Newsletter #35 December 1999
Subcommission on Permian Stratigraphy
International Commission on Stratigraphy
International Union of Geological Sciences

PERMOPHILES

Stage
251.4
Changhsingian
253.4
Wuchiapingian
Capitanian
265
Wordian
Roadian
Kungurian
Artinskian
283
Sakmarian
Asselian
290.6

Vasily Ermolaevich Ruzhencev
1899-1978

Cover Photo: Professor Vasily Ermolaevich Ruzhencev (1899 – 1978) one of the most accomplished ammonoid workers of all time, and a pioneer and major contributor in the fields of paleobiology and Late Paleozoic biostratigraphy. The recent volume in his honor marks the hundredth anniversary of his birth: “Fossil Cephalopods: Recent Advances in their Study”, A. Yu. Rozanov and A. A. Shevyrev, eds., Russian Academy of Sciences, Paleontological Institute, Moscow, 1999.

Permian time scale: Developmental stage and radiometric scale from the Chair’s report, this issue.

Contents

EXECUTIVE NOTES

Notes from the SPS Secretary

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I want to thank all who contributed articles for inclusion in the 35th issue of Permophiles and those who assisted in its preparation. We are indebted to Bruce R. Wardlaw, Brian F. Glenister, and Vladimir Davydov for editorial contributions; to Joan White for coordinating the compilation of this issue and for design of the cover page; Vladimir Davydov translated several submissions from our Russian colleagues. We thank Neil Archbold, Donald W. Boyd, Marc Durand, Laing Ferguson, H. Fontaine, Brian F. Glenister, Karl Krainer, Spencer Lucas, W. John Nelson, Norman Newell, Vincenzo Palmieri, Calvin Stevens, Gregory P. Wahlman, and Zhou Zuren for financial contribution to the Permophiles publication fund in support of this issue. Our fund is in need of additional contributions and readers are referred to the last page of this issue.

Future Issues of Permophiles

Issue 36 will be finalized by June 10, 2000 and I request that all manuscripts be sent before June 1 – but preferably much earlier. The preferred method for sending manuscripts and for other communication is by E-mail (cspinosa@boisestate.edu) or by regular mail. Glenister *et al*., (page 3, issue 34) provides a guide to correct format. References and their citation are particularly problematic and authors are requested to use the format in the above notation. Color figures can be accommodated but we require a contribution to offset the additional printing costs.

Special Permophiles Issue for 31st International Geological Congress

We intend to devote Issue 37, which follows the 31st Congress, exclusively to publishing extended abstracts of the papers presented at the SPS symposium "International Standard References for the Permian System: Cisuralian of Southern Ural Mountains, Guadalupian of Southwestern North America, Lopingian of South China".

Future SPS Meetings

The SPS will meet in conjunction with the 31st International Geological Congress in Rio de Janeiro, Brazil, August 6-17, 2000. The SPS is the sponsor of the general symposium **"**International Standard References for the Permian System: Cisuralian of Southern Ural Mountains, Guadalupian of Southwestern North America, Lopingian of South China", Tamra A. Schiappa, Bruce R. Wardlaw, and Brian F. Glenister are the conveners. The symposium consists of an afternoon poster session followed by a morning oral session of invited keynote speakers. Please refer to the report by Tamra Schiappa (this issue) or the site: http://www.31igc.org for details.

Notes from the SPS Chair

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The following time scale compilation (Fig. 1) will appear in a paper by Wardlaw and Schiappa in the synthesis volume "Proceedings of the Continental Permian Congress", edited by Prof. Cassinis. The generalized standard marine conodont zonation for the Permian of 24 zones is placed within an age framework utilizing the presently available reliable radiometric ages. The base of the Permian is currently dated as 291.6 Ma and the top as 251.4 Ma.

This is a working scale to: encourage more rigorous studies on radiometric age dating within biostratigraphically well constrained sections; further discussions of the 'standard' Permian scale; and better correlate the marine to continental and Tethyan to Boreal sections. It is printed here to invite as much constructive input as possible. We will run this scale in each upcoming issue of *Permophiles* with the discussions and modifications that it generates.

This effort is in the spirit of our newly formed SPS Working Group on Permian Transitional Biotas, to relate regional and marginal basinal zonations and biotas to the more widespread marine standards. Recently, much confusion has been generated about the acceptance of a dual standard for the Permian of Russia. The SPS promotes a single standard and better correlation to provincial areas. In this, the SPS fully supports all initiatives to better understand and further the study the Permian of any region, but especially the Volga Region.

Annual Report 1999
Subcommission on Permian Stratigraphy

Overall Objectives: To establish a reliable chronostratigraphic timescale for and subdivisions of the Permian.

Extent of National/Regional/Global Support of Projects. The SPS receives strong support from Russian, Chinese, and American governments and individuals when working on the specific Series and Stages proposed in each country. In addition, the marine-terrestrial correlation activity, especially for the Upper Permian receives strong support from European countries, specifically this year from Italy for the International Field Conference on the Continental Permian of the Southern Alps and Sardinia.

Interface with other International Projects.
IGCP Project 359: Correlation of Tethyan, Circum-Pacific and marginal Gondwanan Permo-Triassic.
The marine-terrestrial working group of the SPS is establishing a working relationship with the new working groups of the Subcommission on Gondwana Stratigraphy specifically, those under the

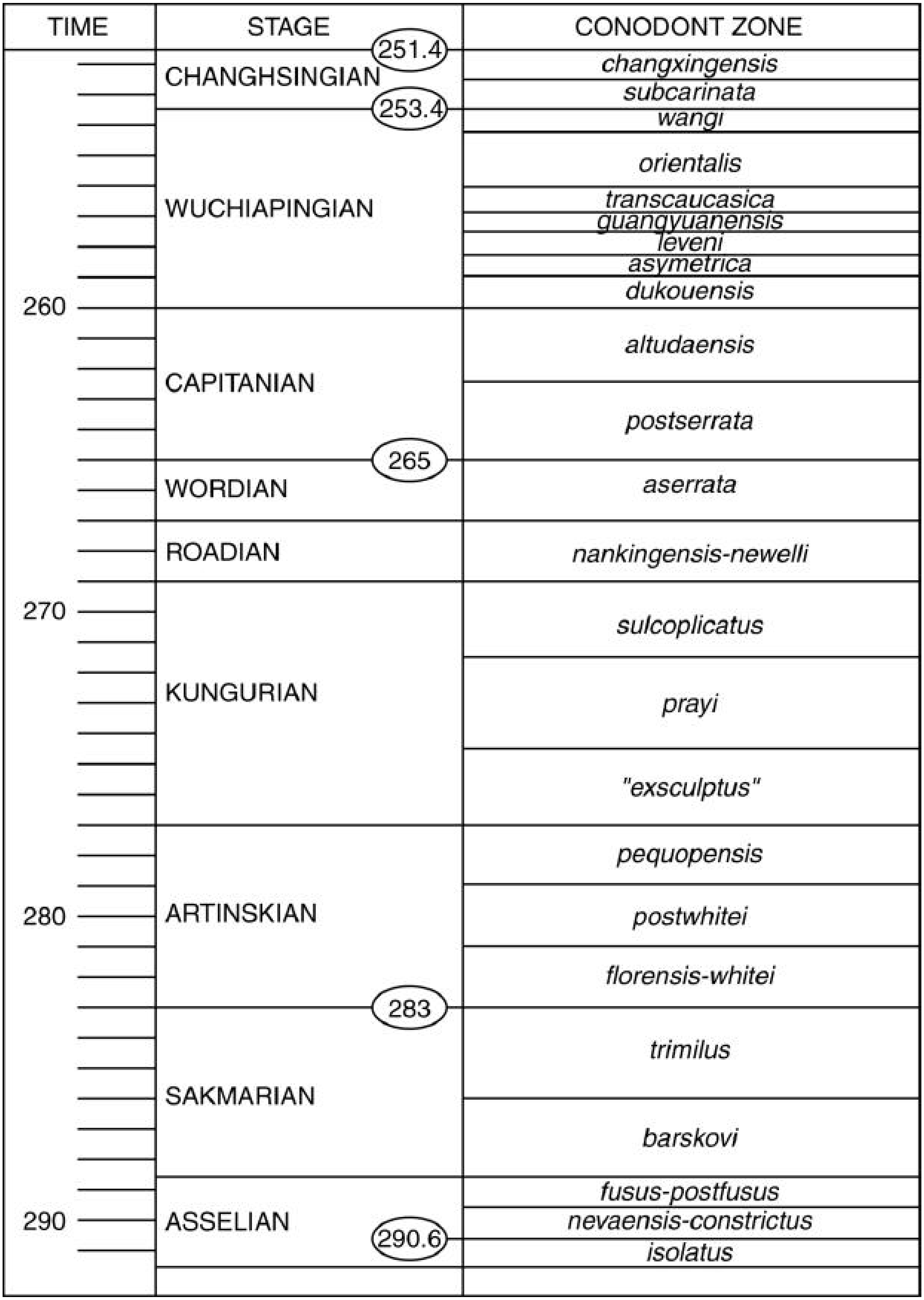

Figure 1. Chronostratigraphic Chart with age in million years before present, Permian stages, and generalized marine conodont zonation. Ages thought to be reliable are highlighted in ellipses.

umbrella of Event Stratigraphy: Floral Correlation, Faunal Correlation, and Physical Correlation with the common aim toward resolution of global correlation of late Paleozoic- early Mesozoic terrestrial and marine sequences.

Accomplishments and products generated in year of the report: Proposal of Guadalupian and component Roadian, Wordian and Capitanian Stages as International Standards for the Middle Permian Series by Glenister, B. F, Wardlaw, B. R., Lambert, L. L., Spinosa, C., Bowring, S. A., Erwin, D. H., Menning, M., and Wilde, G. L. was formally posted to all voting members [and subsequently approved].

The proposal for the base of the Lopingian Series boundary is almost ready for a postal vote and we anticipate it should be mailed out early in the new year.

Chuvashov, Chernykh, Levin, Wardlaw, Davydov, Spinosa, and Schiappa met in August and limited the possibilities and the range of research on the conodonts and fusulinids for definition of the Sakmarian and Artinskian. Additional material has either been collected already or is planned to be collected and processed so that results and preliminary drafts of proposals can be prepared before the IGC.

In June, Mei and Wardlaw worked out a conodont definition of the Changhsingian at the Meishan section which is now being evaluated and should go out for postal vote before the IGC.

In June and August, Henderson, Mei, and Wardlaw made progress in defining the evolutionary lineages of early *Neostreptognathodus* species which are the likely candidates for definition of the Kungurian. A suitable section with guaranteed access is still under consideration.

Continued Support for the Special Project "The Permian: from glaciation to global warming to mass extinction" to use detailed biostratigraphy and numerical age dates to create an initial framework for correlating and evaluating global events during the Permian. This special project will help in the development of the Permian GSSP's by providing important stratigraphic, biostratigraphic and numerical age dates to the specific Subcommission working groups.

The Subcommission successfully sponsored and participated in:

- The Carboniferous-Permian Congress in Calgary, Canada, and conducted a very successful annual business meeting.
- The International Conference on Pangea and the Paleozoic-Mesozoic Transition, Wuhan, China; and co-lead a field trip to the proposed stratotype of the Upper Permian, Lopingian, Series.
- The International Field Conference on the continental Permian of the Southern Alps and Sardinia (Italy): regional reports and general correlations in Brescia, Italy

Problems encountered in year of the Report.

There continued to be some difficulty with many of the Russian corresponding members of the Subcommission. The Kazanian and Tatarian Stages are based on allostratigraphic units, synthems, and these units as defined, will not serve as international stratotypes. Many of the Russian workers refuse to use the Guadalupian and Lopingian, already approved by the Subcommission. The Subcommission allowed that the many Russian workers are continuing to use Kazanian and Tatarian but, again, as last year, suggested that evolutionary lineages above the bounding unconformities be used to define the chronostratigraphic units and to work on the refining the definition and correlation of the these classic Permian sections.

There was a minor but important problem when a counter-proposal at the last minute for the definition of the base of the Lopingian was introduced which has held up the formal mailing of that proposal. We are accommodating both the original proposal and the counter-proposal with some new material to make a stronger and more widely applicable boundary definition.

Work Plan: 2000

- Conduct annual business meeting at IGC in Rio de Janeiro
- Convene the international symposium on the International Standard References for the Permian System: Cisuralian of Southern Ural Mountains, Guadalupian of Southwestern North America, Lopingian of South China, sponsored by the International Commission on Stratigraphy and the SPS.
- Have all stages in at least preliminary formal proposal process.

Budget: The SPS spent $32,450 for 1999.

SUBMISSION GUIDELINES FOR ISSUE 36

It is best to submit manuscripts as attachments to E-mail messages. Please send messages and manuscripts to my E-mail address followed by hard copies by regular mail. Manuscripts may also be sent to the address below on diskettes prepared with WordPerfect or Microsoft Word; printed hard copies should accompany the diskettes. Word processing files should have no personalized fonts or other code. Specific and generic names should be *italicized*. Please refer to recent issues of Permophiles (Glenister *et al*., Permophiles #34, p. 3) for reference style, format, etc. Maps and other illustrations are acceptable in tif, jpeg, eps, or bitmap format. If only hard copies are sent, these must be camera-ready, i.e., clean copies, ready for publication. Typewritten contributions may be submitted by mail as clean paper copies; these must arrive well ahead of the deadline, as they require greater processing time.

Please note that articles with names of new taxa will not be published in Permophiles. Readers are asked to refer to the rules of the ICZN.

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SUBMISSION DEADLINE FOR ISSUE 36 IS May 15, 2000.

Vote on Guadalupian and its Component Stages as International Standards for the Middle Permian

We report that the measure submitted to the voting members of the SPS by the Guadalupian Working Group "Proposal of Guadalupian and component Roadian, Wordian and Capitanian Stages as International Standards for the Middle Permian Series", known as the "Guadalupian Proposal", has received 62.5% affirmative vote, more than the necessary 60% required minimum. It will therefore be forwarded to the ICS for formal evaluation and final ratification at the next regular IUGS meeting in conjunction with the International Geological Congress in Rio de Janeiro in August 2000.

Following are reports of individual votes and tally of the vote for the Guadalupian Proposal. Thoughtful comments accompanied several of the ballots. Persons wishing access to individual reactions may contact the following authors directly (Foster, Henderson, Kato, Kotlyar, Kozur, Leven, Menning).

The original letter accompanying the ballot indicated that:

1. Ballots must be received by December to be valid,
2. Votes not cast will be counted as positive,
3. Only ballots returned, by mail or fax, will be counted.

New rules governing the votes had been in place, unknown to us, specifying that:

1. All votes must be postal votes,
2. Votes not cast would not be counted in the final tally,
3. Successful measure must attain 60% of the votes cast.

To accommodate the new rules and retain flexibility of some of the old rules, the Chair of the SPS, Bruce Wardlaw, allowed the following modifications:

1. The ballot time was extended to the end of December to accommodate delays frequently experienced with regular post from Russia and China,
2. All votes cast as e-mail, post, or fax would be considered valid. Two votes from Russia have been received only in the e-mail form but have been tallied as valid votes,
3. Votes not cast would not be counted in the final tally – as required by the new rules.

We thank all titular members of the SPS for taking the time to vote and those who included comments regarding their vote.

Bruce R. Wardlaw, SPS Chair
Brian F. Glenister, GWG Chair
Claude Spinosa, SPS Secretary

Tabular Summary of Votes for the Guadalupian Proposal

Titular Member		Vote
1	Giuseppe Cassinis	yes
2	Boris I. Chuvashov	abstain
3	Clinton B. Foster	no
4	Brian F. Glenister	yes
5	Charles Henderson	yes
6	Makoto Kato	yes
7	Galina Kotlyar	no
8	Heinz Kozur	yes
9	Ernst Ya. Leven	no
10	Manfred Menning	abstain
11	Sheng Jin-Zhang	yes
12	Claude Spinosa	yes
13	John Utting	yes
14	Jin Yugan	abstain
15	Bruce R. Wardlaw	yes
16	Liao Zhuo-Ting	yes

Totals		
Yes	10	62.5%
No and Abstain	6	37.5%

Vote on Meishan as GSSP for the Permian-Triassic Boundary

The Meishan section of Chanxing County, Zhejiang Province, South China has long been the subject of intensive study as a candidate for the Permian-Triassic boundary. A comprehensive account of the wealth of diverse paleontologic, sedimentologic, geochemical and other data was presented by an international team (Yin Hongfu, W. C. Sweet, B. F. Glenister, G. Kotlyar, H. Kozur, N. D. Newell, Z. Y. Sheng, and Y. D. Zakharov; Newsletters on Stratigraphy, v. 34, no. 2, p. 81-108). A major problem was guarantee of free access to qualified scientists. This last obstacle was removed with the report of P/T BWG Chair Yin Hongfu (Albertiana #23, 1999, p. 4) that:

"The State Council of China has approved to set Changxing County, Zhejiang Province as an open region.——An Open Region means that any foreigner with valid visa can enter this area and do research work."

With access finally assured, the vote for Meishan was submitted to Titular Members of the P/T BWG: Chair Yin Hongfu and Vice-Chair Yuri Zakharov reported by e-mail, January 21, 2000:

"On behalf of the Permian-Triassic Boundary Working Group (PTBWG), we report to you the result of the formal vote on the Global Stratotype Section and Point (GSSP) of the Permian-Triassic Boundary. This vote by correspondence was taken during the period from October 25, 1999 to January 17, 2000. The proposal was to place the GSSP at the base of Bed 27c, Section D, Meishan, Changxing County, Zhejiang Province, China, where the conodont *Hindeodus parvus* first appeared. Among the 28 Titular Members of the PTBWG, Dr. Wang Yigang could not be contacted, and to our great sorrow Professor William T. Holser died recently. Therefore only 26 voting sheets were actually delivered. Following are the results.

Unresponsive votes: 3

Responses: 23, responsive percentage 88.4%, exceeding the necessary 60% quorum

Negative responses (No): 3

Positive responses (Yes): 20, positive percentage 87.0%, exceeding the necessary quorum of support

According to the new regulation of ICS, this motion is passed by PTBWG. We now proceed to apply to STS for a formal vote on the same motion and hope it to be taken as soon as possible.

We take this occasion to mourn the recent death of William T. Holser, Professor of the University of Oregon, and Algirdas S. Dagys, Professor of the Lithuanian Academy of Sciences. Along with other responsibilities, Professor Holser was a voting member of PTBWG. His works on the geochemistry of the Permian-Triassic Boundary contributed greatly to the resolution of the boundary problem. Professor Dagys is long known as the expert on Triassic, especially the Triassic of the former USSR. His works on the Lower Permian of NE Siberia advanced our knowledge remarkably. Their thoughtful ideas and invariably helpful attitude have been stimulating to our group."

Report of the SPS Working Group: 'Using Transitional Biotas as Gateways for Global Correlation'

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With contributions from L. Angiolini, T. Grunt, G. Kotlyar, Mei Shilong, Jun-ichi Tazawa and Wang Xiangdong

Since its inception at the International Symposium on the Upper Permian Stratotypes held in Kazan in August 1998, the working group has been engaged in a range of activities. These include:

1. Recruiting international memberships:

We are pleased to advise that the following colleagues have formally joined the Group: Professor Jun-ichi Tazawa (Japan), Drs Lucia Angiolini (Italy), Mohd Shafeea Leman (Malaysia), Ernst Ya. Leven (Russia), Mei Shilong (China), Dr. Wang Xiang-dong (China), Galina Kotlyar (Russia), Tatyana Grunt (Russia), Tatyana Leonova (Russia), Prof. Natalia Essaulova (Russia), Dr. Yang Weiping (China), Drs Guang Shi (Australia), Shuzhong Shen (Australia), Prof. Neil Archbold (Australia), and Dr. John Rigby (Australia).

2. Establishment of a related working group:

A closely related working group, namely the 'Permian Research Group of SE Asia' (see announcement in Permophiles 34, p. 38), was established at the Shallow Tethys 5 International Conference held early this year in Chiang Mai, Thailand. This new, less formal working group was founded in response to the increasing demand, at both regional and international levels, for improved knowledge and understanding on the Permian of the broad SE Asian region and neighboring countries and, as such, will no doubt enhance the aims and activities of the SPS Working Group on Permian transitional biotas.

3. Regional/national activities connected with the SPS working group:

Russia. Dr. Galina Kotlyar has reported that Russian colleagues will create a special national working group connected with the SPS working group, with focus on the transitional biotas of the Artinskian, Kungurian, Ufimian and Kazanian. Progress is well under way (see publication list below).

Western Yunnan, China. There has been significant progress in the study of the Permian transitional faunas of the Baoshan block, western Yunnan, SW China. Fusulinids, conodonts and Gondwana-type brachiopods have been documented from the upper part of the Dingjiazhai Formation. Both fusulinids (Wang in Fang*et al*., in press) and brachiopods (Shi *et al*., 1996) indicate Late Sakmarian (Sterlitamakian age). The conodonts (Wang *et al*., 1999) assignable to the *Mesogondolella bisselli-Sweetognathus whitei* Zone (Mei Shilong, personal communication, 1999), on the other hand, suggests Late Sakmarian to Early Artinskian according to Isakova (1997, *Palaeontologica Polonica* 58: 261-271) and Mei*et al*. (1999b), but 'middle' Artinskian (?late Aktastinian) if correlated to the scheme of Jin *et al*. (1997) (Mei Shilong, personal communication, 1999).

Regardless of the difference in the fine tuning of the age for the upper Dingjiazhai fauna, it is clear that this fauna provides one of the best examples of biogeographically mixed (or transitional) Permian faunas as biostratigraphical gateways for regional and global correlations. Through its brachiopods, the Dingjiazhai fauna can be correlated with similar brachiopod faunas of the Greater Gondwanan region. Both the fusulinids and conodonts, on the other hand, provide strong links with contemporary faunas of South China and south Urals.

Peninsular Thailand and Malaysia. Permian transitional faunas and sequences have been well documented from several localities of the Shan-Thai (or Sibumasu) terrane of SE Asia. Dr. Guang R. Shi carried out further field work in January this year in central and northern Peninsular Thailand and collected both brachiopod, bryozoan, bivalve and fusulinid samples from the upper part of the Kaeng Krachang Group and basal Ratburi Limestone. Although also considered to be largely Late Sakmarian in age (Shi, 1999b), the fauna from the Khao Phra Formation (topmost formation of the Kaeng Krachang Group) differs to some extent from coeval faunas of the Baoshan block discussed above. This difference may reflect different palaeogeographical and/or palaeoclimatic settings. Across to Peninsular Malaysia, a comparable brachiopod fauna to that of the Khao Phra Formation of Peninsular Thailand has already been documented (Shi *et al*. 1997). Of particular note is that the Malaysian fauna of strong Gondwanan affinity is found in association with *Metalegoceras* sp., the latter suggesting most likely a Late Sakmarian age (Leonova *et al*., 1999).

Additional brachiopods from siliciclastics immediately below the Rat Buri Limestone collected by Dr. Angus Baird, then of the University of London, have been described by Archbold (1999a).

Gondwanan developments. Important, though of variable value for precise dating, conodont faunas have been described from Western Australia (Nicoll & Metcalfe, 1998) and the Torlesse and Caples Terranes of the South Island of New Zealand (Ford *et al*. 1999). Fusulinid faunas have also been documented from the Torlesse Terrane. Continued work on the Permian faunas and palynofloras of Western Australia further demonstrates their value for Gondwanan correlations and correlations with transitional Permian sequences (Archbold 1999b).

Other regions/areas of Permian transitional biotas. On-going research by members of the working group on aspects of Permian transitional biotas has also been very active and productive in other areas/regions of the world, including NE Asia (parts of Japan, NE China and Russian Far East), western and Arctic North America, north Russia (especially north Urals and the Russian Platform), the Middle East (Oman, in particular), and the Karakorum-Himalayan-Tibetan region, and will be progressively reported in Permophiles in the future. [See below for recent publications].

4. Planned future activities:

Group meetings. There will be a group meeting in conjunction with the second international symposium of IGCP 411 in Seoul, Korea, between 28 August and 2 September 2000. To accommodate the interest of our working group, the Organising Committee of the Seoul meeting has very kindly agreed to conduct a post-conference field trip to examine the "Biostratigraphy of the Carboniferous and Permian strata in the northern part of South Korea". For more details of the Seoul meeting, please contact: Prof. Yong II Lee, Department of Geological Sciences, Seoul National University, Seoul 151-742, Korea; fax -82-2-871 3269; email-lee2602@plaza.snu.ac.kr. Alternatively, you may write to us for a copy of the first circular.

There will also be a meeting, the Oman Pangea Symposium and Field Meeting, to be held at Sultan Qaboos University, Seeb/Muscat, between 12-16 January 2001 (see announcement, this issue). One of the our working group members, Dr. Lucia Angiolini, will be involved in leading one of the field excursions to examine the Lower and Middle Permian sedimentation on the Arabian Platform.

Field work. A number of extended field trips/expeditions have been planned for 2000-2001 by members of the working group. These include:

- Expedition to SE Oman in January/February 2001 (Dr. Lucia Angiolini and colleagues);
- Expedition to Western Yunnan, SW China (Dr. Wang Xiangdong and colleagues);
- Expedition to southern Tibet (Dr. Shuzhong Shen and colleagues);
- Fieldwork in NE China (and also possibly in Japan and Primorye of the Russian Far East) (Dr. Guang R. Shi and colleagues);
- Expedition to the Urals (Dr. Galina Kotlyar and colleagues).

If anyone out there is interested in joining any of the above planned field activities, please contact the person identified with each field program.

5. List of recent publications pertinent to the aims of the working group (mostly compiled from responses from members):

Angiolini, L. and Bucher, H., 1999. Taxonomy and quantitative biochronology of Guadalupian brachiopods from the Khuff Fm., SE Oman. *Geobios* 32, no.5 (In press).

Angiolini, L., Nicora, A., Bucher, H., Vachard, D., Pillevuit, A., Platel, J-P., Roger, J., Baud, A, Broutin, J., Al Hashmi, H. and Marcoux J., 1998. Evidence of a Guadalupian age for the Khuff Fm. of SE Oman: preliminary report. *Riv. It. Paleont. Strat*., v. 104, no. 3, p. 329-340.

Archbold, N. W., 1999a. Additional records of Permian brachiopods from near Rat Buri, Thailand. *Proceedings of the Royal Society of Victoria* 111, p. 71-86.

Archbold, N. W., 1999b. Permian Gondwanan correlations: the significance of the Western Australian marine Permian. *Journal of African Earth Sciences* 32.

Crasquin-Soleau, S., Broutin, J., Roger, J., Platel, J-P., Al Hashmi, H., Angiolini, L., Baud A., Bucher H., and Marcoux J., 1999. First Permian Ostracode Fauna from the Arabian Plate (Khuff Fm, Sultanate of Oman). *Micropaleontology*, v. 5, no. 2, p. 163-182.

Fang, Z. J., Wang, Y. J., Shi, G. R. and Zhou Z. C., 2000. On the age of the Dingjiazhai Formation of Baoshan block, western Yunnan, China - with a discussion on the redeposition hypothesis. *Acta Palaeont.Sinica*.[In press].

Ford, P. B., Lee, D. E. and Fischer, P. J., 1999. Early Permian conodonts from the Torlesse and Caples Terranes, New Zealand. *New Zealand Journal of Geology and Geophysics* 42, p. 79-90.

Henderson, C. M. and Mei, Shilong, 1999. Geographical cline of conodonts from the Cisuralian-Guadalupian boundary interval. (Abstract submitted to 31st IGC).

Kossovaya, O.L., Kotlyar, G. V., Zhuravlev, A. V. and Shishvov, S. B. (in progress). Integrated approach to the mid-Artinskian correlation. Proceedings of the XIV International Congress on the Carboniferous and Permian.

Kotlyar, G. V. (in progress). Kungurian-Ufimian Stages, boundaries and correlation. Proceedings of the XIV International Congress on the Carboniferous and Permian.

Kotlyar, G. V. and Nikitina, A.P. (in progress). Fauna of the *Monodiexodina* beds.

Lai, Xulong and Mei, Shilong, 1999. On zonation and evolution of Permian and Triassic conodonts. In Yin Hongfu, J.M. Dickins, G. R. Shi and Tong Jinnan (eds), *Permo-Triassic Evolution of Tethys, Circum-Pacific and Marginal Gondwana*. Elsevier Science (In press).

Leonova, T. B., Mohd, Shafeea Leman and Shi, G. R., 1999. Discovery of *Metalegoceras* sp., an Early Permian ammonoid from Langkawi Island, Malaysia. *Alcheringa*, v. 23, p. 277-281.

Leven, E. Ya., Grunt, T., Lin Jing-dang and Li Liang-fang. Late Permian stratigraphy of Jisu-Hongour area (North China). *Stratigraphy and Geological Correlation* (In press).

Leven, E. Ya, & Campbell, H. J., 1998. Middle Permian (Murgabian) fusuline faunas, Torlesse Terrane, New Zealand. *New Zealand Journal of Geology and Geophysics* 41, p. 149-156.

Mei, Shilong and Henderson, C. M., 1999. Evolution of Permian conodont provincialism and its significance in global correlation and paleoclimate implication. Submitted to *Palaeogeography, Palaeoclimatology, Palaeoecology*.

Mei, Shilong and Henderson, C. M., 1999a. Role of conodont provincialism on defining Permian Series and Stage boundaries. (Abstract submitted to 31st IGC).

Mei, Shilong and Henderson, C. M., 1999b. Implication and response of Permian conodonts to climate changes. (Abstract submitted to 31st IGC).

Mei, Shilong, Henderson, C. M. and Wardlaw, B., 1999a. Evolution and Distribution of *Sweetognathus*, *Iranognathus* and the related conodonts during the Permian and their implications to climate changes. (Submitted to the Proceeding volume of XIV ICCP).

Mei, Shilong, Henderson, C. M., Wardlaw, B.R. & Shi, Xiaoying, 1999b. On provincialism, evolution and zonation of Permian earliest Triassic conodonts. In Yin Hongfu and Tong Jinnan (eds), Proc. Inter. Con. On Pangea and the Paleozoic-Mesozoic Transition, China University of Geosciences Press, Wuhan, p. 22-28.

Mohd, Shafeea Leman and Shi, G.,R., 1998. The Permian of Langkawi Islands and northwest Peninsular Malaysia with comments on the significance of the Kisap Thrust. *Proceedings of the Royal Society of Victoria* 110, p. 405-418.

Nicoll, R. S. and Metcalfe, I., 1998. Early and Middle Permian conodonts from the Canning and southern Carnarvan Basins, Western Australia: their implications for regional biogeography and palaeoclimatology. *Proceedings of the Royal Society of Victoria* 110, p. 419-461.

Shi, G. R., 1999a. Terrane rafting enhanced by contemporaneous climatic amelioration as a mechanism of biogeographical vicariance: Permian marine biogeography of the Shan-Thai terrane in SE Asia. *Historical Biology*. [In press].

Shi, G. R., 1999b. Early Permian brachiopods from central and northern Peninsular Thailand. MS submitted to the Proceedings of XIV ICCP.

Shi, G.R. and Archbold, N.W., 1998. Permian marine biogeography of SE Asia. In *Biogography and Geological Evolution of SE Asia*, ed by R. Hall and J.D. Holloway, Backhuys Publishers, Leiden, The Netherlands, p. 57-72.

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To Voting Members of the Carboniferous and Permian Subcommissions

The attached message of the Chairman of ICS was intended to be read at the XIV International Congress on the Carboniferous and Permian in Calgary, Alberta Canada (August 17-21, 1999). Unfortunately, it was not presented at the Plenary Session nor read at the individual subcommission business meetings. Therefore the Bureau of ICS decided to distribute the text to all voting members of the Carboniferous and Permian subcommissions. Please let us know what you think concerning the Chairman's ideas about the Mississippian/ Pennsylvanian issue. Do you think that the question should be submitted for vote directly to the Full Commission of ICS? This would be justified by the fact that SCCS Executive Committee has postponed holding the final confirming vote for an unacceptably long time and that the matter is of general importance for the stratigraphic community.

Please distribute this message to other Corresponding Members of the respective subcommissions, as you think appropriate.

Sincerely yours,

Olaf Michelsen
Secretary General of ICS

(Editorial Note: The letter from Secretary Michelsen requesting distribution of the opening address "in absentia" by Professor Jürgen Remane, Chairman of ICS, followed me to various parts of the world but did not reach me until October 1999. It is with my apologies to Secretary Michelsen and Chairman Remane that both are included in this issue of Permophiles. C. S.)

OPENING ADDRESS "IN ABSENTIA"

Jürgen Remane
Chairman of ICS

Dear colleagues,

I deeply regret to be unable to attend the XIV International Congress on the Carboniferous and the Permian in Calgary. I really would have liked to follow personally the most recent developments in both Subcommissions of ICS involved in this meeting, the Subcommission on Permian Stratigraphy (SPS) and the Subcommission on Carboniferous Stratigraphy (SCCS). So, all that I can do under these circumstances is to express all my best wishes for a successful meeting and, perhaps, add some considerations of an outsider who has never been personally involved in the problems you have to cope with.

There is the new subdivision of the Permian, adopted by SPS in 1996. Quite a number of traditional European stage names have been abandoned in the new scheme. Quite understandably this is not easily accepted by stratigraphers who have so to say grown up with the classical subdivision, and I understand the concern of our Russian colleagues who are attached to their historical stratotypes. But here in Calgary, in the New World, it is perhaps more obvious that we have to provide the geoscientific community with an internationally applicable chronostratigraphic standard, and that the stages, basic units of that standard, have to be defined where continuously deposited marine successions covering the critical boundary intervals are available. Inevitably, this will in some cases lead us to new type areas and also to nomenclatural changes. So let's hope that rapid progress in the definition of GSSPs for the new Permian stages will help to facilitate their acceptation.

The Subcommission on Carboniferous Stratigraphy is successfully working on the subdivision of a very critical period of Earth history, where interregional correlations are particularly difficult. Therefore, the formal agreement on the mid-Carboniferous boundary is without doubt an important milestone in the creation of an international standard. Important also because there has been a long lasting confusion about the position of that boundary, which was placed at different levels according to the European and the American tradition, thus leading to different concepts about the Early and the Late Carboniferous. The agreement of American stratigraphers to "sacrifice" the Mississippian and the Pennsylvanian Systems in favour of a unified Carboniferous System was a first important step toward an international agreement about the mid-Carboniferous boundary. With the ratification of the boundary through IUGS the problem where to place the boundary is now definitely settled, but a formal decision about the nomenclature to use in the future is still pending. To which tradition European or American do the newly defined divisions Early and Late Carboniferous correspond? As the GSSP is placed at a level very close to the traditional Mississippian/Pennsylvanian boundary, the best solution for non-carboniferous stratigraphers and other outsiders would probably be to use Mississippian and Pennsylvanian as names for the two subdivisions of the Carboniferous. At least this would immediately make clear to everybody what the signification of the mid-Carboniferous GSSP is with respect to competing historical concepts. And, as nomenclature is a matter of convention and not a scientific problem, the issue will hopefully be solved in a very near future.

So I conclude by reiterating my best wishes for the success of this meeting in making progress towards the creation of an international chronostratigraphic standard

Jürgen Remane
Chairman of ICS

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REPORTS

Permian Conodont Provincialism, Zonation and Global Correlation

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Introduction

Permian conodonts are regarded as the most important fossils for chronostratigraphy of the Permian. One reason is that they were thought to be more cosmopolitan in distribution than other important fossils such as fusulinaceans, ammonoids, brachiopods and corals. As a result, a single generalized zonation, usually entitled “standard zonation”, tended to be proposed (Kozur, 1994, 1995, 1996; Wang Chengyuan, 1995) with only acknowledgement of facies differentiation and minor discussion on provincialism. However, the accumulating literature indicates that varying levels of provincialism can be seen for conodonts of Asselian (Henderson and Orchard, 1991), Artinskian (Nicoll and Metcalfe, 1998), Kungurian and Guadalupian (Behnken, 1975; Wardlaw, 1995), Lopingian (Mei, 1996; Mei and Wardlaw, 1996), and Permian-Triassic boundary interval (Matsuda, 1985; Mei, 1996). The lack of appreciation for conodont provincialism has caused taxonomic misidentification for Permian-Triassic conodonts at Selong (for detail see Orchard *et al*., 1994; Mei, 1996), and construction of non-existent zones (for detail see Mei and Wardlaw, 1996). A survey of available references of Permian conodonts suggests an increasing degree of conodont provincialism throughout the Permian. Recognition of the provincialism results in the re-evaluation of Permian conodont taxonomy and zonation. The present authors only briefly dealt with conodont provincialism, evolution and zonation previously (Mei *et al*., 1999a). This paper presents a more comprehensive discussion on Permian conodont distribution, provincialism, zonation, correlation and climate changes.

Permian conodont distribution, provincialism and climate changes

Permian conodonts only occur in a zone between 50^0 North and South paleolatitudes (Fig. 1-6). Beyond this zone are two bipolar zones that are barren of conodonts, which is simply because the waters were too cold for conodonts as Nicoll (1976) has indicated. Permian conodont provinces show a clear paleolatitudinal distribution, and mixed faunas only exist in bordering areas such as west Timor during Artinskian, Pamirs during Kungurian and the Salt Range during Guadalupian and Lopingian. This spatial distribution pattern suggests that the temperature of the water mass is the primary factor controlling Permian conodont provincialism. This confirms the conclusion reached by Henderson (1990) from a discovery that the temporal distribution of Upper Carboniferous and Permian conodonts in the Sverdrup Basin was closely related to climatic cooling, which was caused in part by the Sverdrup Basin progressively moving northward.

Distribution patterns of Permian conodonts suggest that *Vjalovognathus*, *Gondolelloides* and *Merrillina* are cool water residents, and *Diplognathodus*, *Sweetognathus* and *Iranognathus* are warm water residents. *Neostreptognathodus* and *Sweetina* are more common in temperate zones than in the equatorial zone. Neogondolellids and *Hindeodus* are cosmopolitan and the most temperature tolerant. Neogondolellids persist as *Mesogondolella* with a big cusp and low and discrete anterior blade in bipolar temperate zones during Kungurian through Lopingian. In the equatorial zone they differentiated into *Mesogondolella* with a small cusp, a tightly spaced to fused carina, and a high and fused anterior blade during Kungurian, *Jinogondolella* during Guadalupian and *Clarkina* during Lopingian.

During the Asselian and Sakmarian (Fig. 1), extensive glaciation existed in southern Gondwana. Permian conodonts show a cosmopolitan distribution mainly confined to tropical areas, and provincialism is only indicated by less common endemic elements such as *Gondolelloides* and New Genus A (Henderson, 1988) in North Pangea.

During the Artinskian (Fig. 2), Pangea moved off the southern pole and glaciers disappeared altogether. As a result, global warming, accompanied by a worldwide transgression, took place. Corresponding to the climate warming event, the Carboniferous holdovers such as *Streptognathodus* and *Adetognathus* became extinct, and afterwards a cosmopolitan fauna dominated by *Sweetognathus whitei* and *Mesogondolella bisselli* occurred everywhere as a survival fauna. This event was named the Early Permian crisis (Clark, 1972). Provincialism, at this time, is in an initial stage of differentiating into a tropical warm water province and two bipolar temperate provinces, as indicated by the distribution of *Sweetognathus bucaramangus* more or less around the equator and appearance of the cool water element *Vjalovagnathus* in Australia and west Timor.

Starting with Kungurian (Fig. 3), three provinces, the North Cool Water Province, the Equatorial Warm Water Province and the peri-Gondwana Cool Water Province, were well established (Mei *et al*, 1999a). It is noteworthy that the north boundary of distribution of *Sweetognathus*, a warm water element, retreated southward from 50^0N to 15^0N during Kungurian (Mei *et al*., 1999b). This suggests climate cooling in north Pangea during Kungurian. This trend seems to continue to the basal Triassic in north Pangea, at least in part owing to continuous northward motion of Pangea and alteration of oceanic currents. Consequently, the lineage of *Sweetognathus*, *Iranognathus* and *Diplognathodus* becomes confined to the Equatorial Warm Water Province (Mei *et al*., 1999b). In contrast, *Neostreptognathodus* becomes the dominant element in temperate zones.

During Guadalupian (Fig. 4), *Sweetognathus* slightly invaded into the Salt Range of peri-Gondwana, as indicated by less than common occurrence of *Sweetognathus iranicus* (Wardlaw and Mei, 1999). This may indicate a slight climate amelioration or warming in

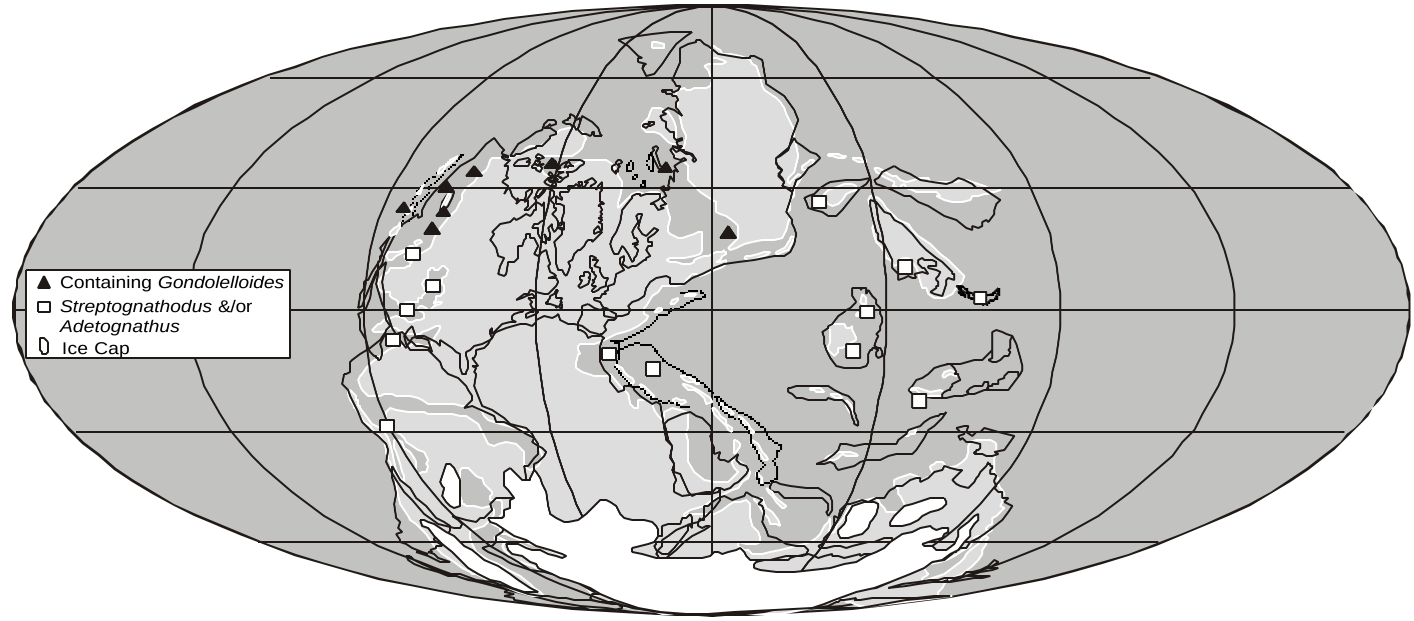

Figure 1. Conodont distribution during Asselian and Sakmarian. Paleocontinent reconstruction is simplified after Ziegler *et al*. (1997).

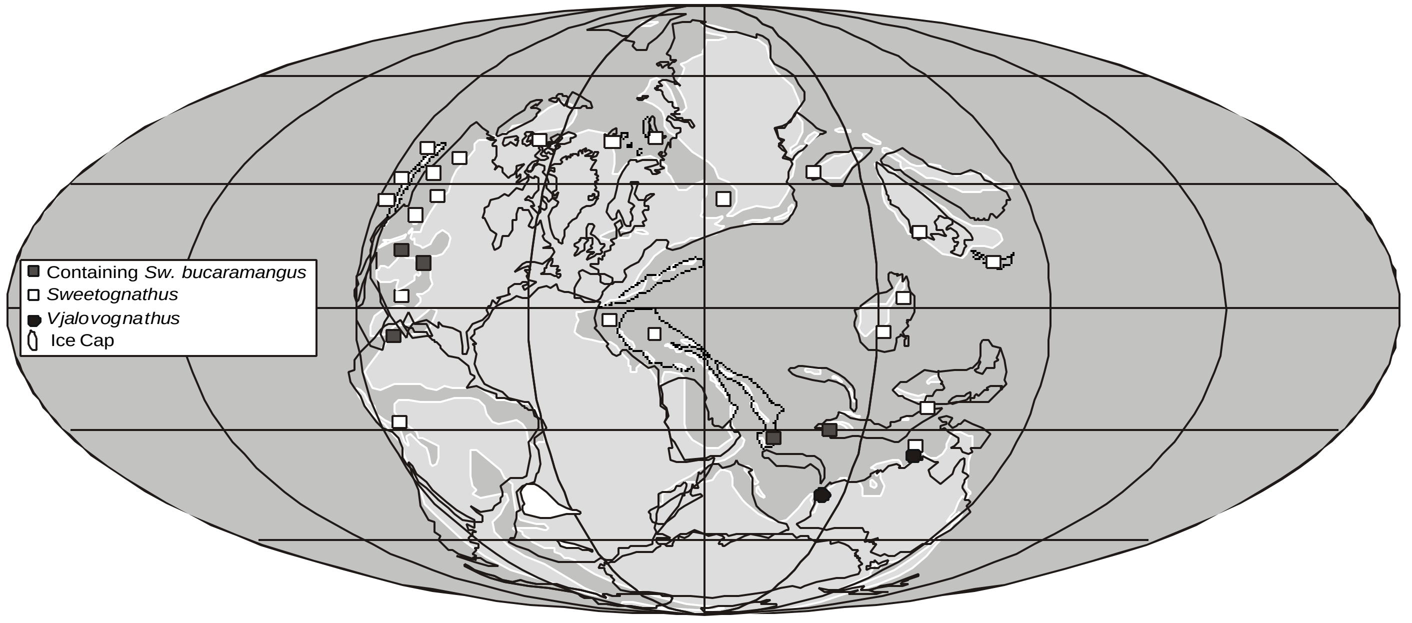

Figure 2. Conodont distribution during Artinskian. Paleocontinent reconstruction is simplified after Ziegler *et al*. (1997).

peri-Gondwana in addition to a general continuation of the Kungurian climate. *Neostreptognathodus*, the dominant element in temperate zones, became extinct in early Guadalupian, which may be related to the Guadalupian warming.

During Wuchiapingian (Fig. 5), a warming took place at least in peri-Gondwana, as indicated by southward migration of the warm water fauna exclusively dominated by *Iranognathus* and *Clarkina* into the Salt Range. Corresponding to the Wuchiapingian warming, *Jinogondolella* and *Sweetoganthus* were replaced by *Clarkina* and *Iranognathus* respectively around the Guadalupian-Lopingian boundary (Mei *et al*., 1994a, 1994b, 1994c, 1998a). Climate cooling again prevailed during Changhsingian, as indicated by the return of the cool water elements such as *Vjalovognathus* and *Merrillina* in the Salt Range. This climate cooling may be responsible for extinction of *Iranognathus* in Lower Changhsingian.

The end for Permian conodont lineages is marked by the Late Griesbachian conodont crisis (Mei *et al*., 1999a), which is represented by the extinction of *Hindeodus* and *Isarcicella*, and an afterward flooding survival fauna exclusively dominated by *Clarkina carinata* (Clark, 1959). Like the Early Permian crisis caused by the Artinskian global warming, the Late Griesbachian conodont crisis is a response to early Triassic global warming (Erwin *et al.*, 1999).

Permian conodont zonations

Conodont provincialism during the Permian, especially during Kungurian through Changhsingian, prevents the development of a single standard zonation, although there are sufficient similarities within lineages to achieve correlation (see below). Permian conodont zones established in several key areas of the world are shown in Table 1. In the Equatorial Warm Water Province, the Cisuralian zones of South China are based on preliminary results from the Luodian (or Nashui) and Ziyun sections, southern Guizhou (Wang, 1994; Kang *et al.*, 1987) and our recent study on Kungurian conodonts (Henderson *et al.*, 1999); the Guadalupian zones are based on materials mainly from Dukou and Nanjiang sections in northeastern Sichuan, Fengshan, Tieqiao and Penglaitan sections in central Guangxi, South China (Mei *et al.*, 1994a, 1994c, 1998a); the Wuchiapingian zones are based on materials mainly from Dukou and Nanjiang sections in northeastern Sichuan as well as Penglaitan and Tieqiao sections in central Guangxi, South China (Mei *et al.*, 1994b, 1994c, 1998a), and all of which, except the lowermost zone, were also well developed in Iran (Sweet and Mei, 1999); the Changhsingian zones are based on materials mainly from Meishan section, Zhejiang, South China (Wang and Wang, 1981; Mei *et al.*, 1998b), Abadeh section, central Iran and Kuh-e-Ali Bashi section, northeastern Iran (Iranian-Chinese Research Group, 1995; Sweet and Mei, 1999). Cisuralian and Guadalupian conodont zones in Texas, USA are based on Wardlaw (1996), Wardlaw and Mei (1998) and Mei *et al*. (1998a). The previously reported occurrence of *Clarkina postbitteri* in Texas is considered questionable and needs to be confirmed. The Artinskian through Lopingian zones of the peri-Gondwana Cool Water Province are based on material from Australia (Nicoll and Metcalfe, 1998) for Cisuralian, the Salt Range for Guadalupian and Lopingian (Wardlaw, 1995; Wardlaw and Mei, 1999), and Selong for the latest Lopingian. The Sverdrup Basin zones are slightly modified from Henderson (1988) and Beauchamp *et al*. (1989). The Cisuralian zones for the Phosphoria Basin and Kansas are based on Boardman *et al*. (1998) and adopted from Mei *et al*., (1999a). Wardlaw (personal communication, 1999) has suggested that the same zonation of Asselian through Artinskian can be found in the Phosphoria Basin, Texas and the Urals. However, the Cisuralian zones in the Urals (Table 1) are based on Chernykh and Chuvashov (1991). Future publications may confirm the similarity of the Cisuralian zonation, but until then we base our chart on published zonations. In addition, Chernykh and Ritter (1996) also proposed a detailed zonation for Asselian. It should be pointed out that definitions for Cisuralian *Streptognathodus* species vary among previous authors, and need to be more strictly defined in the future. Artinskian and Kungurian conodont taxonomy and zonation are the weakest parts in the study of Permian conodonts and subject to further modification. The Guadalupian zones of the North Cool Water Province are based on the Great Basin succession (Wardlaw and Collinson, 1979, 1984, 1986; Wardlaw and Mei, 1998).

In South China, Japan and Canada, *N. exsculptus* was found to appear nearly simultaneously with *N. pequopensis* (Igo, 1981; Henderson and McGugan, 1986). *N. exsculptus* may have evolved from a lineage very different from the *Sweetognathus whitei* to *Neostreptognathodus pequopensis* lineage (Mei *et al*., 1999b). Our recent study shows that some reported *N. exsculptus* from the correlative interval have distinct pustules and are thus different from the holotype. In addition, the *N. exsculptus* reported in much younger strata is also different in micro-ornamentation, configuration of denticulation and blade-platform transition from those from Tethyan blocks such as Japan, South China, Pamir and Sicily. They are all shown in table1 within quotation marks.

Our extensive sampling and study of conodonts from the Luodian section and comparison with other related sections (Henderson *et al*., 1999) suggests that *Mesogondolella siciliensis* is Upper Kungurian in age, not Wordian in age as Kozur (1996, 1998) has proposed, and that *Mesogondolella zsuzsannae* is probably a junior synonym of *Mesogondolella siciliensis*. However, in fairness it should be pointed out that this results in considerable disagreement with fusulinacean and ammonoid ages indicating that the taxonomy of this group should be reviewed. It appears that at both Luodian and Rupe del Passo di Burgio *Mesogondolella siciliensis* occurs with the same Murgabian fusulinaceans, but associated ammonoids (*Waagenoceras*) at Rupe del Passo di Burgio were regarded as Wordian by Kozur (1996, 1998). Henderson *et al.* (1999) also pointed out that the *Mesogondolella* species reported by Kozur from Sicily compare well with typical Kungurian forms in South China and West Texas, and are typical warm water forms with a high anterior blade.

Orchard and Krystyn (1998) pointed out that the specimens illustrated as paratypes of *Clarkina meishanensis* by Zhang *et al.* (1995) are different from the holotype by a distinctly reduced posterior carina and denticles. They probably belong to a new species (Henderson and Mei, in prep.), and are shown in Table 1 under quotation marks. These forms are very common in the reported interval at Meishan, and have been also found in the Hogup Mountains in Nevada (Wardlaw and Mei, 1998). In contrast, forms like the holotype of *Clarkina meishanensis* are very rare.

Global correlation of Permian conodont zonations

Due to distinct provincialism since Kungurian to the end of Permian, Middle and Upper Permian conodont zones established in the Equatorial Warm Water Province (EWWP) can not be correlated precisely with those recognized in the North Cool Water Province (NCWP) and the peri-Gondwana Cool Water Province(GCWP). However, four horizons, which define the boundaries of five conodont evolutionary stages during Permian have strong potential for inter-provincial correlation. They are in ascending order: 1) the first appearance of *Sweetognathus whitei*, which is closely related to the last occurrence of Carboniferous-type conodonts such as *Streptognathodus* and *Adetognathus*; 2) the first appearance of *Neostreptognathodus pequopensis*; 3) the base of the *Jinogondolella nankingensis* Zone; and 4) the base of the *Clarkina postbitteri – Iranognathus erwini* Zone.

The Asselian, Sakmarian and Artinskian are to be established in the Urals, which is in the NCWP, and all other Permian stages are to be established in West Texas and South China, which are located in the EWWP. Permian Series and Stage boundaries should be defined at horizons close to the above-mentioned horizons so that they are as correlatable as possible outside the type area. A study on geographical clines in morphology for each index con-

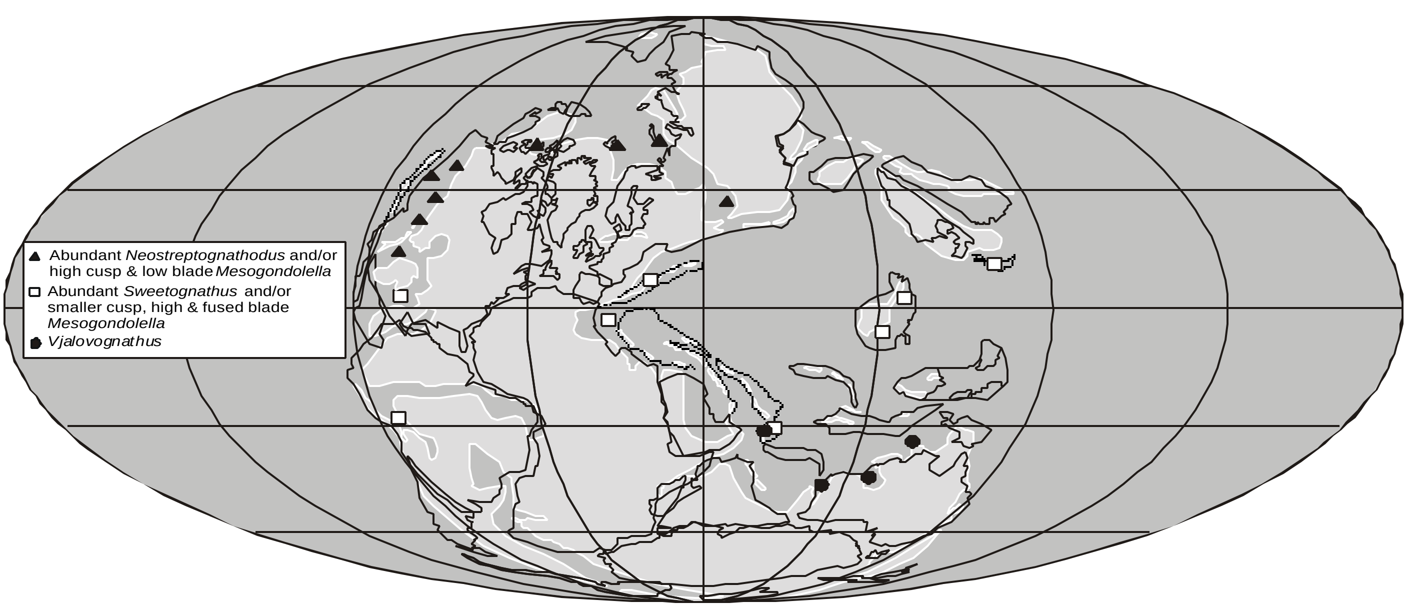

Figure 3. Conodont distribution during Kungurian. Paleocontinent reconstruction is simplified after Ziegler *et al*. (1997).

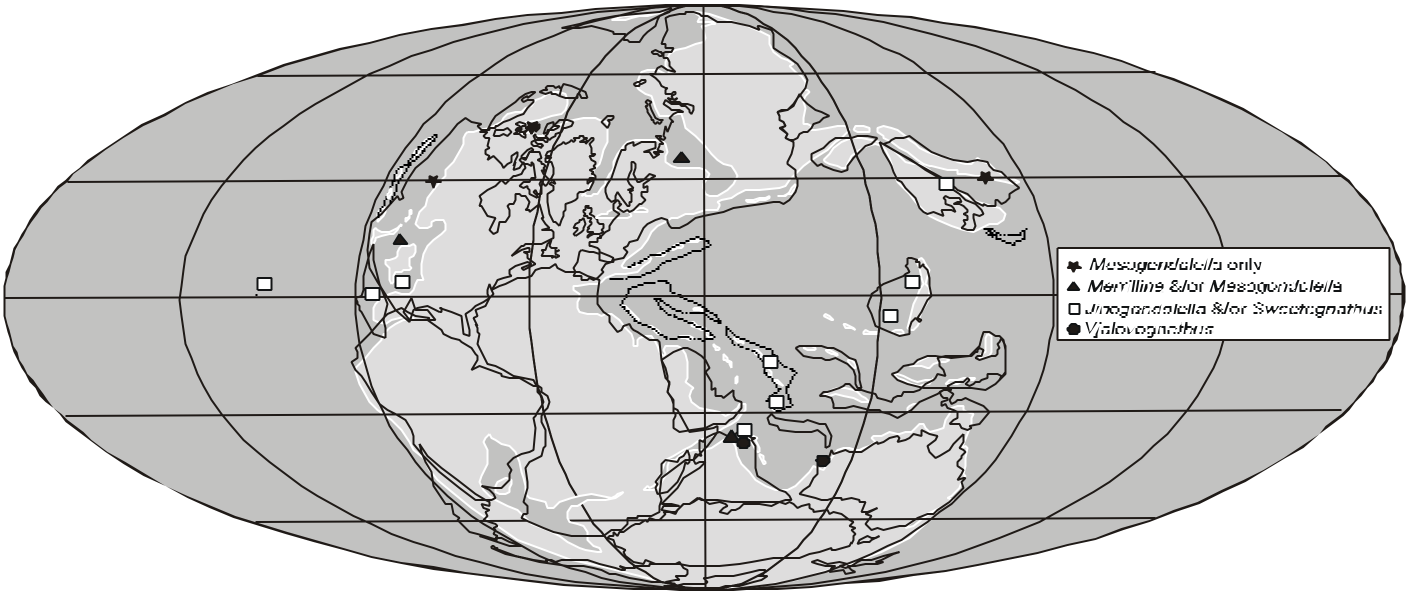

Figure 4. Conodont distribution during Guadalupian. Paleocontinent reconstruction is simplified after Ziegler *et al*. (1997).

odont is also necessary and will be the key to improve inter-province correlation (Henderson and Mei, in prep.).

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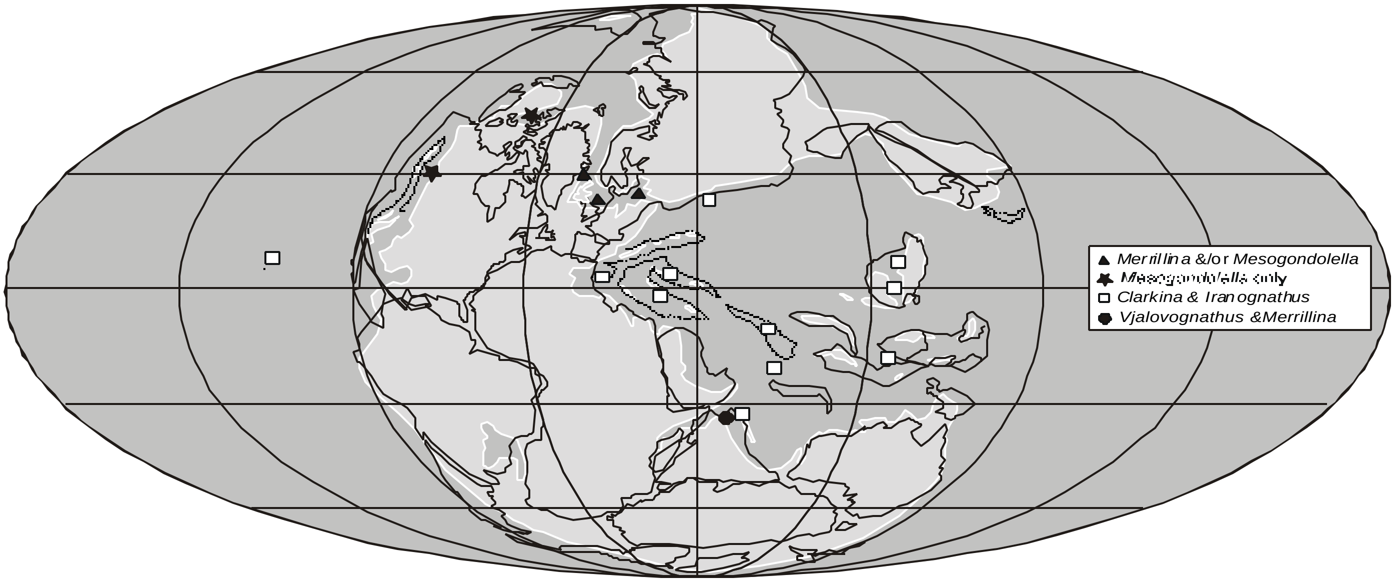

Figure 5. Conodont distribution during Lopingian. Paleocontinent reconstruction is simplified after Ziegler *et al.* (1997).

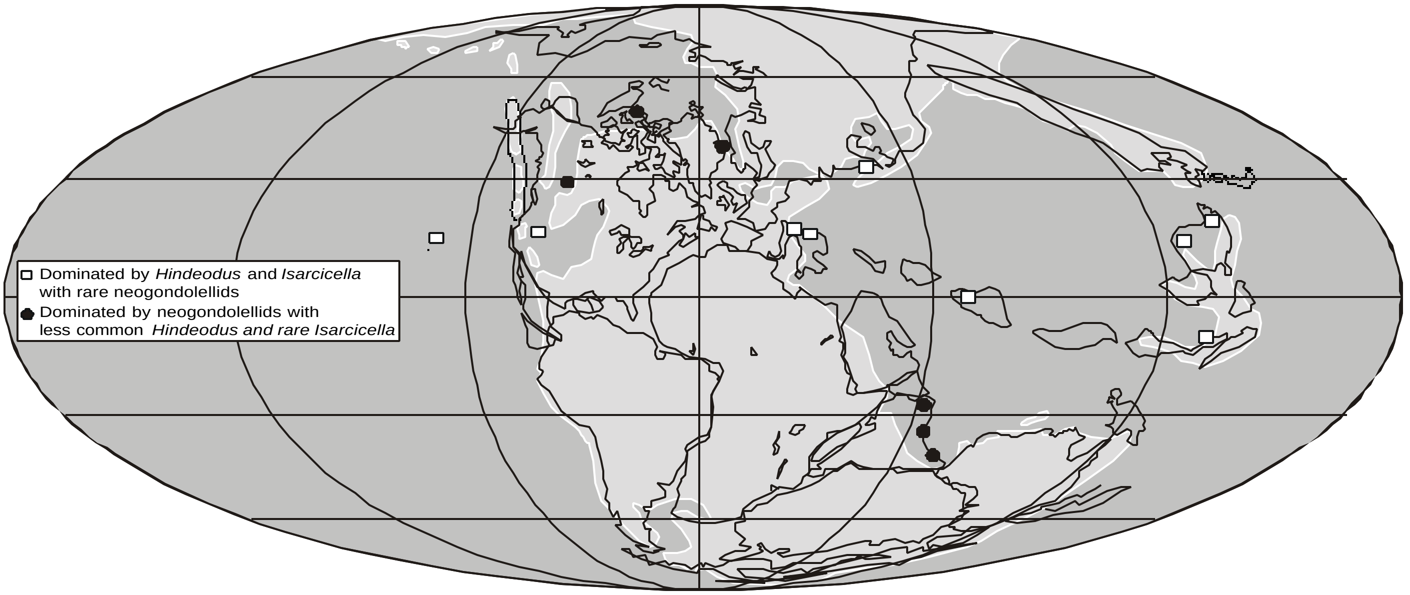

Figure 6. Conodont distribution during Permian-Tiassic boundary interval. Paleocontinent reconstruction is simplified after Ziegler *et al.* (1997).

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Permian Subdivisions		Evolutionary Stages and Major Distribution of Conodonts	Equatorial Warm Water Province				Cool Water Provinces				Climate Changes
							peri-Gondwana Province	North Cool Water Province			
			South China	Texas, USA	Abadeh, Iran	Julfa, Iran	W. Australia, Salt Range and Selong	Phosphoria Basin and Kansas	Sverdrup Basin		Warming N. carinata H. parvus
LOPINGIAN	Changhsingian	Conodont Stage 5 cool water: Mesogondolella Merrillina warm water: Clarkina, Iranognathus	C. "meishanensis" C. yini C. postwangi C. changxingensis C. subcarinata-C. wangi		? Hambast Fm. Unit 7 C. subcarinata	Ali Bashi Fm. H. latidentatus C. yini C. postwangi changxingensis C. subcarinata	M. sheni Chhidru Fm. Vjalovognathus sp. nov.B Merrillina sp. nov.	C. "meishanensis"	M. sheni Shelf M.aff. sheni		Cooling
	Wuchiapingian		C. inflecta C. orientalis C. transcaucasica C. guangyuanensis C. leveni C. asymmetrica C. dukouensis C. postbitteri-I. erwini		C. orientalis C. transcaucasica guangyuanensis C. leveni Unit 6 C. asymmetrica C. dukouensis	Julfa Beds C. orientalis C. transcaucasica guangyuanensis C. asymmetrica C. dukouensis	Wargal Formation C. longicuspidata C. transcaucasica C. liangshanensis C. asymmetrica C. dukouensis I. pakistanensis		M.rosenkrantzi	European Zechstein Formation and Greenland M. rosenkrantzi Me. divergens	Minor Warming
GUADALUPIAN	Capitanian	Conodont Stage 4 cool water: Mesogondolella Merrillina warm water: Jinogondolella, Sweetognathus	J. granti J. xuanhanensis xuanhanensis J. prexuanhanensis J. altudaensis J. shannoni J. postserrata Sw. fengshanensis Sw. hanzhongensis	J. xuanhanensis crofti J. prexuanhanensis J. altudaensis J. shannoni J. postserrata	Unit 5 Abadeh Fm. Unit 4 Sw. cf. fengshanensis Sw. iranicus Sw. sweeti		? Amb Fm. Me. praedivergens M.bitteri-Me.arcucristata Vjalovognathus sp. nov. A	M. wilcoxi Me. praedivergens-M. bitteri M.bitteri-Me. arcucristata	M. "rosenkrantzi"-M. bitteri		Continuation of tropical and temperate zones established in Kungurian
	Wordian		J. aserrata Sw. subsymmetricus	J. aserrata	Surmag Fm. Unit 3		Sw. iranicus	M. phosphoriensis-M. prolongata	M. phosphoriensis		
	Roadian		J. nankingensis	J. nankingensis				N. newelli-M.gracilis	M. gracilis		
CISURALIAN	Kungurian	Conodont Stage 3 cool water: Neostreptognathodus warm water: Neostreptognathodus, Pseudosweetognathus	M. aff J. nankingensis M. zsuzsannae-Sw. adjunctus M. siciliensis-Sw. guizhouensis	N. sulcoplicatus N. prayi-M. zsuzsannae N. prayi-M. glenisteri N. "exsculptus"-M.glenisteri			Noonkanbah Fm. Vjalovognathus shindyensis	N. sulcoplicatus N. prayi N. "tschuvashovi" N. "exsculptus"	M. idahoensis N. pnevi	the Urals N. pnevi	Cooling in North Pangea
	Artinskian	Conodont Stage 2 Sweetognathus Mesogondolella	N. exsculptus-N. pequopensis M. bisselli Sw. whitei Sw. inornatus M. dentiseparata	N. "exsculptus"-M.gujioensis N. pequopensis Sw. whitei-M. bisselli			Callytharra Fm. Vjalovognathus australis	N. pequopensis Unnamed Sw. whitei-M. bisselli St. florensis	N. "ruzhencevi" N. pequopensis-N. clarki Sw. whitei-M. bisselli M. bisselli-Sw. inornatus-A. paralautus	N. pequopensis Sw. whitei M. bisselli-M. visibilis M. lata-Sw. merrilli	Deglaciation and Global Warming
	Sakmarian	Conodont Stage 1 Adetognathus Streptognathodus	A. paralautus St. barskovi					St. trimilus St. postconstrictus St. barskovi	M. bisselli- A. paralautus St. barskovi	M. uralensis M. pseudostriata M. striata	Glaciation in Gondwana
	Asselian		Unnamed St. isolatus	St. nevaensis St. isolatus				St. fusus St. nevaensis St. isolatus	St. "elongatus" St. constrictus St. isolatus	M. simulata-St. fusus St.constrictus-M.belladontae St.cristellaris St. wabaunsensis	

Table 1. Permian conodont stages, zones, provincialism , global correlation and climate changes.

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Tympanicysta and the Terminal Permian Events

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Terminal Permian non-marine sequences are marked by the so-called fungal event, a sharp increase of fungal remains presumably reflecting a rise of saprophytic organisms related to catastrophic devastation of arboreal vegetation (Visscher *et al*., 1996). Dominant among the supposed fungal remains are filamentous fossils assigned to *Tympanicysta* Balme or the related, if not congeneric, *Reduviasporinites* Wilson and *Chordecystia* Foster.

Though originally described as *incertae sedis* of either fungal or algal or else animal origin (Balme, 1980), they were recently interpreted as conidia of ascomycetes. However our study of *Tympanicysta* from the transitional Permian to Triassic microfossil assemblages of Nedubrovo, Vologda Region of European Russia (Krassilov *et al*., 1999) failed to support a fungal interpretation for neither the cell shapes and dimensions, nor their contacts in the linear filaments correspond to any known conidial structures.

At the same time this fossil is most similar to extant zygnematalean green algae *Spirogyra* and *Mougeotia* that have typically unbranched filaments of cylindrical cells that can be swollen at forming thick-walled dormant cells, or acinetes. In the same way, *Tympanicysta* is represented by two kinds of filaments - slender with cylindrical cells and relatively robust with barrel-shaped thick-walled cells (Fig. 1, B) the latter perhaps overrepresented in microfossil assemblages. Moreover, a typical acinete with double wall is found in our material (Fig.1, D).

Other morphological features of *Tympanicysta* also match the typical zygnematalean characters. Thus, in *Spirogyra* the terminal cells of filaments differ from the rest in their elliptical or conical shape which is also the case in *Tympanicysta*. In the extant genus the transverse cell walls, or septae, can be smooth, forming a lenticular joint, or folded, sometimes with an annular thickening. In *Tympanicysta* the septae are either smooth or, in the thick-walled forms, folded by invagination of the cell wall (Fig. 1, C). A granular dark matter in the central part of the cells corresponds to chloroplast of zygnematalean algae in which it can be either axial or parietal, laminar or star-shaped, but in compressed cells appearing exactly as in the fossil.

There might be a fungal event caused by an increased deadmass production in disturbed terrestrial plant communities at about the P/T boundary, but the rise of *Tympanicysta* requires a different explanation. The extant Zygnematales (Zygnematophyceae) include 16 genera of fresh-water and terrestrial green algae of which *Spirogyra* is the largest and the most common genus, comprising about 350 species. They typically inhabit river ponds and lakes, mostly oligotrophic, sometimes swampy, but also occur in brackish waters and mineral springs. In warm well lighted shoal-waters they form dense bottom mats or floating masses sometimes causing water blooms. As fossils zygnemataleans are represented primarily by their characteristic zygospores that appear in the Carboniferous and are occasionally recorded in palynological assemblages later on. An increase of zygnematalean remains in the terminal Permian to lowermost Triassic might be due to the rise of ground water level and a widespread ponding of rivers at the early stage of the end-Permian transgression. Incidentally, this explanations fits the facial occurrence of *Tympanicysta* in the floodplain pond de-

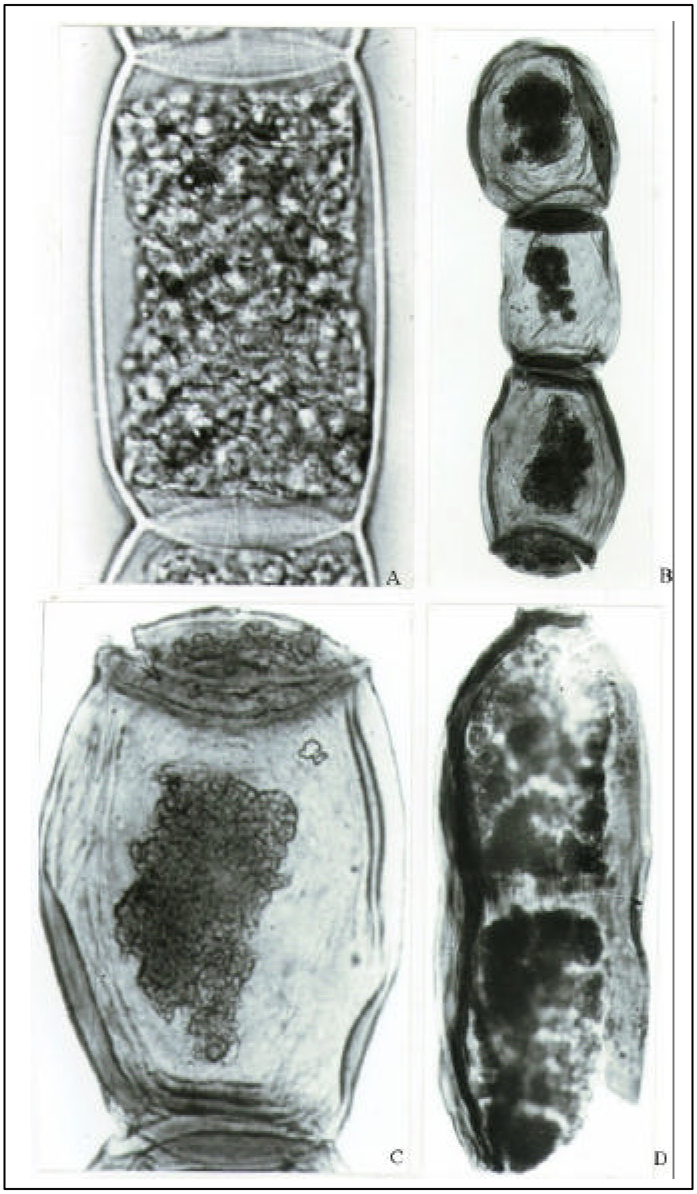

Figure. 1. Extant *Spirogyra* sp. (A, x600) form a flood-plain pond of the Bitsa River, Moscow River Basin, and *Tympanicysta* sp. (B - filament with elliptical terminal cell, x246, C - folded septa, x620, D - acinete, x634) from the latest Permian to lowermost Triassic basal Vetlugian deposits of Nedubrovo, Vologda Region, Russian Platform.

posits of Nedubrovo locality.

Acknowledgements

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Studies of the Upper Permian Reefs in Hunan Province (People Republic of China)

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Joint Chinese-Russian studies of Permian reefs began in the September-October 1999. This year the Upper Permian organogenic carbonate buildups were studied in North-Western (Cili Region) and Southern (Chenzhou Region) Hunan Province, China. The Upper Permian (Changhsingian) reef complex in the Cili Region consists of the coral shore-reef (Gaoya section) and the deeper water sponge reef (Daluokeng section) separated by a shallow-water lagoon with normal marine sedimentation (Wang Yongbia *et al*., 1997, 1998,1999). The coral reef framework is built by branching colonies of *Waagenophyllum.* The spaces between the colonies and their branches are filled by fine-grained cement (grainstone) consisting of coral and crinoid fragments. Observed horizons of hollows filled by coarse-grained, white calcite apparently indicate the recurrent draining of the reef surface following lowering of sea level, accompanied by weathering and dissolution of the reef surface by the terrestrial fresh water. Dolomitization observed in some parts of the reef supports this interpretation.

Each cycle separated by periods of drainage shows specific lithology. The grainstone beds lie in the basal parts of the cycles and form a hard base on which the coral frame developed. The grainstone covers the coral framestone in the upper part of the cycle. Relative thickness of these elements of the cycles and horizons of hollows indicate the rate of the sea level decrease and duration of the periods of drainage of the reef surface. More than 10 cycles were observed in the upper half of the reef body having the thickness of 20-30 m. The cycles are 0.5-2.0 m thick. The final cycle at the top of the reef is approximately 2 m thick and consists of the basal grainstone and coral framestone, while the upper grainstone member is absent. Such cycles indicate a very rapid sea level drop so that the upper grainstone member did not have sufficient time for accumulation.

The hollows in the top of this final cycle penetrate all beds of the cycle. The periodic sea level drop and rise corresponded to small-scale eustatic movements or local changes of the shoreline. The greatest and fastest sea level drop traced at the top of the reef body resulted in the extinction of the reef-building corals. We propose that this level corresponds to the global eustatic fall of the sea level in the middle Changhsingian time (Glenister *et al*., 1999).

The frame of sponge reef is built by plate-like, low branching, massive colonies of very diverse calcareous sponges, *Calcispongia*, *Inozoa*, and *Stromatoporata*. Vertically oriented Sphinctozoa and fenestellid bryozoans are rare. The sponge reef body is 5-10 times thicker than the coral frame. The building of the sponge reef was terminated close to the Permian-Triassic boundary. In the transitional zone between the coral and sponge reefs, grainestones lie at the base of the section. Individual colonies of corals and sponges form the small patch-reefs. Covering packstones-wackstones contain remains of normal marine organisms, e.g. molluscs, forams, and crinoids. These beds are overlain by algal-ooid limestone deposited in a shallow, highly turbulent brackish water environment.

In the Chenzhou region Upper Permian rocks represent different facies. Sponge framestone is the only real reef formation (*sensu stricto*). Siliceous limestones, mudstones and radiolarites with remains of pelagic organisms; black and gray thin-bedded limestones deposited in the deep sea zone of the carbonate platform; extensive massifs of micritic unbedded limestone indicate complex tectonic interrelations in this region. Sponge reef framestones have a different texture compared with the above-mentioned framestones from Cili, e.g., vertical frame-building elements of Sphinctozoa occur more often here. The presence of large primary hollows is the distinctive character of the sponge framestones in this area. Discovery of the reef-like massifs of micritic limestones is very important. The largest of them are more then 40 m thick and extend for a few hundred meters. The textural features of these reef-like bodies, the presence of the spotty parts, the stromatolite-like bedding, and the close associations with deep-water, thinly-bedded limestones and pelagic mudstones suggest their microbial formation in aphotic zones at the border of the carbonate platform.

The high microbial activity and intensity of carbonate accumulation probably caused emanations of a great quantity of biogenic elements from hydrothermal sources at the sea bottom. The presence of copper mineralization in some of the studied micritic limestones supports this hypothesis. Microbial deep-water reefs (*sensu lato*) were previously unknown in the Permian (Kuznetzov, 1996). The detailed study of these reef-like formations is important for reconstruction of paleoenvironmental and geological history of the regions where they were recognized. The authors are indebted Professor Yin Hongfu (Chinese University of Geosciences, Wuhan) for assistance in the field trips and discussions.

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Changhsingian of the Northwestern Caucasus, Southern Primorye and Southeastern Pamirs

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Northwestern Caucasus

Changhsingian deposits in the northwestern Caucasus are exposed as small isolated outcrops in the Forerange (Peredovoi Range) zone in the Belaya, Bolshaya, and Malaya Laba River basins. They were first discovered in 1913 by V. N. Robinson. Later, Robinson (1932) assigned their age as Early Permian based on identifications of brachiopods by F. N. Chernyshev. After a monographic description of the brachiopods, a few fusulinids and bivalves, Likharew (1937) dated the deposits as Late Permian which he previously regarded as Early Permian. A stratigraphic chart of the Permian deposits in the Forerange Zone was presented by K. Miklukho-Maklay (1954, 1956) in which she differentiated four formations in ascending order: 1) Kutan, 2) Nikitin, 3) Urushten, and 4) Abag.

Later, the age of the northwestern Caucasus deposits was changed from Midian to Dorashamian (Changhsingian) (Grunt and Dmitriev, 1973; Kotlyar *et al*., 1983, 1989; Waterhouse, 1976; Waterhouse and Gupta, 1983). Based on ammonoids, mostly represented by poorly preserved xenodiscids, the Urushten Formation to which they were confined was clearly dated as pre-Dzhulfian (Rostovtsev, 1984; Bogoslovskaya, 1984; Zakharov, 1985).

New evidence from later studies of the sections, additional collections of fossils and revision of all faunal groups from the Upper Permian Forerange deposits, has resulted in a new interpretation of their stage and zonal assignment based on relationships among the previously defined units. The Upper Permian deposits

(Kutan, Nikitin, and Urushten formations of K. Miklukho-Maklay) in the Belaya, Bolshaya, and Malaya Laba River basins represent a coeval composite polyfacies assemblage, whose various facies yield diverse and abundant fossils.

The deposits of the terrigenous (Kutan) facies overlie transgressively and with angle unconformity the red-color deposits of the Lower Permian or Middle Carboniferous sandstone. This formation is mainly composed of conglomerate, sandstone, and siltstone with rare species of the small foraminifers *Nodosaria mirabilis caucasica* K. M-Maclay, *Geinitzina* sp., and the fusulinacean *Palaeofusulina* cf. *P. nana* Licharew.

The calcareous (Nikitin) facies is composed of dark gray flaggy-bedded algal-foraminiferal limestone with argillite interbeds. Small foraminifers are represented by *Hemigordius discoides* Lin, Li and Sun, *H. minutus* G Pronina, *H. guvenci* Altiner, *Midiella bronnimanni* (Altiner), *M. zaninettiae* (Altiner), *Agathammina maxima* Xia and Zhang, *Nodosaria longissima camerata* K. M-Maclay, *N. mirabilis caucasica* K. M-Maclay, *Pseudolangella doraschamensis* G. Pronina, *Frondina laxa* (Lin, Li and Sun), *F. paraconica* (K. M-Maclay), *Lingulina tumida* (K. M-Maclay), *Geinitzina gigantea* K. M-Maclay, *G. caucasica* K. M-Maclay, *G. uralica simplex* K. M-Maclay, *G. orientalis* (K. M-Maclay), *G. gloria* G Pronina, *Pachyphloia paraovata* K. M-Maclay, *Colaniella dense-camerata* G. Vuks, *C. media* K. M-Maclay, *C. cylindrica* K. M-Maclay, *C. parva* (Colani), *C. nana* K. M-Maclay, *Robuloides acutus* Reichel, *R. gibbus* Reichel, *Eocristellaria typica* K. M-Maclay, *E. permica* K. M-Maclay, *Paraglobivalvulina globosa* (Wang), *P. piyasini* Sakagami and Hatta, *Paraglobivalvulinoides septulifer* Zaninetti and Altiner, *Dagmarita caucasica* G. Vuks, *D. liantanensis* Hao and Lin, *D. miniscula* Wang, and *Neoendothyra eostaffelloidea* Liem. Fusulinids are dominated by *Palaeofusulina -Palaeofusulina nana* Licharew, *P. sinensis* Sheng, *P. wangi* Sheng, *P.kycungensis* Liem, *P.* ex gr. *P. rhomboidea* Liem, *P. prisca* Deprat, *P. ellipsoidalis* Sheng, *P.* ex gr. *P.pseudoprisca* (Colani), as well as *Parananlingella labensis* Chedija, *P. rhombica* Chedija, *Reichelina cribroseptata* Erk, *R. media* K. M-Maclay, *R. tenuissima* K. M-Maclay, and rare *Codonofusiella* cf. *C. nana* Erk and *C.* ex gr. *C. paradoxica* Dunbar and Skinner. Most characteristic among the brachiopods are *Chonetella nasuta* Waagen, *Tyloplecta yangtzeensis* (Chao), *Labaella bajarunassi* Licharew, *Lamnimargus caucasicus* (Licharew), *Anidanthus sinosus* Huang, *Linoproductus lineatus* Waagen, *Haydenella kiangsiensis* (Kayser), *Marginifera sexcostata* Licharew, *Spinomarginifera lopingensiformis* Licharew, *S. lopingensis* (Kayser), *Leptodus nobilis* (Waagen), *L. tenuis* (Waagen), *Uncinunellina tenuis* Liao and Meng, and *Rostranteris (Notothyrina) pontica* Licharew.

The reefogenic (Urushten) limestone facies forms thick (from 2-5 to 20-30 m) rock exposures and sometimes smaller bioherm bodies in the Belaya River Basin - Raskol-Skala Mountain, in the Malaya and Bolshaya Laba, and the Beskes River basins, along the Nikitin Ravine. The fauna is diverse and abundant, and is represented by the small foraminifers - *Lasiodiscus insecta* K. M-Maclay, *L. irregularis* K. M-Maclay, *L. planus* K. M-Maclay, *L. medusa* K. M-Maclay, *L. minor* Reichel, *L. divergens* Reichel, *L. granifer* Reichel, *Graecodiscus* sp. 1, *Hemigordius minutus* G. Pronina, *Neodiscus milliloides* A. M-Maclay, *Multidiscus* sp., *Nodosaria doraschamensis* G. Pronina, *Colaniella* sp., *Robuloides acutus* Reichel, *R. tumidus* (K. M-Maclay), and *Hubeirobuloides jiannanensis* Lin, Li and Zheng. Fusulinaceans are generally scarce, but present are *Reichelina minuta* Erk, *Parareichelina reticulata* K. M-Maclay, *Eoverbeekina* sp. and *Palaeofusulina* spp. The brachiopod assemblage is composed of typical reef and bioherm forms. The most characteristic are *Enteletes tschernyschewi* Diener, *Enteletella nikschichi* Licharew, *Tethysiella urushtensis* (Licharew), *Strophalosiina multicosta* Licharew, *Strophalosia rugosocostata* Licharew, *Spinomarginifera kueichowensis* (Huang), *Compressoproductus mongolicus* (Diener), *Transennatia gratiosa* (Waagen), *Anidanthus sinosus* (Huang), *Haydenella kiangsiensis* Kayser, *Leptodus nobilis* (Waagen), *L. richthofeni* (Kayser), *Richthofenia caucasica* Licharew, *Permianella parvula* (Licharew), *Hybostenoscisma bamboides* Liao and Meng, *Prelissorhynchia pseudoutah* (Huang), *Semibrachithyrina anshunensis* Liao, *Martinia tongmuqtaoensis* Liao and Meng, and *Notothyris pseudodjoulfensis* Licharew.

The Urushten argillaceous shale facies is mainly composed of argillite containing abundant biohermal bodies, detrital limestone and calcareous nodules. Fossils are found in all rock types. In the limestone detritus there are the small foraminifers - *Graecodiscus* sp. 1, *Multidiscus* sp., *Neodiscus milliloides* A. M-Maclay, *Agathammina maxima* Xia and Zhang, *A. ovata* Wang, *Lasiodiscus medusa* K. M-Maclay, *Nodosaria longissima camerata* K. M-Maclay, *Frondina paraconica* (K. M-Maclay), *Geinitzina uralica simplex* K. M-Maclay, *G. orientalis* (K. M-Maclay), *Pachyphloia paraovata* K. M-Maclay, *P. angulata* K. M-Maclay, *P. pigmobesa* Wang, *P. cukurkoyi* Civrieux and Dessauvagie, *Colaniella parva* (Colani), *C. media* K. M-Maclay, *Robuloides caucasicus* (K. M-Maclay), *R. orientalis* (K. M-Maclay), *R. gibbus* Reichel, *Neoendothyra eostaffelloidea* Liem, *Postendothyra guangxiensis* Lin, *Tetrataxis lichuanensis* Lin, Li and Zhang, and *Deckerella media permiana* Wang, the fusulinids - *Reichelina* sp., *Parareichelina* sp., *Palaeofusulina* sp., and a coral *Waagenophyllum asperum* Zhao (identification by O. L. Kossovaya). In the argillaceous shale and detrital limestone, the brachiopod assemblage is represented by the Nikitian association of *Derbyia grandis* Waagen, *Tyloplecta yangtzeensis* (Chao), *Transennatia gratiosa* (Waagen), *Leptodus nobilis* (Waagen), and *Anidanthus sinosus* Huang. In the upper beds of the argillaceous shale are dominant representatives of *Cathaysia – C. orbicularis* Liao, *C. spiriferoides* Xu and Grant, *C. chonetoides* (Chao) and other taxa. Ammonoids, confined to the upper 30m of the unit, are dominated by *Xenodiscus koczyrkeviczi* Zakharov. In addition, these beds also yield *Stacheoceras* (=”*Cyclolobus*” sp.) (abundant), *Eumedlicottia*, *Neogeoceras*, *Neocrimites*, and *Huananoceras*? (Kotlyar *et al*., 1983, 1989; Zakharov, 1985). Recently, *Dushanoceras valeriae* Zakharov was discovered in the uppermost beds of the argillaceous shale. The bivalves *Palaeolima inequicostata* Maslennikov, *Pernopecten aviculatum labaensis* Maslennikov, *Cyrtorostra caucasica* (Licharew), and *Aviculopecten cubanicus* Maslennikov (identification by L. V. Kushnar) are present throughout the argillaceous shale facies. In its upper part “*Claraioides*” aff. “*C.*” *dianus* (Guo) and “*Claraioides*” *caucasicus* (Kulikov and Tkachuk) are dominant (identification by I. V. Polubotko).

A Late Changhsingian age of the deposits is established based on the fusulinids *Palaeofusulina nana*, *P. sinensis*, *P. wangi*, *P. ellipsoidalis*, *P. prisca*, and *Reichelina cribroseptata* all of which are common with Changhsingian assemblage of the

Palaeofusulina sinensis – Reichelina changhsingensis Zone (Xu and Grant, 1994), or the *Palaeofusulina sinensis* Zone in South China (Sheng and Jin, 1994). *Parananlingella labensis* Chedija, occurring together with the genus *Palaeofusulina*, is close to the type Late Changhsingian Chinese species *P. acervula* Sheng and Rui (Kotlyar *et al*., 1983, 1989). Small foraminifer are also characteristic of the Late Changhsingian in China - *Paraglobivalvulina globosa*, *Pseudolangella doraschamensis*, *Frondina palmata*, *Pachyphloia pigmobesa*, *Geinitzina tcherdynzevi*, *G. inflata*, *Colaniella parva*, *C. cylindrica*, *C. nana*, and *C. media*. Also present is the species *Nodosaria doraschamensis* G. Pronina one of the indexes of the *N. doraschamensis – N. delicata* Zone of the Dorashamian of Transcaucasia (Pronina, 1990). Among brachiopods present are *Enteletes tschernyschewi*, *Cathaysia orbicularis*, *C. chonetoides*, *C. spiriferoides*, *Anidanthus sinosus*, *Haydenella kiangsiensis*, *Spinomarginifera lopingensis*, *Tyloplecta yangtzeensis*, *Transennatia gratiosa*, *Leptodus nobilis*, *L. richthofeni*, *L. tenuis*, and others that are common with those of the Late Changhsingian in South China. Of most significance for dating, however, is the occurrence of the species *Dushanoceras valeriae* that displays the greatest similarity with the only representatives of this genus *D. rotalarium* Zhao, Liang and Zheng from *Rotodiscoceras* Zone in the Upper Changhsingian of South China (Zhao *et al*., 1978).

Southern Primorye

In the Southern Primorye, the upper part of the Lyudyanzian is assigned to the Changhsingian based on small foraminifers and fusulinids (Vuks and Chedija, 1986; Burago *et al*., 1977). The most characteristic present are *Colaniella leei* (Wang), *C. parva* (Colani), *C. pulchra* Wang, *C. xikouensis* Wang, *C. primoriensis* G. Vuks, *C. turris* G. Vuks, *C.* aff. *C. cylindrica* K. M-Maclay, and *Pseudocolaniella* cf. *P. xifulingensis* Wang all known from the Changhsingian in Southern China (Wang, 1966; Zhao *et al*., 1981). Some species are known from the *Shindella pamirica-Sh. simplicata* Zone in the Southeastern Pamirs (Kotlyar *et al*., 1983), and from the Nikitin and Urushten facies of the Northwestern Caucasus. Among fusulinids present are *Palaeofusulina* cf. *P. prisca* Deprat, *Paradunbarula* (*Shindella*) sp. A, *Reichelina* spp., rare *Codonofusiella* sp., *Staffella zisongzhengensis* (Cheng), *S.* ex gr. *S. orientalis* (K. M-Maclay), and *Nankinella* cf. *N. hunanensis* (Cheng).

In addition, Changhsingian deposits are found on the left bank of the Artemovka River and near the Vodopadnaya railway station (Zakharov *et al*., 1995), and are represented by a sandstone, siltstone, and mudstone unit occurring directly on upper Dzhulfian beds with *Eusanyangites bandoi* (Zakharov, 1987, 1992). The lower part of the unit is distinguished as *Iranites* beds with *Neogeoceras taumastum* Ruzhencev, *Eumedlicottia* sp., and representatives of Cyclolobidae. The upper part of the unit distinguished by beds with Pleuronoceratidae-*Liuchengoceras*, is characterized by *Liuchengoceras melnikovi* Zakharov, and a new genus of Pleuronodoceratidae (Zakharov *et al*., 1995). The overlying Kapreev Beds (earlier assigned to the Triassic) contain only *Xenodiscus* aff. *X. carbonarius* (Waagen), *X.* sp., and rare bivalves of the genera *Posidonia* and *Claraia*.

A more complete section of the Kapreev siltstone with abundant Late Changhsingian ammonoids is located on the right bank of the Partizanskaya River near the Vodopadnaya railway station. Here, the beds overlie the deposits of the Yastrebov Formation, with *Palaeofusulina* cf. *P. prisca* Deprat, *Colaniella* cf. *C. parva* (Colani), and *C. media* K. M-Maclay. At the base of the Kapreev beds occur small epiplanktonic thin-valved brachiopods – *Paracrurithyris pygmea* (Liao), *Crurithyris flabelliformis* Liao and *Araxathyris minor* Grunt, characteristic of the uppermost Changhsingian in China (Liao, 1980; Sheng *et al*., 1984), and Dorashamian of Transcaucasia (Kotlyar *et al*., 1983). The overlying deposits containing exclusively ammonoids are distinguished as beds with *Huananoceras quianjiangense*. Ammonoids are dominated by *Xenodiscus* cf. *X. carbonarius* (Waagen), *X.* aff. *X. strigatus* Schindewolf, and *X.* cf. *X. jubilaensis* Zakharov. Among the Araxoceratidae, *Dzhulfoceras orientale* Zakharov is present; there are abundant *Huananoceras peroratum* Chao and Liang, *H.* cf. *H. involutum* Chao and Liang, representatives of the genera *Changhsingoceras*?, *Liuchengoceras* (*L.* cf. *L. crassicostatum* Zhao, Liang and Zheng), *Tapashanites*, *Sinoceltites* (*S.* ex gr. *S. costatus* Zhao, Liang and Zheng), and *Mingyuexiaceras*. The age of the Kapreev siltstone is determined as the Late Changhsingian and can be reliably correlated with zones *Pseudostephanites-Tapashanites* and *Pleuronodoceras-Rotodiscoceras* zones the Late Changhsingian in China (Yin, 1985; Zhao *et al*., 1978), the *Pleuronodoceras occidentale* Zone in Transcaucasia (Zakharov, 1992) and beds with *Dushanoceras valeriae-Xenodiscus koczyrkeviczi* in the Northwestern Caucasus.

Southeastern Pamirs

In the Southeastern Pamirs, the Takhtabulak Formation of the Intermediate (Promezhutochnaya) subzone, and the uppermost (15 m thick) of conglomerate-like and tufogenic limestone of the Kastanatdzhilga Formation in the Kurteke of the Central subzone can be assigned to the Late Changhsingian.

The Takhtabulak Formation, comprising three Subformations (Grunt and Dmitriev, 1973; Kotlyar *et al*., 1983) is predominantly composed of tuff conglomerate, tuff sandstone, tuff siltstone, tuff mudstone with lenses of organic detritus, clastic, clayey and siliceous limestone, and small bioherms. The Takhtabulak Formation is overlain by the Lower Triassic Karatash Formation yielding *Claraia* and *Flemingites* (Dagis *et al*., 1979). Organic detrital and bioherm limestone in the Lower and Middle subformations yield the small foraminifers - *Neodiscus milliloides* A. M-Maclay, *Midiella brunni* (Lys), *Agathammina ovata* Wang, *Lasiodiscus irregularis* K. M-Maclay, *Lasiotrochus* ex gr. *L. tatoiensis* Reichel, *Nodosaria dorashamensis* G. Pronina, *N. mirabilis caucasica* K. M-Maclay, *N. longissima camerata* K. M-Maclay, *Robuloides acutus* Reichel, *R. orientalis* (K. M-Maclay), highly developed *Colaniella parva* (Colani), *C. media* K. M-Maclay, *C. cylindrica* K. M-Maclay, *C. lepida* Wang, *C. lui marcouxi* Lys, *C. exilis* Chedija, and *Paraglobivalvulinoides septulifer* Zaninetti and Altiner, *Postendothyra* sp., *Neoendothyra eostaffelloidea* Liem, and *Abadehella* sp. Most species are characteristic for the Late Changhsingian of China (Wang, 1966; Ishii *et al*., 1975), Northwestern Caucasus, Southern Primorye and the *Palaeofusulina sinensis* Zone in the Tethyan Realm. Fusulinaceans are represented by numerous *Paradunbarula* (*Shindella*) *pamirica* Chedija, *P.* (*Sh*). *prolata* Chedija, *P.* (*Sh*). *dzhilgensis* Chedija, *P.* (*Sh*). *shindensis* Chedija, and *P.* (*Sh*). *plicata* (Sheng) known from the Changhsing Formation in Southern China (Rui and Sheng, 1981). Among other fusulinacean species *Reichelina changhsingensis*

Sheng and Chang, *R. pulchra* K. M-Maclay, *R. cribroseptata* Erk, and *R. mirabilis* (Dutkevich) are very common in the Changhsingian of the Tethyan Realm. The only representative of *Palaeofusulina*, *Palaeofusulina* aff. *P. fusiformis* Sheng, also occurs in the Changhsingian of Southern China (Sheng, 1963; Rui and Sheng, 1981).

Changhsingian (Dorashamian) tetracorals of the Takhtabulak Formation identified as belonging to the *Waagenophyllum* (*Waagenophyllum*) – *W.* (*Huayunophyllum*) Zone, contain *Pseudohuangia collucata* Iljina, *P. pyzhjanovi* Iljina, *Waagenophyllum* (*Waagenophyllum*) *tachtabulasicum* Iljina, *W.* (*W.*) *crassiseptatum* Iljima, *W.* (*W.*) *kueichowense* Huang, *W.* (*W.*) *virgalense* (Waagen and Wentzel), *W.* (*Huayunophyllum*) *pamiricum* Iljina (Iljina, 1998). A similar tetracoral assemblage is very characteristic of the Changhsingian in Southern China (Xu, 1984; Sheng and Yin, 1994).

The Takhtabulakian brachiopods have been assigned ages from the Midian to the Dzhulfian (Grunt and Dmitriev, 1973; Kotlyar *et al*., 1983). Revision and restudy of the Takhtabulak brachiopod assemblage confirmed their similarity with brachiopods of the northwestern Caucasus. The most characteristic are *Enteletella nikchichi* Licharew, *Scacchinella licharewi* Grunt, *Strophalosiina multicostata* Licharew, *Richthofenia caucasica* Licharew, *Leptodus nobilis* (Waagen), *Marginifera sexcostata* Licharew, *Anidanthus sinosus* (Huang), *Compressoproductus mongolicus* (Diener), *Haydenella tumida* (Waagen), *Cathaysia orbicularis* Xu and Grant, *Wellerella arthaberi* (Tschernyschew), *Uncinunellina timorensis* (Beyrich), *Rostranteris* (*Notothyrina*) *pontica* (Licharew), and *Notothyris pseudojoulfensis* Licharew. Present as well are the similar genera *Gerassimovia*, *Camarophorinella*, and *Heterelasmina*.

Of decisive significance for dating the Takhtabulak Formation are the conodonts occurring within it – *Clarkina subcarinata* (Sweet) in the Igrim'yuz section and *C. planata* (Clark) in the conglomerate-like limestone unit in the Kurteke River section (Davydov *et al*., 1991; Kozur *et al*., 1994).

Conclusion

Similar composition of the Urushten – Nikitin faunal communities of the Northwestern Caucasus, Upper Lyudyanzian communities of Southern Primorye, Takhtabulak forms of the Southeastern Pamirs, and their great similarity with Changhsingian faunal assemblages of Southern China clearly indicate their coeval character. Thus, one can state that deposits of the Upper Changhsingian occur in these regions, although uppermost Permian beds have as yet to be identified.

Analysis and comparison of the Changhsingian small foraminifers and fusulinaceans point to the common character and stability of their assemblages within the Tethys Realm from the Northwestern Caucasus in the west to Southern China and Japan in the east. Similar assemblages have been also recorded in the Nabekosi Formation (Toyoma Series) of Japan (Tazawa, 1975), in the limestone lenses of the Oguno Formation, and exotic blocks among the Anisian deposits of Japan (Kobayashi, 1997), in the upper part of the Episkopi Formation in Greece (Nakazawa *et al*., 1975; Xu and Grant, 1994), in the *Palaeofusulina - Colaniella* Zone of Malaysia (Aw *et al*., 1977), and in the *Palaeofusulina sinensis – Colaniella parva* Zone of Thailand (Sakagami and Hatta, 1982).

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Correlation of Guadalupian Series with the Abadeh Section

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Paleontological information about fusulinids of the Capitanian Stage in Permophiles #34, June 1999, indicates that the top of Capitanian Stage (Lamar Limestone) correlates at the most with Unit 3 of the Abadeh Section. Consequently marine equivalent of Unit 4 and Unit 5 (totally at least 334 meters of marine rock strata) are missing between the top of the Capitanian Stage and the base of the Lopingian Series, the *Araxilevis* Beds. Figure 1 shows this missing interval.

Evidences are as follows:

Glenister *et al*. (Permophiles # 34), p.8 describes that "The Late Guadalupian (early Capitanian) is characterized by *Polydiexodina*, a large fusulinacean with fully developed multiple tunnels, including a well-defined central tunnel (Wilde, 1998)." Further down: "The large and complex fusulinaceans of the *Polydiexodina* zone were succeeded by advanced Neoschwagerinidae that replaced simple tunnels with foramina and parachomata."

Referring to the report of the Iranian-Japanese Research Group, 1981, p.118 "Nearly all the larger fusulinids disappeared at the end of Unit 3 and were replaced by smaller ones." Also Fig. 19 of the same report shows range-chart and zones of 48 different species of fusulinids in the Abadeh Section and indicates that large fusulinids and Neoschwagerinidae occur only in Unit 1and Unit 2 of that Section.

Therefore, it is logical to conclude that the Capitanian Stage correlates with Units 1 and 2 of the Abadeh Section only.

Glenister *et al*. (Permophiles # 34), p.8, reported also that in the Capitanian rocks : "Associated with *Polydiexodina* is *Leella bellula*, and the beginning of the codonofusiellids *(Codonofusiella paradoxica)."*

Similarly, Fig. 19 of the Iranian-Japanese Research Group, 1981, confirms that *Codonofusiella spp.* occurs sporadically in Units 1 and 2 of the Abadeh Section in association with *Neoschwagerina*.

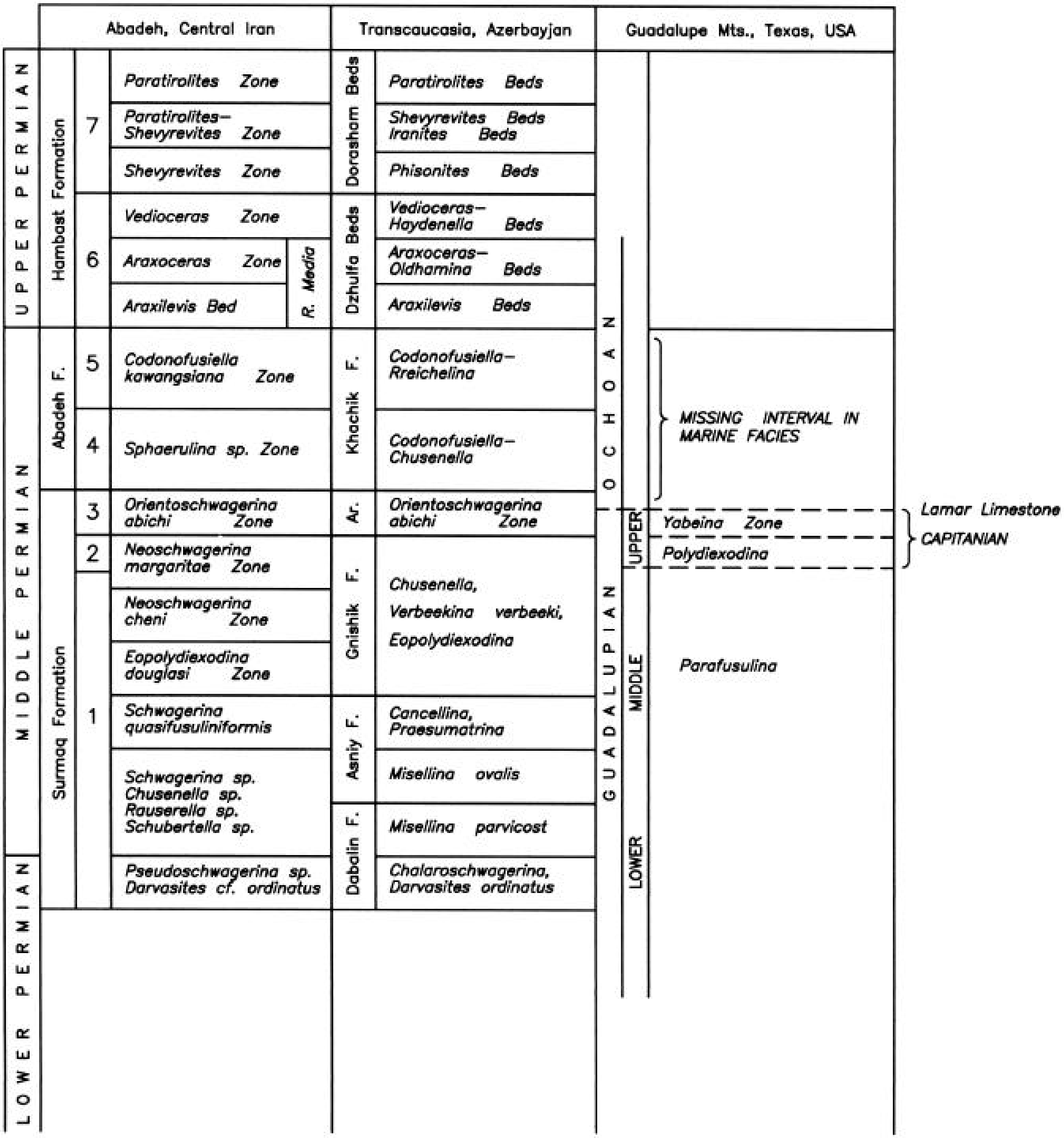

Figure 1. Correlation of sections in Central Iran, Azerbayjan and West Texas.

Therefore, occurrence of *Codonofusiella* in Capitanian rocks does not necessarily indicate that Capitanian is younger than Unit 2 of the Abadeh Section.

Furthermore, the Iranian-Japanese Research Group, 1981, p.104, correlated the Lamar Limestone (top of the Capitanian Stage) with the Abadeh Section as follows: "In this connection (correlation between Lamar Limestone and Abadeh Section), the occurrence of *Yabeina texana*, *Codonofusiella extensa*, *Reichelina lamarensis*, and *Paradoxiella pratti* from the Lamar Limestone, the uppermost member of the Bell Canyon (Capitanian) in Texas is important. *Yabeina texana* was first considered to be a primitive form of the genus by Skinner and Wilde (1966) in having a small shell provided with a small number of volutions and poor development of secondary septula. Minato and Honjo (1959) pointed out that *Yabeina texana* is identical in septal development with *Y. ozawai*, which occurs in the *Neoschwagerina margaritae* zone in Japan. Later, Ross and Nassichuk (1970) expressed the opinion that *Y. texana* has advanced features of septula comparable to that of *Yabeina globosa* and correlated the Lamar Member with the *Yabeina globosa* or *Yabeina-Lepidolina* Zone in Japan. This correlation was approved by Wilde (1975). The coexistence of *Codonofusiela* and *Reichelina* seems to support this correlation.

As discussed already, the Abadeh Formation is believed to be younger than the *Yabeina globosa* Zone, because the underlying

Orientoschwagerina abichi Zone of Unit 3 can be compared to the *Yabeina* Zone, and Unit 5 is correlated with the Wujapingian *Codonofusiella* Zone.

The La Colorada beds which occupy the uppermost part of the Permian at Coahuila, in Mexico, are generally believed to be a Lamar equivalent, but there is no convincing paleontologic evidence in support of this. The beds yield *Eoaraxoceras ruzhencevi*, *Neocrimites* sp., *Stacheoceras* cf. *tridens*, *Propinacoceras* n. sp., *Episageceras* cf *nodosum* and *Kingoceras kingi* (Spinosa et.al., 1970). The fauna is compared to the Amarassi fauna of Timor. Furnish (1973) introduced the Amarassian Stage above the Capitanian, but considered that the Lamar Member is Amarassian. However, the La Colorada beds are about 600m above the beds (Bed 43 of Newell, 1957) which have a typical Capitanian fauna and about 200m above the Zone of *Kingoceras*. Recent discovery of *Eoaraxoceras ruzhencevi* from the basal part of the *Araxoceras* Zone at Abadeh suggests the post-Guadalupian age of the La Colorada beds.

A direct comparison of the Abadehian fauna with the Amarassi fauna is difficult, but the former fauna is compared to that of the Kalabagh-Lower Chhidru in having *Xenodiscus carbonarius*, *Codonofusiella-Reichelina* assemblage and a few common species of foraminifers and brachiopods. The Kalabagh-Lower Chhidru brachlopod fauna is, in turn, very similar to the Amarassi fauna. La Colorada beds, Amarassi “beds”, Kalabagh-Lower Chhidru beds and Abadeh Formation are considered to be nearly time-equivalent, that is, between Capitanian and Dzhulfian in age.”

Conclusion

Above-mentioned evidences suggest that the Guadalupian series correlate only with Units 1 and 2 of the Abadeh Section and it does NOT represent complete time-equivalent of the interval between Artinskian and Wuchiapingian (Dzhulfian) Stages. In other words, as is shown on Fig. 1, Guadalupian Series has no common boundary with Lopingian Series. In such a case, how can this imperfect and incomplete Series be accepted as International Standard for the Middle Permian Series? The writer suggests that such a proposal can not be accepted.

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Response of Glenister, Wardlaw, and Davydov

Recent fusulinid, conodont, and ammonoid data from Sicily and British Columbia (Kozur and Davydov, 1996, Guadalupian II, p. 11-15) suggest that at least upper Wordian correlates with Midian and therefore with the Arpa Formation (Transcaucasia) and unit 3 of the Abadeh section. The Capitanian in this case corresponds to the Khachik Formation and unit 4 at Abadeh. This same correlation was made based on fusulinids and smaller forams from the Abadeh section (Baghbani, 1977, Permophiles, no. 30, p. 24-25). Therefore, the main point for a missing interval by Taraz that unit 3 correlates with the Capitanian has been differently interpretated by fusulinid workers. There is much work left to be done, especially in relating different taxonomic successions; however, the existing data do not support the conclusion of Taraz that the Guadalupian is incomplete.

To clarify some possible misconceptions the following points should be made:

1) The Guadalupian Series and its component stages have been approved (this issue, Permophiles). The base of the Upper Permian Lopingian Series and coincident Wuchiapingian Stage automatically become the upper boundary of the underlying unit (i.e., the Middle Permian and coincident Capitanian Stage, and there can be no missing interval).
2) Bases of all three Guadalupian stages are defined as arbitrarily chosen points within conodont chronomorphoclines.
3) The base of the Lopingian Series and coincident Wuchiapingian Stage will be chosen according to the exact same procedure, an arbitrary selection of a point within a conodont morphocline.
4) Virtually the same conodont successions have been described from West Texas and South China characterizing the highest Guadalupian and Lopingian boundary (Mei *et al*., 1998, Palaeoworld 9, 53-76) suggesting no gap.
5) All three GSSP’s for Guadalupian stages are located within the boundaries of the Guadalupe Mountains National Park, where access is safe, convenient and guaranteed to all qualified/responsible professional scientists (Glenister, 1993, Permophiles, no. 23, p. 20-21).
6) All standard reference sections for the type Guadalupian occur in close geographic proximity and in objective superposition.
7) Other sites cited by Taraz have serious deficiencies. The La Colorada beds are accessible, Amarassi locations in Timor and Kalabagh-Chhidru sections in Pakistan are marginal, and the Abadeh section is not universally accessible to qualified scientists. Amarassi has the additional disadvantage that it is merely a surface collecting site, without objective stratigraphic succession, and, in fact, within a Miocene tectonic mélange. Use of any of these alternatives would add an unnecessary additional geographic reference without objective relationship to the present three series standards.

Given these considerations, the Guadalupian remains the best choice as an international standard for the Middle Permian Series and component stages as attested by the recent majority vote of the SPS. Conodont evidence indicates that there is no gap between the Middle and Upper Permian references.

Alternative Proposal of International Standard References for the Middle and Late Permian Series

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The participants of the International Symposium “Upper Permian Stratotypes of the Volga Region” held in 1998 (Kazan, Russia) made a decision to use two parallel scales for the upper part of Permian System: classical Late Permian scale (consisted of the Ufimian, Kazanian and Tatarian) basing the reference sections exposed within Volga-Uralian area and the International Scale, proposed by SPS titular members, consisted of the Guadalupian and Lopingian series, corresponding as a whole to conventional Upper Permian Series. Early Permian (Cisuralian) Series consisted of the Asselian, Sakmarian, Artinskian and Kungurian stages is common for both scales.

Late Permian deposits of East-European basins are represented by the complete spectrum of facies from normal marine to lagoonal marine and continental. This scale can be used successfully for the Boreal and Notal marine and continental deposits of antitropical realms. At the same time Guadalupian and Lopingian series and especially their constituent stages in reality can serve for the correlation within the marine basins of the Equatorial belt only. That is why two parallel scales for the upper part of the Pemian system are nesessary in the same manner, as it was accepted in previous International Scale (Cowie, Bassett, 1989).

For better modern correlation and coordination of stratigraphic subdivisions of these two alternative scales, we propose formally to improve upon the traditional East-European scale.

1. We propose to introduce the Biarmian Series composed of the Ufimian and Kazanian stages corresponding to the Guadalupian approximately (name “Biarmia”, or “Permia” is derived from the name of a legendary country in the North-East of European Russia; known from Russian and Scandinavian traditions of 9th – 13th centuries). The Urzhumian horizon (lower part of the Tatarian Stage) must be included in the Kazanian in this variant. The point of Global Stratotype for the Biarmian Series lower boundary is defined at the base of the Kozhim Rudnik Formation (Kozhim River key section, Pechora coal basin, Pre-polar Urals). Biogeographically this section is situated between the stratotype area and the territories belonging to Barents Shelf area. It is well characterized by small forams, bryozoans, brachiopods, bivalves, ammonoids, ichtyofauna, flora, and miospores. We propose to define the point of the Global Stratotype of the Biarmian lower boundary at the base of the Kozhim Rudnik Formation (the base of the layer 447, Biota of East European Russia..., 1998, Fig. 26). The materials studied indicate that the Solikamsk Horizon belongs to the Ufimian.

2. We propose to raise the rank of the Tatarian Stage to that of series level and its constituent horizons, the Severodvinian and Vjatkian considered as stages. It would correspond to the Lopingian Series and component Wuchiapingian and Changsingian stages in the terms of the scale proposed by SPS Titular Members, or to the Midian, Djoulfian and Dorashamian stages of the Tethyan Regional Scale. The lower boundary of the Tatarian Series corresponds the base of the Severodvinian Stage which coincides the paleomagnetic boundary of the R-Kiama and NR-Illawara hyperzones. The Russian working group has chosen the Monastyrskoe Ravine section on the right bank of the Volga River near Tetyushi (Tatarstan) as the stratotype for the Kiama-Illawara boundary (Burov, 1996; Petrova, Molostovsky, 1999). We propose to define the point of the Global Stratotype of the Tatarian Series lower boundary at the base of the layer 177 in the uppermost part of the Urzhumian Horizon within the reference section of the Monastyrskoe Ravine (Stratotypes and Reference Sections...., 1996; p. 131, text-Fig. 2.3.2-1). The Sukhona River section (Vologda region) is indicated as the stratotype of the Illawara Upper Permian part (Petrova, Molostovsky, 1999). This boundary is in keeping with the significant changes in the evolution of non-marine fauna (bivalves, ostracods, fishes, tetrapods) and flora.

We would like to pay attention that the using of proper names for the series is not institutionalized still; now those and are used exclusively for the Permian System.

3. Further we would like to give some special comments on the ”Proposal of Guadalupian and Component Roadian, Wordian and Capitanian Stages as International Standards for the Middle Permian Series” (Permophiles, 1999. # 34, p.3) The basement of the Guadalupian Series in West Texas is defined by the first appearance of *Jinogondolella nankingensis* within the evolutionary cline from *Mesogondolella idahoensis* to *J. nankingensis*. Unfortunately, correlation with other regions and scales, which is necessary

according the "Guidelines.." (Remane *et al*., 1996) is insufficient in this publication. Meantime there is no definition in the correspondence in the time of the first appearance of *J. nankingensis* in the sections of West Texas and South China. On one hand it is declared correlation amongst Roadian, Kubergandian and Ufimian and correspondence of the Roadian to the *Praesumatrina neoshwagerinoides* - *Cancellina cutalensis* - Armenina Fusulinid Zone (see: Jin Yugan *et al*., 1997b; fig 3). On the other hand, in its type locality in South China *J. nankingensis* was described "from the Kuhfeng Formation of Wordian age....; its lowest occurence is *Presumatrina neoshwagerinoides* - *Neoshwagerina simplex* Zone, a level, corresponding to the base of the Murgabian Stage" (see the same publication: Jin Yugan *et al*., 1997b, p. 13). On the next side, a portion of new data (Jin Yugan, 1997a; Henderson *et al*., 1999) shows, that "*J. nankingensis* is found to first appear in the fusulinacean *Afghanella schenki* Zone, which is overlain by the *Neoshwagerina margaritae* Zone. This indicates that the base of the Guadalupian correlates to a horizon in the Upper Murgabian" (Henderson *et al*., 1999, p. 57). Moreover, the Kiama/Illawara Hyperzones' boundary is reported in upper part of Maokau Formation of South China (Haag & Heller, 1991). Now, we would like to ask a question: What is the real correlation of the Roadian in the sections of the Tethys (including South China); what is a real volume of Guadalupian Series in the sections of South China and what is a dating of Kubergandian Stage, which is reported to be "at least a partial correlative of the Roadian, having a priority as a named stage...." (Glenister *et al*., 1999, p.3).

Summary

A. All the cited data demonstrate clearly, that there is no evidence for correlative potential of the Guadalupian Series even in well investigated South Chinese sections.

B. In fact these data demonstrate that there is a real stratigraphic gap of stage level (Ufimian or Kubergandian) between upper boundary of Cisuralian (Kungurian) and base of Guadalupian (Roadian).

C. It contradicts all available data (Bogoslovskaya, Leonova, 1995; Davydov, 1995; Leven, 1995) to account the Kubergandian to belong to the Early Permian (Cisuralian).

D. It is irrational to discriminate traditional East-European Late Permian scale which is going on to role as a fundamental for the correlations all over the world.

E. Even if Guadalupian Series and component Roadian, Wordian and Capitanian Stages are formally supported by SPS titular members by a formal vote and afterwards ratified by the 31st International Congress in Rio de Janeiro in August 2000 it does not matter that in fact this subdivision could serve as a single international standard.

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Response of the Editors (C.S., B.F.G., B.R.W.)

The preceding proposal (Grunt *et al.*) is published exactly as submitted, except that the initial word of the original title ("formal") has been omitted. Simply stated, the proposal does not provide the information required for submission of a GSSP (Remane *et al*., 1996, p. 80, section 5.1). Unlike the constructive "Gateways" contribution (Shi and Archbold, herein) the proposal detracts from the attempt to develop a single international standard for the subdivision of Permian time. Rather, it burdens our science with an additional set of regional terms, many new.

Kungurian/Ufimian Boundary in Pai-Khoy

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Kungurian and Ufimian deposits in Northeastern Pai-Khoy (Fig. 1) were first established by Chernov (1936) and later studied by many other workers (Ustritsky, 1959, 1971; Entsova *et al*., 1974; Gus'kov *et al*., 1980; Muromtseva and Gus'kov, 1984; Gus'kov, 1988; Pukhonto, 1998 and others). The age of the stratigraphic units of the Artinskian-Ufimian interval in the area remains widely debated. First of all, it concerns the age of the Talata Formation and recently established Liurjaga and Tabju Formations. Precise dating of these units is important for correlation of deposits of the Pechora region with the stratotype region and other areas in Biarmian province. However, it is particularly important for the refinement of the Kungurian/Ufimian boundary in marine sections of Biarmian province especially in the Russian Platform where it has not been reliably defined.

The age of the Liurjaga Formation, which is assigned by some workers to the upper part of the Talata Formation (Kanev and Kalashnikov, 1990), has been somewhat clarified in the last few years. Ammonoids, *Medlicottia postorbigniana* and *Tumaroceras dignum*, found in the Liurjaga Formation and described by Bogoslovskaya (1997) allowed correlation of this formation with the Kungurian. In addition to the above ammonoids, a large assemblage of brachiopods has been reported in the Liurjaga Formation (Kanev and Kalashnikov,1990; Kalashnikov, 1993): ***Lingula liurjakhensis***, *Arctitreta kempei, A. triangularis, Svalbardia capitolina, Arctichonetes postartiensis, Yakovlevia impressa, Megousia aff. Aagardi, M. kuliki,* ***Rugaria? pajchoica***, *Sowerbina granulifera, Kochiproductus sultanaevi, Linoproductuscora rhiphaeus, Rhynchopora nikitini, Spiriferella telbeica*. Gus'kov and Pukhonto (Gus'kov *et al*., 1980; Pukhonto, 1998) supplemented this list with other brachiopod species "*Cancrinella loweni*" (probably *Kolymaella ogonerensis*), *Sowerbina timanica, Striapustula koninckiana, Yakovlevia mammatiformis* and *Spiriferella drashei*. Kalashnikov (1993) considers the assemblage to be Ufimian, however, all species, except for newly established (bold), occur in Kungurian and even older deposits in the Pechora Basin and other various regions of Biarmian province.

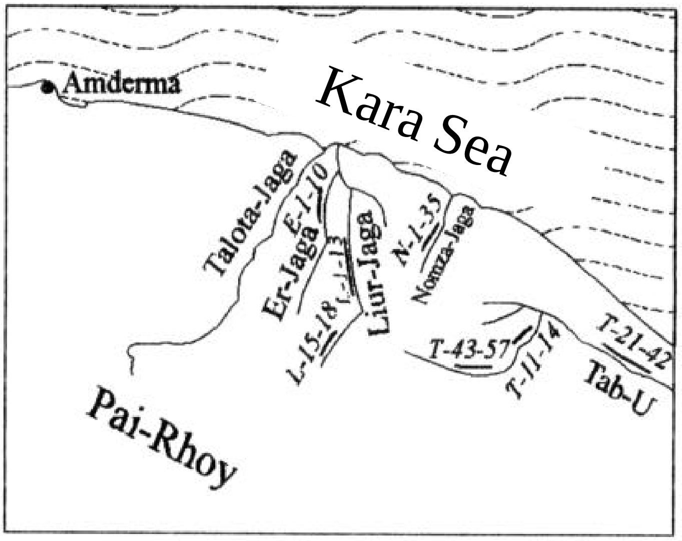

Figure 1. Map showing the location of the main Permian sections in the northweastern Pai-Khoy (after Guskov *et al*., 1980)

The overlying Tabju Formation is treated as Ufimian by many workers (Ustritsky, 1971; Gus'kov *et al*., 1980; Kanev and Kalashnikov, 1990; Pukhonto, 1998). The discovery of a new ammonoid in its lower portion of the (Bed 13, Fig. 2) however, introduces essential corrections into the establishment of the true age of the Tabju Formation and allows considerable improvement of the position of the Kungurian/Ufimian boundary in the Pai-Khoy sections. The ammonoid was found by V. Gus'kov and was first identified by A. Pavlov as *Uraloceras* (Gus'kov *et al*., 1980). Later on, however, A. Pavlov, M. Bogoslovskaya and A. Popov reinterpreted its taxonomy and attributed it to the genus *Epijuresanites*.

Occurrences of *Epijuresanites* as well as the *Tumaroceras* found in the underlying Liurjaga Formation indicate unambiguously the Kungurian age of both Liurjaga and Tabju Formations. Bogoslovskaya (1997), while describing the new species *Epijuresanites vaigachensis* from the Lekvorkuta Formation of Vaigach Island gives strong grounding for this statement.

Thus, we can state with assurance that the lower lagoon-marine subformation of the Tabju Formation (beds 5-14 on Fig. 2, according to Pukhonto, 1998) must be considered of Kungurian age. The top of this subformation is a true geo-historical boundary. It is characterized by an essential increase of fresh-water lagoonal and continental deposits, the appearance of the Inta floristic assemblage (Pukhonto, 1998), and extinction of many genera and species of brachiopods and bivalves.

Kanev considers that the middle part of the Tabju Formation, the lowermost part of the Lekvorkutskaya and lower part of the Inta formations in the Pechora Basin are equivalent to the middle part of the Solikamsky Horizon in the type area (lower Ufimian) because they are characterized by identical *Khosedella alta – K. permica* bivalve assemblages (Kanev and Kalashnikov, 1990: Kanev, 1994).

Therefore, it is safe to say that the Lower Tabju subformation and the Lekvorkuta Formation containing the Kungurian ammonoid *Epijuresanites* and the Lower Ufimian (Solikamian), are characterized by a single bivalve assemblage, and are to be assigned to the Kungurian. The lower boundary of the Ufimian stage in the stratotype should be elevated to the base of the Sheshmian. According to Kotlyar, this level must be considered as the Kungurian/Roadian boundary in the Biarmian province (Russian Arctic).

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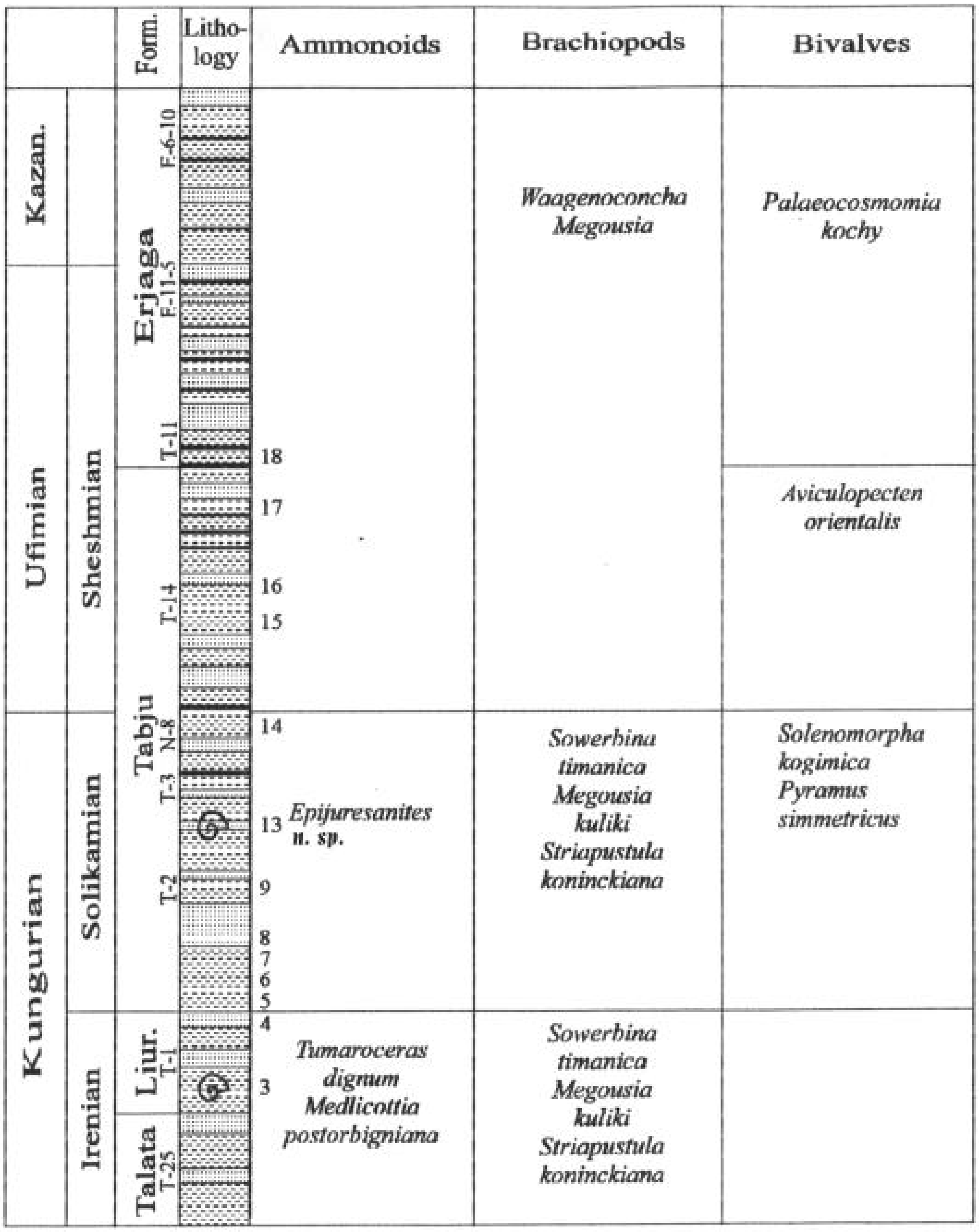

Figure 2. Distribution of the Kungurian and Ufimian faunal associations in the synthetic Permian section of the northeastern Pai-Khoy (Guskov *et al.*, 1980; Pukhonto, 1998).

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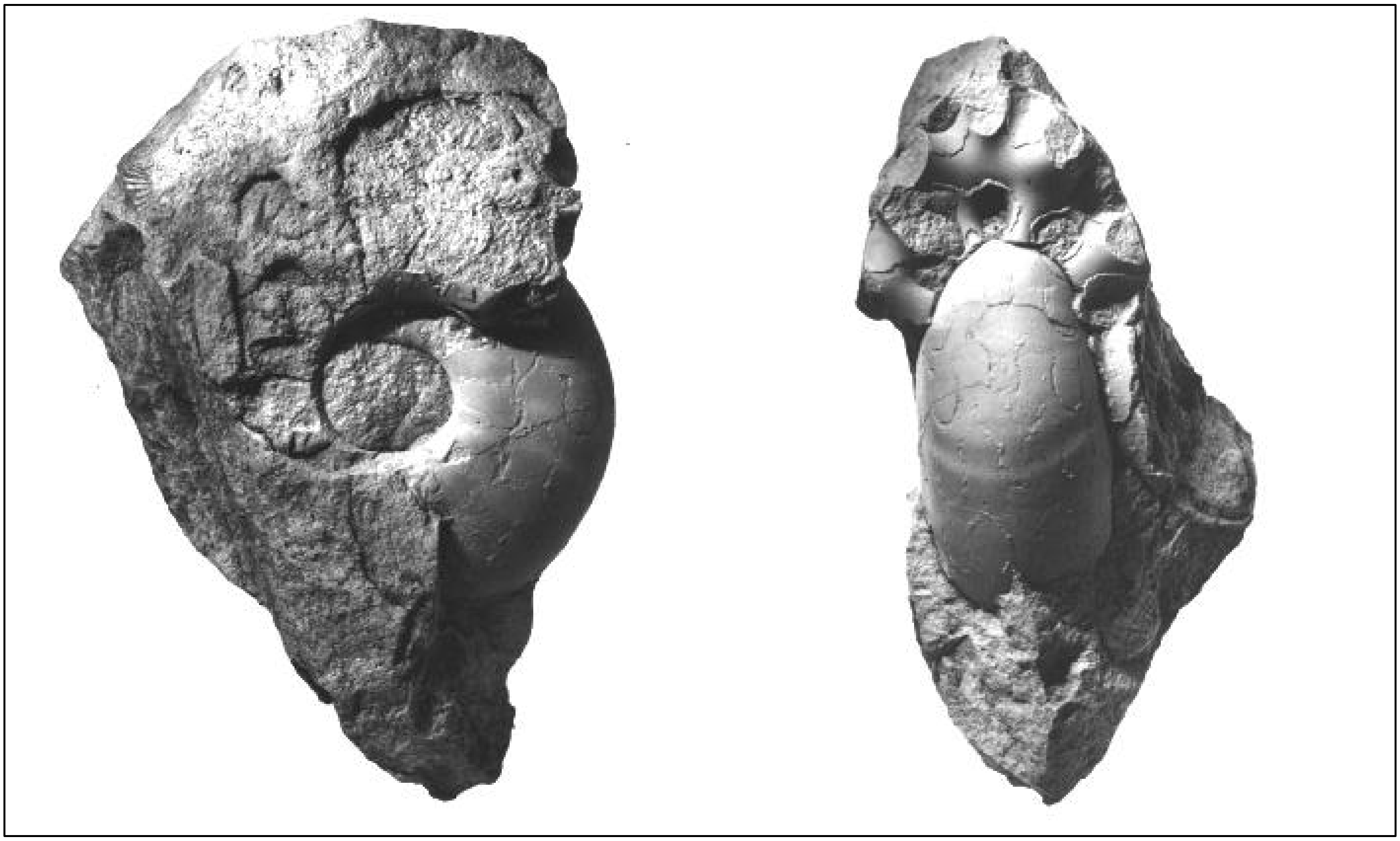

Figure 3. *Epijuresanites* n. sp., Bed 13, Tabju Formation , northeastern Pai-Khoy, x1.25.

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Lower and Upper Permian Boundary in the Pechora Basin

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The traditional Permian scale originally established in the Russian Platform and the Urals is now being suggested for replacement by stages established on other continents. In particular my concerns are about the Kungurian and the Ufimian stages which, in the north Urals and the Pechora Preurals are represented by interbedded continental, normal marine and lagoonal facies that contain abundant and diverse faunas and floras. An analogue of Kungurian in this territory is the Lekvorkutskaya Formation established in the Vorkuta River area. Interbedded, cyclic, predominantly siliciclastic marine, lagoonal and continental strata characterize the formation. Thirteen horizons with marine faunas, four zones of fresh-water pelecypods, eight floristic zones and three palinozones are established in the formation. The boundary between Lower and Upper Permian (between Kungurian and Ufimian) occurs in the upper portion of Lekvorkutskaya Formation. The stratotype and hypostratotype of Lekvorkutskaya Formation occurring in Vorkuta River and surrounding area have been restudied and three stages of plant evolution have been recognized. The first corresponds to the T-S packages of Ayach’yaginskya subformation and contains flora similar to the Krylovsky assemblage of the Saraninsky and Filippovsky horizons of late Artinskian and early Kungurian age. The second stage corresponds to the R-P packages of the Ayach’yaginskya subformation and contains flora similar to the Tisovsky assemblage of the lower Irensky Horizon of Kungurian age. The third floristic stage of the O-N packages of Rudnitsky subformation may correspond with the Chekardinsky assemblage of the upper Irensky Horizon of Kungurian age. The most significant changes in floral evolution occur between packages N and M of the Rudnitsky subformation. The flora of the M-H packages Rudnitsky subformation of Lekvorkutskaya Formation and from overlying Intinskaya Formation is similar to flora of the Solikamsky Horizon of lower Ufimian age. Therefore the boundary between the Kungurian and the Ufimian in the Pechora Basin is placed between packages N and M of the Rudnitsky subformation of Lekvorkutskaya Formation.

(***Editorial note****: This represents an abstract of a longer manuscript submitted in Russian by Dr. Pukhkonto. We apologize for including only an abstract; we do not have the resources to translate and publish the article in its entirety. We are grateful to Vladimir I. Davydov for preparing the abstract of this important contribution. C. S.)*

(***Chairs Note:*** *the difference between this paper and the preceding, Katlyar et al., is that Kotlyar states the whole of the Lekvorkutskaya Formation should be considered Kungurian and Pukhonto states, based on floristic characteristics, that all of the Lekvorkutskaya except for its uppermost bed should be considered Kungurian. B. R. W.)*

Fusulinid Biostratigraphy in Asselian/Sakmarian Transition in Stratotype Area Southern Urals, Russia

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On August 12-14 1999 the authors of this paper met in Boise, ID. The Permian Research Institute (PRI) organized the meeting, as a response to the publication "The base of Sakmarian Stage: Call for discussion" by Wardlaw *et al*., 1999 in issue 34 of Permophiles. One of the goals of this meeting was a discussion of fusulinid taxonomy and new fusulinid data from the Asselian-Sakmarian transition accumulated by different teams working in the stratotype region since the first International Permian Congress in Perm, 1991: Chuvashov, B. I, Chernykh, V. V. and Mizens, G. A., Ekaterinburg Institute of Geology and Geochemistry of RAN; Spinosa, C. S., Snyder, W. S., Schiappa, T. X. and Davydov, V. I., Permian Research Institute, Boise State University; Leven, E. Ya, Leonova, T. B, and Reimers, A. M , Paleontological Institute, Geological Institute and Moscow State University.

Thin-sections from the following important sections were examined and discussed during the meeting:

- Kondurovsky section, the type section for the Sakmarian (materials of Chuvashov, B. I, and Davydov, V. I.);
- Novogafarovo section located 10 km to the north from Kondurovsky section (material of Davydov, V. I.);
- Verkhneozerny section located about 10 km to the south from Kondurovsky section (material of Leven, E. Ya);
- Usolka section near Krasnousol'sky city (materials of Chuvashov, B. I and Davydov, V. I.)
- Aidaralash section, the GSSP for the C/P boundary (material of Davydov, V. I.).

The Kondurovsky, Novogafarovo and Verkhneozerny sections occur in the type area of the Sakmarian Stage and fusulinid biostratigraphy in the area plays an important role in Sakmarian definition. Although fusulinid assemblages in these sections include reworked specimens (Rauser-Chernousova, 1965; Chuvashov *et al*., 1993), they are usually easily recognizable and do not constitute a significant percentage of the total number of specimens of the assemblage. Our collections include thousands of specimens, which allow recognition of the accurate distribution of fusulinids in these sections. The Kondurovsky section is regarded as one candidate as GSSP for the base of the Sakmarian.

The Usolka section is one of the best and most nearly complete for the Asselian/Sakmarian transition in the Urals, as it occurs in the axial part of the Belsk Depression (Uralian Sub-basin) of the Preuralian Trough (Chuvashov *et al*., 1993). The Asselian and lower Sakmarian in this section are represented by thin interbedded micrites, silstones and sandstones with rare beds of carbonate turbidities which are the only beds containing fusulinids. However, no reworked fusulinids were recognized in the Usolka section (Chuvashov *et al*., 1993). Abundant and diverse conodont assemblages from the Usolka section make it another candidate for the GSSP for the base of the Sakmarian.

After examining thin-sections from the sections under discussion we arrived at the following conclusions. In the Kondurovsky-Novogafarovo-Verkhneozerny area, the lower portion of the Kurmainskaya Formation (beds 1-5 in Kondurovsky section) contain fusulinids that appeared in late Asselian: *Schwagerina firma* (Shamov), *S. idelbajevica* (Shamov) (*Schwagerina sensu* Dunbar and Skinner, 1936, *non* Rauser, 1936), *S. parva*, *S. exuberata* (Shamov), *Schwagerina? declinata* (Korzhinskyi), *Schwagerina? composita* (Korzhinskyi), *Pseudofusulina sulcatiformis* Leven & Scherbovich, *Schwagerina? gareckyi* (Scherbovich), *Zigarella lutuginiformis* (Rauser), etc. The first primitive representative of the *Schwagerina moelleri* group (*Schwagerina* sp. 1), appeared in bed 6 in the Kondurovsky section along with Asselian fusulinids. *Schwagerina* sp. 2, reported in our previous publication (Davydov & Leven, 1999) as a close relative to *Schwagerina moelleri*, appears in the Kurmainskaya Formation in the first bed with rudstone and floatstone (bed 8 in Kondurovsky section) and range to the top of Kurmainskaya Formation. Typical *Schwagerina moelleri*, similar to the holotype (Schellwien, 1908), first occurs in the lower third of the Karamurunskaya Formation (bed 12 in the Kondurovsky section).

The Usolka section fusulinid assemblage of bed 24 and 25 is typical of late Asselian: *Schwagerina firma*, *S. parva*, *S. exuberata*, *Schwagerina? declinata*, *Schwagerina? composita*, *Pseudofusulina sulcata*, *Sphaeroschwagerina sphaerica gigas*, *Zigarella lutuginiformis*, etc. One specimen of *Eoparafusulina? sterlitamakensis* has been found in bed 25.

The fusulinid assemblage of bed 26 includes mostly Asselian species. However, appearance of *Eoparafusulina? dubius*, and *Pseudofusulina tastubensis* probably indicates Sakmarian age of this bed. It is important to note the occurrence of *Sphaeroschwagerina karnica* near the top of bed 26.

Fusulinids found near the top of bed 27 are typical of the lower Sakmarian: *Schwagerina rauserae*, *Schwagerina ishimbajevi*, *Schwagerina correcta, Pseudofusulina ex gr. verneuili*, *P. anostiata*, etc. However, an appearance of *Schwagerina paraimplicata, Schw. acalosa* and particularly *Schw. aff confusa*, *Pseudofusulina anostiata* and *Pseudofusulina ex gr. verneuili* may indicate late Tastubian age of bed 27.

From the data we examined the following can be summarized. There are no sharp changes between the fusulinid assemblages of Asselian and Sakmarian. Fusulinid evolution during late Asselian and early Sakmarian time had a very gradual and transitional character. Many of the late Asselian fusulinid species, including those of *Sphaeroschwagerina*, ranged into early Sakmarian. The *Schwagerina moelleri* group first appears in latest Asselian time and most significantly developed in early Sakmarian (Tastubian). Additional study of taxonomy of the *Schwagerina moelleri* group is necessary to provide a precise definition of the base of Sakmarian, which will be established on basis of conodonts.

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ANNOUNCEMENTS

First Circular
Oman Pangea Symposium and Field Meeting

On the occasion of the International Conference on the Geology of Oman organised at Sultan Qaboos University, Seeb/Muscat, January 12 to January 16, 2001, we are planning an Oman Pangea Symposium and field meeting.

This Oman Pangea Symposium and field meeting wil be co-sponsored by the Global Sedimentary Geology Program (Chairman Dr. Benoit Beauchamp), by the International Subcommission on Permian Stratigraphy (chairman Dr. Bruce R. Wardlaw) and by the International Subcommission on Triassic Stratigraphy (chairman Prof. Maurizio Gaetani). The symposium will take place within the Southern Tethys and Arabian Continental Margin topic of the Conference (Prof. Alastair Robertson).

Scientific Organisers Of The Symposium And Field Meeting

Dr. Aymon Baud and Prof. Jean Marcoux, with the help of the BRGM and other experts.

Objective

With the presentation of new and recent results on Permian and Triassic sediments of Oman, the aim of the Symposium and the three fieldtrips are to provide a forum to geologists who are interested in the time interval of Pangea for discussing global changes related to Pangea integration, North Gondwana and Central Tethys evolution. It will be an unique opportunity for sedimentologists, stratigraphers and paleontologists who are working within Permian and Triassic time interval, biotic crisis, extinction, recovery and evolution at the Paleozoic- Mesozoic transition to discuss, to look and to sample at the spectacular Permian and Triassic outcrops belonging to the Oman former continental margin, from shallow shelf to deep marine sediments and seamounts. For the petrographers-geochemists, Oman is a key area for the study of the magmatism linked with the Permian Neotethys opening and with the Triassic intra-oceanic seamounts.

General Theme

Pangea and Tethys, Moving Plates and Environmental Changes.

Secondary Themes

Progress in the Permo-Triassic Stratigraphy and Palaeontology of the Central Tethys and its Gondwana margin.

Comparison between the Permo-Triassic continental margins of Oman, N. India (Himalayas) and N. Australia.

Information and Inscription directly on web site: http://www.geoconfoman.unibe.ch

Further Information by Aymon Baud, Geological Museum, UNIL-BFSH2, CH-1015 Lausanne, Switzerland, tel.: xx41 21 692 44 71, fax xx41 21 692 44 75, e-mail aymon.baud@sst.unil.ch

Pre-Conference Excursion No. A01
Permo-Triassic Deposits: from Slope to Basin and Seamounts

Leaders: A. Baud, F. Bechennec, F. Cordey , L. Krystyn, J. le Métour, J. Marcoux and R. Maury
Dates: January 8 - 11, 2001
Cost: US$500

The mountainous belt located in the eastern part of the Arabian Peninsula, the Oman Mountains, expose a segment of the Gondwanian margin interpreted as a flexural upper plate. During the end of the Cretaceous, this segment was sliced and brought on the Arabian continent with the obduction of the ophiolite, part of the Tethyan ocean. Following a Lower Permian rifting phase and Middle Permian break-up (birth of the Neotethys), a wide carbonate platform developed during late Permian and Triassic times on the inner part of the margin. Carbonates derived from the platform represented the major source for the thick sequence of slope carbonates deposited near the platform margin. On more distal parts, the basinal and oceanic sedimentation resulted in various types of carbonate, cherts and siliciclastic deposits, presently found in the Hawasina Nappe. Middle Permian radiolarites and red ammonoid limestones as Middle Triassic black marls and limestones deposited on lavas (seamounts) are cropping out as blocks of various dimensions, the Oman Exotics, both sides of the “autochthonous” tectonic window. Also new results on Permian and Triassic magmatism will be presented.

Spectacular and well studied outcrops in Wadi Wasit, Ba’id, Rustaq, Buday’ah and Jebel Misht areas allow reconstruction of the former geometry of the margin during Late Permian and Triassic time.

Pre-Conference Excursion No. A02
Lower to Middle Permian Sedimentation on the Arabian Platform: the Huqf Area (S. Central Oman)

Leaders: L. Angiolini, J. Broutin, S. Crasquin and J. Roger
Dates: January 7 - 11, 2001
Cost: US$625

Located on the southeastern margin of the Arabian plate, the Huqf area (Sultanate of Oman) is a region marked by gentle, deformed and uplifted Palaeozoic formations. The lower to middle Permian is represented as part of two mega-sequences. The first sequence consists of a basal succession, beginning with upper Westphalian to Sakmarian glacial deposits, forming the Al Khlata Formation, succeeded by the transgressive marine deposits of the Saiwan Formation marking the complete deglaciation of the region. This latter unit of late Sakmarian age has yielded a rich and very well preserved brachiopod fauna (studies by L. Angiolini).

Overlying unconformably, the upper megasequence is composed of a thick fluvial terrigenous unit (Gharif Formation). This sequence terminates with highly fossiliferous (ostracodes, small foraminifera, conodontes, bivalves, brachiopods, ammonoids, trilobites, etc.) marine transgressive deposits of marly carbonate (Khuff Formation), of which only the Kubergandian-Murgabian

(Roadian) parts are exposed. This succession represents a key-section for the intercalibration of Early to Middle Permian marine and continental biostratigraphical scales.

The newly named “Gharif Paleoflora “, investigated by J. Broutin and his students, is erected as a standard for the Arabian Peninsula. This warm humid assemblage is of outstanding palaeogeographic significance with associated Gondwanan, Cathaysian and Laurasian floral elements.

Post-Conference Excursion No. B01
Permo-Triassic Deposits: from Shallow Water to Base of Slope

Leaders: A. Baud, F. Bechennec, F. Cordey, and J. Marcoux
Dates: January 8 - 11, 2001
Cost: US$500

The mountainous belt located in the eastern part of the Arabian Peninsula, the Oman Mountains, expose a segment of the Gondwanian margin, interpreted as a flexural upper plate. The Permian-Triassic sequence deposited on the inner part of this margin is exceptionally well exposed in the Jabal Akhdar Mountains, as part of the autochthon, which crops out in a large tectonic window. The Permian and Triassic shallow water carbonate rocks occurring in this area belong to the Akhdar Group, with two main lithologic units: the Saiq and Mahil Formations. The Saiq Formation, about 700 m thick and made up of three transgressive - regressive cycles unconformably overlies Precambrian strata, documenting the Upper Permian marine transgression. The following 800 m thick Triassic dolomitic Mahil Formation confirms the cyclic and restricted shallow marine environment upward.

Carbonates derived from the platform represented the major source for the thick sequence of slope carbonates (the Sumeini Group) deposited near the platform margin, cropping out in the Sumeini area near the border between Oman and the United Arab Emirates. The lower part of this group (about 1700 m thick) is included in the Maqam Formation, late Permian to late Triassic in age. Key section of the Oman margin architecture, the Wadi Maqam has been re-investigated in terms of biochronology, sequence and isotope stratigraphy.

Excursions Information and Inscription directly on web site: http://www.geoconfoman.unibe.ch
Further Information by Aymon Baud, Geological Museum, UNIL-BFSH2, CH-1015 Lausanne, Switzerland, tel.: xx41 21 692 44 71, fax xx41 21 692 44 75, e-mail aymon.baud@sst.unil.ch

31st International Geological Congress

International Standard References for the Permian System: Cisuralian of Southern Ural Mountains, Guadalupian of Southwestern North America, Lopingian of South China

Conveners: Tamra A. Schiappa (BSU), Bruce R. Wardlaw (USGS), and Brian F. Glenister (University of Iowa)

Date: August 6th through 17th, 2000
Venue: Riocentro Convention Center
Rio de Janeiro - Brazil

Subject: The International Commission on Stratigraphy and Subcommission on Permian Stratigraphy is sponsoring an international symposium at the 31st IGC meeting in Rio. The symposium will highlight progress on final recommendations for Permian series and stage definitions. The symposium will consist of a poster session highlighting all the volunteered contributions (afternoon) followed by an oral session with the convener’s address and 5 keynote presentations. The keynote speakers selected are:

- Boris Chuvashov presenting “Cisuralian (Lower Permian) Series: History, Current Status and Proposed Stage Definitions”
- Brian Glenister presenting, “Guadalupian Series: International Standard for the Middle Permian”
- Jin Yugan presenting “Lopingian Series: International Standard for the Upper Permian”
- Heinz Kozur presenting “Importance of Different Microfaunas for Definition and Correlation of Permian Stage Boundaries”
- John Utting presenting “Palynostratigraphic Correlation and Dating of Marine and Continental Permian Successions”. Proceedings of the symposium will be published as a special issue on the Permian System.

Permophiles #37 will contain extended abstracts of all the papers presented at the SPS symposium.

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