generally via Dresden).

Airport connections:
- Dresden airport: http://www.dresden-airport.de/
- Leipzig airport: https://www.leipzig-halle-airport.de/en/
- Frankfurt airport: http://www.frankfurt-airport.com/content/frankfurt_airport/en.html
- Berlin/Schönefeld and Berlin/Tegel airports: http://www.berlin-airport.de/en/

Railway connections: http://www.bahn.de/i/view/DEU/en/index.shtml
- Dresden railway main station (Dresden Hauptbahnhof)
- Dresden airport station (Dresden Flughafen)
- Leipzig railway main station (Leipzig Hauptbahnhof)
- Leipzig airport station (Leipzig/Halle Flughafen)
- Frankfurt railway main station (Frankfurt am Main Hauptbahnhof)
- Frankfurt airport station (Frankfurt (M) Flughafen)
- Berlin railway main station (Berlin Hauptbahnhof)
- Berlin airport Schönefeld station (Berlin-Schönefeld Flughafen)
- Berlin airport Tegel station (Berlin Flughafen Tegel)

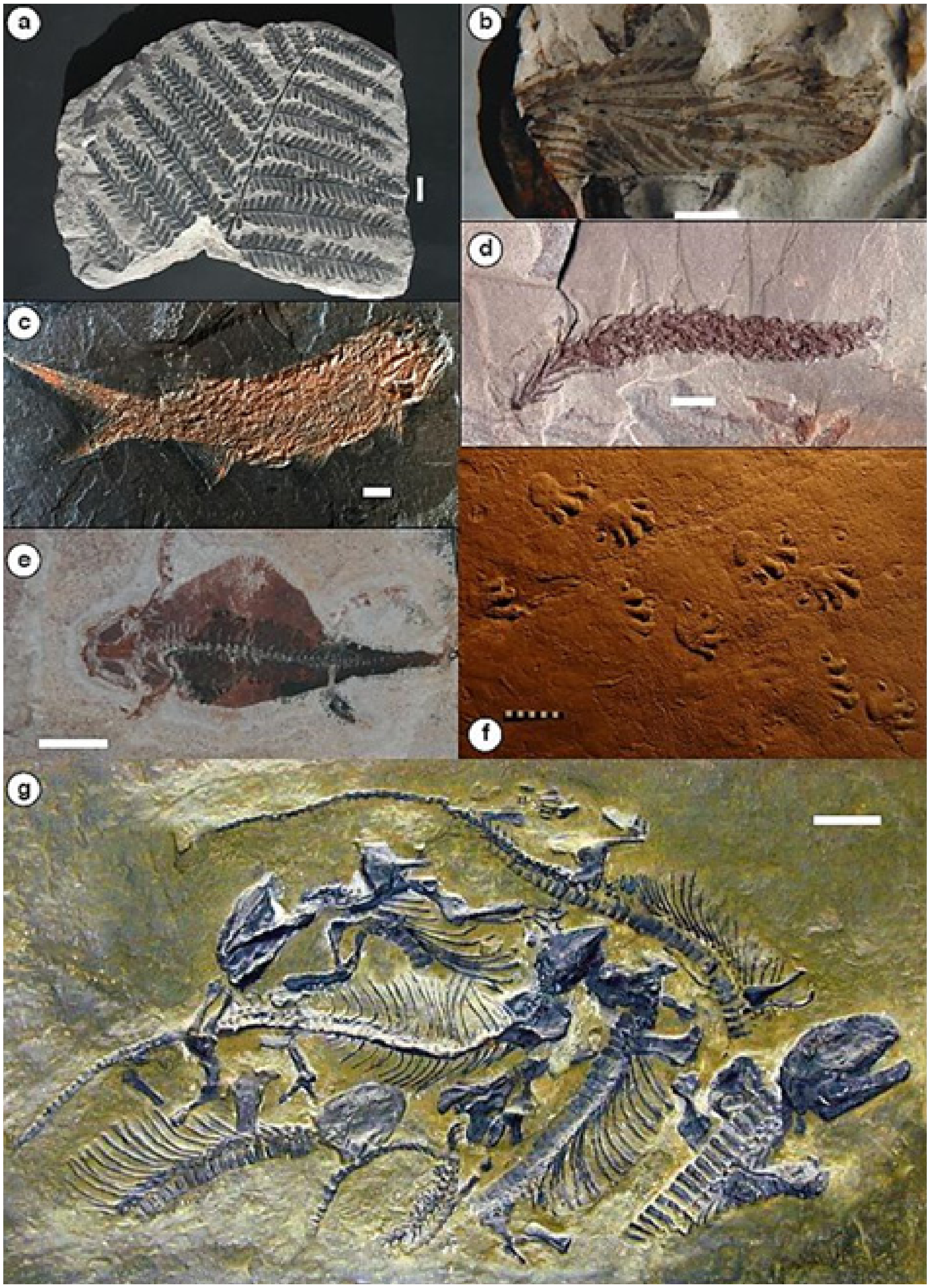
If you need any assistance, don't hesitate to e-mail us.

How to reach your hotel / the meeting locations in Freiberg?

For your stay in Freiberg, we have the option for accommodation (pre-reservation) at *Hotel Kreller* (for details see above). The hotel is situated in the city center (http://www.hotel-kreller.de) and can be reached from the railway station either by taxi or by foot (about 1 km; map: http://www.hotel-kreller.de/kreller2/anfahrt.html). A map showing the meeting locations and other interesting spots will be supplied on the meeting website.

Further Communication

Detailed schedule and organizational things will be distributed by e-mail to all the interested colleagues which have preregistered until April, 1st, 2014. The meeting website is located at: http://tu-freiberg.de/geo/palaeo/schneidj/cpc-2014



Typical Carboniferous and Permian fossils of the Saxo-Thuringian basins.
a Seed fern *Alethopteris subdavreuxi,* Westphalian D, Oberhohndorf, Zwickau Basin, scale bar 2 cm (collection TU Bergakademie Freiberg). **b** Cockroach zone species *Sysciophlebia ilfeldensis,* L. Rotliegend Netzkater Formation, IIfeld Basin, scale bar 0.5 cm (collection F. Trostheide). **c** Palaeoniscid fish *Elonichthys,* L. Rotliegend Goldlauter Formation, Gottlob quarry, Thuringian Forest Basin, scale bar 1 cm (collection TU Bergakademie Freiberg). **d** Male cone of the conifer *Walchia piniformis,* L. Rotliegend Goldlauter Formation, Cabarz quarry, Thuringian Forest Basin, scale bar 1 cm (collection TU Bergakademie Freiberg). **e** Branchiosaur zone species amphibian *Melanerpeton tenerum,* Lower Rotliegend Börtewitz lake horizon, Oschatz Formation, NW Saxony Basin, scale bar 1 cm (collection Geological Survey of Saxony).**f** *Ichniotherium sphaerodactylum,* the track of a diadectid reptile, U. Rotliegend Tambach Formation, Bromacker quarry, Thuringian Forest Basin, scale bar 10 cm (Holotype, collection Natural Museum Gotha). **g** Group of the synapsid reptile *Pantelosaurus saxonicus,* Lower Rotliegend Niederhäslich Formation, Döhlen Basin, former Königin Carola coal mine, scale bar 20 cm (collection Geological Survey of Saxony).

FIRST CIRCULAR

XVIII INTERNATIONAL CONGRESS ON THE CARBONIFEROUS AND PERMIAN (ICCP 2015)

Invitation

It is our privilege and pleasure to invite you to the XVIII International Congress on the Carboniferous and Permian, to be held at the Kazan Federal University, City of Kazan, Russia, August 11 – August 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. This makes Russia one of the most famous and popular locations for basinal studies, global and regional tectonic reconstructions, paleogeographical and biostratigraphic research, and upper Paleozoic fossil collecting. Carboniferous and Permian research in Russia has recently seen a marked increase in activity. National and international projects have focused on documentation of candidates for global stratotypes for stage and substage boundaries in historical and newly discovered sections, and paleotectonic reconstructions of the Uralian Ocean, leading to new interpretations of the evolution of the Paleo-Tethys. Considerable progress was made in the study of Carboniferous and Permian successions in Siberia and the Russian Far East. Exciting fossil excavations revealed new faunas in the Cis-Uralian Region, which in combination with modern geochemistry technologies has led to great advances in our understanding of the paleoclimate at the end of the Paleozoic, and new insights into the causes and consequences of Carboniferous-Permian events, especially the P-T extinction. The ICCP-XVIII Congress 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 the European and Asian regions of Russia.

General sponsors
Russian Academy of Sciences
Interdepartmental Stratigraphic Committee of Russia
Carboniferous and Permian Commissions of Russia
The International Subcommission on Carboniferous Stratigraphy
The International Subcommission on Permian Stratigraphy

Congress Organizers
Kazan (Volga region) Federal University
Lomonosov Moscow State University
A.P. Karpinsky Russian Geological Research Institute (VSEGEI), St. Petersburg
The Paleontological Institute, Russian Academy of Sciences, Moscow
The Geological Institute, Russian Academy of Sciences, Moscow
Perm State National Research University
The Zavaritsky Institute of Geology and Geochemistry, Russian Academy of Sciences, Ural Branch, Ekaterinburg
Institute of geology of the Ufimian scientific centre, Russian Academy of Sciences, Ufa
North-East Interdisciplinary science research institute, Russian Academy of Sciences, Far East Branch, Magadan

Scientific Committee
Alexander S. Alekseev, Igor V. Budnikov, Alexander S. Biakov, Zhong Q. Chen, Boris I. Chuvashov, Ilshat R. Gafurov, Valeriy K. Golubev, Natalia V. Goreva, Olga L. Kossovaya, Galina V. Kotlyar, Elena I. Kulagina, Danis K. Nourgaliev, Svetlana V. Nikolaeva, Victor V. Ogar, Galina Y. Ponomareva, Barry C. Richards, Shuzhong Shen, Vladimir V. Silantiev

Venue
The City of Kazan is among the most ancient cities in Russia. With a population of 1.2 million people, it is a cultural and industrial center included in the UNESCO World Heritage list, and its mosaic of Muslim and Christian architecture contributes to its unique atmosphere and scenery. Kazan is easily accessible from Europe via Frankfurt, Moscow or St. Petersburg, and its position in the center of European Russia makes it an ideal base from which to explore a wide variety of sections and outcrops located in several adjoining districts of Russia.

Schedule for 2015

August 10: Arrival to Kazan, Registration and welcome reception
August 11 – August 15: Talk and poster sessions, workshops
August 13: Mid-Congress field excursions and Congress banquet
August 16: Departure from Kazan

Travel
By air to Kazan via Moscow or St. Petersburg.
By train to Kazan via Moscow (12 hours) or St. Petersburg (14 hours).
Obtaining a visa to visit Russia: Please check to see if your visit to Russia will require a visa. http://www.visitrussia.org.uk/visaform/not-need/ or http://ru.vfsglobal.co.uk/ The process involves contacting the nearest Russian embassy or consulate in the country where your passport is issued. We will send an official invitation letter issued by Kazan University to delegates who need to apply for a visa. Please send us a request for a visa invitation.

Scientific Programs

Meeting Format: The meeting will consist of concurrent sessions of talks, each of 20 minutes (including questions and discussion). Talks will be grouped based on broad geological topics. There will be one poster session, which will include afternoon refreshments. Speakers will normally be limited to one presentation (talk) at the meeting. Individuals may participate as a non-presenting coauthor on additional talks. Individuals may participate in as many posters presentations as they wish. Details will follow in the Second Circular.

XVIII INTERNATIONAL CONGRESS ON THE CARBONIFEROUS AND PERMIAN
Session titles

1. Carboniferous stage boundaries, stratotype sections, and GSSPs

2. Permian stage boundaries, stratotype sections, and GSSPs

3. Carboniferous and Permian high-resolution stratigraphy (multi-proxy correlations)

4. Late Paleozoic glaciations and interglacials: impact on ecosystems and sedimentation

5. Carboniferous and Permian plate tectonics and orogenies

6. Late Paleozoic marine macrofossils: systematics, biostratigraphy, and paleobiogeography

7. Late Paleozoic continental biota: systematics, ecosystems, and paleobiogeography

8. Micropaleontology: systematics, phylogeny and biostratigraphy

9. The terrestrial late Paleozoic world: paleosols, lithofacies, and environments

10. Sequence stratigraphy and cycles

11. Late Paleozoic reefs, biostromes, and carbonate mounds

12. Cold-water to tropical carbonate lithofacies and environments

13. The late Paleozoic oceans: paleoceanography

14. Latest Devonian and mid-Carboniferous extinctions and recovery

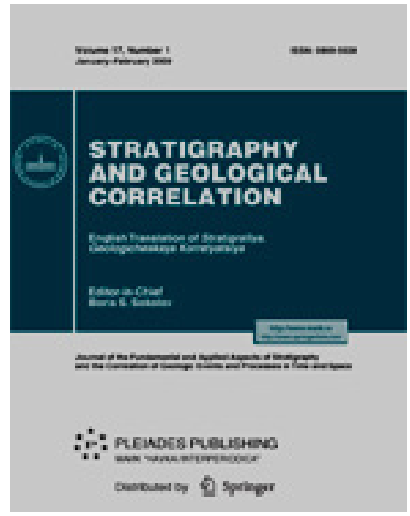
15. End-Permian mass extinction and Early Triassic recovery

16. Carboniferous and Permian coal and mineral deposits

17. Eurasian conventional and unconventional hydrocarbon systems

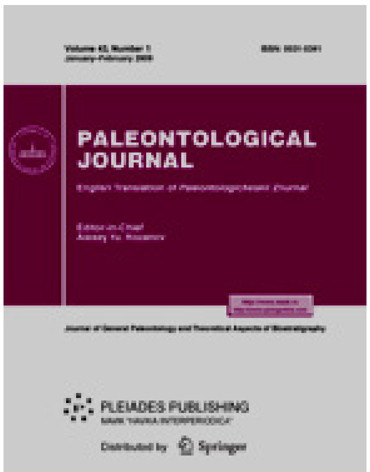
Call for Abstracts: Abstracts for the meeting are due on April 1, 2015. A request for abstracts will be announced in the Second Circular, which will also have instructions for electronic submission. The Abstract volume for the meeting will be edited by Alexander A. Alekseev, Galina V. Kotlyar, Svetlana V. Nikolaeva and distributed to registered delegates at the meeting.

Proceedings Volume: Congress proceedings are planned for publication in two bimonthly peer-reviewed scientific journals of MAIK "Nauka/Interperiodica" publishing house.



Stratigraphy and Geological Correlation (Stratigrafiya, Geologicheskaya Korrelyatsiya) covering fundamental and applied aspects of stratigraphy and the correlation of geologic events and processes in time and space.

Paleontological Journal (Paleontologicheskii Zhurnal) is oriented toward the anatomy, morphology, and taxonomy of fossil organisms, as well as their distribution, ecology, and origin. It also publishes studies on the evolution of organisms, ecosystems, and the biosphere and provides information on global biostratigraphy.



Manuscripts for the proceedings volumes are encouraged, and should be prepared following the Guide for Authors of MAIK "Nauka/Interperiodica" (http://www.maik.rssi.ru/). Contributed papers relating to the topics of ICCP are invited from registered participants. Please note that the deadline for contributions to the proceedings volume is scheduled for October 30, 2015.

Workshops: Several free workshops will be scheduled and are mainly designed for the Subcommissions on the Carboniferous and Permian stratigraphy.

Any colleagues or working groups wishing to hold a special symposium or workshop are advised to contact the organizers with their ideas no later than December 31, 2014.

Language: The official language for the scientific program and all business of the meeting is English.

Proposed Field excursions

A. Pre-congress excursions:

A1. Lower Carboniferous of the St. Petersburg region (north-western Russia).
A2. Moscow Basin. Stratotypes of the Serpukhovian, Moscovian, Kasimovian and Gzhelian stages.
A3. Southern Urals. Deep water successions of the Carboniferous and Permian. Lower Permian GSSPS.
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.

B. Mid-congress excursion:
B1. Permian deposits and historical-cultural sites along the Volga River (boat tour).
B 2. Middle Permian paleosols in succession of the Urzhumian Stage around Kazan.

C. Post-congress excursions:
C1. Volga and Kama Region. Middle and Upper Permian.
C2. Middle Urals. Carboniferous and Permian marine and continental successions.
C3. Carboniferous reference sections: potential candidates for the base of the Serpukhovian GSSP, organic buildups, Southern Urals.

Dates and payment for field excursions will be detailed in the Second Circular.
Guest Program: No formal guest program is planned at this time. However, the congress organizers can help coordinate local excursions to suit most interests. Feel free to request information, provide suggestions or share potential interests. See the Official Kazan City Guide at http://gokazan.com/
Accommodation: A large variety of hotels is available in the city of Kazan (see the ICCP website). Kazan Federal University will provide low cost dormitory accommodation for all students – participants of the Congress – in the 2013 Summer Universiade Games Village.
Travel insurance: Participants should have valid health insurance for the entire journey. All foreign participants are required to bring with them health insurance contracts, covering the period of the trip, from an insurance company that provides an international insurance policy.
Climate: Kazan has a continental climate with warm, often hot, dry summers. August is hot, average 21°C to 25°C, infrequently exceeding 33°C or dropping below 16°C. There is a possibility of light rain. Overall it is pleasant.
Type of clothing and weather conditions: For the field excursions, you are advised to bring sturdy field boots (rubber boots could be useful), a raincoat, and a hammer. All hotel rooms are normally air-conditioned.

REGISTRATION

Registration form will be available on the Congress website: www.ICCP2015.kpfu.ru after March 1, 2014.

Registration fees:

	Before April 1, 2015 (Early Bird)	After April 1, 2015
Regular participant	400 Euro, this price is inclusive of the Congress fee, the volume of Abstracts, and refreshments during session breaks	450 Euro; this price is inclusive of the Congress fee, the volume of Abstracts, and refreshments during session breaks
Student	200 Euro as above: students must show a valid student ID card	250 Euro as above: students must show a valid student ID card
Accompanying person	80 Euro, as above: with the exception of the volume of Abstracts	100 Euro, as above: with the exception of the volume of Abstracts

Geohost program

The organizers are trying to raise funds to support regular participants and students from countries with struggling economies. The funds will be used to waive the registration fee and to pay the accommodation during the Congress. If your participation in the Congress depends on such financial support, please fill in the application form on the Congress website: www.ICCP2015.kpfu.ru or kpfu.ru/iccp2015

Important Dates

March 1, 2014: First Circular available for distribution and online.
February 1, 2015: Second Circular available for distribution and online.
March 1, 2015: Deadline for Application form to the Geohost program.
April 1, 2015: Deadline for Early Bird payment and abstract submission.
May 1, 2015: Third Circular available for distribution and online.
October 30, 2015: Deadline for manuscript submission to the Proceedings volumes.

Contact us

Vladimir V. Silantiev, Congress Secretary
Russian Federation, Republic of Tatarstan, Kazan
Kazan (Volga region) Federal University
Institute of Geology and Petroleum Technologies
Kremlevskaya St., 4/5

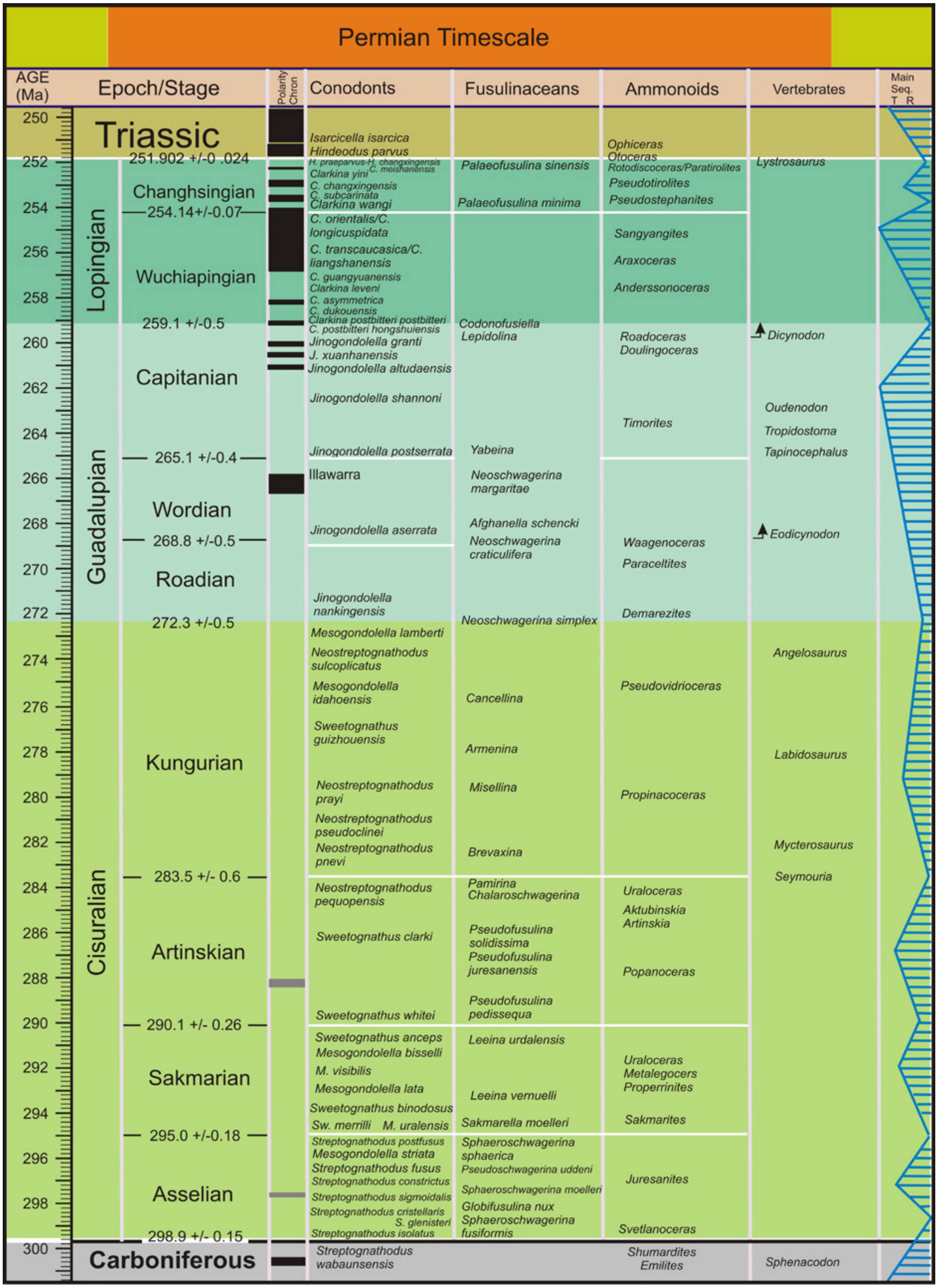
Tel. +7 (843) 292 08 19
Fax +7 (843) 292 82 67
E-mail: iccp2015@kpfu.ru
www.iccp2015.kpfu.ru
kpfu.ru/iccp2015

SUBMISSION GUIDELINES FOR ISSUE 60

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

The deadline for submission to Issue 60 is November 15, 2014.



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. (Lithos, in press) 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).