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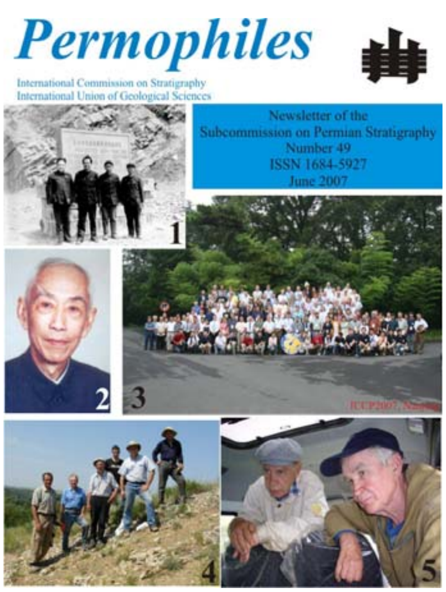
Contents



Explanation of Cover: **1.** Professor Sheng Jinzhang (2nd to the right) and colleagues at Meishan in 1982. **2.** Academician Professor Sheng Jinzhang (1921-2007). **3.** Group photo of participants of ICCP2007 in Nanjing. **4.** Cisuralian Field Workshop at potential GSSP of the base of Sakamrian (Kondurovsky in June, 2007). **5.** Valery V. Chernykh and Boris Chuvashov in a van at the Mechtlino Section, southern Urals.

EXECUTIVE NOTES

Notes from the SPS Secretary

Shuzhong Shen

Introduction and thanks

I want to thank Lucia Angiolini, G. Cassinis, Vladimir Davydov, Marina V. Durante, Charles Henderson, Yiping Qi and Qun Yang who contributed reports, notes and memorial for inclusion in this 49th issue of Permophiles. I also thank Charles Henderson for his coming to Nanjing Institute of Geology and Palaeontology; we did a partof the editorial work for this issue during 5 days from June 14th to 18th before the 16th ICCP, which was held between June 21-24, 2007 in Nanjing. This issue is delayed because we wanted to include reports of the ICCP2007 (see report by Shuzhong Shen *et al*. in this issue) and the Cisuralian field trip immediately after the ICCP2007 (see report by Vladimir Davydov and Charles Henderson in this issue). The XVI ICCP congress was sponsored by the Chinese Academy of Sciences, the National Natural Science Foundation of China, the Ministry of Science and Technology, China, the Chinese Academy of Geological Sciences, the International Subcommission on Carboniferous Stratigraphy and the International Subcommission on Permian Stratigraphy. Prof. Xiangdong Wang and I co-chaired the Organizing Committee of the conference. A one-day field trip to the well-known Meishan section was guided by Charles Henderson and Changqun Cao before the conference. All the participants enjoyed the field trip and were impressed by the excellent Geopark at Meishan, as well as the fantastic museum and 4-D cartoon to show the life history on the earth and the end-Permian mass extinction.

Previous SPS meeting and minutes

An SPS business meeting was held in conjunction with the XVI International Congress on Carboniferous and Permian. This meeting was held immediately after a session in memory of Prof. Yugan Jin on the evening of June 21. Charles Henderson chaired the business meeting. He summarized the recent progress on Permian issues and announced the forthcoming Cisuralian field trip and future business meetings for SPS. The individuals in attendance at this meeting included the secretary general of ICS Jim Ogg, SPS Chairman Charles Henderson, vice-chair Vladimir Davydov and SPS Secretary Shuzhong Shen. Other participants were Lucia Angiolini, Aleksandr Alekseev, Sam Bowring, Changqun Cao, Zhongqiang Chen, Aleksandia Dzhenchuraeva, Doug Erwin, Valeriy K. Golubev, John Groves, Yukio Isozaki, Olga Kossovaya, Lance Lambert, Horng-sheng Mii, Goreva Natalia, Yiping Qi, Mark Schmitz, Joerg Schneider, Mike Stephenson, Junichi Tazawa, Wei Wang, Xiangdong Wang and Yue Wang.

The Cisuralian field excursion organized by Boris Chuvashov and Vladimir Davydov was held between the 25th of June and the 4th of July immediately after the XVI ICCP. The aims of this trip were to observe the candidates of the GSSP sections in the Urals for the bases of Sakmarian, Artinskian and Kungurian stages. I would like to thank Boris Chuvashov and Vladimir Davydov for organizing such a productive field trip and showing the Cisuralian Working Group the potential GSSP sections. Charles Henderson and I collected conodont samples from the boundary intervals. I collected geochemical samples for the entire Asselian, Sakmarian and the most part of the Artinskian. Tamra Schiappa collected ammonoids from some horizons in the Cisuralian. Mark Schmitz collected many samples from the ash beds in the Cisuralian. Mike Stephenson collected some palynological samples at the visited sections. We all enjoyed the fieldtrip although we were nearly eaten up by thousands of mosquitoes at the Kondoruvsky section.

Forthcoming SPS meeting

The next SPS business meeting will be held in conjunction with the 33rd Geological Congress which will be held in Oslo between August 5-14, 2008. During the next SPS business meeting, the SPS Executive Committee will be re-elected and SPS members who have any recommendation and opinions, please write to me or Charles Henderson.

Future issues of Permophiles

The next issue of Permophiles is the 50th issue of Permophiles. Charles and I plan to edit Permophiles #50 in Melbourne when we join in the field trip to the Sydney Basin organized by Guang Shi. Permophiles as the newsletter of SPS has offered a great deal of information, communication and has become a forum for the Permian community. Papers, reports, comments, communications on Permophiles have been well cited by many journal papers. Charles Henderson and I hope to celebrate the 50th anniversary for Permophiles and to edit **a special issue for Permophiles #50**. **We herein invite all the SPS members to contribute manuscripts, comments or communications**. The deadline for submission to Issue 50 is December 21, 2007. Manuscripts and figures can be submitted via my email address (szshen@nigpas.ac.cn; or shen_shuzhong@yahoo.com) as attachments or by our SPS website (http://www.nigpas.ac.cn/permian/web/index.asp). Hard copies by regular mail do not need to be sent unless requested. However, large electronic files such as plates in Photoshop or TIF format may be sent to me on discs or hard copies of good quality under my mailing address below. Alternatively, large files can also be transferred via the submitting system on our SPS website. Please follow the format on Page 3 of issue 44 of ***Permophiles***.

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Notes from the SPS Chair

Charles M. Henderson

Shuzhong Shen and I completed most of this issue during five days at the Nanjing Institute of Geology and Palaeontology prior to the XVI International Congress on the Carboniferous and Permian. I would like to thank him again for being such a wonderful host. This issue and the previous forty-eight issues are available at our website (http://www.nigpas.ac.cn/permian/web/index.asp). All of these issues of Permophiles have centred on providing timely information on the Permian as well as to increase communication between researchers on the Permian. As a result ***Permophiles*** is widely cited in the scientific literature and this testifies to the value of the efforts of previous executives to continue to produce and help evolve this volume. We intend to produce a special 50th issue of Permophiles including a table that will allow for the searching of all articles in the series. I intend to ask certain individuals in particular to provide a contribution to the 50th issue, but as always, we welcome contributions from anyone interested in the Permian.

I have been fortunate this year to see Permian successions in several regions around the world including Bolivia, China, Russia, and the United States. As I worked on these successions it became apparent how important GSSP definitions are for correlation and communication. It would be as impossible to discuss climate change during the Permian without a GSSP-defined time scale as it would be to discuss climate change today without a calendar and common reference. SPS is trying to finish its work on GSSPs in a timely fashion and the fieldtrip to the southern Ural Mountains this June and July was aimed to complete that task. Vladimir Davydov and I report on that field excursion later in this issue. I made several comments in my notes to Permophiles 46 regarding the Cisuralian GSSPs and the importance of a field excursion to visit the sites. This field excursion was delayed, but the message remains the same that "it is important that full and free access to these locations be demonstrated by the Russian geologic community such that geochemical and paleontologic samples can be collected and shipped in a timely fashion for analysis". Discussion on Permian climate change necessitates the detailed correlation of continental sections as well as the search for climate proxies in the rock record. The difficulty of correlating our marine time scale into continental successions is underscored by the report on the Continental Autun meeting by Professor Cassinis and others in this issue. At this point it is important to emphasize the difference between definition and correlation. Obviously, the conodont definitions are not going to be found in continental successions, but each GSSP proposal offers many correlation tools that do cross these realm boundaries. It is gratifying to see papers at the Autun meeting in Burgundy France as well as at a session chaired by Joerg Schneider at the recent ICCP meeting in Nanjing China that highlight progress toward these marine-continental correlations. These correlations are difficult, but not impossible!

I conducted a business meeting at the Nanjing ICCP meeting in June 2007 and Shuzhong Shen has reported the minutes in his notes. I would like to take this opportunity to thank Xiangdong Wang and Shuzhong Shen (Co-Chairmen of the XVI ICCP) for the excellent meeting this year. They, as well as their large committee of volunteers, produced a very informative meeting that generated considerable discussion. I am sure that new collaborations will emerge because of this meeting and those discussions. This ICCP meeting, more than any other in my memory seemed to emphasize the importance of international multidisciplinary collaboration and cooperation. Xiangdong and Shuzhong are to be congratulated for their hard work in hosting this meeting and bringing this spirit of cooperation to the forefront of our minds.

My next task as Chairman of SPS is to produce our annual report to ICS later this fall. This report will be added to our website once complete and will be included in the next issue of ***Permophiles***. In addition, I ask for your input regarding the current SPS executive. Both Vladimir Davydov and I are willing to serve a second term if the SPS community agrees. Apparently, there is no formal procedure for voting for a second term, but if there is a desire for change to the executive then a formal vote will be required and this procedure will need to be completed before IGC in Oslo next August. Please indicate your opinion on this matter to SPS Secretary (an appointed position) Shuzhong Shen prior to the deadline for Issue 50.

REPORTS

Congress report: The XVI International Congress on the Carboniferous and Permian (ICCP 2007), Nanjing, China, June 21-24, 2007

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The XVI International Congress on the Carboniferous and Permian (ICCP2007), sponsored by the Chinese Academy of Sciences (CAS), the National Natural Science Foundation of China (NSFC), the Ministry of Science and Technology of China (MST), the National Commission of China (NCC), the International Subcommission on Carboniferous Stratigraphy (SCCS) and the International Subcommission on Permian Stratigraphy (SPS), was successfully held at the Dongjiao State Guesthouse in Nanjing, China between June 21st and June 24th. It was organized by the Nanjing Institute of Geology and Palaeontology (NIGP), the State Key Laboratory of Palaeobiology and Stratigraphy (LPS), Institute of Geology of Chinese Academy of Geological Sciences, China University of Geosciences, and Nanjing University. The congress included four-days of oral and poster presentations, two pre-congress field excursions and three post-congress excursions.

One hundred and forty-three colleagues from 29 different countries (Algeria, Ireland, Estonia, Australia, Brazil, Belarus, Belgium, Poland, Germany, Russia, France, Kazakhstan, Netherlands, Kirghiz, Canada, Czech Republic, Romania, USA, Norway, Japan, Thailand, Turkey, Ukraine, Spain, Iran, Israel, Italy, England and China) attended the congress. One hundred and sixty-nine papers were presented in 12 different sessions. Opening

and closing ceremonies were chaired by Xiangdong Wang and Shuzhong Shen. The congress was also honoured by the presence of Dr. James G. Ogg (ICS), Drs. Yucheng Chai and Yu Liu (NSFC), Drs. Shaoping Zhou and Shijie Li (CAS) and Dr. Qun Yang (NIGP). After a welcoming address by Dr. Qun Yang, deputy-director of the Nanjing Institute of Geology and Palaeontology, Drs. Yucheng Chai (NSFC), James Ogg (ICS), Henk Pagnier (Chairman of the last ICCP in Utrecht, Netherlands), Charles Henderson (SPS Chair) and Xiangdong Wang (co-chair of ICCP2007) gave important congratulatory and opening addresses. The closing ceremony was addressed by Drs. Philip Heckel (SCCS chair) and Shuzhong Shen (co-chair of ICCP2007).

Following the opening ceremony on the first day of the congress, nine plenary talks respectively on Earthtime (Sam Bowring), PT extinction (Hongfu Yin), C-P pteridosperms (Hans Kerp), C-P glaciation and aridification based on oxygen isotopic record (Ethan Grossman), Pennsylvanian glacial-eustatic cyclothems (Philip Heckel), impact of icehouse on tropical vegetation and plant evolution (Hermann Pfefferkon), Lopingian correlation and GSSPs (Charles Henderson), PT rapid deforestation in South China (Shuzhong Shen) and Early Triassic biotic recovery strategies (Doug Erwin) were presented.

The next three days featured sessions on a wide range of topics, including "End-Permian biotic mass extinction and early Triassic recovery convened by Doug Erwin and Shuzhong Shen", "Earthtime-Carboniferous and Permian geochronology convened by Sam Bowring", "Carboniferous and Permian macro- and microfossils; integrative stratigraphy and high resolution biostratigraphy convened by Ian Somerville, John Groves and Lucia Angiolini", "Late Paleozoic floras as proxies for climate change convened by Hermann Pfefferkorn and Jun Wang", "Stratotypes, boundaries and global correlations convened by Barry Richards and Charles Henderson", "Carboniferous and Permian reefs, biofacies, and basin analysis convened by Aretz Markus", "Evolutionary palaeogeography and palaeoclimatology, Pangea formation and breakup convened by Richard Lane and Walter Snyder", "Isotopic geochemistry and geobiology in the Permo-Carboniferous convened by Ethan Grossman and Horng-sheng Mii", "Gondwana and peri-Gondwana faunas, stratigraphy, and geology (In cooperation with IGCP 516: Geological anatomy of East and South Asia) by Xiaochi Jin and Katsumi Ueno", "Bio-diversity patterns and quantitative analysis of biotic databases, computerized palaeontology convened by Yue Wang", "Cyclothems and sequence-stratigraphy convened by Philip Heckel", and "Carboniferous-Permian non-marine–marine correlations convened by Joerg Schneider". In addition, two sessions in honour of two distinguished Chinese paleontologists, were held. One celebrated the 90th birthday of Prof. Xingxue Li, who has made great contributions to paleobotany in China, and the other was in memory of the late Prof. Yugan Jin, who was the main organizer of the XI International Congress on the Carboniferous and Permian held in Beijing 20 years ago and who made significant contributions to Permian stratigraphy and the end-Permian mass extinction.

During the four-day congress, our colleagues intensively discussed various aspects of stratigraphy, paleontology, sedimentology, paleoclimatology, and coal geology. It is remarkable that many hot issues of broad interest were discussed during this congress. These included isotope geochemistry, the end-Permian mass extinction and subsequent recovery, geobiology, computer-based biodiversity, Earthtime and geochronology, GSSPs, evolution of terrestrial ecosystems, correlation between marine and non-marine sequences *etc*. In addition, Dr. Vladimir Davydov (vice-chair of SPS) gave a short course on PaleoStrat and Drs. Walter Snyder and Rich Lane organized a meeting on Geosystems.

The abstract volume was published before the congress as a printed volume of a supplementary issue of Journal of Stratigraphy (Wang et al., eds., 2007) and includes a total of 185 abstracts. In addition, a special issue of *Palaeoworld* in memory of late Professor Yugan Jin was published shortly after the congress. All the papers are already available online at Elsevier ScienceDirect (http://www.sciencedirect.com/science/journal/1871174X). This special issue includes a memorial paper and 17 scientific papers to explore a number of research areas that are either directly or indirectly related to Prof. Jin's research interests. Thus, they obviously reflect Prof. Jin's profound influence in the field (Shen et al., eds, 2007).

Five field trips were offered before and after the congress. These trips were designed to show participants some of most important Carboniferous and Permian sequences in China, all of them were heavily booked. The pre-congress excursions were "GSSPs of the Permian-Triassic boundary and the base-Changhsingian at the Meishan sections (leaders: Shuzhong Shen, Charles Henderson and Changqun Cao)" and "Pennsylvanian to Lower Triassic continental sequences in Hebei and Inner Mongolia (leaders: Jun Wang and Lujun Liu)". Three post-congress excursions included "Peri-Gondwanan Carboniferous to Permian sequences in West Yunnan (leaders Xiangdong Wang, Tetsuo Sugiyama and Changqun Cao)", "Stratigraphy and lithofacies of the Tournaisian and Visean in the Guilin-Liuzhou area, Guangxi, South China (leaders: Xiaochi Jin, F.X. Devuyst, L. Hance, E. Poty, Baoan Yin, Xianghu Wu, Hongfei Hou)" and "Pennsylvanian and Lower Permian carbonate succession from shallow marine to slope in southern Guizhou (leaders: Yue Wang, K. Ueno, Yiping Qi)".

Proceedings of the congress will be published in two different journals "*Geological Journal*" and "*Palaeoworld*"; both are peer-reviewed international journals. The organizing Committee of ICCP 2007 hopes all of the participants will submit papers to the proceedings. We will put your papers into publications as soon as possible, with several volumes to come out before the opening of the next congress.

During the congress, the international Permanent Committee of ICCP held a business meeting with several important decisions being adopted. For the next congress, three countries, USA, Russia and Australia, offered applications. The committee decided that the next congress in 2011 will be at Perth, Australia, a country where the Gondwanan Carboniferous and Permian strata are well-preserved.

References

Wang Yue, Zhang Hua, Wang Xiaojuan (eds.). 2007. XVI International Congress on the Carboniferous and Permian, abstracts. *Journal of Stratigraphy*, vol. 31, supp. 1, 242 p.

Shen Shuzhong, Wang Xiangdong, Erwin, D.H. (eds.). 2007. Contributions to Permian and Carboniferous Stratigraphy, Brachiopod Palaeontology and End-Permian Mass Extinctions: In Memory of Professor Yugan Jin. *Palaeoworld*, vol. 16, nos. 1-2.

The Cisuralian GSSP Field Workshop

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A long expected field workshop on the Cisuralian of the Urals was successfully conducted from June 25-July 4, 2007. Unfortunately not everybody who wanted to join this workshop was able to come to Russia due to visa problems and we are sorry for those problems. There are several other issues, such as accessibility to the sections and the complicated and long process of getting permission to get samples through customs that might affect establishment of these GSSPs in Russia. However, we hope that with recent improvements of the economy and political climate in Russia that these problems will be simplified or no longer an issue in the near future.

The main goal of the field workshop was to visit and collect samples from three sections that have been proposed as potential GSSPs for the base of Sakmarian (Kondurovsky), for the base of Artinskian (Dal'ny Tulkas section) and for the base Kungurian (Mechetlino section) stages (see Permophiles 41, 2002). The original plan of 2005 was to visit all Cisuralian stage sites including the ratified Aidaralash section in Kazakhstan that is GSSP for the base of the Permian System and Asselian Stage. However, again due to potential complications with samples that would be brought through both Russian and Kazakhstan customs, we limited this workshop to only those sections in Russia.

The workshop was hosted by Boris Chuvashov, the Chairman of the Cisuralian Working Group and Valery Chernykh, both from the Institute of Geology and Geochemistry of the Uralian Branch of Russian Academy of Sciences, Ekaterinburg and by Viktor Puchkov, the Director of the Institute of Geology of the Russian Academy of Sciences, Ufa, Bashkortostan.

The following specialists were participants of the workshop (in alphabetic order):

Dr. Chernykh, Valery V., - Institute of Geology and Geochemistry of Uralian Branch of Russian Academy of Sciences, Ekaterinburg, Russia - conodonts

Dr. Chuvashov, Boris I. - Institute of Geology and Geochemistry of Uralian Branch of Russian Academy of Sciences, Ekaterinburg, Russia – foraminifera, algae, general stratigraphy and geology of the Urals

Dr. Davydov, Vladimir I., Vice-Chairman, Subcommission on Permian Stratigraphy, Research Professor, Department of Geosciences, Boise State University, Boise, ID, USA - foraminifera

Eastman, Nancy J., student of Dept. of Geography, Geology and the Environment Slippery Rock University, Slippery Rock, PA, USA

Photo showing the participants of the Cisuralian GSSP field Workshop at Kondurovsky

Dr. Gareev, Emir Z., Secretary-General of Bashkirian Academy of Sciences, Ufa, Bashkortostan, Russia – geochemistry and geological heritage

Dr. Henderson Charles M., Chairman, Subcommission on Permian Stratigraphy, Professor, Department of Geoscience, University of Calgary, Calgary, Alberta, Canada - conodonts

Dr. Kulagina, Elena I., Senior Researcher, Geological Institute of Russian Academy of Sciences, Ufa, Bashkortostan, Russia - foraminifera

Dr. Puchkov, Viktor N., Director of Geological Institute of Russian Academy of Sciences, Ufa, Bashkortostan, Russia - tectonics

Dr. Schiappa, Tamra A., Associate Professor, Dept. of Geography, Geology and the Environment Slippery Rock University, Slippery Rock, PA, USA - ammonoids

Dr. Schmitz, Mark D. Assistant Professor, Department of Geosciences, Boise State University, Boise, ID, USA – radiogenic geochemistry

Dr. Shuzhong Shen, Secretary, Subcommission on Permian Stratigraphy, Professor and Director of State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing, Jiangsu 210008, P.R. China - brachiopods

Dr. Stephenson, Michael H., Principal Researcher, British Geological Survey, Keyworth, Nottingham, Ng12 5gg, UK – palynology

It was a great advantage that we had specialists in various disciplines that provided information on different aspects of Uralian geology. It was very important to learn from Dr. Gareev, the official representative from Bashkirian Academy of Sciences, that all sections in Bashkortostan are now included in the list of geological heritage sites and protected by the Bashkirian government.

The trip started immediately after ICCP in Nanjing on June 25, 2007 (see report in this issue of Permophiles). After a long flight to Moscow followed by a long wait at Sheremetyevo Airport and then an overnight flight to Ufa we arrived at the Mechetlino section in central Bashkortostan on the afternoon of June 26. The trip ended on July 4, 2007 at the Kondurovsky section, Orenburg Province. During our trip we carefully examined transitional boundary beds in four sections. Conodonts, fusulinids, ammonoids, brachiopods and palynology samples were collected in all sections by the participants. The Usolka section, although it is not considered for a Cisuralian GSSP, was also examined for volcanic ash samples and biostratigraphy. In addition, several volcanic ash layers were found and collected from Mechetlino and Dal'ny Tulkas sections. Dr. Shuzhong Shen, with help of Dr. Davydov, collected a set of samples for stable isotopic study in the Kondurovsky section. Dr. Chernykh distributed among participants his new book "Early Permian conodonts of the Urals", Transactions of Institute of Geology and Geochemistry, Ekaterinburg, 2006; it included descriptions of the visited sections during our field trip, as well as the taxonomy of key conodont species.

The field trip was successful overall and we enjoyed great geology, the beautiful scenery and natural setting of the southern Ural Mountains, and excellent hospitality. The wishes were especially warm after an excellent lunch hosted by our Russian colleagues at their camp next to the Kondurovsky section in which excellent sandwiches of sardines, onions and potatoes and fine vodka were consumed. The toasts spoke of the deep feelings for Uralian geology as well as the hopes for continued and long-term international collaboration.

A number of suggestions were made to Dr. Chuvashov, Leader of the Cisuralian Working Group, for further consideration prior to submission of formal GSSP proposals including: 1) drafting of new stratigraphic columns with metres above base and new and old bed numbers indicated; 2) additional closely spaced conodont samples to be collected at the proposed GSSP sites in order to have a clear, high-resolution, defined point; 3) preparation of the sites to improve the exposures; 4) preparation of a detailed description regarding access and sample transportation and customs procedures; and 5) shipment of collected samples as soon as possible and hopefully no later than October 2007. The latter is especially important so that these samples can be processed (for conodonts, geochronology, isotopic geochemistry, palynology…) and reported in the proposals. Furthermore, the early shipment of these samples is necessary to demonstrate the accessibility of these sections as well as the reproducibility of the definitions. The Permian Subcommission is planning jointly with ICS to send a letter to the Russian government explaining the importance of simplification of custom procedures for such geological samples.

It is hoped that proposals can be produced by August 2008 for the base-Sakmarian and by August 2009 for the remaining two GSSPs. SPS will also be inviting others, in addition to those on the field excursion, to serve on the working group and make contributions to Permophiles. We especially need information about the correlation of the proposed definitions (Permophiles 41) into other regions, as well as suggestions for supplementary reference sections; the latter may be especially important for the base-Kungurian proposal given the provincialism apparent at this time. We also need any new information on the environments of deposition at each site. We plan to publish a more comprehensive report that will summarize recent progress of the Working Group including paleontological, stratigraphic and geochemical data in the next issue of Permophiles (#50).

Report on the Continental Autun Meeting, Burgundy, France, 2-4 July 2007

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An international symposium co-organized by the Geologists' Association of Permian and Triassic (AGPT) and the Autun Museum of Natural History was held on the topic: "Continental Early Permian (Cisuralian) paleoenvironments: physical and biological components". The meeting consisted of a preliminary field trip to the Autun Basin, and two days of lectures and poster sessions.

The pre-conference excursion led to the publication of a well-illustrated field guidebook of 32 pages, edited by G. Gand, J.-J. Châteauneuf, M. Durand, D. Chabard and J.-P. Passaqui, with the collaboration of P. Marteau and J. Galtier.

The Autun Basin is situated at the northeastern border of the Massif Central. It occupies a surface area of 250 km^2, and the total thickness of the deposits reaches 1200 m in the central part of the basin. The Lower Permian continental succession, which represents the historical stratotype of the "Autunian" defined by Munier-Chalmas in 1881, has been divided into four formations (base to top), including the Igornay, Muse, Surmoulin and Millery, which collectively can be treated as a group. Generally, the coarse detrital sediments of the southern and eastern borders of the basal "Autunian" gradually pass upward, in the north and west parts of the basin, to calcareous and clay mudstone, which is often interbedded with bituminous layers. The stratigraphic boundaries and the fossiliferous content of the "Autunian stratotype" has long been a subject of debate. The guidebook presents a biostratigraphical synthesis based primarily on the macro- and microfloral elements that determine the boundary between Stephanian and "Autunian" and designate an Asselian–early Sakmarian age to the "Autunian stratotype". Otherwise, the upper limit of this stratotype is not fixed owing to the gap occurring between the "Autunian" and the Triassic.

The field trip was planned to examine, in stratigraphic order, the main typical facies and fossiliferous beds yielding macro- and microfloral assemblages from the "upper Stephanian" to the "upper Autunian", which was also complemented by a visit to the rich faunal and floral collections, as well as reference drill-hole cores, housed in the Autun Museum of Natural History.

Following the field excursion, the next two days in the Hotel de Ville of Autun saw the start of the scientific sessions of the Symposium, as well as the presentation of talks and posters. They were preceded by opening speeches by the Mayor of the town and the organizers of the Meeting, welcoming the 50–60 participants, and dealing with the long-term geological and industrial history of the Autun Basin, in which tests for oil extraction were initiated in 1824.

The topics of the talks and posters, 23 in all, are listed below:

First Session (3 July): Structural Geology, Sedimentology, Palaeoenvironments

Durand M.: Cisuralian global stratigraphy.

Deroin J.-P.: Early Permian (Cisuralian): Tectonics and Geodynamics.

Arche A. and López-Gómez J.: The Early Permian basins of Spain: An outline of their biostratigraphic, sedimentologic and structural characteristics.

Cassinis G., Perotti C. and Ronchi A.: The "Autunian": Its stratigraphic and tectonic significance in Italian geology.

Garric J.: Structural and sedimentological relations between Stephanian and Autunian Groups in the Graissessac and Lodève basins (Languedoc, France). (Poster).

Garric J.: The Autunian Tuilière-Loiras Formation of the Lodève Basin: sedimentology and palaeoenvironmental results. (Poster).

Châteauneuf J.-J., Marteau P. and Passaqui J.-P.: Autun bituminous shales: geology, reserves, qualities and exploitation history.

Marteau P.: Présentation de la Carte Géologique de Toulon sur Arroux à 1/50000ème éditée par le Service géologique national (BRGM).

Second Session: Palaeobiodiversity

Hervet S., Steyer J.-S. and Pouillon J.-M.: Palaeontology of the Lower Permian locality of Buxières-les-Mines (Allier, France): an overview.

Steyer J.-S., Sidor C.A., Damiani R., Boulay M. and Lorrain S.: 3D reconstructions of fossil amphibian skulls.

Werneburg R. and Steyer J.-S.: "*Actinodon*": the most typical amphibian from the Autun Basin.

Falconnet J. and Steyer J.-S.: Revision, osteology and locomotion of *Aphelosaurus*, an enigmatic reptile from the Lower Permian of France. (Poster).

Jiquel S. and Maquignon Y.: Fouilles paléontologiques dans le Permien de Lodève menées par des équipes françaises et allemandes. (Poster).

Second Session (4 July): Palaeodiversity

Sanchez S.: Palaeohistology of the Lower Permian tetrapods: Palaeoecological and Palaeobiological implications.

Santi G.: Modern view of the Lower Permian palaeoichnology of the South Alpine (Northern Italy) as testified by the ichnocoenoses of the Collio Formation in the Orobic basin (Lombardy). (Poster)

Gand G. and Durand M.: The lower Permian footprints of France: palaeontology and stratigraphical implications.

Valentini M., Nicosia U. and Conti M.A.: large sized Permian footprints: ichnosystematics and biochronology.

Germain D.: A new aistopod from the Massif Central of France and lifestyle of aistopods.

Diez J.B., Broutin J. and Martinez-Garcia E.: palynological data of Sotres Formation, Asturias (Spain).

Ronchi A., Galtier J. and Broutin J.: The Autunian silicified floras from Autun Basin (Massif Central, France) and Perdasdefogu (Sardinia, Italy): bio- and chronostratigraphic correlations. (Poster).

Thery J.-M.: Approche paléobotanique et palynologique d'une séquence Kazanien/Sakmarien/Assélien au SW du Gondwana. (Poster).

Schneider J., Gand G., Bathoux O. and Werneburg R.: Insect biochronology of classical French and German Late Carboniferous/ Early Permian sequences – links to the Global Standard Profiles.

Jalil N.E., Saber H. and Steyer J.-S.: Les vertébrés terrestres du Permien du Maroc, données nouvelles.

The above presentations were assembled into an "abstracts volume" of 35 pages. This also includes two articles, the first by Hallalouche D., Bougara N. and Hamidi M. ("Etude sédimentologique du Permo-Trias du Djebel Doui (Région de Ain-Defla, Algérie): Implications géodynamiques globales"), and the second by Štamberg S. ("Actinopterygians from Buxières-les-Mines and their relationships to the fauna of Permo-Carboniferous basins of the Bohemian Massif"), neither of which could be presented due to the absence of the authors.

Third Session (4 July): Workshop on continental Permian Formations

In essence, this session represented the focus of the Symposium and centred on the stratigraphic significance of the "Autunian" in the European continental context. The session was introduced by Jean Galtier, a well-known Carboniferous and Permian paleobotanist from the University of Montpellier (southern France), who pointed out the difficulty in defining precise stratigraphic limits and correlations between intra-continental basins (*i.e*. above all between the "Autunian" and "Saxonian"), leading to the abandonment or neglect of these traditional French terms in preference of marine stages, which are the only ones admitted by the IUGS. But how do we use them to date continental formations that don't contain marine fossils? The difficulty is sometimes solved when marine deposits are interbedded with continental sediments as, for instance, in Italy and the US. However, except for these and other particular areas, it is generally very difficult to adopt the marine global timescale.

Today, the best way to date continental successions is by suitable radiometric analyses, magnetostratigraphic reconstructions and exhaustive interregional correlations. Moreover, the choice of an up-to-date marine timescale is also essential for appropriate age-assessments of continental rock units.

In light of the above stratigraphic problems, the well-known paper by Broutin J., Châteauneuf J.-J., Galtier J. and Ronchi A. on "The Autunian of Autun: will it remain a reference for the Early Permian continental deposits in Europe?" (*in* Géologie de la France, 2: 17-31, 1999) was particularly a subject of discussion for some participants. Despite the poor quality of the "Autun stratotype" outcrops, the numerous published references to the "Autunian" paleoflora of the Autun Basin are valid. In the absence of a substitute parastratotype, the aforementioned authors re-propose that the "Autunian" biostratigraphic content of the Autun Basin continues to be considered as characteristic of the continental Early Permian from the latest Gzhelian to the early Sakmarian. Certainly, a geologically more complete stratotype containing an equivalent biostratigraphic suite should be looked for in the continental domains of Europe.

In this context, Schneider and Gand presented, at the end of the meeting, a contribution on the topic: "Towards a European lithostratigraphic scheme for the Late Palaeozoic continental deposits – a discussion". The suggested arguments, on p. 43 of the abstracts volume, are of great interest, but the trans-European stratigraphic scheme given by the above authors must still be considered as provisional, in our opinion, since it needs further

Fig. 1: Participants inside the townhall of Autun, Burgundy (France), 3 July 2007. (Photo by G. Gand).

geological data and careful reflection. In this scheme, the term "Autunian" should be used as "Autunien" (as in France) instead of "Autunian" as applied to Germany and some other countries. Thus, at the moment, the application of this term seems to be at least locally preserved. It is also interpreted as a synonym of the German Unter-Rotliegend, and both units are considered as useful lithostratigraphic terms in a European context. Again according to the cited authors, based on the synthesis of biochronological data and isotopic ages, the above units may be correlated with the international global scale, after further effort.

A large part of the above presentations and discussions will probably be published in a special volume of the Autun Museum of Natural History.

During the late afternoon of Wednesday 4 July, the Autun Symposium completed its rich and diverse program with concluding speeches from the Organizing Committee.

Progress report of the International Lopingian Working Group (ILWG)

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The Lopingian Series represents a critical interval in geological history. This interval is bracketed by pre-Lopingian crisis (the end-Guadalupian mass extinction) associated with the greatest regression and ended by the greatest mass extinction at the end of the Changhsingian. After the successful establishment of the Wuchiapingian-base (also the Lopingian-base) GSSP at the Penglaitan section in Laibin, Guangxi and the Changhsingian-base GSSP at the Meishan Section D in Changxing, Zhejiang, South China (Jin et al., 2006a; Jin et al., 2006b). The Lopingian Series and its component stages (Wuchiapingian and Changhsingian) have been precisely defined by the FAD of the conodont *Clarkina postbitteri postbitteri* (Jin et al., 2006a) at the base, *Clarkina wangi* (Jin et al., 2006b) at the middle and the FAD of *Hindeodus parvus* at the top (Yin et al., 2001). The precise definition for the Lopingian Series and its component stages brings us further scientific opportunities. Among them, the high-resolution correlation of the Lopingian provides the basic framework for delineating the tempo of the end-Permian mass extinctions and the paleoenvironmental evolution of the Lopingian. The ILWG presently focuses on the post-GSSP issues, and the highlights of these issues are briefly summarized as follows:

1) Integrated high-resolution succession of the Lopingian and global correlation. This includes high-resolution biostratigraphy based on different fossils groups including conodonts, foraminifers, ammonoids, brachiopods etc. Study of the end-Permian mass extinction and paleoenvironmental change requires a high-resolution biostratigraphic framework. This requires the correlation of important Lopingian sections across the world in different sedimentary settings. It has been well-accepted that conodonts are the primary fossil group for high-resolution correlation of all the marine Paleozoic and Triassic systems, and all the established GSSPs for this interval are based on conodonts. The ILWG focuses on conodonts for high-resolution correlation and, at the same time, combines with the importance of brachiopods, fusulinids and ammonoids as current and historical tools for Permian correlation. Presently, its activities include the correlation of the Lopingian sequence in Iran and South China and the correlation of the Apache fauna with the Guadalupian/Lopingian boundary section. Significant progresses has been made and the initial results will be reported in the next issue of Permophiles.
2) High-precision geochronologic ages for the Lopingian in South China. The Lopingian Series in South China contains volcanic ash and carbonized tuff at many different levels from the base of the Lopingian to the lowest part of the Triassic. U-Pb zircon geochronology of the ash-beds from Meishan and other sections has resulted in a number of published dates (Bowring et al., 1998; Claoue-Long et al., 1991; Mundil et al., 2004; Renne et al., 1995). The value differences between the two newest data sets disagree by as much as 3 mys for Bed 25 at the Meishan section. Therefore, more precise dating for those ash beds by different labs in the same time is being analyzed by Sam Bowring and his research group in MIT.
3) Geochemical signature and paleoenvironmental implications. The Late Palaeozoic Research Group in Nanjing supported by NSFC made two drills at Meishan in early 2004 and obtained more than 340 m cores for geochemical analysis to reveal the palaeoenvironment across the Permian-Triassic boundary. An international Workshop on the Meishan Core was held in Nanjing between October 5-10, 2004. Rich Lane (NSF), Doug Erwin (Smithsonian Institution), Sam Bowring (MIT), Roger Summons (MIT), Frank Kyte (UC), Luann Becker (UC), Charles Henderson (University of Calgary) and the Late Paleozoic Research Group in Nanjing jointly visited the Meishan section and joined in the workshop. Some results have already been published jointly with the colleagues in MIT and Australia (Grice et al., 2005). Currently, Roger Summons and Changqun Cao are working the biomarkers from the core. Changqun Cao and Wei Wang (Cao et al., 2002) worked on and will continue to work on the carbon and strontium isotopes from the core samples. Yanan Shen will work on the Sulfur isotope in collaboration with the Nanjing research group. In addition, some samples from the eventostratigraphic interval have been delivered to different labs for blind test of possible extraterrestrial impact at the PTB. Further studies on the nature of organic molecules are being undertaken. In addition, the core will provide a precise and uniform stratigraphic succession to integrate the results from parallel investigations of paleontology, geochemistry and sedimentology and thus, might lead to better understanding the relation between various lines of evidence.
4) End-Changhsingian mass extinction. Although extensive studies have been carried out for the end-Permian mass extinction, the causes of the extinction remain unclear yet. During the past decade, Jin et al. (2000) in collaboration with Doug Erwin published the results on Science about the extinction pattern based on the Meishan section. This result reveals that the end-Changhsingian mass extinction happened within a very short time (less than half million years) by a major phase followed by an extinction tail in the earliest Triassic associated with a dramatic carbon isotope depletion at the extinction level. However, this result is based on a single section only in the carbonate setting. Shen et al. (2006) documented the pattern of the end-Permian mass extinction based on a few sections in the peri-Gondwanan margin which is nearly consistent in timing and pattern with that at the Meishan section. However, more and more sections in different geological setting need to be investigated in detail to identify the possible causes of the end-Permian mass extinction. This topic remains one of the ILWG focuses.
5) Quantitative graphic correlation of the Lopingian Series using CONOP9. Many Lopingian sections in China have been measured in a high-resolution scale and large biostratigraphic data have accumulated during the last decades. This has provided a basic condition to establish a large database for running CONOP9 to realize the quantitative graphic correlation among different sections in China and with other sections in the world.
6) A special issue edited by Shuzhong Shen, Xiangdong Wang and Doug Erwin, in memoriam of our dear friend Yugan Jin, has been published in the journal *Palaeoworld* established by Yugan Jin and published by Elsevier (Shen et al., 2007). This special issue includes 17 papers. The pdf versions of the papers are available at http://www.sciencedirect.com/science/journal/1871174X.
7) Special issue of the Lopingian Series and global correlation. Since the base and the top of the Lopingian and its component stages have been precisely defined. It is very important to establish the correlation of the Lopingian Series in the different continents. We plan to organize a special issue on the Lopingian Series in the world next year and we will invite colleagues to make contributions on the Lopingian special issue.
8) The XVI International Congress on the Carboniferous and Permian was held in Nanjing between June 21-24 successfully. A detailed report is provided in this issue of Permophiles by Shen et al. The abstract volume was published before the congress as a printed volume of a supplementary issue of

Journal of Stratigraphy (Wang et al., eds., 2007). Xiangdong Wang and Shuzhong Shen will organize two special issues for the papers presented in the congress before the XVII ICCP.

Call for contribution

On behalf of the International Lopingian Working Group, I cordially invite all members to send us suggestions for the planning and major future aspects for the ILWG. Any colleague who wish to make contribution to the ILWG is welcome to send your contact details and your major interests to us at the address given above.

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SUBMISSION GUIDELINES FOR ISSUE 50

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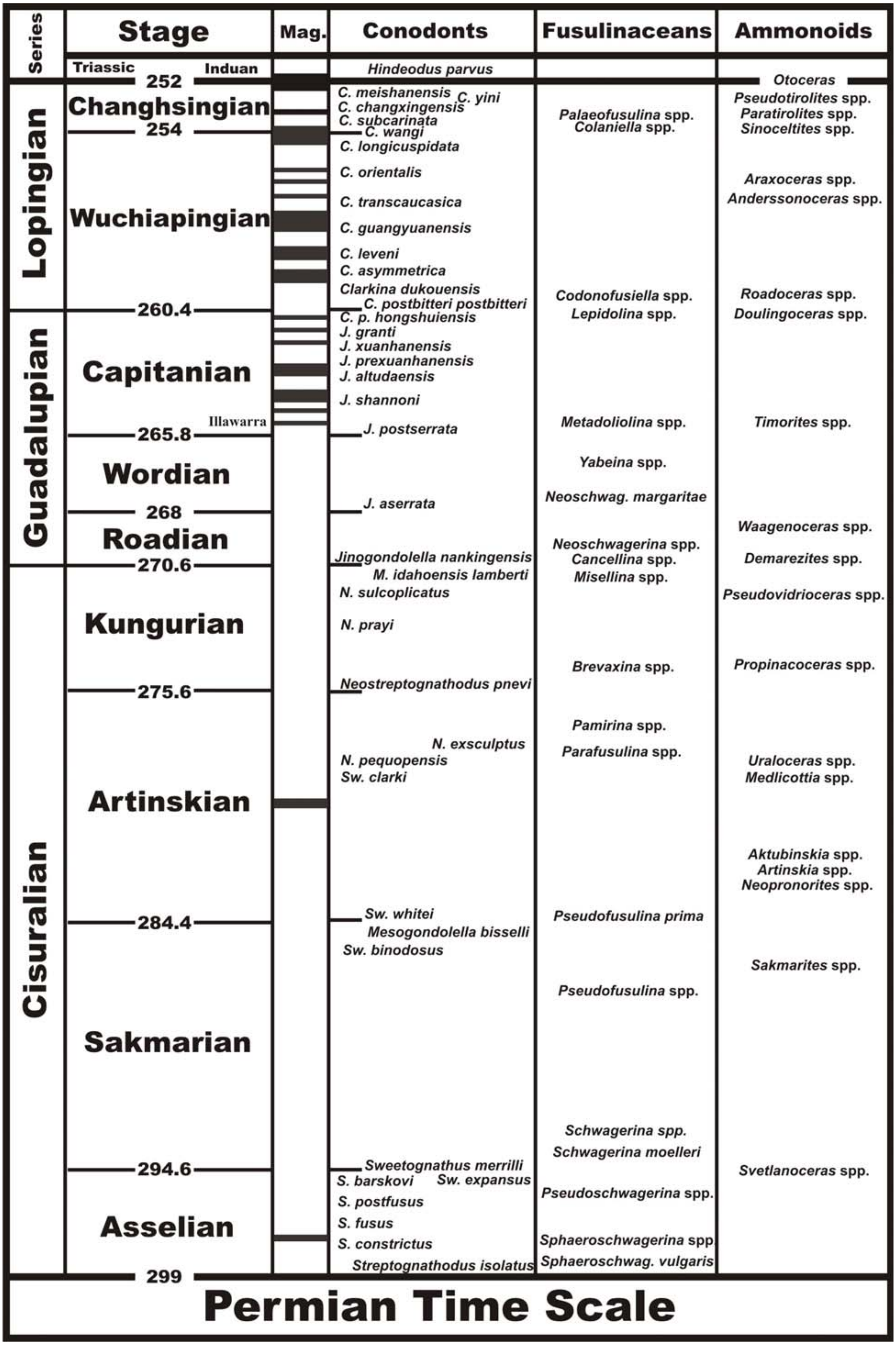

International Permian Time Scale

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Tectonics and Paleogeographic Applications of Peri-Gondwanan Permian Fusulinid Fauna from Kalmard Region, Easy-Central Iran

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Introduction and Previous Work

This paper is a summary of a project on the taxonomic study of fusulinids from Kalmard area in East-Central Iran that will be published in Paleontologia Electronica, vol. 10, issue 2 and also is part of the Ph.D. project of Sakineh Arefifard entitled "Study of Microbiostratigraphy, Microfacies and Geochemistry of Permian Sedimentary Rocks in Kalmard, Shotori and Shirgesht Regions (East central Iran)" that has been carried out by the junior author for the last six years (Arefifard, 2006; Arefifard and Davydov, 2004a; Arefifard and Davydov, 2004b; Arefifard *et al*., 2004; Arefifard and Davydov, 2005).

Permian strata are widely distributed in the Kalmard area in East-Central Iran. The Permian sediments were first reported by Aghanabati (1977) who recognized the uniqueness of this sequence and proposed the name "Khan Formation" for it. Aghanabati (1977) divided the formation into three members (A, B and C), corresponding to Early, Middle and Late Permian, respectively. These members were correlated with the Dorud, Ruteh and Nessen formations of the Alborz area in North Iran. In all, six stratigraphic sections have been studied including Abdollaho, Bakhshi, Gachal, Rahdar, Halvan and Madbeiki.

Triticites primaries isfarensis (Bensh, 1972) and *Pseudofusulina alpine antique* (Schellwien 1898), attributed to the Late Carboniferous, were reported in the Kalmard region, although without specific locations of the samples (Kahler, 1977). The analyses of figures provided in this publication suggest that these fossils belong to the new genus *Perigondwania*.

In recent years, biostratigraphic study of member A of the Khan Formation by Haftlang (1998) and Gorgij (2002) showed that this member belongs to the Mississippian and includes no evidence of Permian fossils.

The goals of this contribution are 1) to summarize the stratigraphy of the Khan Formation, 2) offer thorough taxonomic studies and analyses of fusulinids that are found in the Khan Formation, and 3) provide biostratigraphic dating of Permian deposits based on fusulinids.

Geologic Setting

Structural evolution during the Phanerozoic was complicated in Iran. The area can be divided into several tectonic provinces based on several structural and sedimentary features (Stocklin, 1968; Eftekharnezhad, 1980; Stampfli, 1978; Berberian and King, 1981; Alavi, 1991). One of the most active of these provinces (especially during the Mesozoic and Cenozoic) is central Iran. This tectonic domain formed part of a broad platform through coalescence with other Iranian provinces during the Paleozoic. Prevailing structural patterns mostly include detached tectonic blocks along with major faults. A recent study by Alavi (1991) has divided central Iran into four blocks including the Lut block (LB), Tabas block (TB), Posht-e-Badam block (PBB) and Yazd block (YB) (Figure 1). The area under study for this paper, Kalmard (West Tabas), is located within the Posht-e-Badam block, which is separated from the Tabas block by the Kalard and Kuhbanan (southern continuation of Kalmard) faults. Aghanabati (2004) considered the Kalmard area part of the Tabas block based on a strong resemblance between the Precambrian basement in the Kalmard and Tabas areas. He also proposed that since the Kalmard area is situated between two active faults (Kalmard fault in east and the covered Naeini fault in west) it is possible to designate this area as an isolated sub-block within Tabas. The oldest rocks in Kalmard are the Kalmard Formation of Precambrian age. They are well folded and overlain by the Ordovician Shirgesht Formation, separated by an angular unconformity. The Ordovician-Middle Triassic strata in Kalmard area were deposited in a shallow water platform that possesses lithologic dissimilarities with the Tabas area. There is no report of Upper Triassic sediments in the Kalmard area, which would be indicative of a longer hiatus than in the Tabas area resulting from the early Kimmerian orogeny (Aghanabati, 2004).

Stratigraphy and Sedimentology

The sections in our study are located on Bakhshi Mountain (92 km southwest of the town of Tabas), Madbeiki Mountain (12 km of northwest of the Bakhshi Section), Gachal Mountain (approximately 100 km southwest of Tabas), Rahdar Mountain (65 km west of Tabas) and Halvan Mountain (80 km northwest of Tabas) in the Kalmard area, Iran (Figure 1).

The type section of the Khan Formation was established by Aghanabati (1977) as being on Bakhshi Mountain, 8.5 km southeast of Kalmard Karavansaray. Five stratigraphic sections were measured and sampled and more than 546 samples were collected for both geochemical and paleontological studies (Figure 2). The lithologic features will be explained in general because the successions discussed here show only minor differences from one another. The Khan Formation overlies the limestone of Gachal Formation where Mississippian *Archaesphaera*, *Endothyra* and *Earlandia* were reported (Gorgij, 2002). It mostly consists of red to brown cyclic sequences that start with gravel to cobble conglomerate or with very coarse to coarse sandstone. The size of the clasts decreases upwards and the topmost portion of each cycle are shallow water thick- to medium-bedded packstone to grainstone. The distinguishing feature of this formation is the siliciclastic material that encompasses many of the units. The lithological content of the Khan Formation suggests that it was deposited near a terrigenous source (Arefifard, 2006).

There are several cyclic sequences present in the Khan Formation. Each starts with gravel to cobble conglomerate or with very coarse to coarse sandstone (Figure 2). The size of clastic grains decreases upward. This part of the cycle is the transgressive phase. With increasing water depth, carbonate sediments that consist mainly of shallow water thin to medium-bedded packstone to grainstone with a few horizons of mudstone, were deposited. The fossil content of this limestone is commonly dominated by

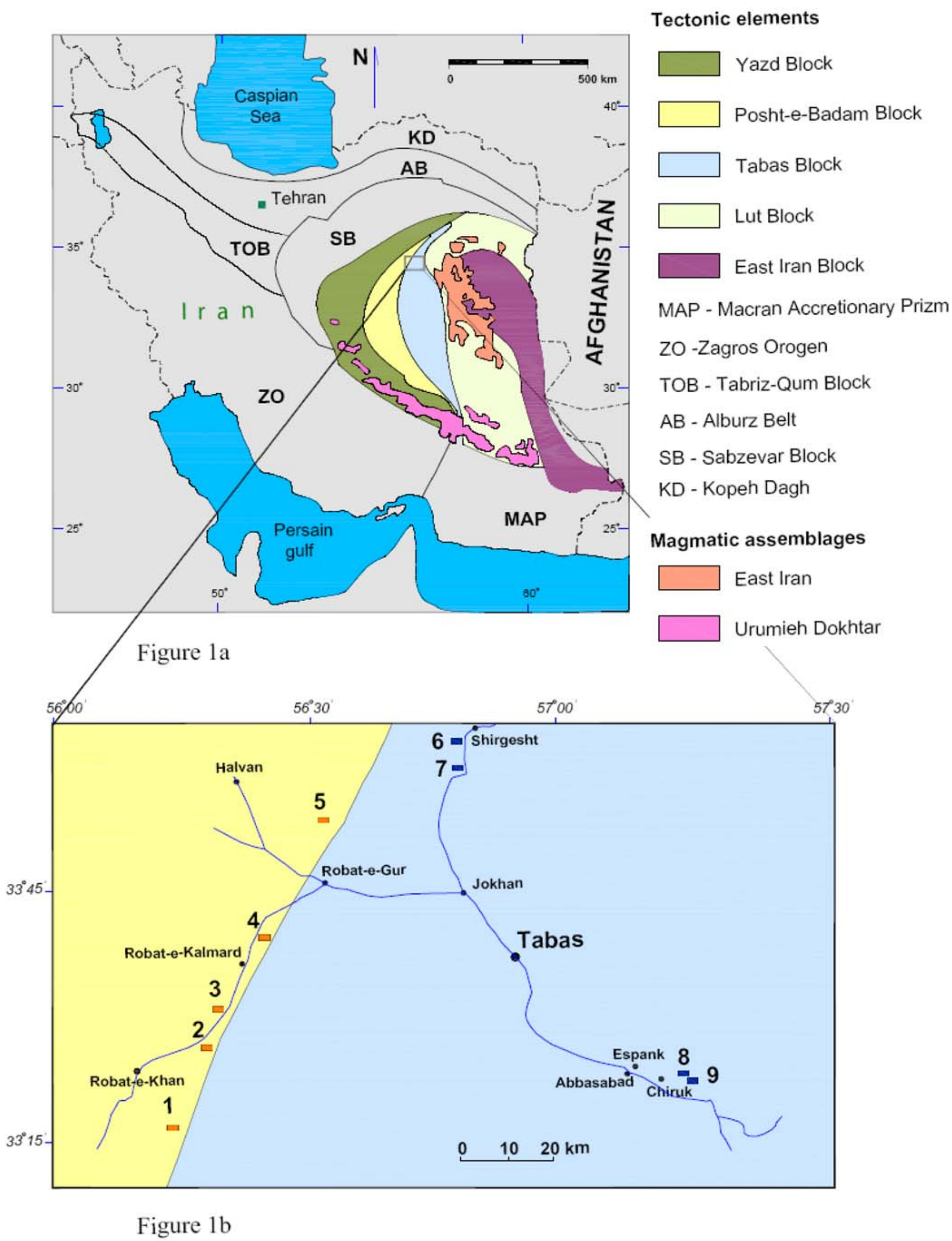

Figure 1. Generalized tectonic map of Iran (after Alavi, 1991) and index map with location of studied sections. In this classification Central Iran micro-continent divided into four blocks. Kalmard area located within Pash-e-Badam (PBB) Block. Sections discussed in this paper: 1, Gachal, 2, Bakhshi (type section of Khan Formation), 3, Madbeiki, 4, Rahdar, 5, Halvan. Other studied sections: 6, Shish Angosht, 7, Bagh-e-Vang, 8, Jamal 1, 9, Jamal 2.

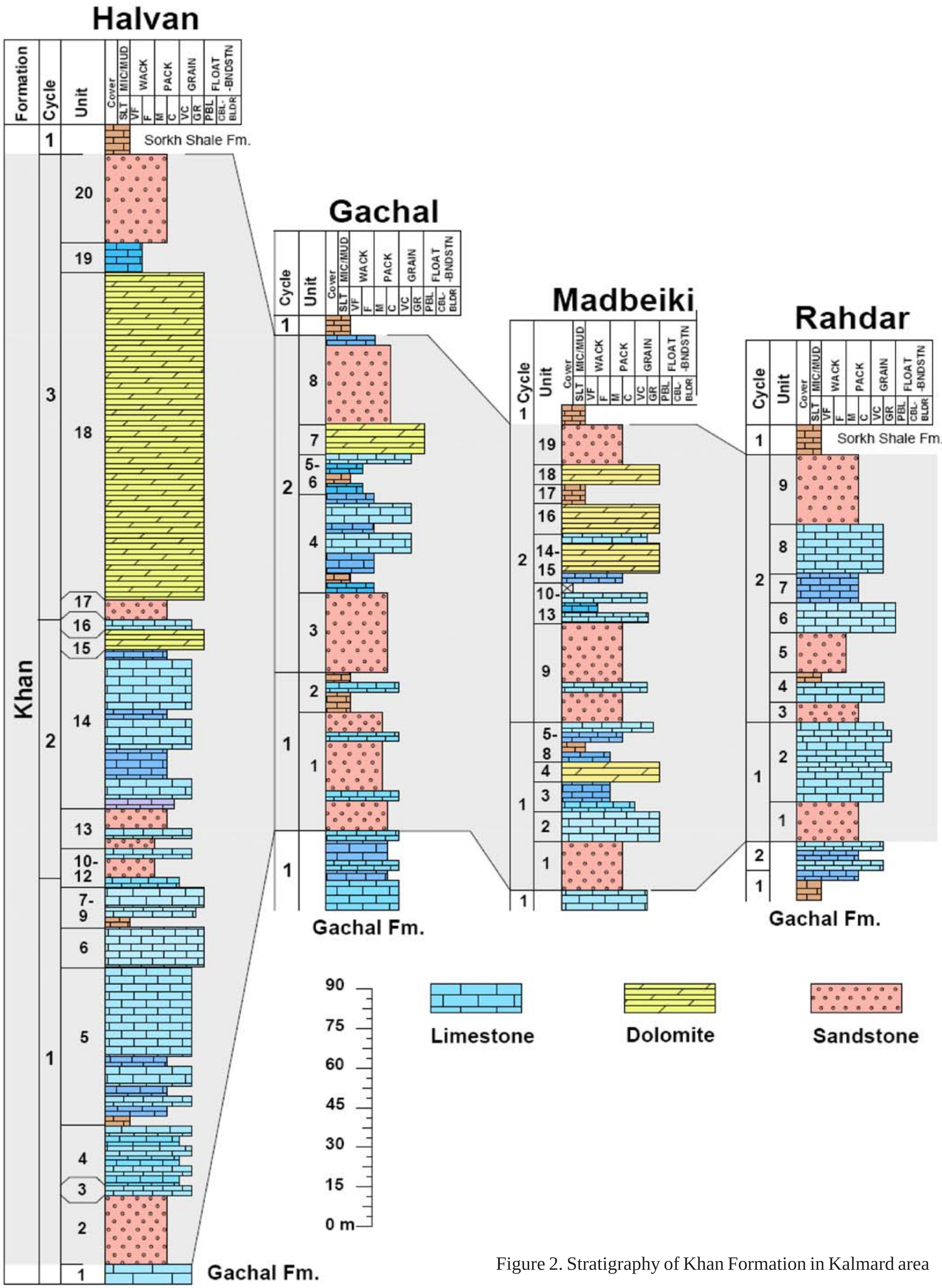

Figure 2. Stratigraphy of Khan Formation in Kalmard area

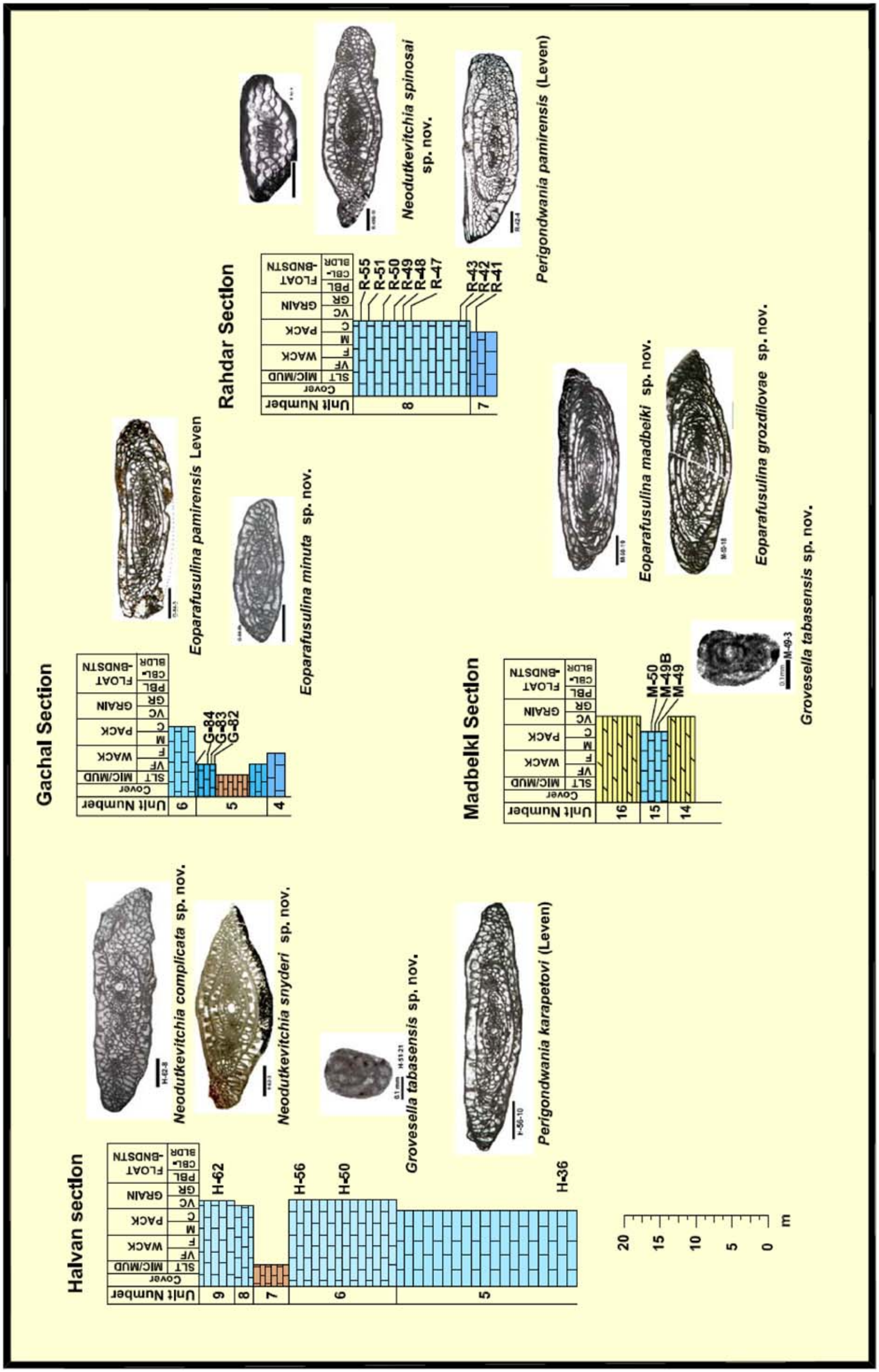

Figure 3. Correlation chart of fusulinid-bearing deposits among studied sections.

small foraminifers, fusulinids, corals, bryozoans, crinoid stems and brachipods. It is also quite thin, suggesting short duration stabilization within the depositional basin. Medium-bedded fusulinid-bearing limestone of the Khan Formation was found in a second sedimentary cycle in the Madbeiki, Gachal and Rahdar sections. The first cycle was present in the Halvan section (Figure 3). There was no packstone or grainstone at the Bakhshi section. Dolostone and dolomitic limestone form part of the carbonate sediments of each cycle in some sections of the Khan Formation. For example, in the Halvan section the carbonate part of the third cycle is defined by the predominance of grey medium-bedded dolostone. Petrographic studies of these dolostones demonstrate that they are secondary in origin. The topmost portion of each cycle terminates in red coloured sandstone, showing a possible regressive phase.

Through the analysis of five stratigraphic sections it becomes apparent that the number of sedimentary cycles in the Khan Formation varies from section to section. The Madbeiki, Rahdar and Gachal sections possess two cycles and Bakhshi and Halvan sections show four and three cycles, respectively. Additionally, the regressive, siliciclastic sediments of each cycle are a result of basin uplift and consequent erosion. Therefore, transgressive siliciclastic deposits of each cycle directly overly carbonate sediments. The lower boundary of the Khan Formation is placed at a disconformity, which is recognized by channeling immediately above the Mississippian limestone of the Gachal Formation. It is overlain by Lower Triassic yellow vermiculite limestone of the Sorkh Shale Formation. The disconformity between Khan and Sorkh Shale formations is marked by a bauxite horizon.

The early Artinskian is marked by a regression in the Kalmard region. Continental conditions in the area remained until the Early Triassic. As such, uplift did not give way to subsidence until the end of the Permian, as recognized in the Lower Triassic Sorkh Shale Formation that unconformably overlies the late Sakmarian-early Artinskian Khan Formation. Facies analysis, petrographic studies and lithologic features of the Khan Formation suggest that it was deposited in a shoreline environment with mixed siliciclastic-carbonate sediments.

Systematic Paleontology (see Paleontologia Electronica, vol. 10, issue 2; http://palaeo-electronica.org/2007_2/00124/index.html)

Six genera and 27 species of Permian fusulinids, of which three genera and 15 species are described as new, have been recovered for the first time from the Khan Formation in east-central Iran.

Correlation and Biostratigraphy of the Khan Formation with Correlative Peri-Gondwana Deposits

Twenty one samples were collected from four sections at one-metre intervals and 352 oriented thin-sections with fusulinids were prepared. The recovered assemblage of fusulinids consists of 6 genera and 24 species. Six genera of smaller foraminifera were found as well. The most abundant taxa in the assemblage are diverse *Eoparafusulina*, and *Perigondwania*; the *Neodutkevitchia* are much less diverse. Schubertellides (*Eoschubertella* and *Grovesella*) and staffellids are very rare, but present in the assemblage. Smaller foraminifera in the studied material are very rare.

Eoparafusulina, *Perigondwania*, and *Neodutkevitchia* that are distributed within Peri-Gondwana appear there as the earliest, relatively warm water marine assemblage above cool water carbonates. They are associated with brachiopods and bryozoans and cold/cool-water siliciclastic deposits including glacial diamictites (Angiolini *et al*., 2006; Leven, 1993, 1997; Ueno, 2003; Shi and Grunt, 2000). This assemblage represents the transition between non-fusulinid cold-water communities and typical warm-water fusulinid communities of a tropical area. Accordingly, a stressful environment can be expected in this transition that is marginal for fusulinids. These conclusions are based on the following observations. First, the diversity of the assemblage is relatively low compared to assemblages in the Tethys of a comparable age (*e.g*., Afghanistan, North and South China). Second, an abnormally large number of the specimens (>5% of the total population) have double proloculi. A similar phenomenon was observed in the published data from Central Pamir (Leven, 1993). From the 102 figured specimens of *Eoparafusulina*, *Perigondwania*, and *Neodutkevitchia* in this paper, six specimens have a double proloculi (Leven, 1993). The unusually large number of specimens with a double proloculi might indicate a stressful environment that is marginal for these surviving fusulinids. In normal warm-water conditions the number of specimens with double proloculi never exceeds 0.1% of the population.

Two assemblages can be recognized in the Kalmard area. One is *Eoparafusulina*-dominated and found in Gachal and Madbeiki sections. The second, a *Perigondwania*-*Neodutkevitchia*-dominated assemblage is found in the Halvan and Rahdar sections. The *Eoparafusulina*-dominated assemblage consists of eight species of *Eoparafusulina*, seven of which are new, and one species of *Neodutkevitchia*. One previously known species is *E. pamirensis* (Leven, 1993). It has been found in the Kalmard area previously and was originally described from bed 6 of the Dangikalon Formation in the Central Pamirs (Leven, 1993), where it is appears in an assemblage with several other *Eoparafuslina*, numerous *Perigondwania*, less diverse *Neodutkevitchia* and perhaps rare *Pseudoendothyra*, *Schubertella* and *Pseudoreichelina* (Leven, 1993). Unfortunately, no documentation about species distribution in samples from each section, nor were ecological or environmental information provided in this publication. It is hard to judge whether *Eoparafusulina* in the Central Pamirs appear together with *Perigondwania* and *Neodutkevitchia* or whether these two assemblages occur separately as in the Kalmard area.

Two new species of *Eoparafusulina* (*E. grozdilovae* and *E. stevensi*) that are found in Kalmard also occur in bed 6 of the Dangikalon Formation in the Central Pamirs and were designated there as *Eoparafusulina tschernyschewi tschernyschewi* and *Eoparafusulina tschernyschewi memoranda* (Leven, 1993). The latter two species were originally described from late Asselian-early Sakmarian of Timan (Schellwien, 1909; Grozdilova and Lebedeva, 1961). It is plausible that neither population of *E. grozdilovae* nor *E. stevensi* from the Central Pamirs or from the Kalmard areas belong to species from the Arctic, because of several reasons. First, they differ from Arctic *Eoparafusulina* in morphology. The thickness of septa in all *Eoparafusulina* from the Arctic is as thick as a spirotheca (Grozdilova and Lebedeva, 1961), whereas septa in *Eoparafusulina* from Central Pamir and Kalmard areas are at least twice as thin as the spirotheca. It seems that thin septa are characteristic for all other *Eoparafusulina* in the Peri-Gondwana region (Premoli-Silva, 1965; Leven, 1993, 1997;

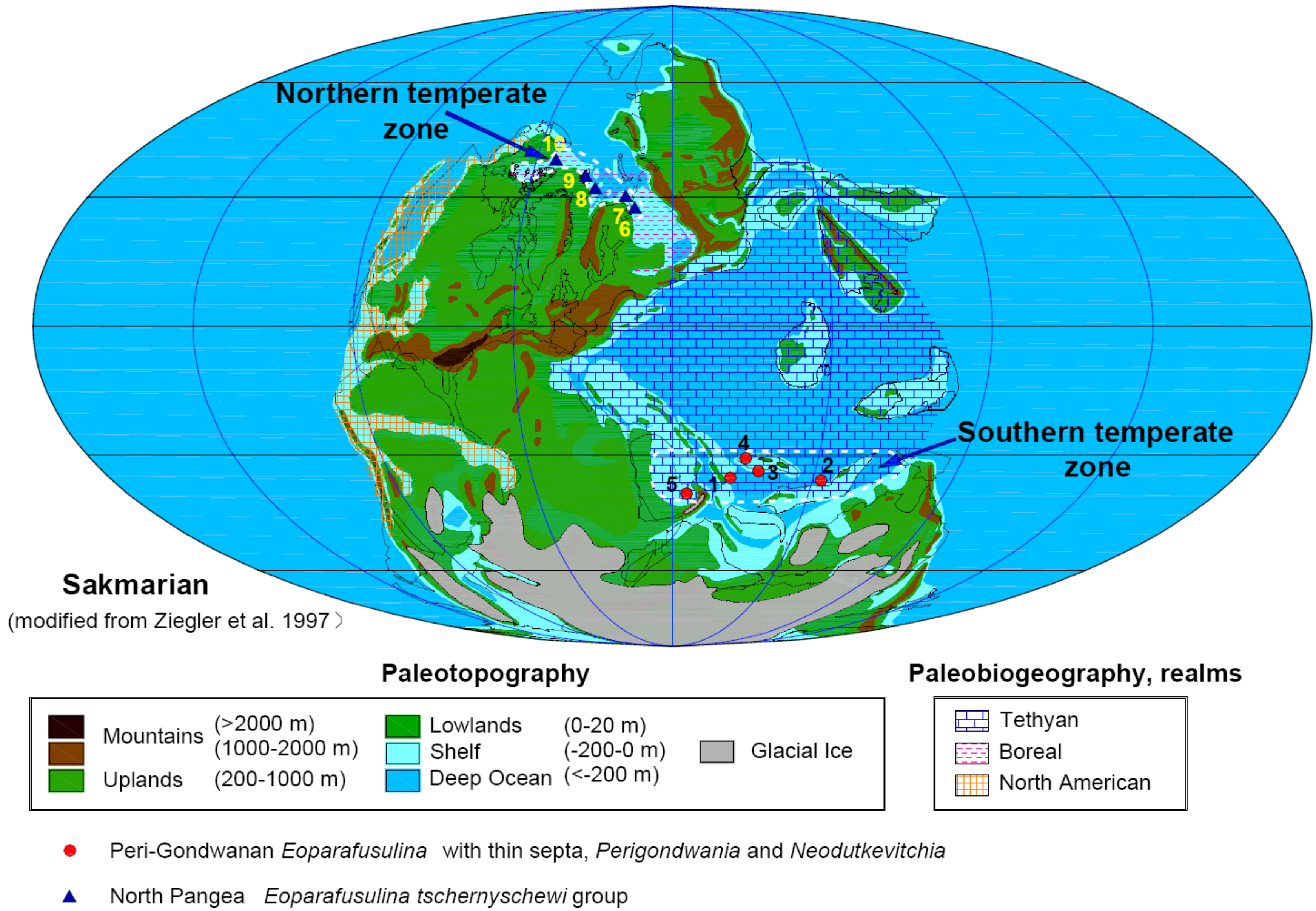

Figure 4. Distribution Peri-Gondwanan *Eoparafusulina* with thin septa and *Perigondwania - Neodutkevitchia* stocks and Arctic *Eoparafusulina tschernyshevi* group with thick septa in Sakmarian, Early Permian. Map slightly modified from Ziegler *et al*., 1998. Note the presence of bridge between Pangea and Kazakhstania plates south from Uralian sea that prevent connections between Boreal and Tethyan faunas starting from early Sakmarian. Occurrences:1, Posht-e-Badam block, Kalmard area, East-Central Iran; 2, Baoshan, Sibumasu, Tengchong Blocks, Indo-China (Cimmerian) Blocks; 3, Quangtang Block (including South Tibet, East Hindu Kush, Karakorum and south Afghanistan), 4, Central Pamir; 5, Central Oman; 6, North Timan; 7, Kolguev; 8, Barents Sea subsurface; 9, Spitsbergen; 10, Canadian Arctic.

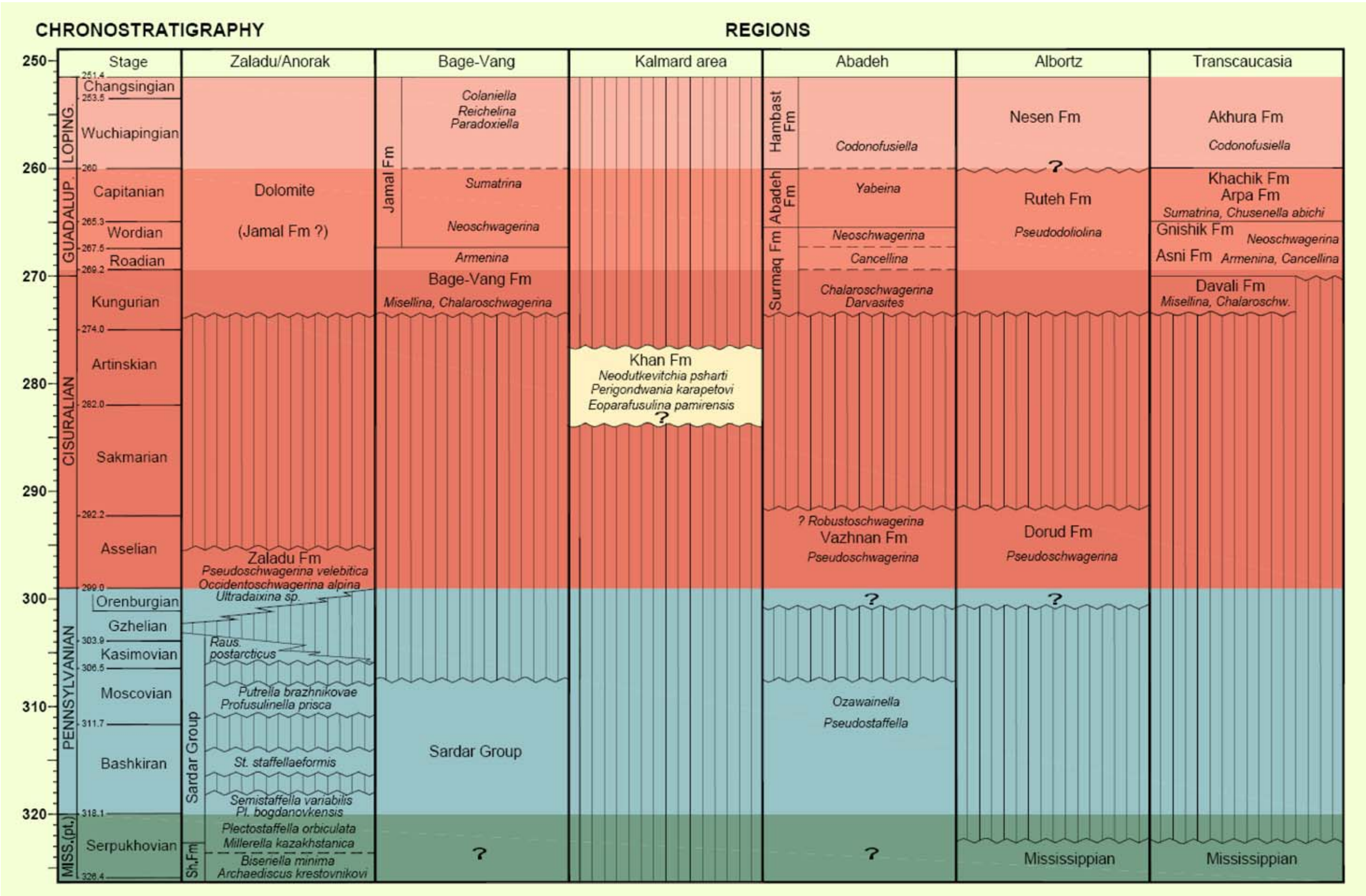

Figure 5. Correlation chart of main Carboniferous-Permian sections in Northern, Central, Eastern Iran and Transcaucasia. Zaladu, Anorak and Bage-Vang - Leven and Vaziri (2004), Leven and Gorgij, 2006; Leven *et al*., (2006); Abadeh - Baghbani, 1993, 1997; Albortz - Jenny-Deshusses, 1983; Transcaucasia - Leven, 1998.

Gaetani *et al*., 1995; Ueno, 2003). Second, *Eoparafusulina* from the Arctic, Central Pamir and Kalmard areas possess a different stratigraphic range: late Asselian-early Sakmarian vs. latest Sakmarian-early Artinskian. Third, these two groups of *Eoparafusulina* are distributed within two separate antitropical temperate high latitude belts in opposite sides from the tropical belt (Figure 4). That is, *Eoparafusulina* from the Arctic occurs in the northern antitropical belt, whereas *Eoparafusulina* from the Peri-Gondwana region occurs in the southern antitropical belt. During the early Sakmarian, the northern transitional temperate zone of the Arctic became completely isolated from either Tethys and/or Peri-Gondwana (Davydov and Leven, 2003) and consequently Arctic *Eoparafusulina* had no path for migration into Peri-Gondwana during the latest Sakmarian-early Artinskian. An independent origin of *Eoparafusulina* in Peri-Gondwana is the most probable scenario. However, no direct evidence is available.

Eoparafusulina is widely distributed in the Peri-Gondwana region and known from the Baoshan and Tengchong Blocks in Yunnan (Ueno, 2003; Shi Yukun, 2006, personal communication), the Rutog area, South Tibet (Nie and Song, 1983a), East Hindu Kush (Gaetani *et al*., 1995), Karakorum (Premori Silva, 1965), South and Central Afghanistan (Leven, 1997), central Pamir (Leven, 1993) and Oman (Angiolini *et al*., 2006). Leven also reported several species of *Eoparafusulina* in the Central Pamirs that were originally described in Alaska and the Shasta Lake area of North America (Petocz, 1970; Skinner and Wilde, 1965). Although they possess remarkable similarity to some specimens from the Central Pamirs (Leven, 1993), these are most probably different and new species. For example, *Eoparafusulina depressa* Skinner and Wilde, 1965 and *E. laudoni* Skinner and Wilde, 1965 from Shasta Lake area possess much better developed cuniculi in two to three outer volutions whereas cuniculi in *Eoparafusulina* from Peri-Gondwana are always less well developed and can be barely observed only in the final volution.

The *Perigondwania-Neodutkevitchia* dominated assemblage is distributed within Peri-Gondwana approximately in the same regions as the *Eoparafusulina*-dominated assemblage. In the Kalmard area the diversity of this assemblage is relatively poor. Six species of *Perigondwania* are found there and are also known in South Tibet (Nie and Song, 1983b), East Hindu Kush (Gaetani *et al*., 1995), Karakorum (Premori Silva, 1965), South and Central Afghanistan (Leven, 1997), central Pamir (Leven, 1993) and Oman (Angiolini *et al*., 2006). The two species of *Perigondwania* from Kalmard area (*P.rahdariensis* and *P. aghanabati*) as well as all *Neodutkevitchia* are new.

Age of Peri-Gondwanan *Eoparafusulina* and *Perigondwania-Neodutkevitchia* Assemblages

The age and stratigraphic range of the species in the *Eoparafusulina* and *Perigondwania-Neodutkevitchia* Peri-Gondwana assemblage is not clear because of endemism and a limited geographic distribution of these faunas within Peri-Gondwana. In Central Pamir, where this assemblage is taxonomically most diverse, the presence of *Robustoschwagerina*, *Paraschwagerina tianshaniensis* (Chang, 1963), *Zellia nunosei* (Hanzawa, 1938), and *Sphaeroschwagerina zhongzanica* (Zhang, 1982) were reported and a Sakmarian age for the assemblage has been proposed (Leven, 1993). The latter species were compared with similar taxa from the Trogkofel and Rattendorf Stages of Carnic Alps (Kahler and Kahler, 1980), from Sakmarian rocks in North Afghanistan (Leven 1971, 1997), Darvaz (Leven and Scherbovich, 1980) the Kelping Mountains of Xinjiang (Chang, 1963), and from the lower part of Sakamotozawa Stage of Japan (Choi, 1973). The FAD of *Robustoschwagerina*, *Paraschwagerina tianshaniensis*, *Zellia nunosei* is Sakmarian. However, in the Carnic Alps the acme of these taxa is in the Artinskian as they occur together with the Artinskian conodont *Sweetognathus whitei* (Forke, 1995, 2002).

The *Eoparafusulina* and *Perigondwania-Neodutkevitchia* Peri-Gondwana assemblage is also reported in Central and South Afghanistan (Leven, 1997). In the Khaftkala tectonic zone several typical Artinskian species from the Urals were mentioned in association with *Perigondwania-Neodutkevitchia*. However, none of these important age control species from the Urals were described or figured and thus no observation can be made regarding the age of the assemblage in Khaftkala tectonic zone. In the Khoja Murod tectonic zone, typical Artinskian (Yakhtashian) species *Pamirina* cf. *evoluta* Sheng have been reported together with *Perigondwania karapetovi* and *P. peregrina*. Again, neither a description nor figure of these important taxa has been provided (Leven, 1997). In the other localities in Central Afghanistan the *Eoparafusulina* and *Perigondwania-Neodutkevitchia* Peri-Gondwana assemblage occurs between sequences with staffellids, bryozoans and brachiopods of probable Sakmarian age below and typical Artinskian (Yakhtashian) *Pseudofusulina kraffti*, *Ps. exiqua*, *Ps. fusiformis*, *Darvasites contractus*, *Chalaroschwagerina vulgaris* fusulinids above (Leven, 1997).

In Northern Karakorum, *Pseudofusulina* aff. *sedujachensis* Konovalova and Barishnikov, 1980 and *Ps*. aff. *synensis* Konovalova, 1980 that were originally described from lower Artinskian in Timan-Pechora Basin (Konovalova and Barishnikov, 1980) were reported in association with *Perigondwania plena* (Leven, 1993), *Pr. incomperta* (Leven, 1993), *Pr*. ex gr. *karapetovi* (Leven, 1993) and *Eoparafusulina* aff. *pamirensis* Leven, 1993, *i.e*. with a typical Peri-Gondwana fusulinid assemblage (Gaetani *et al*., 1995). Although specimens from Northern Karakorum are quite similar to Uralian species, they differ from the latter by the presence of phrenotheca that are typical for *Perigondwania* and that have never been described in these Uralian *Pseudofusulina*. Thus, these " *Pseudofusulina*" from Northern Karakorum are most probably a new species of *Perigondwania*.

Brevaxina sp. has been reported from Member A of the Khan Formation (Aghanabati, 1977). This would suggest a Kungurian (Bolorian) or younger age for the basal part of the formation. However, our analyses of fusulinid assemblages from the Khan Formation and similar fusulinids from Peri-Gondwana suggest that they cannot be older than Artinskian.

Two conodont occurrences are known to appear together with *Eoparafusulina* and *Perigondwania-Neodutkevitchia* fusulinids in Peri-Gondwana. In Central Pamir *Neogondolella bisselli* (Clark and Behnken) 1971 have been reported immediately below the Peri-Gondwana fusulinid assemblage (Leven, 1993). This species is an index of Sterlitamakian (Upper Sakmarian) conodont zone *Sweetognathus anceps-Mesogondolella bisselli* recently established in the Urals (Chernykh, 2005). However, the species ranges up to the top of Artinskian and is also typically associated with *Sweetognathus whitei*.

In the Baoshan block, west Yunnan, southwest China, the occurrence of *Sweetognathus whitei* in association with

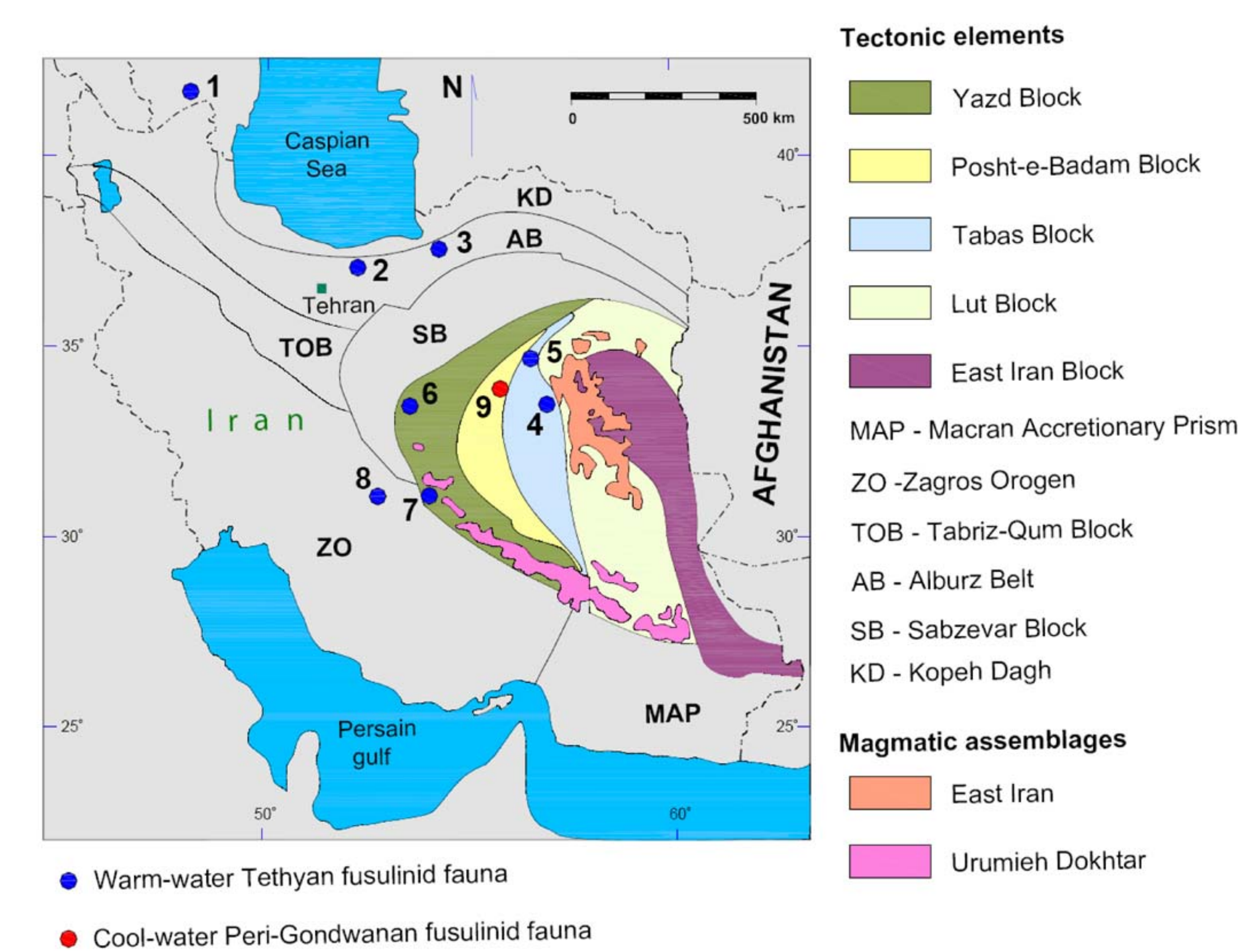

Figure 6. Geographic occurrences of warm-water Tethyan and cool-water Peri-Gondwanan fususlinid faunas in Iran and surrounding areas. 1 - Transcaucasia (Leven, 1998); 2, 3 – Albortz, 4 - Jamal (Jenny-Deshusses, 1983); 5 – Ozbak Kuh, 6 – Anorak (Leven and Vaziri 2004; Leven and Gorgij, 2006; Leven *et al*., 2006); 7 – Abadeh, 8 – Zagros (Baghbani, 1993, 1997); 9 – Kalmard area, Posht-e-Badam block (present paper).

Eoparafusulina and *Perigondwania* has been reported (Ueno *et al*., 2002). V.V. Chernykh (personal communication, January 2007) confirmed that forms from the Baoshan block closely resemble *Sweetognathus whitei*, the index species of the lower Artinskian conodont zone in the Urals (Chernykh, 2005).

Within the whole area of Iran, the time of deposition of the Khan Formation corresponds to a major unconformity between the Sardar and Jamal formations in the Shirgesht and Ozbakuh areas.

Summarizing everything above, the following can be proposed regarding the age of *Eoparafusulina* and *Perigondwania-Neodutkevitchia* Peri-Gondwana assemblage. In many areas this assemblage appears immediately above glacial deposits that are most probably late Sakmarian in age. The appearance of this fusulinid assemblage corresponds with a relatively warmer climatic episode. Some recent models suggest the middle Sakmarian age for the warming episode (Montanez *et al*., 2007), whereas others suggest a latest Sakmarian-early Artinskian age (Schneider *et al*., 2006). Fusulinid data support a warming trend during the late Sakmarian-Artinskian transition (Davydov *et al*., 2003). Fusulinids *Robustoschwagerina*, *Zellia* and *Paraschwagerina* and conodont *Sweetognathus whitei* that are found together with *Eoparafusulina* and *Perigondwania-Neodutkevitchia* suggest an early Artinskian age, although it cannot be excluded that the FAD of some fusulinid species might be in the latest Sakmarian. The youngest fusulinid species reported from this assemblage is *Pamirina* cf. *evoluta* (Leven, 1997) of Artinskian (Yaktashian) age. However, it has not been described and/or figured and therefore its presence in the assemblage is somewhat questioned here. Artinskian fusulinid species from the Urals that were reported in association with *Perigondwania-Neodutkevitchia* assemblage (Leven, 1993, 1997, Gaetani *et al*., 1995) most likely belong to *Perigondwania* and cannot clarify the age model for the assemblage.

Paleobiogeographic and paleotectonic implications of the *Perigondwania-Neodutkevitchia* assemblages from the Khan Formation

Three major biogeographic realms are usually recognized in the distribution of the Late Paleozoic foraminifers: North American or Midcontinent-Andean, Boreal or Uralian-Franklinian, and Tethyan (Reitlinger, 1975; Ross and Ross, 1985). Two antitropical transitional realms (or provinces) periodically appear in the north and south from the Tethyan realm. The northern transitional zone that has been tentatively called the Arctic province (Rui *et al*., 1991) appears in response to cooler-water environments and possesses a somewhat endemic biota and has a low-diversity taxonomic composition. It extends along the northern margin of Pangea, from the Northern Urals in the east up to the Canadian Arctic and Alaska in the west (Figure 4). This province exists only in the Late Moscovian-Kasimovian through Gzhelian and the late Asselian-early Sakmarian. Beginning during the late Sakmarian through Artinskian and the early Kungurian, the entire Boreal realm became completely isolated from other realms. At the time it had relatively cooler water, but was in general very similar to the entire area from the Pre-Caspian, along the Urals, to the Canadian Arctic. The southern transitional zone or, the Peri-Gondwanan province (Australian by Miklukho-Maclay, 1963), does exhibit cooler climate faunas. This leads to observations of biogeographic differences with other realms that have been proposed and recently accepted (Leven, 1993; Kalvoda, 2002, Ueno, 2006). It exists from the latest Sakmarian and Artinskian through Guadalupian. One more transitional zone, sometimes called the "McClaude realm," includes several accreted terranes of western North America (Ross, 1997). During the late Carboniferous and early Cisuralian, the fauna there closely resembled fusulinids of the North American realm. During the late Cisuralian it possessed significant Tethyan elements, but many of these elements of the North American fauna can still be found today (Skinner and Wilde, 1965).

Fusulinaceans were distributed in different carbonate to mixed carbonate-siliciclastic shallow water conditions in tropical-subtropical belts (up to 40-45° south/north latitude; Belasky, 1996) and often formed foraminiferal limestone with numerous specimens that are collected and studied in many sections throughout the globe. As a result, foraminifers are a great indicator of paleoclimate and paleoenvironments within a high-resolution spatial and temporal framework. It is assumed that the majority of fusulinaceans hosted photosynthetic symbionts that are found in many of the larger living foraminifera (Ross, 1982). Because large, extant tropical foraminifera with symbionts live in conditions with temperature ranges between 35-15°C, which never fall below 14°C for several weeks (Hohenegger, 2004) it seems reasonable that fusulinaceans may have lived under similar conditions (Ross, 1972; Murray, 1991). Temperature appears to control the diversity of extant larger foraminifer assemblages. Shallow water assemblages with optimal water temperature (30-20°C) for foraminifera are generally much more diverse than those with temperatures greater than approximately 31°C and/or less than approximately 20°C (Murray, 1991; Beavington-Penney and Racey, 2004).

Perigondwania-Neodutkevitchia fauna that are found in the Khan Formation in the Posht-e-Badam block, Central Iran also occur in South Tibet, East Hindu Kush, Karakorum, South and Central Afghanistan, central Pamir and Oman (Nie and Song, 1983b; Gaetani *et al*., 1995; Angiolini *et al*., 2006; Premori Silva, 1965; Leven, 1993, 1997) and strictly indicate the southern antitropical temperate zone. The fusulinid assemblages in these regions appear to be restricted taxonomically and include either *Eoparafusulina* with thin septa or *Perigondwania-Neodutkevitchia* faunas. Furthermore, these assemblages contain unusually large number of specimens with double proloculi that might indicate a stressful environment, which is marginal for these surviving fusulinids. Based on these observations, it is suggested that this temperate zone was geographically and climactically quite narrow. It probably represents a narrow climatic belt (30-40° southern hemisphere) where environmental conditions were marginal for fusulinids with annual temperature range around 14-20°C. Thus, it is hard to overestimate the biogeographic significance of the *Perigondwania-Neodutkevitchia* fauna.

This fauna might also have important paleotectonic significance. The petrographic and sedimentologic studies of the Gachal and Khan formations, and especially the transition between these formations, which are critical for understanding details of paleotectonics of the area, were beyond the scope of the current project. Nevertheless, some general paleotectonic observations can be suggested. On most of the paleotectonic models the Iran microcontinent has the northernmost position within the Cimmerian Continent. The Posht-e-Badam block was a part of the Cimmerian Plates (terranes) that were proposed to have separated from Gondwana in the Late Carboniferous (Golonka and Ford, 2000; Stampfli and Borel, 2002). Detailed petrographic, biostratigraphic, and taphoniomic studies of the Pennsylvanina-Cisuralian glacial-postglacial transition in Oman were interpreted as recording continental break-up and the onset of Neotethyan spreading between northern Gondwana and the Cimmerian terranes during the mid-Sakmarian, as constrained by brachiopod assemblages (Angiolini *et al*., 2003). Similar brachiopod assemblages associated with *Perigondwania-Neodutkevitchia* fusulinid fauna were recovered in Central Oman (Angiolini *et al*., 2006) and so this continental break-up and onset of Neotethyan spreading is probably latest Sakmarian-early Artinskian in age as suggested by the fusulinids and conodonts.

The biostratigraphic and paleontologic data from the Khan Formation can also be applied in an effort to gain better understanding of the local and regional tectonic framework and post-Permian tectonic development of the area. Fusulinids in localities 1-8 are typical Tethyan, whereas fusulinids from the Posht-e-Badam block belong to temperate transitional cool to cold water fauna of higher latitude. There are no common forms in Tethyan and Peri-Gondwanan assemblages and taxonomically they are sharply different. This might suggest that during the Early Permian the Posht-e-Badam block was far south in comparison to the rest of the locations that formed recent Iran.

Conclusions

1. A well-defined assemblage of Permian Peri-Gondwanan fusulinids from the Khan Formation in East-Central Iran has been found for the first time in this region.
2. Six genera and 27 species were designated in this assemblage, in which three genera and 14 species are new. In addition, two new species were established from the published source (Leven, 1993).
3. The evolutionary pattern of Peri-Gondwanan early Artinskian *Perigondwania* and *Neodutkevitchia* are quite similar and homeomorphic to the evolution of Late Gzhelian and Asselian *Shagonella* and *Dutklevitchia* from the tropical Tethyan realm.
4. The *Eoparafusulina*, *Perigondwania-Neodutkevitchia* assemblage is widely distributed in a narrow southern antitropical belt surrounding Peri-Gondwana and has important implications in understanding the paleogeography, paleotectonics and paleoclimate in East-Central Iran and Peri-Gondwana.

5. The Pennsylvanian-Permian correlation chart provided in this paper shows that the time of deposition of the Khan Formation corresponds to a major unconformity between the Sardar and Jamal formations in the Shirgesht and Ozbakuh areas and has important applications for paleotectonic reconstruction of the tectonic history of the whole of Iran.

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The problem of the recognizing the 'Changhsingian' in northeastårn Asia (Boreal Realm)

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Introduction

The new version of the standard Permian stratigraphic scale was presented by the International Permian Subcommission at the end of the last century (Jin *et al*., 1994). This new proposed version is quite different from the previous one founded in the Permian System stratotype region sections of theUral and eastern Russian plate.The Permian Subcommission argument to not use the East-European standard is the presence of continental measures within the upper part of the Russia Permian succession. The proposed new Permian scale is based on three different marine sections that yield rich marine faunas including conodonts. The total volume of these three sections is regarded as equal to the Permian System as a whole. In spite of the location of these three sections in different parts of the tropical world they have been regarded as the reference sections of the three main subdivisions of the Permian System. The lower of them, the Cisuralian, is nearly the same as the Lower Permian of the East-European scale. The type section of the middle subdivision (Guadalupian) is the Guadalupian series of West Texas (Glass and Guadalupe Mountains). The reference section of the Upper Permian or Lopingian series is located in South China. There are three index fossil groups (conodonts, ammonoids and fusulinids) that serve as the basis for subdivision and correlation of the tropical Permian. According to the recommendation of the International Commission on Stratigraphy all chronostratigraphic boundaries must be determined by the change of conodont species belonging to one evolutionary line.

Different points of view regarding age of uppermost Permian strata, northeastern Asia

The high degree of Permian phytogeographic differentiation makes it problematic to use the new Permian standard in the Boreal area, where conodonts are absent. The boreal marine biota of Late Permian is much poorer then the tropical one. The endemic pelecypod-brachiopod associations are widely distributed here. The only index fossil group in the area is represented by rare ammonoidea. There is a very characteristic ammonoid association including *Daubichites, Sverdrupites* and other genera near the base of Guadalupian. This association marks the boundary between Lower and Middle Permian and is widely distributed. It is one of the best correlative levels within the Permian System around the World. As to the younger part of the boreal Permian, including most of the Middle and Upper Permian subdivisions, good ammonoid associations are unknown. Rare findings of ammonoid shells as a rule come from alluvial deposits and do not have any significance for correlation.

Correlatives of the Changhsingian, the uppermost Permian stage of the new standard, have been proposed to be recognized at the top of the Upper Paleozoic marine section of northeastern Asia (Boreal area, eastern part). According to Bjakov (Bjakov *et al*., 2002; Budnikov *et al*., 2002) the uppermost Permian measures of northeast Asian sections are characterized by the regional brachiopod-pelecypod zone *Stepanoviella paracurvata - Intomodesma costatum*, which he regarded as Changhsingian. Within the above-mentioned zonal assemblage, Bjakov shows that some pelecypod species are very similar to those described from the Changhsingian of South China.

The determination of a Changhsingian age for the uppermost Permian of northeastern Asia is not correlated by paleofloristic data. It is possible to see in one well-studied section of the Verkhoyan Ridge (Baraja River), an upper part (Khalpirsky Horizon) that ñontains assemblages of plants and pelecypods (*Intomodesma evenicum, I. costatum*). According to A.S. Bjakov, this *Intomodesma* association from the lower part of the horizon belongs to the above-mentioned regional zone *Stepanoviella paracurvata - Intomodesma costatum* with an age he regarded as Changhsingian. Fossil plants coming from the upper part of the Khalpirsky Horizon do not belong to the youngest Permian plant association of Angaraland because of the presence of *Rufloria* here. This endemic genus of Angaran cordaitean leaves is widely distributed within the upper half of the Carboniferous and most of the Permian, but they did not survive to the end of the Permian System. At the Kuznetsk Basin plant-bearing reference section of Angaraland, *Rufloria* has disappeared within the middle of the Leninsky suite, which is the lowermost subdivision of the thick Erunakovsky Series (the youngest Late Paleozoic coal-bearing level). Thus according to paleobotanical data, the Khalpirsky Horizon cannot belong to the latest Permian.

To contradict this opinion there is another point of view that the presence of *Rufloria* at the upper part of the Khalpirsky Horizon is due to a distribution at this level in basinal (marine) facies. Budnikov (Budnikov *et al*., 2002), who expressed this opinion, takes into consideration the Kuznetsk Basin situation, where localities of Late Permian *Rufloria* are connected with thin coal-bearing (basinal) deposits and these types of leaves are not found in coarser sediments where leaves of *Cordaites* predominate. Among them, small leaves with specific sulcial venation have appeared and are widely distributed. The amount of sulcial *Cordaites* increased above the mentioned level of the *Rufloria* disappearance. S.V. Meyen (1966) regarded this youngest Cordaitean association of Angaraland as a separate (sulcial *Cordaites*) assemblage. The assemblage has been recognized all over this great palaeofloristic area. In addition to the Kuznetsk Basin, it is also known in different parts of the Tunguska Basin, Taimyr Peninsula, and North and South Mongolia. A very similar Late Permian Cordaitean assemblage is recognizable in the uppermost parts of the Permian in all of these regions. It is very important to mention that there are some uppermost Permian stratigraphic subdivisions that consist of near-shore marine (the Chernojarsky Horizon of Central Taymir) or basin coal-bearing deposits (coal-bearing measure of the South Mongolian Jaman-Us section). Nevertheless, *Rufloria* is absent from these areas. Thus it is possible to conclude that the idea of the constant association of *Rufloria* leaves with coal-bearing and other basin facies over all of the Late Permian is not supported. At the Kuznetsk Basin, this association occurs only below the level of the *Rufloria* disappearance. All data discussed above show that it is impossible to explain the presence of *Rufloria* in the upper part of the Khalpirsky Horizon by the facies type. It is clear that this situation demonstrates an absence of uppermost Permian strata in the reference Baraja section.

The author came to the same conclusion earlier (Durante and Biterman, 1978) when the composition and age of floristic assemblages within the upper parts of Permian sections all over the Verkhoyan Ridge were analyzed. The results of this analysis were that the age of the regarded assemblages were either uncertain or the same as the Khalpirsky Horizon plant assemblage. Later S.V. Meyen determined a younger sulcial Cordaites association at two localities (Undjulun and Lepiske Rivers) near the south-eastern border of the Verkhoyan Ridge. These findings support the existence of a gap between the Permian and Triassic over the greater part of the ridge. On the other hand, they show that the absence of the youngest Cordaitean assemblage within the upper parts of the Verkhoyan Permian sections is impossible to explain by the facies type. All data above show that it is difficult to imagine the presence of Changhsingian correlatives, not only at the Baraja River reference section, but also all along the region (see Figure 1).

To estimate the Permian-Triassic gap duration, it is possible to take into consideration Upper Permian Cordaitean assemblages of the eastern part of the Russian plate (Bashkirian area, A.V.

Correlation of Upper Permian plant-bearing Kuznetsk Basin deposits with near-shore and marine measures of North-East Asia

Modernized East-European Scale: System	Division	Stage	Kuznetsk basin: Series	Subseries	Suite	Plant assemblages	Different parts of the Verkhoyan Ridge — Northern part, Region between Omoloy and Lena Rivers: Suite	Subsuite	Northern part	Western part; Basins of Undulung, Kundudey, Djanyshka Rivers: Suite	Western part	Eastern Part, Baraja River basin: Series	Suite	Marine fauna assemblages	Plant assemblages	Omolon massif: Horison	Marine fauna assemblages
Triassic	Lower		Maltsevo			Tomiostrobus, ferns			Otoceras boreale, Khonomakidium, Katasiopteris		Triassic pelecipods Elatocladus sp.			Triassic pelecipods			
Permian	Tatarian	Vjatka	Kolchugino	Erunakovo	Tailugan	Cordaites with sulcial venation					?						
					Gramotei						Cordaites clercii						
					Lenino						?					?	?
		Severnaja Dvina		Iljino	Uskat	Small leaves of Cordaites and Rufloria	Dulgalakh		Phyllotheca turnaensis, Annularia jerunakovensis, cf. Tychtopteris (?) sp., Rufloria aff. delicata, Cordaites ex gr. gracilentus, C. sp. nov., Tungussocarpus tychtensis, Cancrinelloides obrutschevi, Kolymia sp.	Dulgalakh	Glottophyllum aff. cuneatum, Cordaites ex gr. gracilentus, C. ex gr. minax, C. cf. clercii, C. cf. adleri, Crassinervia ex gr. tenera, Cr. pentagonata, Laxostrobus sp., Tungussocarpus spp., Paracalamites ex gr. communis,	Dulgalakh	Khalpir	Myonia bicarinata, Intomodesma ex gr. costatum	Rufloria brevifolia, Cordaites gracilentus	Khivach	Stepanoviella paracurvata - Intomodesma costatum Maitaia tenkensis
	Biarmian	Urzhum			Kazankovo-Markino								Amkand	Cancrinelloides obrutschevi		Gizhiga	Cancrinelloides curvatus
													Mol				Cancrinelloides obrutschevi
		Kazan		Kuznetsk	Mitino		Sjuren	Upper	Rufloria ex gr. brevifolia, Cordaites cf. gracilentus	Delenzha	Rufloria sp., Cordaites cf. gracilentus, Cordaites sp.	Delenzha	Nenjunga	Olgerdia zavodovskyi	Rufloria brevifolia	Omolon	Magadania bajkurica
					Staro-kuznetsk			Lower	Paracalamites sp., Sphenopteris ex gr. tunguscana, Rufloria ex gr. derzavinii, Cordaites ex gr. singularis		Salairia sp., Rufloria ex gr. derzavinii, Cordaites ex gr. latifolius, C. ex gr. singularis, Samaropsis kemeroviensis, Sylvella sp.		Mugochan	Sverdrupites harkeri, Daubichites goohi			Terrakea korcodonensis, Terrakea borealis, Omolonia snjatkovi Sverdrupites Mongolosia russiensis
				Usa layers													

Gomankov oral communication). As mentioned above these assemblages are of Angaran outline and the level of *Rufloria* disappearance may be recognized here. According to Esaulova (1998) this level coincides with the base of the Upper Tatarian substage, which is regarded now at the base of the Tatarian division (Interdepartment Stratigraphical Committee Decision, 2005). Gomankov showed that *Rufloria* crossed the Tatarian division basal boundary and was distributed within the lower half of the Severodvinsky (Vyshkilsky according to Gomankov) stage. As to the *Rufloria* disappearance level, Gomankov supposed that it possibly coincides with the boundary between the Severodvinsky and Vjatsky stages. Thus the Vjatsky age may be regarded as the possible time for the sulcial Cordaites assemblage existence. In other words the duration of the Permian-Triassic gap at Verkhoyan Ridge has been estimated as close to the duration of the Vjatkian.

According to paleomagnetic data (Burov *et al.*, 1996; Molostovsky, 2004), the stratigraphic extent of the Vjatsky Stage is nearly equal to that of the Changhsingian. The idea concerning the presence of the Changhsingian along the Verkhoyan Ridge is not corroborated by the paleoflora, nor by paleomagnetic data.

It is not currently clear how widely the conclusion about the Permian-Triassic gap may be distributed around northeast Asia. As to the Omolon Massif, where the reference marine section for the eastern Boreal area stratotype is located, the above-mentioned 'Changhsingian' zone *Stepanoviella paracurvata - Intomodesma costatum* has been recognized here by Bjakov. This zone includes the uppermost part of the Khivach Horizon - the youngest one in the Omolon Massif Permian. Taking into consideration Bjakov's opinion about the identity of upper parts of Khalpirsky and Khivach Horizons, the author (Durante, 2005) came to the conclusion regarding the absence of uppermost Permian strata along the Omolon Massif. On the other hand, it is necessary to pay attention to the great diversity of the Khivach Horizon marine fauna, which may suggest that the stratigraphic extent of the *Stepanoviella paracurvata – Intomodesma costatum* Zone along the Omolon Massif is greater then the same zone along the Verkhoyan Ridge. This explains why it is possible to imagine that there are younger strata in the Omolon Massif as compared with the Khalpirsky Horizon. Unfortunately it is impossible to determine an age for these probable youngest Permian deposits of the Omolon Massif because of the big difference between boreal and tropical biota and an absence of common index fossils that could form the basis for correlation.

Conclusion

The situation described above shows the difficulties of using the new standard Permian scale that is based on tropical marine index fossils including ñonodonts, ammonoids, and fusulinids into the Boreal area where brachiopod-pelecypod associations predominate, and where conodonts and fusulinids are absent and ammonoid findings are rare. There is an opinion that the problem of the standard Permian scale distribution can be solved because of the great diversity of the tropical fauna, permitting the use for correlation not only of the index fossil groups, but also by other invertebrate groups. Nevertheless the above data do not support this opinion. As mentioned earlier, the Changhsingian age determination of the Verkhoyan Ridge Khalpirsky Horizon is based on the presence of rare pelecypod taxa, which have been determined as Changhsingian (Bjakov *et al.*, 2002) in the boreal endemic zonal assemblage. This conclusion contradicts paleobotanical and paleomagnetic data, which are impossible to refute. As to the determination of the Changhsingian pelecypod genera in the central part of the Boreal area, their presence may be explained with parallelism - the biological phenomenon that demonstrates an appearance of analogous morphological forms within different evolutionary lines. Thus some Boreal and Tethyan pelecypods, regarded as belonging to the same taxa, may be only similar, but not related.

There is also another way to explain a different age for the same taxon within the Boreal and Tethys areas. It may be the result of migration from north to south. In both above-mentioned cases the presence of the same taxon within different phytogeographical areas cannot be used as evidence for the same age of deposits containing this genus. Difficulties with recognizing the Changhsingian in the Boreal area show that the new Permian scale version cannot be regarded as the world standard. Because of the difference between boreal and tropical marine faunas, only division boundaries can be recognized globally. Stage boundaries of the new scale cannot be found in the Boreal area. This is the reason why the Russian Interdepartmental Stratigraphic Committee recommended (Decision…, 2005) to use only subdivisions of the modernized East-European Upper Permian scale (see the above table) for the Russian part of the Boreal area. Thus it is clear that the Permian Standard Scale cannot now be used for rather detailed global correlation and its revision requires a great deal more new investigations.

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Editors Note: This article required considerable editing and I hope that I have retained the original views of the author. It is important to note that the Subcommission on Permian Stratigraphy is primarily charged by ICS with constructing a global standard marine time scale. No scale can be truly global without some problems arising and this is especially the case in the Permian. Difficulties arise when trying to correlate the marine scale with terrestrial deposits as well as across strong provincial boundaries. It is hoped that the detailed work around each of the stage boundaries on a variety of fossil groups as well as studies of paleomagnetism, stable isotope geochemistry and geochronology will provide some means of making correlations into boreal and terrestrial settings possible. The ultimate goal of this work is not to dismiss regional scales, but rather to provide a standard against which these can be compared in order to facilitate communication and achieve better understanding of the timing of various events that control Permian deposits around the world. Therefore, as responsible geoscientists, we need to <u>try</u> to add the global stages to our regional charts. New investigations that support this endeavour will make valuable contributions to Permian stratigraphic correlations. I challenge, or perhaps plead is a better word, Marina Durante and other Permian workers to include the Standard Global Time Scale as part of all of our stratigraphic diagrams alongside the regional stages.
Charles M. Henderson, SPS Chairman.

Discovery of the Latest Permian Gondolellid Conodonts from the Microbialites across the Permian-Triassic Boundary in the Tudiya Section, Chongqing, South China and its Implications

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The microbialites across the Permian-Triassic boundary (PTB) have been reported from almost all over the world, such as southern Alps, southwest Turkey, southern Armenia, central and north Iran, northern Oman (Baud *et al*., 2005a, 2005b), western United States (Schubert *et al*., 1992), Mexico (Bush, 1984), Poland (Peryt, 1975), Transcaucasia (Rostovtsev *et al*., 1973), Japan (Sano et al., 1997) and many places in South China (Kershaw *et al*., 1999, 2002; Lehrmann, 1999; Lehrmann *et al*., 2001, 2003; Ezaki *et al*., 2003; Fang, 2004; Wang *et al*., 2005; Liu *et al*., 2006). The microbialites across the PTB interval are called herein "the PTB microbialites" for short because of their special horizon and worldwide distribution. All the PTB microbialites discovered up to now are considered to be Early Triassic in age, or after the PTB event based on the occurrence of the conodont *Hindeodus parvus* within them (Kershaw *et al*., 2002; Lehrmann *et al*., 2003; Fang, 2004; Wang *et al*., 2005). However, latest Permian gondolellid conodonts have never been reported from the PTB microbialites, therefore, the precise geological time extent of the PTB microbialites has not been determined.

Microbialites can be regarded as products of interactions between benthic microbial communities and environments (Fang, 2004). Riding (1991, 2000, 2005) proposed that microbialites mainly included stromatolites, thrombolites, dendrolites, travertine, leiolites and cryptic microbial carbonates. The PTB microbialites in South China, mainly distributed on the top of Changhsingian reef facies or shallow carbonate platforms, are composed mostly of coarse crystal digitate and micrite carbonate, locally thrombolitic and contain primarily microfossils that are quite different from Permian macrofossils (Kershaw *et al*, 1999; Lehrmann *et al*, 2003; Wang *et al*, 2005). The globally abrupt appearance of the PTB microbialites on shallow marine platforms during the Permian-Triassic transition imply that the PTB microbialites contain much more important ecological information regarding the ancient marine environment associated with the end-Permian mass extinction, than do deep water facies.

The Tudiya section is located at latitude 29°532 34.1"N, and longitude 106°302 53.5"E, about 50 km northwest of Chongqing city and 250 m northeast of the Laolongdong section, both sections are well known as the prime sites for Permian reef study in South China, where the Upper Changhsingian reef complexes rank among the youngest known Paleozoic reefs of the world (Qiang *et al*., 1985; Reinhardt, 1988; Fan *et al*., 1996; Wignall *et al*., 1996). The two sections, at the southern end of the Guanyinxia anticline, are located within the Huayingshan Mountains near the southeastern margin of Sichuan Basin, which is the most important tectonic unit of the western Yangtze Platform. Both sections exhibit rare outcrops of latest Permian and earliest Triassic strata. The mapped sedimentary sequence includes fossiliferous Upper Permian reef limestone of the Changxing Formation, the PTB microbialites and Lower Triassic shale with limestone intercalations of the Feixianguan Formation. In Tudiya section, the PTB microbialites, 1.9 m in thickness, directly overlying the top of the reef complex of the Changxing Formation, were considered to be Early Triassic in age based on the occurrence of *Hindeodus parvus* in the upper part of the microbialites (Kershaw *et al*., 2002).

However, new progress has been made by restudy of the conodont biostratigraphy of the Tudiya section, the latest Permian gondolellid conodonts including *Clarkina yini* and *Clarkina deflecta* are discovered from the base of the PTB microbialites in this section, which reveals that the PTB microbialites in the Tudiya section should be latest Permian to earliest Triassic rather than Early Triassic in age, and it began to grow before the abrupt extinction event at 251.4 million years ago within the *Clarkina*

Figure 1. Outcrop of the PTB microbialites of the Tudiya section in Chongqing, South China

yini Zone. The appearance of the PTB microbialites in the Tudiya section coincides with the disappearance of the Changhsingian reef complexes, together with the extinction of a range of sensitive and stenotropic fauna, including calcisponges, fusulinids and many Permian brachiopods. The same conditions have been detected in many other shallow-marine PTB sections in South China, such as the Laolongdong section in Chongqing, the Gendan and Tanluzhai sections in Ziyun, the Heping section in Luodian, Guizhou Province and the Taiping section in Pingguo, Guangxi Province, as well as the PTB sections in Japan, Iran, Turkey *etc*. (Wu *et al*., 2007; Lehrmann *et al*., 2003; Wang *et al*., 2005; Baud *et al*., 2005a, 2005b). The similar biotic decline characterized by the extinction of corals, most fusulinids, ammonoids, radiolarians and many Permian brachiopods has been detected at the top of bed 24d, or the base of bed 24e at Meishan and its equivalents throughout the Tethys (Yin *et al*., 2007; Fang *et al*., 2004), coincident with the end-Permian sequence boundary (Zhang *et al*., 1997) caused by a worldwide marine regression. In addition to the sea-level fall and biotic decline, there are molecular and isotopic changes that reflect environmental stress and microbial community development (Yin *et al*., 2007; Xie *et al*., 2005, 2007). All the above evidence strongly support that there is a biotic crisis earlier than that of the main extinction in bed 25 at Meishan, indicating the existence of the first episode (Prelude) besides the Second episode (Major episode) and the Third episode, the last episode (Epilogue) of the PTB mass extinction (Yin *et al*., 2007; Fang *et al*., 2004).

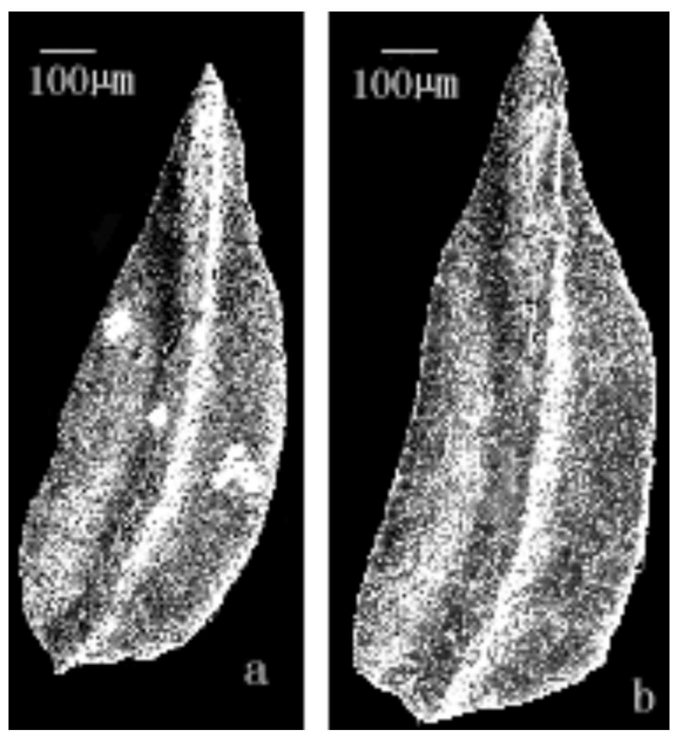

Figure 2. Showing the latest Permian gondolellid conodont pictures, a: *Clarkina yini*; b: *Clarkina deflecta*. Both are from the base of the PTB microbialites of the Tudiya section

The abrupt disappearance of the Changhsingian metazoan reefs and the nearly synchronous appearance of the PTB microbialites in the Tudiya section mark the beginning of the prelude of the end-Permian mass extinction, which happened prior to the major episode in bed 25 at Meishan, and coincided with the most significant regression in the Phanerozoic, but the causal links between them have not been confirmed despite the fact that the patterns and mechanisms of the PTB mass extinction, the most severe biotic crisis during the Phanerozoic, are extensively reported and discussed (Yin *et al*., 2007; Erwin, 2006; Rong and Fang, 2004; Jin *et al*., 2000; Yang *et al*., 1991, 1993; *etc*.). Therefore, further studies on this subject are badly needed.

Keywords: microbialites, conodonts, mass extinction, Permian-Triassic boundary (PTB), Tudiya section, Chongqing, South China

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Discussion on Sea-level Changes at the Permian-Triassic Transition in Huaying Area, Chongqing, South China with Implications for the End-Permian Mass Extinction

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There are two opposite viewpoints about sea-level changes at the Permian-Triassic transition (Fang, 2004). The traditional one is that a great worldwide regression took place at the end of the Middle Permian, and ended by terminal Permian, followed by renewed transgression in earliest Triassic. The end-Permian regression was supposed to be the main cause responsible for the mass extinction (e.g., Hallam, 1989; Dickins, 1992; Erwin, 1993). The other viewpoint is that the end-Permian regression stopped tens of centimetres or several metres below the Permian-Triassic boundary (PTB), and was followed by a phase of rapid transgression (*e.g.*, Wu *et al*., 1993; Wignall *et al*., 1996) beginning in the latest Permian.

A good example to consider these viewpoints is from the Huaying area, Chongqing, South China. This area, namely Huayingshan Mountains, is located at the southeastern margin of Sichuan Basin, which is the most important tectonic unit of the western Yangtze Platform. Here the microbialites across the Permian-Triassic boundary, generally 1 or 2 metres in thickness, are developed at the interval between the underlying Changhsingian reef complexes and the overlying Feixianguan Formation. The abrupt disappearance of the Changhsingian metazoan reefs and the nearly synchronous appearance of the PTB microbialites in this area are largely ascribed to paleoenvironmental changes (regression and exposure) within an arid climate zone (hypersalinity) (Reinhardt, 1988). On the contrary, some authors (Fan *et al*., 1990; Wignall and Hallam, 1996; Kershaw *et al*., 2002; Fang, 2004) consider that the PTB microbialites were deposited under water with anoxia associated with rising sea-level and not, as previously claimed, with an episode of emergence and karstification caused by regression.

However, Wu *et al*. (2006) reported the presence of the erosional surfaces at both the base and top of the PTB microbialites in the Laolongdong section. Reinhardt (1988) and the present authors observed the same conditions in the nearby Tudiya section in this area. The erosional surfaces are regarded to be the product of a fluctuating water depth within an inter-supratidal environment, which shows evidence for sea-level fall caused by a worldwide end-Permian regression, coincident with the PTB mass extinction.

The PTB microbialites in China and those from elsewhere in the Tethys were considered to be Early Triassic age based on the presence of the conodont *Hindeodus parvus* (*e.g.*, Kershaw *et al*., 2002; Lehrmann *et al*., 2003). The present authors discovered latest Permian gondolellid conodonts including *Clarkina yini* and *Clarkina deflecta* from the base of the PTB microbialites in the Tudiya section of this area, indicating that the PTB microbialites in this section should be latest Permian to earliest Triassic age (Qi *et al*., 2007, this issue). Therefore, the sea-level and facies changes at the Permian-Triassic transition in this area are of fundamental importance to understanding the cause of the mass extinction.

The precise age determination of the PTB microbialites and the confirmation of the presence of the erosional surfaces at both the base and top of the PTB microbialites in the Huaying area shows that the sea-level had no distinct change after the end-Permian regression, and maintained a low level during the Permian-Triassic transition, followed by a new transgression in Early

Triassic. Therefore, the oceanic anoxic event, related to the deposition of the PTB microbialites, is not associated with sea-level rise caused by a rapid transgression, but is postulated to be linked with other catastrophic events (methane hydrate release, oceanic overturn and spread of anoxic waters, sluggish oceanic circulation, surplus of primary production and organic matter and reduced sediments prevailed, *etc*.) caused by the Siberian flood basalt eruptions and global mass volcanism across the Permian-Triassic transition (Fang, 2004). The great end-Permian regression is possible, but is neither an adequate nor a necessary explanation for mechanisms of the end-Permian mass extinction.

Keywords: sea-level change, microbialites, Permian-Triassic boundary (PTB), end-Permian mass extinction, Huaying area, Chongqing, South China

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Abstracts on Permian GSSP definitions from Session 3 Chaired by Charles M. Henderson and Barry C. Richards: Stratotypes, Boundaries, and Global Correlations. XVI International Congress on the Carboniferous and Permian, Nanjing, China, June 21-24, 2007.

All of the abstracts from this meeting are available in the Journal of Stratigraphy, vol. 31, Supplement I, June 2007 (edited by Wang Yue et al., 2007).

The Cisuralian (Lower Permian) time-scale: progress report

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The following activity has been performed since last report of Cisuralian Working Group (Chuvashov, 2004). The first priority for the Permian stratigraphy is a completion the GSSP process by ratifying proposals for the Cisuralian stages. The Cisuralian field workshop in the Urals will be going immediately after XVI ICCP at Nanjing in late June 2007. Three sections in southern Urals that are proposed as potential GSSPs to establish the base of Sakmarian, Artinskian and Kungurian Stages (respectively Kondurovsky, Dal'ny Tulkas and Mechetlino sections) will be visited and thoroughly examined. Conodont faunas from these and other key sections in the Urals have been studied and recently published with many new and well-know species described and figured (Chernykh, 2005, 2006). More studies on conodont and ammonoid faunas from Kondurovsky section (Schiappa and Wardlaw) and fusulinid faunas from all above- mentioned sections (Chuvashov and Davydov) are in a progress. Radiometric calibration of the Cisuralian is an important task that is consistently worked out at Permian Research Institute, Boise State University. Precise radiometric age of 298.90+0.31/"0.15 Ma (2ó) for the Carboniferous-Permian boundary has been established (Ramezani et al., 2007). Several other ages from Pennsylvanian and Cisuralian were obtained recently (see abstract of Schmitz et al., in this volume). A study of conodont radiogenic strontium also has been performed for the Usolka Section (Needham et al., 2006). This study provided for the first time the consistent trend in strontium distribution with errors less than 0.5 %. We are envisioning a study of ä^{18}O isotopes from conodonts for the entire Cisuralian as well. In 2006, our colleagues from Nanjing Institute of Geology and Paleontology collected a set of whole rock samples for stable isotopic study from Dal'ny Tulkas and Mechetlino Sections. Most of the data for the potential GSSPs are available to the public through an internet accessible database www.paleostrat.org (see abstract of Snyder et al. in this volume).

Characterization of the type Guadalupian and its component stage GSSPs, international reference for the Middle Permian Series

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The Subcommission on Permian Stratigraphy formally accepted the Guadalupian Series and its component Roadian, Wordian and Capitanian stages in 1999, which was subsequently ratified by the International Union of Geological Sciences in 2000. Proposal of the Guadalupian as a chronostratigraphic unit predates any potential competitors by decades, as do the upper two stages. Although the Kubergandian has priority as a named stage, the Roadian reference "black, thin bedded-limestone" (=Cutoff Formation) forms the base of the original Guadalupian Series. These rocks and the GSSPs are characterized by 100% exposure in an arid-climate national park, where access is guaranteed to international specialists with valid research proposals. The basal Guadalupian Series and concurrent Roadian Stage GSSP is defined within the transitional paedomorphocline from *Mesogondolella lamberti* to *Jinogondolella nankingensis*. The basal Wordian Stage GSSP is similarly defined on the morphocline from *J. nankingensis* to *J. aserrata*, as is the basal Capitanian Stage GSSP on the morphocline from *J. aserrata* to *J. postserrata*. These conodont-defined boundaries do not coincide precisely with the traditional boundaries based on ammonoid zones, nor should that be expected. Nevertheless, ammonoids and fusulinaceans can still be used largely in the traditional sense to characterize these stages. The uppermost type Guadalupian maintains an excellent marine record up to the zone of *Clarkina postbitteri hongshuiensis*, whose transition to *Clarkina postbitteri postbitteri* defines the overlying basal Lopingian GSSP in South China.

Definition and correlation of the Lopingian (Upper Permian) Global Stratotype Sections and Points

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The GSSP for the base of the Wuchiapingian Stage (base Lopingian) is defined at the base of Bed 6k at the Penglaitan Section in South China on the basis of the first appearance of the conodont *Clarkina postbitteri postbitteri* (Jin et al., 2006a). The evolution of the genus and early species of *Clarkina* are best seen in the lowstand successions in the Delaware Basin of West Texas and the Jiangnan Basin in South China. In many regions, a profound unconformity separates the Guadalupian and Lopingian and in those localities, the first appearance of *Clarkina* may allow correlation of the Lopingian. The boundary also nearly coincides with the extinction of verbeekinids and the dominance of the fusulinaceans *Codonofusiella* and *Reichelina*. The GSSP for the base of the Changhsingian Stage is defined at the base of bed 4a-2 at the Meishan Section D in South China on the basis of the first appearance of the conodont *Clarkina wangi* (Jin et al., 2006b). The evolution of *Clarkina longicuspidata* to *C. wangi* is a gradual process, but the point is chosen by using a population concept and looking at the entire growth series. The appearance of the fusulinacean *Palaeofusulina* is nearly coincident with the boundary, which has been dated at about 254 Ma. Profound provincialism restricts the distribution of all of these key taxa throughout most of the Lopingian meaning that correlation requires other techniques like carbon isotopic shifts and magnetic reversals. The top of the Changhsingian (base Triassic) is also defined at the Meishan D section, making this interval a body stratotype for the Changhsingian Stage.

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IN MEMORIAL

Academician Professor Sheng Jinzhang (1921-2007)

In Memoriam: Sheng Jinzhang (J. C. Sheng) (1921–2007)

Qun Yang
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Professor Sheng Jinzhang, a world famous micropaleontologist and biostratigrapher, the 1996 recipient of the Joseph A. Cushman Award, former Chairman of the Subcommission on Permian Stratigraphy, Member of the Chinese Academy of Sciences, and a senior professor of Nanjing Institute of Geology and Palaeontology, passed away peacefully in a hospital near his home in Nanjing on January 7, 2007. He was in his 86th year.

Professor Sheng was born to an ordinary family in the countryside of Jingjiang County, Jiangsu Province, on the lower reach of the Yangtze River on May 15, 1921. He graduated from the Department of Geology, Chungking University in 1946 and started his research career at the Geological Survey of China in Nanjing when the city was the capital of China. Since 1949, he had been conducting research and research supervision at Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, where he served as the Head of the Technical Department and the Head of the Department of Upper Palaeozoic Studies. He was the founding editor of the journal Acta Micropalaeontologica Sinica published by the institute together with the Micropalaeontological Society of China and served as the Editor-in-Chief from 1984 to 1997. For a long period of time, Professor Sheng served on the Council of the Palaeontological Society of China and on the Executive Council of the Micropalaeontological Society of China. Professor Sheng also served as Vice President (1981-1987) and then President (1987-1996) of Jiangsu Palaeontological Society based in Nanjing. He was elected to the Chinese Academy of Sciences in 1991 in recognition of his outstanding contributions in paleontology and stratigraphy.

Professor Sheng is well-known for his high-standard scientific integrity and being widely knowledgeable in his research areas. He was a diligent researcher and a great educator. His works on fusulinid foraminifers and Permian biostratigraphy were widely cited, including eight monographs and over 60 research papers published during his research career. A small sample of Professor Sheng's widely cited publications would include: Fusulinids from the Penchi Series of the Taitzeho Valley, Liaoning (1958), The Permian System in China (1962), Fusulinids in China (1962), Permian fusulinids from Kuangsi, Kueichou and Szechuan (1963), Radiolarian fauna from the Jilong Gourp, Mt. Qomolangma region (1976), The Changhsingian Stage and the Permo-Triassic Boundary in South China (1980), The Fusulinida (1985), Carboniferous-Permian boundary beds and fusulinid zones at Xiaodushan, Guangnan, Yunnan (1987), Taxonomic Principles of Fusulinids - a Restudy on Pemian Staffellids (1994), and Correlation of Permian Deposits in China (1994).

Many of his research achievements were recognized by the Chinese government with great honours, including the National Natural Science Awards (1956, 1982, 1987, 2003) for his outstanding contributions in systematic studies on fusulinid foraminifers and in Carboniferous and Permian biostratigraphy.

During the early years of his career, Professor Sheng participated in the exploration of coal geology in the region of North China and southern northeast China. Since 1956, Professor Sheng's primary research focus had been on fusulinid paleontology and marine Permian biostratigraphy; his contributions to these subjects were instrumental for the subdivision and correlation of Permian carbonate sediments in the provinces of Southwest China and which laid down a solid foundation for the establishment of the regional stratigraphic series and stages of the Permian System in China, later proven so important for the international Permian chronostratigraphy. Professor Sheng pioneered in the studies of Upper Permian fusulinids, which were critical to the establishment of Upper Permian chronostratigraphic subdivision. Such research also proved significant in the exploration of Late Permian coal-bearing deposits in South China. During 1980's, Professor Sheng organized an international research team to investigate the Upper Permian "Changhsing Stage" and the marine Permo-Triassic boundary and concluded that the Changhsingian sediments were the youngest Permian strata in the world and the Changhsingian *Palaeofusilina* Zone is the highest Permian biozone. These studies

Professor Sheng (2nd to the right) and colleagues at the type locality of the Changhsinggian Stage, Meishan, Zhejiang Province in 1982

have led to the adoption of the Changhsingian Stage in the international geological timescale.

Professor Sheng contributed greatly to the training of local geologists and teachers of vocational colleges by compiling text-books, including The Fusulinida (1959), The Fusulinids in China (1962) and the Permian System in China (1962), and by teaching short courses in universities, colleges and professional societies. He also trained numerous professional visitors from local geological surveys and energy production companies throughout China, many of whom became Professor Sheng's lifetime friends and collaborators. The spreading of this professional knowledge in fusulinids and fusulinid biostratigraphy was very instrumental to the geological mapping and coalmine exploration throughout China during the 1950's and 1960's.

Professor Sheng pioneered in fossil radiolarian studies in China, when the multidisciplinary expeditions of the Tibetan Himalayan region organized by the Chinese Academy of Sciences produced numerous chert and micritic limestone samples during late 1960's and early 1970's, especially those from the suture zone between the Indian subcontinent and the Eurasian plates. Identification of the fossils and determination of ages for those samples were critical to the understanding of the regional geology. Professor Sheng led the experimental work under the environment of that time when the external communications were effectively blocked for the "Cultural Revolution". Professor Sheng's decision to start fossil radiolarian studies proved that he had good visions for the future development in science.

Professor Sheng communicated and collaborated widely with the international academic communities, including many colleagues from Russia, Japan and the United States. In the 1980's, he organized an international research team working on the Permian of South China. He chaired the Subcommission on Permian Stratigraphy during the period of 1984-1989 and served as a titular member of the Subcommission on Triassic Stratigraphy. He participated and organized numerous international conferences, including the International Geological Congress (1984, Moscow, Russia), Benthos'90 (Sendai, Japan), and the International Symposium on Permian Geology and Resources (1994, Guiyang, China).

To a great many of us, Professor Sheng was an outstanding scientist, a great teacher and a friend. Even during his last years, he was always enthusiastic about any development in our research field. He would provide opinions, advice and support to the administration or colleagues whenever requested. He would also be ready to help the younger generations in organizing research projects or on a specific research subject. The passing of Professor Sheng is a great loss to all of us and to our profession that he contributed to and cared so much about during his lifetime.

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ANNOUNCEMENTS

SPS Working Group: Neotethys, Paleotethys, and South China Correlations

Purpose

As directed by the SPS Chair, Charles Henderson (Note: this working group has been inactive and I have asked Lucia Angiolini and Yue Wang to serve as the new working group co-chairs):

To investigate the problems in the correlation of the Permian successions of the Paleotethys, Neotethys and South China, problems which are associated with bioprovinciality and taxonomy. The working group will work on Permian correlation problems, but with special focus to the Cisuralian and Guadalupian. The working group will focus on the successions characterized by the co-occurrence of fusulinids and conodonts, as well as other fossil groups, and to investigate in detail the correlation problems. The working group will establish (at least intrabasinal) a correlation through the application of graphic correlation.

Composition of the working group

This working group will be co-chaired by Lucia Angiolini and Yue Wang.

Suggested members

There are many possible members as indicated in Permophiles 44, but we would like this rejuvenated working group to be truly multidisciplinary in scope and this means it should include people working on geochemistry, sedimentology, and geochronology *etc*. as well as biostratigraphy of key fossil groups. Vladimir Davydov, Heinz Kozur, Alda Nicora and Charles Henderson have already agreed to be on this group. Anyone interested please contact the SPS Secretary. The co-chairs will be inviting others to join the working group over the coming months and an announcement of the working group members will appear in Permophiles 50.

Opening statement

An opening statement for the original working group was proposed by H. Kozur (2004, Permophiles 44, p. 19). In this statement, Kozur focused on the problems of correlation of conodont faunas of open sea with those from intraplatform basins in the Guadalupian and even more in the Lopingian. As examples of problematic correlations he quoted the "fossil localities" of Rupe del Passo di Burgio (Sicily), Rustaq and Wadi Wasit (Oman) and Kuh-e-Ali Bashi (NW Iran). Kozur (2004) indicated the endemism of conodonts and ammonoids as the main cause of the difficulties in correlation and suggested to use other fossil groups such as fusulinids and radiolarians, starting from the South China sections.

Despite the fact that some of these correlation problems may also be caused by different taxonomic approaches, the best way to try to find a possible solution or a plausible interpretation is starting from the base, *i.e*. with the rocks themselves, providing detailed description of bed-by-bed sampled stratigraphic sections and limit the use of "fossil localities" (such as Rupe del Passo di Burgio) for subsequent times, when details are more clear. When detailed logs and fossil contents are made available from (and for) the components of the Working Group, taxonomic problems may be faced by specialists of each fossil group and finally correlation may be discussed, using all the available taxa, keeping in mind the importance of brachiopods, conodonts, fusulinids and ammonoids as current and historical tools for Permian correlation. The use of graphic correlation may facilitate the correlation of selected logs both in the preliminary phase of intrabasinal study and in the last steps of wider Tethyan correlation.

The working group should start examining data from Neotethyan and Paleotethyan settings, starting from South China and moving westward to SE Pamir, Karakorum (North Pakistan), Salt Range (Pakistan), central Afghanistan, Iran, Oman, Turkey and possibly others. We would like to finally establish a consensus regarding the correlation of Tethyan stages like Kubergandinian, Murgabian, and Midian with the stages of the International Stratigraphic Time Scale of the International Commission on Stratigraphy.

With this goal in mind, Alda Nicora and I will soon make available to the members of the working group, once it is fully established, stratigraphic logs from Turkey, Oman, Iran and Karakorum with co-occurrence (even if sometimes rare and scattered) of conodonts and fusulinids as well as other fossil groups. Also, we are planning to organize some field work next year in the Alborz Mountains and at Kuh-e-Ali Bashi and we hope to be joined by other members of this rejuvenated working group.

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