Permophiles

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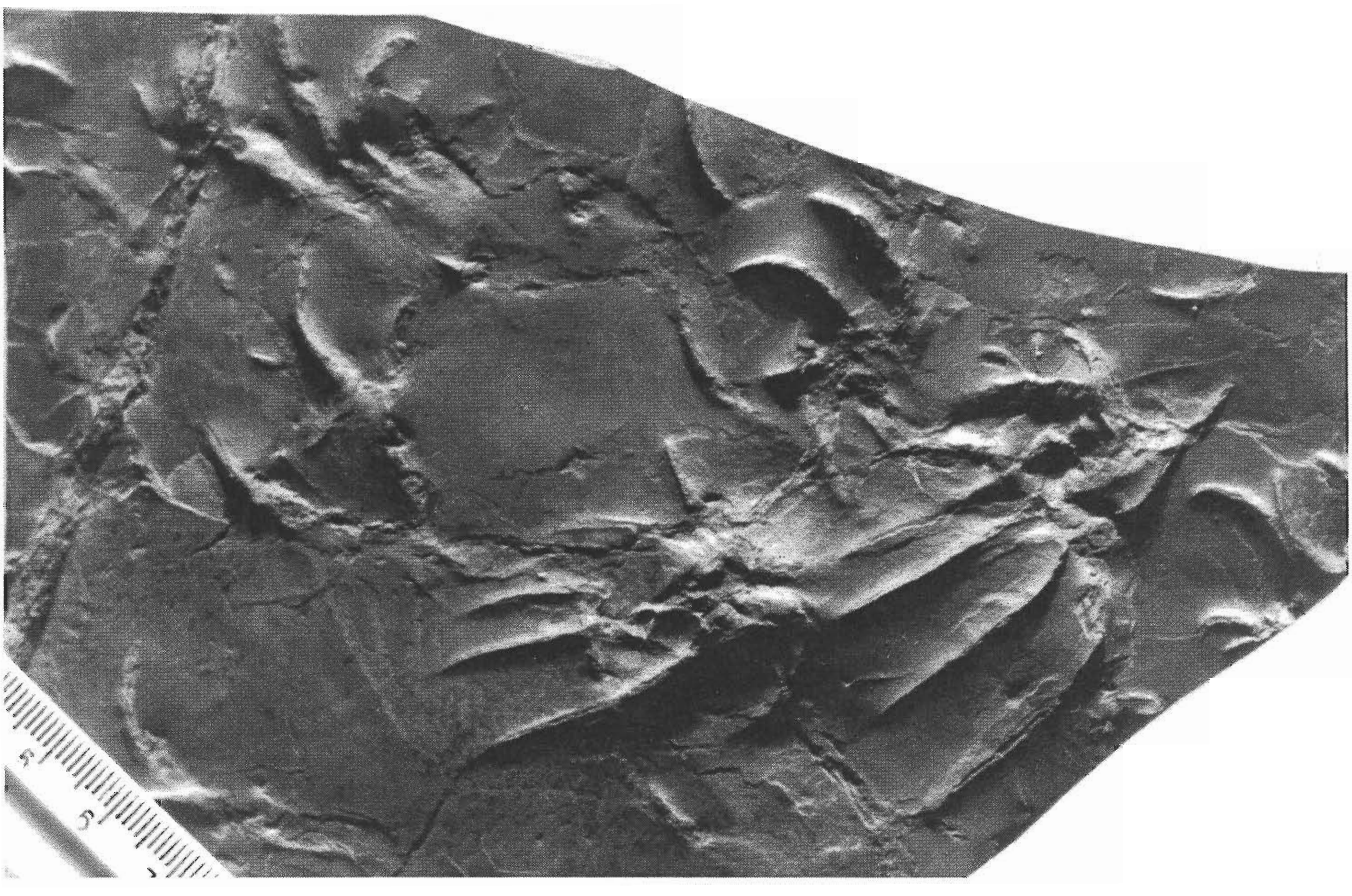

SUBCOMMISSION ON PERMIAN STRATIGRAPHY

INTERNATIONAL COMMISSION ON STRATIGRAPHY

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES (IUGS)

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Early Permian footprints from the Hueco Formation, Robledo Mountains, southern New Mexico, USA. The larger footprints are *Dimetropus nicolasi* (tracks of a sphenacodontid pelycosaur). The smaller footprints are *Dromopus agilis* (tracks of an araeoscelid reptile). The scale is in centimeters. Photograph provided by Spencer G. Lucas

1. SECRETARY'S NOTE

I should like to thank all those who contributed to the issue of "Permophiles". The next issue will be in June 1996; please submit contributions by May 1.

Contributors may send in reports by mail, FAX or E-mail. "Permophiles" is prepared using WordPerfect 6.1 for those wishing to send in 5¼" or 3½" IBM computer discs (please also send printed hard copy). Files can also be sent in their native format with an ASCII version.

J. Utting
Institute of Sedimentary and Petroleum Geology
Geological Survey of Canada
3303 - 33rd Street N.W.
Calgary, Alberta, Canada T2L 2A7
Phone (404) 292-7093
FAX (403) 292-6014
E-mail INTERNET address: utting@gsc.emr.ca

2. MINUTES OF BUSINESS MEETING OF SUBCOMMISSION ON PERMIAN STRATIGRAPHY: 30 AUGUST 1995, XIII INTERNATIONAL CONGRESS ON CARBONIFEROUS-PERMIAN (XIII ICC-P), KRAKOW, POLAND

A. Those in attendance were

Chairman Jin Yugan (China), Secretary J. Utting (Canada), Chairman of Carboniferous/Permian Boundary Working Group B. Glenister (USA)

I. Budnikov (Russia), V. Davydov (Russia), N. Esaulova (Russia), H. Forke (Germany), K. Gennugy (Russia), T. Grunt (Russia), T. Jasper (Germany), M. Kato (Japan), H. Kozur (Hungary), K. Ueno (Japan), C. Virgili (Spain), P. Yuris (Russia), V.R. Lozovsky (Russia)

B. The following agenda was proposed and accepted

- i) Introduction (Jin Yugan)
- ii) Review of Subcommission activities and working groups (J. Utting)
- iii) Working Group reports by B. Glenister, V. Lozovsky, J. Dickins, Yin Hongfu
- iv) Report and invitation from Anatoli Shevelev (President of the Committee of Mineral Resources, Tatarstan, Russia)
- v) Discussion
- vi) Miscellaneous

C. i) Introduction: The chairman Jin Yugan commenced the meeting by welcoming all those in attendance. He pointed out that the Subcommission on Permian Stratigraphy has been very active since the last business meeting which was held one year ago in Guiyang, China. Positive progress was being made on a number of topics by Working Groups, but especially active was the Carboniferous/Permian Boundary Working Group.

ii) Review of Subcommission activities. The activities of the Working Groups were briefly summarised. These include Carboniferous/Permian Boundary (B. Glenister, Chairman), Permian/Triassic Boundary (Yin Hongfu, Chairman), Guadalupian (B. Glenister, Chairman), N.American/Russian post-Artinskian Working Group (B. Wardlaw, Chairman), Major Subdivisions of Tethyan Permian (Y. Leven, Chairman), Permian Stages-Artinskian, Kungurian, Ufimian (B. Chuvashov, Chairman), Continental beds at the Permian/Triassic Boundary (V. Lozovsky, Chairman), Upper Permian correlation (G. Kotlyar, Y. Leven, D. Baghbani, Jin Yugan), Upper Permian (J. Dickins),Permian of Turkey and Transcaucasian-Central Asia (T. Guvenc, Chairman).

iii) Working Group reports: B. Glenister reviewed the progress made by the Carboniferous/Permian Boundary Working Group. The voting members of this group voted formally in writing on the proposal of the Aidaralash Section, Kazakhstan, as the GSSP for the base of the Permian System. Voting members are B.I. Chuvashov, C.A. Ross, C.M. Henderson, J. Utting, J. Yanagida, B.R. Wardlaw, B.F. Glenister, V.I. Davydov, Zhou Zuren, C.B. Foster, H. Kozur, Wang Zhihao.
12 members voted and of these 10 were in favour, with 1 abstention (B.I. Chuvashov) and 1 against (C.M. Henderson). Dr. Glenister stressed that there was significant degree of urgency in holding a formal SPS vote and submitting the results to IUGS as soon as possible if we wished the boundary decision to be ratified by the ICS at the Beijing meeting in 1996.

N.B. In the weeks following the Krakow meeting a formal SPS vote was taken and the results are given in the *Footnote "Carboniferous/Permian Boundary Working Group Voting Results".

V. Lozovsky summarised work in progress on "the Continental beds at the Permian/Triassic Boundary". A detailed written report is given later in this Newsletter. Written reports from J. Dickins (Upper Permian) and Yin Hongfu (Permian/Triassic Boundary) were read by the secretary and have been reproduced in full later in this Newsletter.

iv) Report and invitation from A. Shevelev: A. Shevelev summarised work in progress on the Kazanian stratotype of the Volga/Urals area in Tatarstan and the detailed contents of his address are given later in this Newsletter. He announced that a film on the Kazanian stratotype area made by the University of Kazan and Committee of Mineral Resources, Tatarstan was being shown during the conference and that all were welcome to see it. Also he announced that an international symposium to be held in Kazan was being planned for 1997 on Upper Permian rocks of the Volga-Ural region.

v) Discussion: There was considerable discussion following A. Shevelev's presentation about the use of Kungurian, Ufimian, Kazanian and Tatarian stages. B. Glenister considered that they lacked sufficient marine fauna to be useful as the basis for world correlation, and that although the sections are very interesting geologically, there are more suitable stratotype candidates in China or N. America. However, T. Grunt took the view that the stages have historical precedence and that it was premature to discard them before they had been thoroughly studied. Also it was preferable to have all the stratotypes for the Permian system in one part of the world rather than having them in several different areas. J. Utting pointed out that a lot of detailed geological work was in progress on the Ufimian, Kazanian and Tatarian stratotype areas and this would be published soon by the University of Kazan as a monograph. H. Kozur agreed that the lack of diverse marine fauna in the above mentioned stages is a drawback, but stressed the usefulness of the sections for correlating continental Permian. Jin Yugan added that it is important to carry out correlation on continental Permian rocks including those of Gondwana. C. Virgili mentioned that the northwestern Chines sections were important for correlating continental Permian and that these should enable correlations to be made with the southern Urals. However, she questioned correlations between the Tethyan divisions and those of North America. B. Glenister replied that no single section or series of sections were suitable for the whole Permian system stratotype, but that these could probably be found in three localities: southern Urals, South China and southwest USA.

vi) Miscellaneous:
A reminder about The Guadalupian Symposium April 4-6, Alpine, Texas (see Permophiles 25, p. 43). Contact B. Wardlaw, US Geological Survey, Phone (703) 648-5288; FAX (703) 648-5420; E-mail BWARDLAW@geochange.er.usgs.gov

Proceedings of the Guiyang, China, meeting should be published by the end of 1995.

The next business meeting will be held during the 30th International Geological Congress, Beijing, China (4-14 August 1996). A request has been made to have a symposium on Stratigraphy and Paleontology.

J. Utting (Secretary)

* Footnote: Results of formal SPS written vote on the Carboniferous/Permian Boundary.

16 Titular members voted on the boundary. They are G. Cassinis(Italy), B.I. Chuvashov (Russia), J.M. Dickins (Australia), B.F. Glenister (USA), C.B. Foster (Australia), Sheng Jin-zhang (China), M. Kato (Japan), G.V. Kotlyar (Russia), H. Kozur (Hungary), E. Ya. Leven (Russia), M. Menning (Germany), W.W. Nassichuk (Canada), C.A. Ross (U.S.A.), J. Utting (Canada), Jin Yu-gan (China), and B.R. Wardlaw (USA). 15 members voted in favour, and there was one abstention (B. Chuvashov).

The base of the Permian System is defined as the first occurrence of "isolated-nodular" morphotype of *Streptognathodus "wabaunsensis"* conodont chronocline, 27 m above the base of Bed 19, Aidaralash Creek, northern Kazakhstan. This recommendation is being submitted to the International Commission on Stratigraphy for approval.

3. UPPER PERMIAN WORKING GROUP

The working group set up in Italy at a meeting of the subcommission in 1986, has resulted in the production of a number of correlation charts for the Upper Permian and associated published reports and reports in Permophiles. General agreement was reached on the suitability of a five-fold stage subdivision for the Upper Permian (of the classical twofold division of the Permian) with a grouping of the three lower stages and the two upper stages. The same agreement was not reached on the names of the stages for a world standard stratigraphical scale or the names of their two groupings. During the course of this work and the work of IGCP 272, the Midian-Dzhulfian boundary (and/or equivalents) and its character and significance was more clearly recognized including its importance for recognizing two divisions within the classical Upper Permian.

Certain problems in stratigraphy and correlation and their significance for attaining some agreement on a world standard scale were also recognized but so far have not been satisfactorily elucidated. These include, inter alia, the nature of the Ufimian, the correlation of the Uralian and Tethyan scales, and the correlation of these with the Chinese and North American sequences.

From consideration of "An Operational Scheme of Permian Chronostratigraphy" (Jin Yugan, B.F. Glenister, G.V. Kotlyar and Sheng Jin-zhang, Palaeoworld 4, 1994), "A Revised Operational Scheme of Permian Chronostratigraphy" (Permophiles 25, 1994) discussion in Permophiles and at the meeting of the subcommission in Guiyang, China, 1994, and discussion and correspondence with many colleagues, no general agreement is likely until some questions on correlation and stratigraphy including those referred to above are addressed. Without consideration of these questions about the stratigraphical scale, no satisfactory "Chronostratigraphical Scale" is possible. From the reaction already available it would seem the Guadalupian is not generally acceptable as a unit of the world standard scale - the differences in this sequence from those in other parts of the world would seem to minimize its value in this respect (although not in other respects).

Be that as it may, the Upper Permian Working Group could play an important part in resolving these problems.

J.M. Dickins (Chairman/Convenor)

4. ANNUAL REPORT ABOUT THE ACTIVITY OF THE CONTINENTAL SEQUENCES OF PERMIAN AND PERMIAN/TRIASSIC BOUNDARY WORKING GROUP

In "Permophiles" No. 25 I summarized the main aims of the WG. Responding to my proposal, the team of German geologists (J.W. Schneider, R.R. Robler, B.G. Gaitzsch) proposed the combined profile of the Saar, Salle and North German basins as the Regional Continental Standard for the Permian. Really it is one of the best in the World for the lowest part of the continental Permian, because it is well characterized by diverse terrestrial groups (Tetrapods, Conchostracans, Palynomorphs, Insects, Arthropod trails). This section is especially very important because it enables one to correlate the Carboniferous/Permian boundary in the continental facies with the marine ones via the succession of the Donezt Basin. The latter contains limestones with fusulinids. At the same time in the Middle part of the European Permian there are a very distinctive breaks in sedimentation, and only the youngest part of the continental Permian (U. Rotliegendes and Zechstein) can be taken into account.

The more interesting and uninterrupted continental Permian succession for the Middle and Upper part of Permian is known from the Cis-Ural region, and many groups of Russian specialists work on its stratigraphy. Actually the principal activities are concentrated on the study of Kazanian and especially Tatarian stages. In the framework of this task the very interesting meeting about the Tatarian and partly Kazanian stratigraphy took place in Moscow 27-28 January, 1995. Twenty-four specialists from Moscow, St. Petersburg, Kazan, and Saratov participated in this work. The proceeds of the meeting noted the progress in the study of Tatarian stratigraphy, in particular.

Tetrapods. The *Pareiasaurus-Gorgonopsian* fauna, which characterizes the Upper Tatarian, is subdivided by M.F. Ivachnenko (Paleontological Institute, Russian Ak. Se.) into three complexes.

Kotclnitcheskian, Dokolovskian, Vjashikovskian, and the second of them in turn into two subcomplexes. It creates the basis for detailed subdivision and interregional correlating.

Fish-scale remains. The first biostratigraphy zonation for the Tatarian, including four Ichthyolith Ass. Zones, were established by D.N. Esin (State Geological Museum). The study of this group, continues by M.G. Minich (Saratov University).

Macroflora. The Upper Tatarian *Tatarina* flora was subdivided by A.V. Gomankov (Geological Institute Russian Ak. Sc.) into four subcomplexes that allow one to make the mutual correlation between the principal sections of Tatarian-Vjatka and Suchona basins. N.K. Esaulova continued the study of Kazanian flora.

Miospore Ass. A.V.Gomankov, and M.N. Shelechova established three Tatarian Sporomorph Ass., typical for the Urzumskian, Severodvinskian and Vjatskian horizons and demonstrated the potential for subdividing each of them in turn into two or three independent ones.

Charophytes. N.K. Esaulova shown a very important stratigraphic role of this group and the validity of the independent Lower and Upper Kazanian, Lower and Upper Tatarian complexes.

Ostracodes. I.I. Molostovskaya (Saratov State University) subdivided the Tatarian ostracods into Belebeevskian (Upper Kazanian), mixed (Lower Severodvinskian), Severodvinskian and Vjatskian Ass. The last two can be subdivided in more detail.

The decision of the meeting emphasized the fact that the important stratigraphic levels in diverse groups do not coincide with each other. For example the very distinctive level between the Upper and Lower Tatarian ostracod and pelecypods complexes lie below the level, where the change of Ichthyolith Ass. and replacement of Kotelnitcheskian tetrapod complexes by the Sokolkovskian one take place.

N.K. Esaulova reported that the Monograph "Typical Stratigraphic Sections of the Upper Permian of the Volga-Ural region", where the detailed description of the Ufimian, Kazanian and Tatarian stages was made, is complete and it will be published soon. During the XIII International Congress on the Carboniferous-Permian the first Organizing Meeting of the ISCPS Working Group "Continental Sequences of the Permian and Permian/Tertiary boundary", took place the 31st August.

Attendance. C. Virgili (France), G. Cassinis (Italy), R. Wagner, P. Karnkowski, A. Iwanow (Poland), J. Utting (Canada), Yugan, Jin, Weiping Yang, Huicheng Zhu (China), H. Kozur (Hungary), M. Menning, C. Hastkopf-Froder (Germany), V. Lozovsky, N. Esaulova, G. Kanev, Y. Papin, J. Budnikov, E. Malysheva (Russia).

V. Lozovsky told about the previous activity of the WG. The proposal for its creation was published in 1991 (Permophiles, No. 19). Then it was adopted in the meeting of SCPS, August 16, 1993, during the Pangea Conference, Calgary, Canada. The principal goals of the activity of WG were proposed by the Chairman (Permophiles, No. 25, 1994).

H. Kozur, C. Virgili, M. Menning, Yugan Jin, P. Karnkowski and J. Utting took part in the discussion. The meeting decided that the principal goals of the activity of WG in the immediate years will be the following:

1. The establishment of the Carboniferous/Permian boundary in the continental series and its correlation with the marine scale (responsible - J.W. Schneider, Germany).
2. The cooperation with the WG on "Nonmarine Triassic Correlation", for establishment of the Permian/Triassic boundary in continental series (responsible - V.R. Lozovsky).
3. The paleomagnetic correlation of the principal continental sections of Permian (responsible - M. Menning).
4. Establishment of continental zonations, based on Tetrapods, Conchostracans, Palynomorph Ass., Flora, Insects, Ostracods, Fish and other groups.
5. Elaboration of the methods for the mutual correlation of the continental and marine scales of Permian.

It was decided that for the successful activities of WG it will be necessary to elaborate the special project as part of the International Geological Programs. The title of this project will be "The Continental Permian of the World", by the proposal of M. Menning (responsible - J. Schneider, V. Lozovsky).

The meeting recommended Dr. J.W. Schneider as Vice-Chairman of WG. Later he agreed with this proposal.

The next meeting of WG will take place during the 30th IGC, August 4-14, 1996, Beijing, China with the special discussion of the problem of the choice of stratotype section for the Permian/Triassic boundary.

The chairman asks all permophiles, who are interested in the problems of the continental stratigraphy, to send their proposal about the activity of WG to him or to Permophiles (J. Utting) for publication.

Prof. V.R. Lozovsky
Geological Prospecting Institute
Chair of Regional Geology and Paleontology
Moscow, 117485, Miklucho-Maklay
Str. 23, Russia
Phone: (095) 168-78-13
Fax: 7 (095) 433-64-55 or 162-26-21

5. REPORT OF THE PERMIAN-TRIASSIC BOUNDARY WORKING GROUP TO THE MEETING OF PERMIAN SUBCOMMISSION

Since the International Permian Symposium (August, 1994, Guiyang, China), work on the Permian-Triassic boundary has been rigorously carried on. Census (including members and non-members) about the preference of the four candidates at two 1994 workshop meetings (International Permian Symposium and Shallow Teths 4, Albrechtsberg) came to the following results: Meishan (22), Guryul (1) ad Meishan (4), Guryul (3) respectively, while Shangsi and Selong received no support. A questionnaire was sent to all members in June, asking whether it is now appropriate to take a vote and which level, and which section would they prefer if they vote. The result has not come out yet. There is now a momentum toward taking the conodont *Hindeodus parvus* (*Isarcicella parva*) as marker of the Permian-Triassic boundary (PTB). Evolutionary lineage of *Hindeodus latidentatus* (*Isacicella latidentata*) - *H. parvus* (*I. parva*) - *H. turgidus* (*I. turgida*) - *I. isarcica* has been suggested. The first appearance of *H. parvus* or *I. parva* within this lineage is proposed as the marker of the boundary stratotype point. However, Dickins (1994) preferred a multispecies criterion over a monospecies one, Tozer (1994) and Dagys (1994) suggested application of *Otoceras* as the marker of the PTB, and Newell (1994) recommended ^{13}C the marker of the PTB. The chairman (1995) thus suggested, in addition to *parvus* as the main marker of the PTB, *Otoceras latilabotum*, ^{13}C excursion and, less importantly, Iridium as auxiliary markers which denote proximity of the boundary. A book updating recent works on the candidate sections will be published next year (China Univ. Geosci. Press).

Meishan. Sections D and Z of Meishan have been suggested as the Global Stratotype Section. These two are quarries of the same outcropping section and are a few hundred meters apart. As required by the guideline B.III.5.(b) of International Commission on Stratigraphy, a global boundary stratotype section should not be in an isolated position, but should be with a succession which can be followed easily above and below the GSSP and preferably laterally as well. In this connection sections D and Z should be considered as parts of a single section (Meishan section) with laterally continuous and traceable outcrops. Biostratigraphic, sequence stratigraphic and palaeomagnetic works have been carried out this year. *Hindeodus latidentatus, H. parvus* (*I. parva*), *I. turgida* and *I. isarcica* have been found in the suggested sequence at Meishan. A proposal of Meishan as the GSSP of PTB is now being prepared.

Guryul Ravine. Inquiries about the possibility of doing more work at this very important section has been repeatedly made to institutions and experienced individuals. It is encouraged for all members to make contacts on this possibility. Dr. Kapoor is now compiling an updated paper on this section.

Selong. Situation about this section has been reported in Newsletter 3. Orchard (1994) reported important conodonts discoveries. More papers are now prepared for publication. Due to conspicuous hiatus below the boundary (Geldsetzer, 1994), few people are now favouring this section.

Shangsi. Due to lack of *parvus* or other biomarkers at the boundary, few people are now supporting this section. An update is now prepared by Lai, Hallam et al.

Forthcoming workshop meetings. Hanoi, November 1-3, 1995; Brisbane, April 9-12, 1996; Beijing, August 4-14, 1996 (see Albertiana 14, p. 13-14 for detail).

Yin Hongfu
Palaeontology Laboratory
China University of Geosciences
Wuhan, Hubei, 430074, China
Fax: 01086 27 7801 763

6. FIELD WORK ON THE LOPINGIAN STRATIGRAPHY IN IRAN

An Iranian-Chinese cooperative group studied the Permian sections in the Hambast Mountains and the Kuh-E-Ali-Bashi Mountains in Iran in May. The group consists of F. Golshani and H. Partoazar from the Geological Survey of Iran, and Jin Yugan and Zhu Zili from Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Thanks to the thoughtful arrangements made by the Geological Survey of Iran, the main tasks of this trip were successfully fulfilled.

The Iranian-Chinese cooperative project aims to establish the stratigraphic sequences between the Guadalupian and the Lopingian Series in Central Iran as it is one of the most promising regions in which a candidate section for global stratotype of the basal boundary of the Lopingian Series can be found. The first trip was designed to improve the stratigraphic sequences of latest Guadalupian and Lopingian in two classic areas, the Mambast Mountains and the Kuh-E-Ali-Bashi Mountains. These sequences were extensively studied respectively by Stepanov et al. (1965), Kummel and Teichert (1971), Tarax (1972, 1973), and the Iranian-Japanese Research Group (1976). The Abadehian Stage was formally proposed to denote a time interval between the Guadalupian Series and the Dzhulfian Stage, an equivalent of the Wuchiapingian Stage. However, further reports of the studies on these sections are few and a precise correlation between the Lopingian sequences in South China and Central Iran is hardly possible to reach based on the previously available data. As an important supplemental section to those in the Abadeh area, the well exposed Permian beds in Shahreza area, the western part of Hambast Mountains, which are virtually unknown outside Iran, were studied. Meanwhile, collections of fossils from other parts of the Permian were also obtained in order to better understanding the new observations made by Iranian colleagues in recent years.

Cisuranian-early Guadalupian sequences in the Abadeh-Jolfa Belt of Iran

The base of the Permian in Hambast Mountains coincides with an unconformity between the Moscovian and Asselian marine beds. The latter is represented by the Vazhnan Formation with *Pseudoschwagerina* fauna. This unit is composed of red sandstone with intercalations of grey wackestone or packstone with a thickness varied from 20 to 140 m. The corresponding unit in the Alborz Mountains is the Dorud Formation (Glaus, 1965), which is unconformably overlain pre-Permian volcanics and contains fusulinids of the *Pseudoschwagerina* fauna and a Tethyan brachiopod assemblage.

The upper part of the Vazhnan Formation, consisting of thin to medium bedded wackestone with intercalations of siltstone and shale comprises well preserved brachiopods, bryozoans and fusulinids closely related to the late Artinskian faunas of South China. The generic composition of brachiopods assemblage is basically the same as that from the Kuangshan Formation in Eastern Yunnan (Jin and Fang, 1987). It shifts into thin bedded wackestone with *Schwagerina* and *Pseudofusulina*.

The Surmaq Formation in Abadeh area is composed of a rhythmic median to thin bedded wackestone with a thickness up to 1000 m in the lower (Unit 1), and thin bedded wackestone with chert bands in the middle (Unit 2). And in the Alborz Mountains, only Unit 1 of Surmaq Formation is present while Units 2 and 3 seem to be missing. In addition to the *Eopolydiexodina* and the *Neoschwagerina magaritate* zones reported by the Iranian-Japanese Research Group (1976). It was announced that advanced *Misellina* and *Cancellina* have been found from the beds below the *Eopolydiexodina* Zone in Shahreza section. If it is documented, the Surmaq Formation should comprise the strata corresponding with the Chihsia and the Kuhfeng formations of South China.

The Abadehian Stage
The Abadeh Formation is divided into Unit 4a, and Unit 4b in the Hambast Mountains. The corresponding sequences of Unit 3 in Jolfa area used to be assigned to the Gnishik Beds, and those of Units 4 (including 4a and 4b) and Unit 5 of the Hambast Formation to the Khachik Beds. Baghbani (1994) has reported *Yabeina* and *Metadoliolina* from Unit 4b. We have not found it in the field but did obtain abundant fusulinid fossils from bed 13 of Unit 4b, the very beds that *Yabeina* and *Metadoliolina* occur as Baghbani informed us after this trip.

However, the characteristic beds of both sequences are so identical that one can easily recognize most cliff-making beds of limestone common in both areas. For example, the horizon bed 13 characterized by abundant *Sphaerolina* and some *Schwagerina* and *Chusenella* in the basal part of Unit 4b and the cherty limestone beds with rich *Cryptospirifer* in the top part of this unit are traceable in the Khachik Formation in Jolfa area. On the other hand, the Gnishik Formation in Transcaucasus is corresponding with Units 1 and 2 of Sermaq Formation, the Arpin Formation with Unit 3, and the Khachik Formation with Units 4a, 4b, and 5.

The corresponding sequence of Unit 6 and Unit 7 of the Hambast Formation in Jolfa area is referred respectively to the Jolfa Beds and the Alibashi Formation, and Akhylin Formation in Transcaucasus. Again, there is no significant difference in lithological characters between these areas. The conodonts from the uppermost of the Hambast Formation are correlatable to the late Changhsingian conodonts in South China. Profile of carbon isotope around PTBS exhibits a gradual shift from high value in the uppermost part of Hambast Formation to a negative value in basal part of the Elikah Formation.

Guadalupian-Lopingian boundary sequences
Dense sampling from the upper part of the Abadeh Formation and the Hambast Formation in the Hambast Mountains, and the Kachik Formation and the Alibashi Formation in Kuh-E-Ali-Bashi Mountains has been done. In the field, two aspects on the Guadalupian-Lopingian boundary sequences in Central Iran were surveyed. These are the major sequence boundary surface corresponding with the pre-Lopingian global eustatic fall and the transitional sequence or the turning point around which the macro fossil groups as well as the fusulinids experienced a rapid evolutionary change, an initial phase of the end-Permian mass extinction.

Firstly, the depositional sequence of Unit 4 of the Abadeh Formation indicates a gradually deepening of sedimentary environment or a transgression. Apparent erosional surface between Unit 4 and Unit 5 has not been observed in Hambast Mountains, but bored surfaces do appear in between in the Kuh-E-Ali-Bashi Mountains. Probably, this should be regarded as a regional or subordinate sequence boundary. The unconformity between Unit 5 and Unit 6 (Taraz, 1976) is not only marked by distinct lithological change of depositional sequences but also by the occurrence of gypsiferous shale beds. However, no continental deposits were found along these beds and therefore, no depositional gap caused by subaerial erosion is apparent. This fact implies that the depositional sequence between the Guadalupian and the Lopingian Series sounds is relatively complete in Central Iran. Discovery of *Clarkina postbitteri* and *C. dukouensis* at the basal level of Araxilevis Bed further prove the completeness. The profile of carbon isotope around the boundary sequence in Shahreza shows only a gentle excursion.

The evolutionary change corresponding with this global eustatic fluctuation is less distinct. Such characterized fossil groups of pre-Lopingian fauna as the Schwageriniids and the Cryptospiriferids are common in Unit 4b. While the environments were becoming more shallow and restricted, macro fauna virtually disappeared in Unit 5, but only algae and the small foraminifers of long-ranging occurred. Before the Araxilevis fauna emerged with the new transgression of earliest Lopingian, there was a long gap in which only a disaster fauna persisted. This fauna is characterized by appearance of a *Codonofusiella-Reichelina* fusulinid assemblage and of ramiform conodonts, and can be correlated to a similar fauna from the topmost of Maokou Formation in South China.

In conclusion, Permian faunas of Central Iran show a close affinities with those of South China, particularly in those of Cisuralian and the Chihsian Epochs, but become more endemic from the Guadalupian to the Lopingian Epoch. The Guadalupian and the Lopingian sequences were fully developed, and there is no obvious sedimentary evidence of depositional gap between the sequences of these two epochs, though Guadalupian-Lopingian transitional sequence is commonly composed of sediments in rather shallow and restricted environments and contains almost no macro fossils. The boundary level between these two series lies below the Araxilevis Bed.

The Iranian-Chinese Research Group

7. THE TRANSITION FROM CARBONIFEROUS TO PERMIAN IN THE CARBONATE ROCKS OF THAILAND

In Permophiles No. 24, the transition from Carboniferous to Permian was said to be located in clastic rocks and in poorly fossiliferous or dolomitic limestone in central and eastern Thailand (Fontaine and Suteethorn, p. 15-16). This remark was made after studies in Ban Na Duang and Ban Na Charoen areas of northeast Thailand and in Chon Daen area of central Thailand. In Ban Na Duang area, Asselian limestone containing *Sphaeroschwagerina* is intercalated in a large body of sandstone which is deprived of fossils and not well exposed at its base; the underlying Late Carboniferous strata have yielded so far few fossils (Fontaine and Suteethorn, 1992; Fontaine et al., 1994). Accordingly, the precise boundary between Carboniferous and Permian is difficult to draw there. Other difficulties have arisen from the development of dolomitic limestone in Ban Na Charoen area and the presence of poorly fossiliferous limestone in Chon Daen area.

Very recently, the Carboniferous-Permian boundary has been highlighted by the discoveries of fossiliferous limestones ranging from Upper Carboniferous to Permian. Studies are still very few; they pave the way for a new research.

In northeast Thailand, the Carboniferous is complete, well exposed, consisting mainly of shale and limestone. Limestone is present in many horizons, appearing to be less common in Middle and Upper Carboniferous. Diverse fossils have been found in abundance and their study has already been subject of 40 papers (see Fontaine et al., 1995). Very recent discoveries, some remaining unpublished, have shed light on this Carboniferous. Upper Kasimovian to Upper Gzhelian fossils have been collected near Ban Na Din Dam from a limestone hill and limestone blocks in paddy fields (Ueno and Igo, 1993; Fontaine et al., 1994, p. 26), at a distance of about 200 m from a Lower Permian limestone exposed along a creek. Upper Carboniferous fossils including Gzhelian forms have been found in a boulder and in place at the foot of Khao Tham Nam Maholan, a large limestone hill which belongs largely to Lower Permian (Ueno et al., 1995; Fontaine et al., 1995, in press). Further south in Ban Huai Som Tai area, limestone which is mainly Permian in age has yielded again Upper Carboniferous fossils at its base at several localities (Fontaine et al., 1995, in press). All these results have revealed, in northeast Thailand, the presence of several sections suitable for a detailed study of the Carboniferous-Permian boundary in a calcareous facies. During the latest Carboniferous and the earliest Permian, the sea was shallow in northeast Thailand. Influx of terrigenous sediments occurred, but, as we understand it today, in restricted areas; elsewhere, water was clean and deposition of pure limestone was possible.

In central Thailand, limestone is prominent in the lower part of the Carboniferous, rare in higher strata. It has yielded diverse fossils indicating commonly Early to Late Visean ages, rarely Late Serpukhovian-Early Bashkirian and Moscovian ages (Fontaine et al., 1983; Chonglakmani et al., 1983; Altermann, 1989). Above the Visean, terrigenous sediments are prominent and contain brachiopods, bryozoans and crinoids which have remained unstudied. Above this sequence, limestones were known, in the past, some without good stratigraphic markers, rare others with Asselian fossils. Recently, the Ban Nam Lum limestone exposed south of Phetchabun and considered Early Permian in age in the past (Igo, 1972) has been correlated with the Uppermost Carboniferous (Ueno and Igo, 1993, p. 216-218; Ueno et al., 1995, p. 32-34). The Carboniferous is presently less known in central Thailand than in northeast Thailand because exposures are discontinuous and not widely distributed; the potential sections for the study of the Carboniferous-Permian boundary should be a rarity.

In northwest Thailand, limestone is prominent in the whole of the Carboniferous. It has been carved deeply by karstic erosion and its exposures are commonly discontinuous. It has yielded Tournaisian, Visean, Bashkirian, Moscovian, Kasimovian and Gzhelian fossils. Foraminifers and conodonts are the main fossils which have been identified. The Carboniferous is overlain by Permian limestone (Hahn and Siebenhuener, 1982; Fontaine et al., 1990, 1994; Vachard et al., 1992). Studies remain insufficient and presently, the transition from Carboniferous to Permian has not been observed in a section containing both Gzhelian and Asselian deposits. However, such a section should exist in northwest Thailand.

Conclusions

At first glance, there is no significant break in sedimentation within the limestones of Thailand ranging from Upper Carboniferous to Permian. Before the discovery of this continuous sedimentation, an eustatic sea level fluctuation at the Carboniferous-Permian boundary was easily accepted. Now, there is a need to explain why this fluctuation has been masked. In Thailand, corals appear so far much less developed in the Upper Carboniferous than in the Middle Carboniferous and they remain uncommon until Middle Asselian; this fact corroborates some environmental change during Late Carboniferous and the beginning of Early Permian.

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8. LOWER-UPPER PERMIAN BOUNDARY IN PECHORA AND KUZNETZK COAL-FIELDS

The question of the series boundary in the Permian of Pechora and Kuznetzk Coal Basins has been repeatedly discussed in the press, at geological conferences and congresses. Its position is continually debated and various stratigraphic horizons have been proposed. On the basis of Permian flora of the two fields studying, it became possible to compare the plant assemblages, characterizing the local stratigraphic units of the regions, and to rather assuredly identify the age of the Permian formations and suites in Kuznetzk Coal-Field as well as to locate the Permian series boundary on its territory. The author tried to demonstrate it in the enclosed scheme (Fig. 1). Actually, the work was stimulated by a paleobotanic meeting and a stratigraphic conference held in Novokuznetzk on March 22-24, 1993 and devoted to preparations for establishing a stratigraphic scale of the Late Palaeozoic of Kuznetzk Basin.

There are 4 boundaries of substantial changes in the development of vegetation in the Permian period on the territory of Pechora Coal Basin which coincide with the phases of coal accumulation completion, marked by B.L. Afanasiyev (2). These boundaries correspond with 4 phytostratigraphic assemblages of high class, dated by the composition of plant megafossils and miospores, and by comparison with assemblages of type sections of the Permian in the Middle Urals and Russian Platform.

The oldest sediments with plant remains in the Pechora Coal-Field are known in the lower part of Goosinaya suite (Yunyaginskaya Formation), dated as Irginsky (Artinskian stage) according to the fauna and miospores. The plant assemblage is represented by small and narrow cordaite leaves and rare imprints of the equisetic stems and seeds of *Sylvella alata, Samaropsis frigida, S. triquerta, S. triquerta f. immatura, Bardocarpus* ex gr. *aliger,* dispersed in the rock mass. In all probability these are the most ancient Permian plants known in the Urals region. Up section, at the top of Talantisnskaya suite, i.e., in the uppermost Artinskian, these plants become more widespread, while plant assemblages get much richer. Here appear elements typical for the Sarginsky horizon of the stratotypical territory: *Paracalamites decoratus, P. frigidus, Cordaites* sp., small-leaf ferns *Pecopteris,* small subcircular seeds *Cordaicarpus.*

According to A.B. Virbitzkass (5, 18, 21) at this boundary a new miospore assemblage appears. It is quite different from that of Yunyaginskaya formation (palynozone O) and is typical for Talatinskaya suite's top sediments, Ayachyaginskaya member and O-packet of Rudnitzkaya member (*Chanovejisporites mosaicus* (R. Pot) Virb., *Lophotriletes* sp., small acritarchs, etc.).

Widespread distribution of fossil plants in the Pechora Coal Basin begins at the boundary of the Yunyaginskaya and Vorkutskaya formations, dated as Artinskian-Kungurian. The plant assemblage preserves its stability during the whole Kungurian. At this boundary over 50 genera and 70 species of plants (represented by practically all known groups) appear. A substantial difference of Pechora Coal-Field Lekvorkutskaya suite plant assemblage from the assemblages of the coeval stratotypical sections is a total absence of ginkgoaceous plants, representatives of *Dicranopteridium, Mauites, Bardia, Uralobaiera, Meristophyllum* and some other, and the presence of quite negligible quantity of rather homogenous (in specific respect) conifers and pteridosperms. However, about 40% of the plant remains are common for these regions both at the generic and the specific level. The most widespread are plants, picked out by M.D. Zalessky in the so-called "bardinsky" assemblage believed now (1) to correspond to Krylovsky, Tysovsky and Checardinsky assemblages of Kungurian suites with the same names.

Unified scale of Ural region					Scale of Pechora coal basin				Flora develop. phases		Kuzn.bas.scale: Pukhonto 1993			Kuzn.bas.scale: Betehtina 1991		
System	Series	Stage	Subst.	Horiz.	Format	Suite	Member	Packet	Pechor Basin	Kuzn.b	Format	Subfor	Suite	Format	Subfor	Suite
PERMIAN	UPPER PERMIAN	Tatarian	Upp.		Pechorskaya	Talbeiskaya	Upper		V	VII	Kolchuginskaya	Yerunak.	Ta	Kolchuginskaya	Yerunak.	Ta il
			Low					А		VI			Gr+Le			Gr am
								Б								Le ni
		Kazanian	Upper				Lower	В	IV	V		Ilinsk.	Kaz-Mr+U		Ilinskaya	Uskatskaya
								Г								
								Д								
			Lower			Seidinskaya	Upper	Е	3б III			Kuznetzkaya	Mytin			Kazankovo-Markinskaya
								Ж								
							Lower	З	3a				Starokuz			
								И								
		Ufimian		Sheshmin				Е	2в						Kuznetzkaya	Mytinsk.
					Vorkutskaya	Intinskaya	Upper	F	2б II	IV	Balahonskaya	Verhne-Balahonskaya (Upper Balahonskaya)	Usyatskaya			
								G								
				Solikamsky			Middl	H								Starokuznetzk.
								J								
							Lower	K	2a							
								L								
						Lekvorkutskaya	Rudnitzkaja	M								
	LOWER PERMIAN	Kungurian		Iren.				N	1г				Kemerovskaya	Balahonskaya	Verhnebalahonskaya	Usyatskaya
								O								
				Phillippovsky			Ayachyagin.	P	1в				Ishan			
								R					Promezhutochnaya			Kemerov.
								S	1б							
								T								
		Artinskian		Saran.	Yuniyaginskaya	Talat.			1a							Ishanovskaya
				Sarg.		Belk.										
				Irg.		Goos										
		Assel. Sakm.				Sizym.				III						Pro-mezh
												N.Bal. (L.Bl)	Alykayevskaya		N.Bal.	Alyka-yevsk.
					C_2+C_3											

Comparison of Stratigraphic Schemes of Ural, Pechorski and Kuznetzki Coal Basins (flora)

(after S.K.Pukhonto)

Fig.1

The floristic assemblage of Lekvorkutskaya suite generally corresponds to typical Kungurian flora from localities in stratotypical areas (Sylva, Barda and Kolva rivers sections). Within the above-named stratigraphic intervals at least 3 levels of lesser scale flora renovation, corresponding to rather short time intervals (the packets in Pechora Coal-Field) are recognized.

As for miospores, within Lekvorkutskaya suite 2 more palynozones (I and II) are recognized. Palynozone I characterizes the N-packet of Rudnitskaya member and is subdivided into 2 subzones: the lower with *Lophotriletes parvis* Virb., *Triquitrites* sp., *Jurschorisporites auritus* Virb., acritarchs, and the upper one with *Psilolacinites dilutus* Virb., *Granulatisporites parviverrucosus* (Waltz), *Acanthotriletes bellus* Virb., *Raistrickia ifanovi* Virb. and acritarchs. Palynozone II includes the M-packet and is characterized by the presence of *Nencisporites stylophorus* Virb., *Kraeuselisporites vulgaris* (Warj.) and others. Within the seam m_8 stratum there is an abundance of acritarchs - *Leiosphaeridia vorkutensis* Virb. (5, 18, 21).

The next level of floral renovation takes place at the Lekvorkutskaya-Intynskaya suites boundary (between N- and M-packets of Rudnitzkaya member). That, according to the existing stratigraphic scale (26), corresponds with the Kungurian-Ufimian boundary. It is a boundary, where considerable change of floristic assemblage is observed (mostly on a specific level) and more than 40 species of arthrophytes, ferns, cordaites, mosses, gymnospermous seeds as well as 6 new genera, i.e., *Kosjunia, Syrjagia, Vojnovskya, Lobatopteris, Peltaspermum* and *Wattia* appear for the first time. Five genera (*Xiphophyllum, Neuropteris, Cardioneura, Odontopteris, Carnucarpus*) of high stratigraphic importance for the underlying Lekvorkutskaya suite, as well as more than over 45 species disappear.

Plenty of *Viatscheslavia vorcutensis, Viatsoheslaviophyllum vorcutense, Zamiopteris glossopteroides, Rufloria loriformis, Vojnovskya paradoxa, Samaropsis vorcutana, S. oblongata, S. elegans, Sylvella alata* and other plant remains are typical for the Intynskaya suite. The floristic assemblage of Intynskaya suite corresponds to the flora from Ufimian type sections. Within this stratigraphic interval a change of vegetation, conforming to Solikamsky-Sheshminsky horizons' boundary is observed. Two new genera (*Oligocarpia* and *Sulcinephropsis*) and 13 species appear, while 23 species disappear.

The abrupt change of palynoflora takes place at the boundary of the Lekvorkutskaya and Intynskaya suites (more precisely, in the uppermost M-packet of Rudnitzkaya member). Throughout the Intynskaya suite 5 palynozones are recognized. They contain numerous spores and pollen grains; the most important of these are: *Charbejisporites charbejensis* Virb., *Ch. jcecundus* Virb., *Turrisporites bonus* Virb., *Kraeuselisporites vulgaris* (Warj.) (maximum of occurrences - in L-packet), *Raistrickia ifanovi* Virb., *Acanthotriletes rutispinus* (Lub.), *Pustulatisporites strobilatus* Belos. et Virb., and others. Throughout the whole section acritarches, forming 2 marking horizons: i.e., in the seam 4 with *Leiosphaeridia vorcutensis* Virb., and in the seam G_{11} with *Tetraporina naum* Virb. (5, 18, 21).

In the upper part of the section some typical Kazanian elements of flora and miospores appear.

At the bottom of the Pechorskaya Formation, in the interval, corresponding to the Ufimian-Kazanian boundary, an abrupt change in assemblage takes place: xerophytic plants, new genera of lycopods, conifers, plants of uncertain systematic position, gymnospermous seeds (*Comia, Callipteris, Compsopteris, Rhipidopsis, Paichoia, Phylladoderma, Nucicarpus* and others). Twelve genera and at least 50 species of fossil plants appear and are widespread. Approximately just as many, 13 genera and 28 species, disappear. The hygrophilous plants are replaced by those growing in dry environments. The most widespread of these are: pteridosperms, small cordaites, ruflorias with rather wide, hairy dorsal furrows of *Rufloria* synensis type, small scaly leaves of *Lepeophyllum* and *Crassinervia*, small lycophytes with hexagonal leaf cushions - *Paichoia* and *Signacularia*, small seeds of *Bardocarpus, Nucicarpus, Tungussocarpus* and others. This floristic assemblage is rather stable. Yet, at the Seidinskaya-Talbeiskaya suites boundary, corresponding to Lower-Upper Kazanian substage boundary, and throughout these stratigraphic subdivisions as well, taxonomic renovation of plant assemblages is observed. In the first case (at the Seidinskaya and Talbeiskaya suites' boundary) 10 genera and up to 40 species appear, while 5 genera and 24 plant species disappear. In the second case (inside the substages) the changes are less considerable.

The last and rather essential floral renovation takes place at the boundary between Lower- and Upper Talbeiskaya members, corresponding to the Kazanian and Tatarian boundary. Many flora elements, widespread in the underlying deposits, disappear; new lycophyte mosses, ginkgos, ferns etc. totalling in 10 genera and over 10 plant species appear, including ferns of mesophytic type - *Taeniopteris* and *Cladophlebis*, ginkgos i.e., *Ginkgophyllum* and *Baiera, Phylladoderma* with large leaves, *Aequistomia, Ullmannia* with small leaves, *Voltzia, Quadracladus* and others. In general, this plant assemblage corresponds to the Tatarian one.

The level of palynologic assemblages changes in Pechorskaya formation, as A.B. Virbitzkass showed (5, 8, 21), practically coincide with the renovation phases of fossil plants, and are drawn in the boundaries between Intynskaya and Seidinskaya, and Seidinskaya and Talbeiskaya suites, as well inside these stratigraphic subdivisions.

Thus, significant sufficient changes of plant complexes took place

1. At the boundary of Kungurian and Ufimian (N-M packets' boundary of Rudnitzkaya member in Pechora Coal-Field).
2. Between Ufimian and Kazanian (the boundary between N- and 3-packets of Seidinskaya suite in Pechora field).
3. Between Lower and Upper Kazanian substages (Seidinskaya-Talbeiskaya suites' boundary in Pechora Basin).
4. At the boundary of Kazanian and Tatarian stages (within the Talbeiskaya suite).

An analogous situation is observed in practically all regions of European Russia formation in the Pechorskaya and Bolshesyninskaya depressions, in the Pechorskaya syneclise, and on the Russian Platform (described in papers by V.I. Chalyshev, 1966, 1968), L.A. Phephilova (1975, 1977, 1979, 1981), S.V. Meyen (1971, 1986), S.K. Pukhonto (1977, 1983, 1990) and others.

The biostratigraphic analyses of Permian marine bivalves made by V.A. Gooskov (10, 11, 12), enables one to pick out 2 assemblages of high stratigraphic rank, corresponding to the Permian series. Early Permian assemblages characterize Asselian, Sakmarian and Artinskian deposits, while Late Permian - does the same for Kungurian, Ufimian and Kazanian. According to this data, the Early Permian complex has little in common with Carboniferous one. On the whole, its appearance is formed by representatives of Nucubacea, Nucubanacea, Pectinacea, Trigoniacea, Carditacea, Crassatelacea, and Edmondiacea. The "leaders" in the complex are representatives of Pectinacea superfamily, which are found in terrigenous, including carbonaceous rocks.

Late Permian assemblages of bivalves are extremely rich. In the Kungurian alone over 100 species, belonging to all the families and nearly all the genera of Upper Paleozoic are known. In the Late Permian assemblages appear representatives of *Pseudomonotis, Stutchburia, Nuculavus, Polidevcia, Pseudobakewelia, Aviculopecten, Janeia,* etc.

The majority do not range above the Nevolinskaya member of Irensky horizon, or deposits, synchronous with it, and only a few taxa continue into the Ufimian and Kazanian.

A mixed zone of Early Permian and Late Permian assemblages (ranging from the base of the Saraninsky horizon to the Irensky horizon's Nevolinskaya member top), can be recognized from a study of bivalve occurrences. Drawing a boundary-line between Permian formations seems to be the most preferable in the base of Phillippovsky horizon of Kungurian. At the same level in the Pechora Coal-Field due to the abrupt change of paleogeographic and paleotectonic situations plant assemblages appear, possessing up to 40% of "Bardinsky" floral elements. Meanwhile, the most abrupt change (plant assemblages of high rank takes place on a leve corresponding to Ufimian-Kazanian boundary. Th: reflects the real course of the geological events, and withi its progression in the stratotypical area 2 large-scale phase may clearly be picked out: marine and continental one: while in the Pechora field there are 3 phases: marin (Yunyaginskaya Formation), regressive (Vorkutskay Formation), and continental (Pechorskaya Formation). A the boundary of the Vorkutskaya and Pechorskay formations a new Paleourals uplifting was taking place, an that had brought about different sedimentation condition (thick conglomerates, sandstones and many-coloured rock appeared). The vegetation changes from hydrophytic t xerophytic.

In connection with this a 3-fold subdivision for the Permiar cannot be ruled out with the lower series containing Asselian-Artinskian, the middle-Kungurian and Ufimian. and the upper one - Kazanian and Tatarian. But, assuming a 2-folded division and applying the analyses of flora and marine bivalves, a variant of drawing P_1-P_2 boundary line in the base of Phillippovsky horizon is possible.

Presently the general problem of the age of the local stratigraphic units and the boundary-line between Upper and Lower Permian (which is traditionally drawn at the bottom of Starokuznetzkaya suite) is also a problem in the Kuznetzk Coal Basin. Some even propose to draw the boundary at the base of Mytinskaya suite (4). However, the analysis of Permian flora from Pechora and Kuznetzk fields along with comparison of plant assemblages do not support this idea. The similarity of Permian flora of the two coal-fields was long ago noticed by M.D. Zalessky, M.F. Neuburg, S.V. Meyen and other researchers. The flora of Kolchuginskaya Formation was correlated with that of the Pechorskaya Formation; Verhnebalahonskaya subformation's flora - with Vorjutskaya one. The meeting, held in Novokuznetzk in March 1993 gave the author an opportunity to make herself certain of it. Vast and imposing collections from key sections of the Kolchuginskaya Formation were seen above the Aralichevski seam (river Tom near Novokuznetzk and Mytina village) as well as sections of Leninskaya suite in Uropsko-Karakansky and Gramoteinsky blocks, Gramoteinskaya and Tailooganskaya suites at Vostochno-Karakanski coal deposit, and Balahonskaya formations in Raspadskaya-2 and Tomskaya deep bore-holes, and Prokopievsk-Kiselyovsk region bore-holes. Besides, a vast research material, published by M.F. Neuburg (17), G.P. Radchenko (22, 23), S.V. Sukhov (24), S.G. Gorelova (3, 6, 7), S.G. Gorelova and others (8, 9), S.G. Gorelova and S.K. Batyaeyva (3) was used. In the development of the Kuznetzk field's Permian flora, as well as in the Pechora field 4 phases important changes are picked out. Moreover, the boundaries of floral change coincide in the two fields. The fulfilled analysis resulted in the following conclusions.

Composition of the flora of the Verhnebalahonskaya subformation is similar to that of Vorkutskaya formation's flora, while Promezhutochnaya-Ishanovskaya and, partly Kemerovskaya suites in their plant fossils can be compared with Lekvorkutskaya suite, and the upper part of Kemerovskaya and Usyatskaya suites - with Intinskaya one in Pechora field. More detailed comparisons are also possible. So, for example, in the Promezhutochnaya suite *Cordaites* and *Rufloria* with large leaves as well as arthrophytes with large verticils dominate, wood with annual rings appears, etc. In Pechora Coal-Field the same plants are typical for the Ayachyaginskaya member. In Ishanovskaya flora a noticeable role is played by large leaves of *Zamiopteris glossopteroides*. The same goes for Rudnitzkaya member of Pechora field. The Kemerovskaya flora is characterized by mass occurrences of the seeds of gymnosperms. In the Pechora field it is typical for the Intynskaya suite. The Usyatskaya flora is rich in the remains of mosses, and so is the lower part of the Intynskaya suite. An abrupt floral change takes place at Usyatskaya-Starokuznetzkaya suites' boundary. Here xerophytic plants i.e., *Comia, Callipteris, Compsopteris*, as well as *Ruflorias* with wide hairy dorsal furrows (of *Rufloria synensis* and *R. brevifolia* type), small-scale leaves of *Lepeophyllum* and *Crassinervia*, and a bit up-section - *Rufloria minuta, R. minima*, and others occur. In the Pechora field this boundary, as was mentioned above, is matched with the boundary of Vorkutskaya and Pechorskaya formations. It is easy to notice, that Starokuznetzkaya suite's flora gets easily compared with Nizhneseidinskaya member's flora, and is characterized by combined finding the plants from over- and under-lying rocks, i.e., of Balahonskaya and Kolchuginskaya formations. Mytinskaya flora is similar to Verhneseidinskaya (*Crassinervia arta, Lepeophyllum belovaensis, Nephropsis grandis, Callipteris ivancevia, Samaropsis pseudotriquetra, S. trapeziformis* and others).

Floristic assemblages of the Ilyinskaya and Yerunakovskaya members have a lot in common with Talbeiskaya suite's plant assemblages (Pechora Coal Basin). The further detailed analysis helps to notice a rather close similarity between them. Here are just some of the floral elements that were found in the foregoing section intervals: *Cordaites cahdalepensis, C. clercii, C. insignis, Rufloria brevifolia, R. minima, R. minuta, Lepeophyllum actaeohelloides, L. rotundatum, Crassinervia peltiformis, Cr. elliptica, Cr. nervosa, Rhipidopsis palmata, Bardocarpus superus, B. tychtensis* and others. The level of *Rufloria* remains disappearing is also well marked at the top of Gramoteinskaya suite (Kuznetzk Basin) and in the upper third of the Talbeiskaya suite (Pechora Basin). On the same level the boundary between Kazanian and Tatarian is drawn.

According to S.G. Gorelova and S.k. Batiayeva (3) Gramoteinskaya flora is characterized by almost total absence of *Ruflorias*, flourishing of sulcal *Cordaites*, the bigness of non-sulcal *Cordaites* with sparse veins, the presence of Early Mesozoic floral elements and Pteridosperms of mesophytic appearance. An analogous situation is observed in Pechora Coal Basin as well: the Verhnetalbeiskaya member does not contain *Ruflorias*, and is notable for mass occurrences of small sulcal *Cordaites* and the presence of a horizon with multiple fossilized *Cordaites* with large leaves and sparse veins of *Cordaites latifolius* type. Throughout the whole section mesophytic plants appear (*Cladophlelis* aff. *nystroemii, Ginkgophyllum vsewolodii, Rhipidopsis palmata, R. laxa*, etc.).

Thus, the community of Permian floras of Pechora and Kuznetzk basins and synchronism of their development phases give vast opportunities for correlations of key sections of the basins and dating the local stratigraphic units of the Kuznetzk Basin by allocation to the Unified Ural region stratigraphic scale through comparison with Pechora Basin, where the age of the local stratigraphic units is practically out of the question (Unified and Correlative Stratigraphic Schemes of Urals, 1980).

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S.K. Pukhonto
SGE "Polyarno Ural Geologiya"
Vorkuta, Russia

9. CARBONIFEROUS AND PERMIAN PLANT LOCALITIES IN THE MIDDLE CISURAL

See Figure 1 for locality numbers

Lower Carboniferous: Viséan stage

1 - Kizel town. Coal-bearing Formation, Lower-Middle Visean (Tschirkova, 1944).

2 - Gubakha town. Coal-bearing Formation, Lower-Middle Visean (Tschirkova, 1944).

3 - Uzva railway station. Coal-bearing Formation, Lower-Middle Visean (Tschirkova, 1944).

4 - Obmanka coal mine on the Chusovaya river. Coal-bearing Formation, (Yavorsky, 1940).

Permian of Kolva - Vishera region

5 - Kolva river 2, 5 km upstream from the mouth of Berezovaya river. Solikamsk horizon, Ufimian (Vladimirovich, 1982, 1986).

6 - Kolva river 1 km downstream from Urtsevo village. Iren - Solikamsk horizons, Kungurian - Ufimian (Vladimirovich, 1986).

7 - Kolva river, Butyrki, Nech, Selkova, Nizva villages. Iren horizon, Kungurian (Vladimirovich, 1986).

8 - Visherka river downstream from Sartakovka. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

9 - Vishera river, Romanikha village. Sypuchy Formation, Artinskian (Vladimirovich, 1981).

10 - Vishera river, Sypuchy village. Sypuchy Formation, Artinskian (Vladimirovich, 1981).

11 - Yazva river near Parshakovo village. Parshakovo Formation, Artinskian (Vladimirovich, 1981).

12 - Yazva river near Surdya, Bychino, Kichigino, Antipino. Iren horizon, Kungurian (Vladimirovich, 1986).

13 - Vaburovo area near Parma village, borehole 5617 (133-187 m). Kungurian (Vladimirovich, 1986).

14 - Yazva river near Volum and Tsenty villages. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

15 - Yazva river near Nyrya village. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

Permian of Solikamsk depression

16 - Kama river Aches village, borehole 51 (58 m). Solikamsk horizon, Ufimian (Vladimirovich, 1982).

17 - Eremino village (8 km northeast from Bereznyaki town), borehole 669 (86 m). Solikamsk horizon, Ufimian (Vladimirovich, 1982).

18 - Vayva river, south from Volodin Kamen village, borehole 601 (89 m). Solikamsk horizon, Ufimian (Vladimirovich, 1982).

19 - Yayva river, northwest from Romanovo village, borehole 155-C (93 m). Solikamsk horizon, Ufimian (Vladimirovich, 1982).

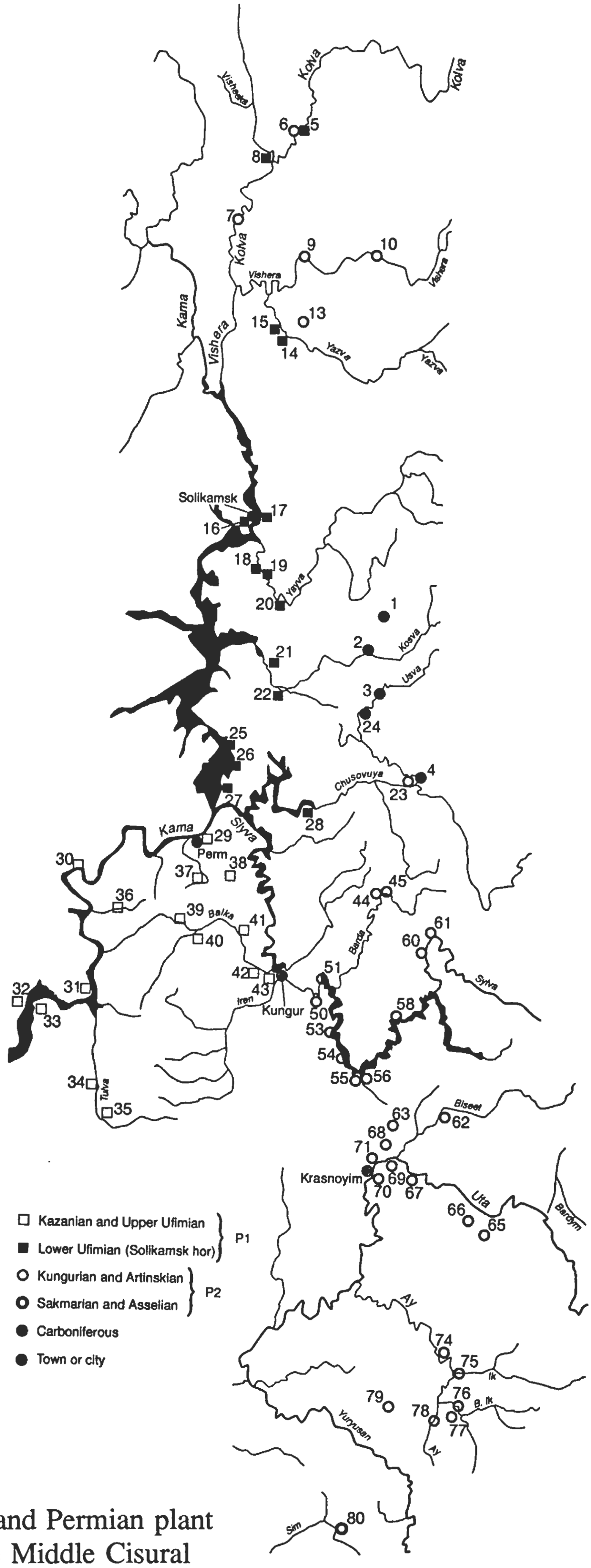

Fig. 1 Carboniferous and Permian plant localities in the Middle Cisural

20 - Yayva river, upstream from Elovo village. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

21 - Solikamsk road; 200 and 206 km. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

22 - Kosva river downstream from Zolotyanta village. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

Permian of the Cisural (=Sylva depression)

23 - Chusovaya river, 1200 m downstream from the bridge. Iren horizon, Kungurian (Vladimirovich, 1986).

24 - Usva river, tributary of the Chusovaya river near Vilva village and outcrop Kamen Navisshy. Artinskian (Vladimirovich, 1981).

25 - Kama river north from Perm city: Dobryanka town. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

26 - Kama river north from Perm city: between Divya and Polazna stations. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

27 - Kama river north from Perm city: Lyady station. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

28 - Chusovaya river, Verkhne-Chusovskie gorodki. Solikamsk horizon, Ufimian (Vladimirovich, 1982).

29 - Perm city: "Vyshka" and Motovilikha factory Sheshma horizon, Ufimian (Vladimirovich, 1982).

30 - Kama river, mouth of the Nytva river. Sheshma horizon, Ufimian (Moskaleva, 1940; Vladimirovich, 1982).

31 - Kama river downstream Okhansk town. Sheshma horizon, Ufimian (Moskaleva, 1940; Vladimirovich, 1982).

32, 33 - Kama river downstream from the Tulva river mouth. Sheshma horizon, Ufimian (Moskaleva, 1940; Vladimirovich, 1982).

34 - Tulva river downstream from Barda village. Sheshma horizon, Ufimian (Vladimirovich, 1982).

35 - Tulva river near Aklushi village. Sheshma horizon, Ufimian (Vladimirovich, 1982).

36 - Yug-Kama village. Sheshma horizon, Ufimian (Moskaleva, 1940; Vladimirovich, 1982).

37 - Yug river, left tributary of the Kama river south from Perm. Sheshma horizon, Ufimian (Moskaleva, 1940; Vladimirovich, 1982).

38 - Nistyukovo, Balatovo, Novo-Plosky villages south and southwest from Perm city, Klestyata village on the Sylva river. Sheshma horizon, Ufimian (Vladimirovich, 1982).

39, 40 - Babka river, left tributary of the Sylva river. Sheshma horizon, Ufimian (Moskaleva, 1940; Vladimirovich, 1982).

41 - Kurashim village on the Babka river, left tributary of the Sylva river. Sheshma horizon, Ufimian (Vladimirovich, 1982).

42 - Syra river, tributary of the Sylva river. Sheshma horizon, Ufimian (Vladimirovich, 1982).

44-48 - Barda River, right tributary of the Sylva river.

44 - Barda river, Krasnaya Glinka village near Matveevo. Koshelevka Formation, Iren horizon, Kungurian (Zalessky, 1927; Vladimirovich, 1986).

45 - Barda river, Krutaya Katushka gully near Matveevo village. Koshelevka Formation, Iren horizon, Kungurian (Zalessky, 1927; Vladimirovich, 1986).

46 - Barda river near N. Isady and Utkino villages. Koshelevka Formation, Iren horizon, Kungurian (Vladimirovich, 1986).

47 - Barda river near Troshino village. Lek ?Formation, Iren horizon, Kungurian (Vladimirovich, 1986).

48 - Barda river near Afonino village (Tulumbasy region). Suksun Formation, Iren horizon, Kungurian (Vladimirovich, 1986).

49-61 - Sylva river upstream from Kungur town

49 - Sylva river near Sukhoy Log, Kazarino, Spas-Bardy villages. Lek Formation, Philippovo horizon, Kungurian (Vladimirovich, 1986).

50 - Sylva river near Ust-Kishert station. Lek Formation, Philippovo horizon, Kungurian (Vladimirovich, 1986).

51 - Sylva river near Kishert village. Lek Formation, Philippovo horizon, Kungurian (Vladimirovich, 1986).

52 - Sylva river near Kokuy mount and Lipok gully.

53 - Sylva river around Suksun town. Kungurian (Vladimirovich, 1986).

54 - Sylva river basin, the Irgina river. Lek Formation, Philippovo horizon, Kungurian (Vladimirovich, 1986).

55 - Sylva river around Tis village. Irensk horizon, Koshelevo Formation, Kungurian (Vladimirovich, 1986).

56 - Sylva river near Chekarda village. Koshelevo Formation, Iren horizon, Kungurian (Vladimirovich, 1986).

57 - Sylva river near Yulaevo village. Koshelevo Formation, Iren horizon, Kungurian (Vladimirovich, 1986).

58 - Sylva river near Molebka village. Lek Formation, Philippovo horizon, Kungurian (Vladimirovich, 1986).

59 - Sylva river near Shamary village. Urmi Formation, Artinskian (Vladimirovich, 1981).

60 - Sylva river near Shaydury village. Urmi Formation, Artinskian (Vladimirovich, 1981).

61 - Sylva river near Urmi village. Urmi Formation, Artinskian (Vladimirovich, 1981).

62-63 - Bisert River, right tributary of the Ufa river.

62 - Bisert river near Afanasyevskoye village. Gabdrashitovo Formation, Artinskian (Vladimirovich, 1981).

63 - Ut river, tributary of the Bisert river. Belokatay Formation, Artinskian (Vladimirovich, 1981).

64 - 71-Ufa River Basin

64 - Bardym river near V. Bardym village. Bardym Formation, Artinskian (Vladimirovich, 1981).

65 - Shaksha river, Artinsky factory. Gabdrashitovo Formation, Artinskian (Vladimirovich, 1981).

66 - Ufa river, Arti village. Gabdrashitovo Formation, Artinskian (Vladimirovich, 1981), and Krylovo Formation, Saraninsk-Philippovo horizon, Kungurian (Vladimirovich, 1986).

67 - Ufa river around Rakhmangulovo village. Krylovo Formation, Saraninsk-Philippovo horizon, Kungurian (Vladimirovich, 1986).

68 - Achit river, tributary of the Ufa river. Koshelevka Formation, Kungurian (Vladimirovich, 1986).

69 - Ufa river near Krylovo village. Krylovo Formation, Saraninsk-Philippovo horizon, Kungurian (Vladimirovich, 1986).

70 - Ufa river near Kriulino. Krylovo Formation, Sraninsk-Philippovo horizon, Kungurian (Vladimirovich, 1986).

71 - Podgornaya village north from Krasnoufimsk. Koshelevka Formation, Kungurian (Vladimirovich, 1986).

Permian of Bashkiria

72-78 - Ay River Basin

72 - Ay river near Sabanakovo village. Sabanakovo Formation, Saraninsk-Philippovo horizon, Kungurian (Vladimirovich, 1986).

73 - Ay river basin, the Kushkayak river near Karanaevo village. Gabdrashitovo Formation, Artinskian (Vladimirovich, 1981) and Sabanakovo Formation?, Kungurian (Vladimirovich, 1986).

74 - Ay river near Lemiz-Tomak village. Ust-Ik Formation, Saranino-Philippovo? horizon, Kungurian (Vladimirovich, 1986).

75 - Ay river basin, Ik river, Karashayly-Kul gully. Gabdrashitovo? Formation, Artinskian (Vladimirovich, 1981).

76 - Ay river basin, Bol. Ik river downstream from Yusupovo village. Ust-Ik Formation, Kungurian (Vladimirovich, 1986).

77 - Ay river near Alegasovo village. Koshelevka Formation, Kungurian (Vladimirovich, 1986).

78 - Ay river near Mesyagutovo village. Gabdrashitovo Formation, Artinskian (Vladimirovich, 1981).

79 - Yuryuzan River Basin

79 - Yuryuzan river basin, the Koshelevka river near Mikhaylovka village. Koshelevka Formation, Iren horizon, Kungurian (Vladimirovich, 1986).

80 - Belaya River Basin

80 - Sim river. Asselian (Vladimirovich, 1986a).

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I.A. Dobruskina
The Institute of Earth Sciences
The Hebrew University of Jerusalem
Givat Ram, Jerusalem 91904 Isreal

M.V. Durante
Geological Institute of USSR
Academy of Sciences
Pyzhevsky 7, Moscow 17
Russia 109017

10. SAKMARIAN BRACHIOPODS FROM SOUTHERN OMAN

Located in the south-eastern margin of the Arabian plate (Sultanate of Oman), the Huqf area is a region marked by gently deformed and uplifted Paleozoic formations.

The Lower Permian succession represents the last term of a mega-sequence which begins with the deposition of the Late Westphalian to ?Sakmarian Al Khlata Fm. tillites, succeeded by the transgressive marine Saiwan Fm. This unit contains a rich brachiopod fauna together with bivalves, gastropodes, crinoids, cephalopods and bryozoans.

The brachiopods of the Saiwan Fm. have been collected firstly by A. Pillevuit in two localities in the Huqf area (1991); later on (January 1995) an international expedition

(L. Angiolini, A. Baud, J. Broutin, H. Bucher, H. Al Hashmi, J. Marcoux, J. Platel, J. Roger) was carried out for a better understanding of the stratigraphy, paleontology, sedimentology and paleoecology of the Permian succession of the Huqf area. During this expedition a large collection of brachiopods was sampled along two stratigraphic sections at Saiwan and uadi Haushi (fig. 1).

The brachiopods of southern Oman have been previously studied by Hudson & Sudbury (1959). In particular, the brachiopod fauna under examination probably corresponds to the Haushi Fauna of Hudson and Sudbury (1959). However attention must be paid in considering what the two authors described as Haushi and Lusaba faunas: in fact a mixing of Lower Permian and Upper Permian brachiopods is recorded in their collection.

In type section of the Saiwan Fm. close to the Saiwan 1 oil well, the first fossiliferous level of the consists totally of Cyrtella nagmargensis (Bion). The following fossiliferous levels show higher taxonomic diversity consisting of Derbyia sp., Arctitreta cf. bioni (Reed), Reedoconcha permixta (Reed), Subansiria sp., Permospirifer cf. wardakensis Legrand Blain, Neospirifer aff. hardmani (Foord), Neospirifer sp., Trigonotreta sp., Punctospirifer sp, Gjelispinifera sp., Fletcherthyris sp., ?Gilledia sp.. Conularids, bivalves, cephalopods and gastropods are also present. The highest fossiliferous level of the Saiwan Fm. is characterized by a large amount of N. aff. hardmani together with bivalves.

The Saiwan faunas show affinity with the Himalayan faunas (Reed, 1932; Singh & Archbold, 1993), the Peninsular India faunas (Badhaura, Dickins & Shah, 1979), Central Afghanistan (Termier et al., 1974) and slightly less with W Australia.

According to the Russian Committee on Stratigraphy, the Sakmarian stage is subdivided into Sterlitamakian above and Tastubian below.
On the basis of the brachiopod content we suggest that the first level of the Saiwan Fm. is Early Sterlitamakian in age, whereas the higher levels are Late Sterlitamakian on the basis of the following considerations:

- the faunas of the Saiwan Fm. lack the typical forms of the Asselian-Tastubian time interval, such as Brachythyrinella, Tomiopsis, Globiella (Australia, Garwhal Himalaya, Umaria on the Indian shield, Kashmir). These genera possibly occur also in the Early Sterlitamakian (Australia, Garwhal Himalaya);

- the genus Trigonotreta is widespread in the Asselian to Tastubian of Australia, of Karakorum and Central Afghanistan but it is also present in the Sterlitamakian and in higher levels (Himalaya, Australia);

- the genus Cyrtella occurs both in the Asselian-Tastubian (Australia, Karakorum, Central Afghanistan) and in the Early Sterlitamakian (Australia, India, Himalaya);

- Subansiria is an endemic genus of the Early Sterlitamakian of Peninsular India and Himalaya;

- according to Archbold & Gupta (1986) and Singh & Archbold (1993) the Cyrtella-Subansiria fauna may straddle the Tastubian-Sterlitamakian boundary;

- Reedoconcha and Neospirifer aff. hardmani are of Late Sterlitamakian age (W Australia, Himalaya, Central Afghanistan).

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ROGER, J.

(A.L.: Dip. Scienze della Terra, Via Mangiagalli 34, Milano, Italy; B.A.: Musée cantonal del Geologie, UNIL-BFSH2, CH Lausanne; B.j.: UPMC, Paleobotanique et Paleoecologie, 12 Rue Cuvier, Paris, France; B.H.: Univ. de Dijon, Centre des Sciences de la Terra, Dijon, France; A.H.H.: M.P.M. Directorate of Petroleum and Minerals, Muscat, P.O. Box 551, Oman; M.J.: Univ. Paris 7 Denis Diderot Place Jussieu Paris, France; P.J.P.: BRGM Aquitaine, Pessac, france; P.A. Institute og Geology and Paleontology, University of Lausanne, CH; R.J.: BRGM B.P. 6009, Orleans Cedex 2, France.)

11. CROSS CORRELATION OF EARLY PERMIAN MARINE BIOCHRONOLOGY AND TETRAPOD FOOTPRINTS, SOUTHERN NEW MEXICO, USA

Extensive ichnofossil assemblages of tetrapod (amphibian and reptile) footprints have long been known from Lower Permian strata in Europe and North America. In Europe, tetrapod footprints have been used to develop detailed biostratigraphic schemes for the nonmarine facies of the Rotliegend and correlative strata. Little effort has been made to exploit the biostratigraphic potential of the North American tetrapod footprint record of Early Permian age. Instead, studies have focused on the paleoecological significance of the tracks, especially those from ancient dune (eolian) facies.

Until now, neither the European nor the North American Early Permian ichnofossil assemblages could be directly correlated to the SGCS (standard global chronostratigraphic scale). Tracksites discovered in southern New Mexico (USA) provide the first direct tie of tetrapod footprints to Early Permian marine biochronology. Articles cited here (all are published in Lucas and Heckert, 1995) document this cross correlation.

The tracksites are in red-bed siliciclastics exposed in the Robledo Mountains near Las Cruces in Doña Ana County, southern New Mexico at approximately latitude 32°23', longitude 106°53' (Fig. 1). The track-bearing siliciclastics are intercalated with marine limestones and calcareous shales in a lithostratigraphic unit locally termed the Robledo Mountains Member of the Hueco Formation (Lucas et al., 1995) (Fig. 2). Tracksites were formed on siliclastic tidal flats during early stages of base level rise (transgression). Marine facies were deposited in relatively quiet, shallow-water shelf environments, usually below active wave base, and sometimes under conditions of restricted circulation.

In the Robledo Mountains Member, tetrapod footprints co-occur with a diverse invertebrate ichnofauna dominated by *Paleohelcura* (Braddy, 1995) and a *Walchia* -dominated paleoflora (Lucas et al., 1995). The interbedded marine strata are extremely fossiliferous and produce prolific fossil assemblages dominated by ostracods, non-fusulinid foraminifers, bryozoans, brachiopods, gastropods and bivalves (Kues, 1995; Kietzke and Lucas, 1995; Kozur and LeMone, 1995). Ammonoids and conodonts also are present but less common constituents of these assemblages (Kues, 1995; Kozur and LeMone, 1995).

In the Robledo Mountains, 33 tetrapod tracksites are found in a single, 5-m-thick stratigraphic interval over a 20 km^2 area, so this interval can be referred to as a megatracksite (Fig. 2). Tetrapod ichnotaxa are *Batrachichnus delicatulus* (Lull), *Dromopus agilis* Marsh and *Dimetropus nicolasi* Gand & Haubold (most common) as well as less common *Limnopus* cf. *L. vagus* Marsh, *Hyloidichnus bifurcatus* Gilmore, *Erpetopus* cf. *E. willistoni* Moodie, *Gilmoreichnus hermitanus* (Gilmore) and *Dimetropus leisneranus* (Geinitz) (Haubold et al., 1995; Hunt et al., 1995).

The megatracksite interval is bracketed by conodont-bearing limestones (Fig. 2). Limestone immediately above the megatracksite level produce *Sweetognathus merrilli* and other conodonts of the *Mesogondolella bisselli-Sweetognathus merrilli* conodont zone of late Sakmarian (late Wolfcampian) age (Kozur and LeMone, 1995). The tracks can thus be directly tied to marine biochronology, though age-diagnostic conodonts remain to be extracted from limestones immediately below the megatracksite level.The upper part of the Robledo Mountains Member, about 50 m above the megatracksite level, produces the ammonoid *Properrinites bosei* (Plummer & Scott) and the ostracod *Cavellina edmistonae* (Harris & Lalicker), taxa that indicate the contact of the Robledo Mountains Member and overlying upper member of the Hueco Formation may approximate the Wolfcampian-Leonardian boundary (Kues, 1995; Kietzke and Lucas, 1995).

The tracks are also important because of their abundance and preservational diversity. One quarry alone has yielded about 1500 track-bearing slabs. This sample calls into question much of the oversplit taxonomy of late Paleozoic tetrapod footprints by demonstrating a tremendous amount of extramorphological variation in footprint shape. Much European, footprint-based biostratigraphy may be suspect, simply because the ichnotaxa which are thought to be biozonal indicators are actually based on extramorphological variants of temporally long-ranging footprint ichnotaxa.

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Spencer G. Lucas
New Mexico Museum of Natural History
1801 Mountain Road N. W.
Albuquerque, New Mexico 87104 USA

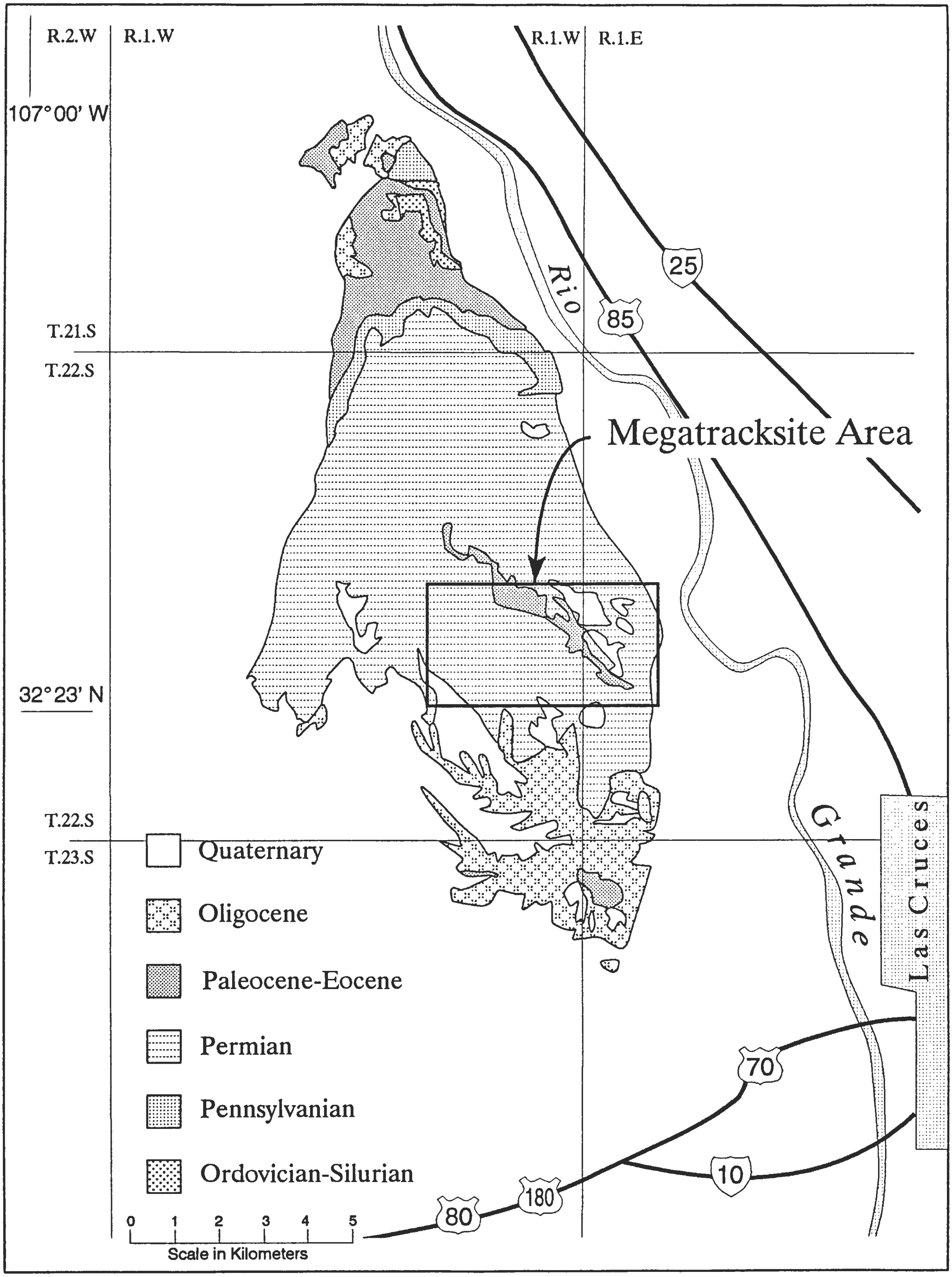

Figure 1. Generalized geological map of the Robledo Mountains, southern New Mexico, USA, showing location of the Early Permian megatracksite.

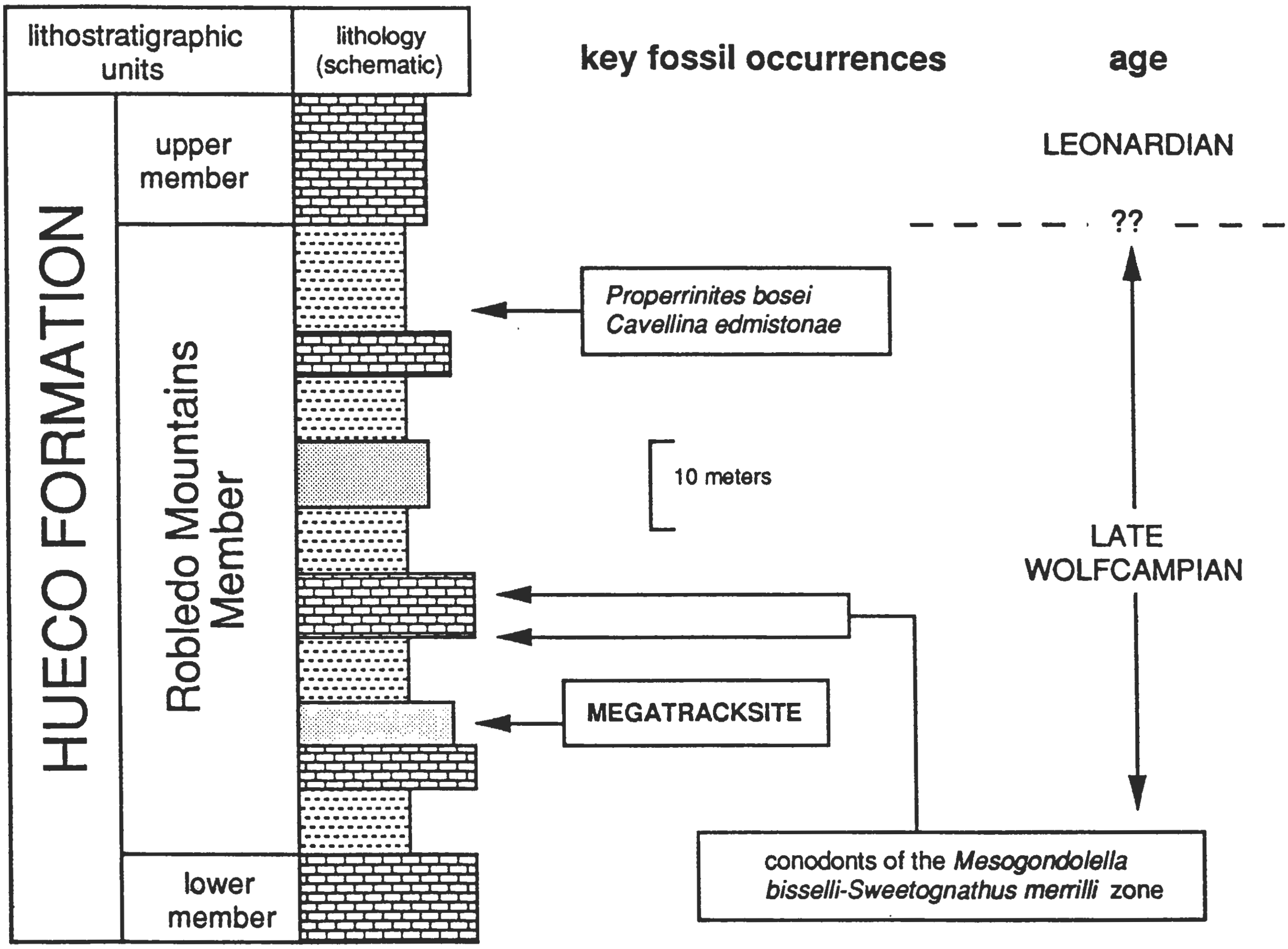

Figure 2. Generalized Lower Permian stratigraphic column in the Robledo Mountains showing relationship of the megatracksite to marine biochronology.

12. PRESENT STATUS AND RECENT DEVELOPMENTS OF NEW ZEALAND PERMIAN BIOSTRATIGRAPHY

Permian sedimentary rocks form a significant component of New Zealand geology and are presently recognised within six separate terranes or basins: Caples terrane (marine, Early Permian to Late Triassic), Waipapa terrane (marine, ?Carboniferous to Late Jurassic), Torlesse terrane (marine and non-marine, Carboniferous to Cretaceous), Parapara Group (marine and non-marine, Late Permian), Brook Street terrane (marine, Early to Late Permian), and Maitai Group (marine, Late Permian to Middle Triassic).

While spanning a great deal of geological time, the Caples, Waipapa, and Torlesse terranes are structurally complicated (probably all accretionary complexes) and although fault bounded blocks with simple stratigraphy are locally preserved, a simple stratigraphy spanning a significant part of Permian is unlikely to be found in these three rock units. Largely indeterminate atomodesmatinid bivalve fragments have locally been found in Caples terrane, and Phil Ford and Peter Fisher, post-graduate students at the University of Otago, have recently discovered an exceptionally rich conodont fauna in atomodesmatinid bearing limestones from the Caples terrane in the vicinity of Nokomai, Otago. Preliminary identifications suggest a Leonardian (late Early Permian age for the Nokomai conodont fauna.

"*Atomodesma*" s.l. is the main Permian macrofossil known from the Torlesse terrane but specimens are rare. Phil Ford has also recently described a late Early Permian conodont fauna in Torlesse rocks of siliceous sea floor association, from the Myers Pass area of South Canterbury (Ford 1995). Permian fusuline faunas are known from a number of localities in the Torlesse terrane but all are considered to be allochthonous blocks within the dominantly clastic accretionary complex (see Hada and Landis 1995).

The Parapara Group of northwest Nelson comprises a coherent marine to non-marine sequence from which an early Late Permian (Ufimian to early Kazanian) fauna including bryozoans, brachiopods, bivalves, rostroconch, gastropods, and crinoids was first described from the shallow marine Flowers Formation by Waterhouse and Vella (1965). Fossils are not known from any other Parapara units. The Parapara fauna and sedimentary petrology compare closely with Permian faunas and sedimentary rocks of Tasmania. Hamish Campbell is currently revising the Parapara fauna as part of a larger collaborative study of the stratigraphy, sedimentology, petrology, and age of the Parapara Group.

The most extensive Permian faunas are to be found in the Brook Street and Maitai terranes, which together provide the basis of much of New Zealand's Permian biostratigraphy. However, recent work on both these rock units indicates significant problems with the existing interpretation of New Zealand Permian stratigraphy. The Takitimu Group, Brook Street terrane, forms the basis of the local Early Permian stages and brachiopod zones (Waterhouse 1967, 1969, 1976, 1982) which remain sound but need recollection and refinement. Revised mapping and reinterpretation of the Productus Creek Group by Landis (1987) and Landis et al. (in prep.) shows that the local Late Permian Makarewan Stage is based on fossiliferous lenses within a melange and is therefore stratigraphically unconstrained. The Makarewan fauna is also known from a single location in the upper Maitai Group (Hyden et al. 1982), but recent developments in Maitai stratigraphy suggest that this locality is also stratigraphically allochthonous (Owen 1995, in prep.A). Owen (1995, in prep.B) also shows the Late Permian faunas in the upper Maitai Group which formed the basis of the local Waiitian stage are stratigraphically allochthonous, and follows Furnish et al. (1976) in assigning the controversial ammonoid *Durvilleoceras woodmani* Waterhouse 1973 to the Early Triassic Flemingitidae. This interpretation demands a Triassic age for much of the Maitai Group. Furthermore, stratigraphic considerations and lithologic correlations between the stratigraphically allochthonous Waiitian limestones in the upper Maitai Group and lower Maitai units suggests that the local Puruhauan and Waiitian stages (and brachiopod zones) are probably in reverse order to that given by Waterhouse (1967, 1982). New Zealand's Late Permian stratigraphy clearly needs thorough reassessment and a programme involving detailed mapping, radiometric dating, and micropaleontological sampling is now in progress.

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H J Campbell[1], S R Owen[2] & C A Landis[2]
[1]Institute of Geological & Nuclear Sciences Limited
PO Box 30-368, Lower Hutt, New Zealand
[2]Department of Geology, University of Otago
PO Box 56, Dunedin, New Zealand

13. MURGABIAN AND MIDIAN STAGES OF THE TETHYAN REALM

Standardization of stratigraphic subdivisions for all Phanerozoic systems, including the Permian, must follow requirements of the International Commission on Stratigraphy (ICS). These requirements include the necessity to define series and stage boundaries in marine sections (Cowie et al., 1986). Progress has been made in standardization of stage nomenclature in all other Phanerozoic systems, and need for development of an international scale for the Permian is therefore urgent. This motivated the proposal of an operational scheme for chronostratigraphy of the Permian by the group of specialists (Jin et al., 1994) from the Subcommission on Permian Stratigraphy (SPS).

The operational scheme advocated use of the Guadalupian Series, comprising in ascending order the Roadian Wordian and Capitanian stages, as the middle Permian standard. This reference was considered unsatisfactory by some specialists, and SPS member E. Ya. Leven proposed to use instead the Kubergandinian, Murgabian and Midian of the FSU Tethyan scale (Leven, 1980; Resolution, 1981). The purpose of the present statement is to review these Tethyan references and evaluate their suitability as international standards.

The Murgabian was originally established by A. D. Miklukho-Maklay (1958) as the "horizon" with higher (advanced) fusulinids, and was subdivided (Figure 1) into two "subhorizons": the lower one contains *Neoschwagerina, Afghanella, Verbeekina* and *Polydiexodina*, and the upper one *Yabeina* and *Lepidolina*. The stratotype is a section comprising the Agalkhar, Dzhamantal, Deirin and Karasin units of G. A. Dutkevich (1937) in Dzhamantal Mountain, SE Pamirs. In the Agalkhar and Dzhamantal units, Miklukho-Maklay (1963, 1966) reported *Verbeekina verbeeki* Gein., *Afghanella magna* M.-Macl., *Neoschwagerina craticulifera* Schwag., *Sumartrina annae* Volz, etc. In modern terms this part of the section corresponds to the *Neoschwagerina craticulifera* Zone (Leven et al., 1989). The Karasin unit is characterized by *Neoschwagerina margaritae* Depr. and *Yabeina archaica* Dutk. The stratotype of the stage is underlain by the Kuberganda suite containing in the upper part the fusulinid assemblage of the *Neoschwagerina simplex* Zone (Grunt & Dmitriev, 1973). Thus, if the Murgabian is based on the stratotype rather than on the author's concept of the stage's volume, it includes the *Neoschwagerina craticulifera* Zone and the *N. margaritae* Zone in the modern nomenclature of the Tethyan scale.

Later, using the same stratotype, Leven (1967) restricted the scope of the stage to the lower "subhorizon" of Miklukho-Maklay, considering that it corresponds to the *Neoschwagerina* Genozone. He included the upper "subhorizon" with *Yabeina* and *Lepidolina* in the overlying Pamirian Stage, based on the appearance of aberrant fusulinids that characterize younger deposits.

Leven (1975) further revised the scope of the proposed Tethyan stages, basing definitions exclusively on fusulinid development. Using neoschwagerinins (Leven, 1965, 1967), he divided the Murgabian into three zones (in ascending order those of *Neoschwagerina simplex, N. craticulifera,* and *N. margaritae*), arbitrarily transferring the zonal sequence proposed for Japan by Ozawa (1927). Deposits previously referred to the upper Kuberganda suite, corresponding to the *N. simplex* Zone, were renamed as the Gansk suite, thereby also changing the range of the Murgabian Stage. Previously Leven (1967) had noted the presence of misellins and cancellins in the *N. simplex* Zone, both characteristic of Bolorian-Kubergandinian deposits. Additionally, the presence of the first *Yabeina archaica* Dutk. was recorded from the upper Murgabian *N. margaritae* Zone.

Miklukho-Maklay, 1958, 1963, 1966; Likharev, Miklukho-Maklay, 1964; Decisions, 1959 — Stage	Horiz.	Zone
Pamirian	Pamirian (with smaller foraminifers)	of smaller foraminifers and aberrant fusulinids
Murgabian	Murgabian (with higher fusulinids)	Lepidolina, Yabeina
		Neoschwagerina, Verbeekina, Sumatrina, Afghanella, Polydiexodina
Darvasian	Kubergandinian	Misellina, Cancellina, Armenina

Leven, 1963 — Stage	Zone
Pamirian	Codonofusiella, Reichelina
	Lepidolina
	Yabeina
Murgabian	Neoschwagerina
Kubergandinian	Cancellina
	Armenina
	Misellina
Artin.	Brevaxina

Leven, 1965, 1967, 1975 — Stage		Zone
Pamirian	Dzhulfian	Yabeina, Lepidolina, Codonofusiella
	Capitanian	
Murgabian	Neoschwagerina	N. margaritae
		N. schuberti
		N. simplex
Kub.		Cancellina
Chihsian		Misellina

Grunt, Dmitriev, 1973 — Stage		Beds
Dzhulfian		with numerous Codonofusiella, Reichelina, Palaeofusulina, Colaniella
Murgabian		with single Codonofusiella, Reichelina
		N. margaritae, Yabeina archaica
		N. schuberti
Darvasian	Kuberganda suite	N. simplex
		Cancellina
		Misellina

Leven, 1980 — Stage	Zone	
Dzhulfian	Vedioceras ventroplanum	
	Araxoceras latum	Araxilevis
		Codonofusiella
Midian	Yabeina	
	Lepidolina	
Murgabian	N. margaritae	
	N. craticulifera	
	N. simplex	
Kubergan.	Cancellina cutalensis	
	Armenina, Misellina (Misellina) ovalis	
Bolorian	Misellina (Misellina) parvicosta	
	Misellina (Brevaxina)	

Kotlyar et. al., 1989, 1991 — Stage	Zone
Dzhulfian	Vedioceras ventroplanum
	Araxoceras latissimum
	Codonofusiella kwangsiana-Pseudodunbarula arpaensis
Midian	Lepidolina kumaensis
	Yabeina globosa, Lepidolina multiseptata
Murgabian	N. margaritae
	N. craticulifera
	N. simplex
Kubergan.	Cancellina cutalensis
	Armenina, Misellina ovalis
Bolorian	Misellina parvicostata
	Misellina dyhrenfurthi

Leven, 1993 — Stage	Zone
Dzhulfian	
Midian	Yabeina globosa
	Afghanella robbinsae
Murgabian	Afghanella schencki
	Afghanella tereschkovae
	Praesumatrina schellwieni
	Praesumatrina neoschwagerinoides
Kubergandinian	
Bolorian	

Davydov, 1994 — Stage	Zone
Dzhulfian	
Midian	Yabeina globosa
	Yabeina archaica A. robbinsae
Murgabian	N. margaritae sensu Ozawa-A. schencki
	N. rotunca-A. tereschkovae
	N. simplex-P. schellwieni
	N. tenuis - P. neo-schwagerinoides
Kubergandinian	
Bolorian	

Kotlyar, 1993; Kotlyar et. al., 1994 — Stage	Zone
Dzhulfian	Codonofusiella sp.
	Reichelina media
	Codonofusiella kwangsiana-Pseudodunbarula arpaensis
Midian	Lepidolina kumaensis-Neomisellina lepida
	Lepidolina multiseptata-Neoschwagerina "margaritae"
Murgabian	Afghanella schencki-Neoschwagerina craticulifera
	N. simplex
Kubergan.	Cancellina cutalensis
	Armenina, Misellina ovalis
Bolorian	

Regional scale of USA — Series	Stage
	Ochoan
Guadalupian	Capitanian
	Wordian
	Roadian
Leonardian	Cathed-ralian

Figure 1. History of stage and zonal nomenclature Permian System, Bolorian-Dzhulfian.

Grunt & Dmitriev (1973) returned to the stratotype as reference for the Murgabian, defining the base of the stage to correspond with the base of the Agalkhar unit and the Zone of *Neoschwagerina schuberti* (=*N. craticulifera* Zone of later authors). Subjacent occurrence of *N. simplex* was accepted as defining the top of the Kuberganda suite. The upper boundary of the Murgabian was drawn in the middle of the Kutal suite (all of which was assigned by Miklukho-Maklay to the post-Murgabian Pamirian "horizon"), with the succeeding interval assigned to the Dzhulfian Stage.

In the (FSU) Interdepartmental regional scale for the Permian of the Tethyan Realm, the Murgabian has been accepted following E. Ya. Leven as the *Neoschwagerina* Genozone, subdivided into the zones of *N. simplex* below followed by *N. craticulifera* and *N. margaritae*. The *Yabeina-Lepidolina* Genozone separating the Murgabian from the Dzhulfian was named as the Midian, but established without indication of a precise stratotype other than an expressed preference for Transcaucasia. The Arpa and Khachik suites were conditionally assigned to the stage. Characterizing the lower boundary of the Midian by the advent of the higher (younger) genera *Yabeina* and *Lepidolina* and mass appearance of aberrant fusulinids, Leven proposed a hypothetical stratotype either "in the base of the *Chusenella abichi* beds (the upper part of the Arpa suite) or in the base of the Arpa suite" (Leven, 1980, p. 18). He placed the upper boundary of the stage at the base of the *Araxilevis* (brachiopod) beds, an interval that is devoid of ammonoids but is included in the Araxoceras (ammonoid) Zone (Leven, 1980) and lies above the top of the *Codonofusiella* (fusulinid) beds.

Detailed study of the Midian deposits of Transcaucasia revealed, however, that they do not contain higher (younger) fusulinids (Kotlyar et al., 1989), although a single species of the genus *Yabeina* was found recently in Iran (Baghbani, 1991). Thus in the stratotypical region for the Midian, the lower boundary cannot be substantiated by reference to fusulinids. Further, as a result of detailed correlation of Murgabian/Midian deposits across the entire Tethys, it can now be demonstrated that the upper zone of the Murgabian (the *N. margaritae* Zone) everywhere contains the Midian assemblage of fossils. Specifically, in China, Japan, and in the Murgabian stratotype of the SE Pamirs, representatives of *Yabeina* that supposedly determine the lower boundary of the Midian actually occur in the upper zone of the Murgabian (Yang, 1985).

Restudy of the Akasaka limestone of Japan (Honjo, 1959), the sequence for which the three neoschwagerinid zones were established, failed to confirm presence of the index species of the *Neoschwagerina* Genozone. However, some appear in the overlying *Yabeina globosa* Zone, where *Neoschwagerina margaritae* Depr. has been reinterpreted as *Yabeina ozawai* (Honjo, 1959), resulting in renaming of the zone as the *Y. ozawai* Zone. Significantly, it can be demonstrated that this taxon is joined through a gradual transition to a clinal succession in the underlying *N. craticulifera* Zone. These data were not taken into consideration in creation of the Tethyan scale (Leven, 1980), in which traditional zonal components of both the Murgabian and Midian and the bases for definition of the base of the Midian remained unaltered. Presence of *Neoschwagerina minoensis* Depr. and *Yabeina archaica* Dutk. in the Karasin unit of the stratotypical Murgabian also were not taken into consideration, and appearance of *Yabeina* was still considered the basis for defining the lower boundary of the Midian (Leven, 1967).

Joint occurrence of *Neoschwagerina margaritae* with *Yabeina* and *Lepidolina* directly above the *Neoschwagerina craticulifera* Zone in the most complete Tethyan sections supports assignment of the *N. margaritae* Zone to the Midian (Vachard, 1991; Sheng & Jin, 1994). This fusulinid assemblage and other associated faunal elements thus warranted exclusion of the zone from the Murgabian (Leven, 1993; Kotlyar, 1993). Consequently, the scope of the Murgabian was reduced by restriction to the *N. simplex* and *N. craticulifera-Afghanella schencki* zones; the Midian then comprised the *Lepidolina multisepta-N. "margaritae"* (lower) and *L. kumaensis-Metadoliolina lepida* (upper) zones (Kotlyar, 1993). Overall, problems in definition are posed by the difficulty in framing acceptable diagnoses for the neoschwagerinids, and the slow evolution of the sumatrinids. Special difficulties also result from failure to designate stratotype locations for the zones.

Another version of zonal division of the Murgabian and Midian (Figure 1) was proposed by V. I. Davydov (1994): in ascending order *Neoschwagerina tenuis-Praesumatrina neoschwagerinoides*, *N. simplex-P. schellwieni*, *N. rotunda-Afghanella tereschkovae*, *N. margaritae* sensu Ozawa-*A. schencki* for the Murgabian, and *Yabeina archaica-A. robbinsae*, and *Y. globosa* for the Midian. Again, stratotypes for the zones were not designated. In this regard, it should be added that the most complete and best known sections for the Murgabian are in China, where zonations more detailed than in the Tethyan scale are accepted.

Changing interpretations of Tethyan stage boundaries and component zones for the Murgabian and Midian are summarized in Figure 1. Comparable schemes for these time intervals have been proposed for other areas, including China (Sheng & Jin, 1994). However, they have not been widely accepted (China, Japan), or were conceived arbitrarily (e.g. Baud et al., 1993: Lys & Marcoux, 1978).

Ammonoids and conodonts alone provide the key to valid age assignments for the Murgabian and Midian. Wordian ammonoids are known from the lower Midian in several regions of the Tethys. The Cache Creek section of British Columbia is notable, yielding a rich assemblage of Wordian ammonoids in association with abundant *Yabeina* (Ross & Nassichuk, 1970), a relationship that has been verified repeatedly. Supporting evidence has been assembled by G. P. Pronina through recognition of Midian small foraminifers in direct association with Wordian ammonoids. Similar associations of foraminifers and ammonoids probably also occur in the Wordian of Sicily. Secondly, Capitanian ammonoids occur in upper Midian deposits. Notable are the Chandalaz horizon of the Southern Primorye (Kotlyar et al., 1989), and the analogous Osakhtin suite of the Priamurye (Ruzhentsev, 1976). Thus the Midian in the sense of Leven is characterized by two sharply distinctive ammonoid assemblages, one Wordian and the higher of Capitanian age. In addition to other advantages, these latter two American references enjoy more than a half century of priority over the Midian.

Similar problems arise with the Murgabian. Recent studies of Permian limestones from the Crimea revealed enormous assemblages of smaller foraminifers, fusulinids, ammonoids and brachiopods of Kubergandinian, Murgabian and Midian ages (Kotlyar et al., in press). Zonal fusulinid assemblages of these same Upper Permian Tethyan stages were established previously by V. I. Davydov (1991). Those of the *Neoschwagerina simplex* Zone are of special interest because of association with Kubergandinian ammonoids, the Burna assemblage of O. G. Toumanskaya. This confirms conclusions reached by Toumanskaya (1963) and M. Ph. Bogoslovskaya (1984) on the Kubergandinian age of the Burna limestone. More importantly, it verifies the assertions of Miklukho-Maklay (1966) and Grunt & Dmitriev (1973) that the *N. simplex* Zone of the Pamirs belongs in the upper part of the Kuberganda suite that underlies the Murgabian stratotype.

In summary, drastic modification of the scope of the Murgabian Stage has occurred. Leven (1993) concluded that Midian assemblages of fusulinids together with the appearance of *Yabeina* necessitate exclusion of the *Neoschwagerina margaritae* Zone, considered previously as upper Murgabian. Similarly, the *N. simplex* Zone must be Kubergandinian, leaving only the middle zone (*N. craticulifera*) to represent the Murgabian Stage. This interval has been demonstrated to correspond to the Wordian of North America, which has clear priority. Even with return to the original scope of the stratotypic Murgabian "horizon", including the *Yabeina-Lepidolina* Genozone, the interval would correspond to Wordian and succeeding Capitanian stages.

As to the Kubergandinian, its scope has changed repeatedly (e.g. Leven, 1967, 1975, 1980). However, in the sense of the original definition, it continues to be characterized by the Roadian ammonoid assemblages (e.g. Bogoslovskaya, 1984: Chedija et al., 1986). It would be illogical to attempt to preserve the Kubergandinian as an international standard while defining the base by appearance of Wordian ammonoids.

Galina V. Kotlyar
Galina P. Pronina
All-Russian Geological
Research Institute (VSEGEI)
Sredny pr., 74,199026
St. Petersburg, Russia

14. THE IMPORTANCE OF THE PERMIAN PELAGIC SEQUENCES OF THE SOSIO VALLEY (SICILY, ITALY) FOR THE ELABORATION OF AN INTERNATIONAL PERMIAN SCALE.

The Permian of the Sosio Klippes belongs to the classical area of the Permian in the world. A large part of their predominantly Wordian fauna was described already in the last century by Yemmelaro. Catalano et al. (1991) proved that these Klippes are not exotic blocks in Serravalian (late Miocene) clays, but juxtaposed against Permian deep-sea sediments. All Permian rocks of the Sosio Valley were regarded as interfingering basin and slope facies belonging to the basal part of the Upper Nappe Unit. Kozur (1994) pointed out that only the Permian Klippes belong to the Upper Nappe Unit (named as the Palazzo Adriano Nappe), whereas the other Permian facies belong to tectonic slices between the Palazzo Adriano Nappe and the Lower Nappe Unit. The Permian deep-sea facies did not originate adjacent to the Sosio Klippes, because their Triassic covers are different and contain different faunas indicating a more northern origin of the Sosio Klippes compared with the Permian deep-sea facies. There is still a third Permian facies containing Cathedralian-Roadian siliclastic turbidites. Wordian "ammonitico rosso" and Changxingian calcarenites.

The rich faunas of all 3 facies are important for certain aspects of the world-wide correlation of Permian deposits. The Cathedralian and Guadalupian faunas can be correlated in detail with the proposed standard and pelagic zonations (conodonts, ammonoids) in North America. The Lopingian can be correlated with the Chinese standard and zonations (conodonts, radiolarians) proposed as world standard as well. A correlation with the Kungurian, Ufimian, Kazanian and Tatarian stages is impossible, a correlation with Tethyan scale (in reality fusulinid ages) is only partly possible and partly even misleading.

The serrated *Mesogondolella nankingensis* lineage is missing in Sicily, because the conodont fauna belongs to the cold bottom-water faunas (like the paleopsychrospheric ostracods), whereas the *nankingensis* lineage occurs in warm-water environments of the upper slopes of open sea successions or of semirestricted basins such as the

Delaware Basin or similar basins in East China. This does not mean one should disregard the very precise Cathedralian-Roadian boundary with the first appearance of *M. nankingensis* in the cline *M. idahoensis* - *M. nankingensis*. This cline is the correlation level, and a good correlation is possible with the first appearance of *M. nankingensis* in the warm-water faunas and the unserrated *M. phosphoriensis* in the cool water faunas. *M. phosphoriensis* developed in a cline *M. idahoensis* - *M. phosphoriensis*. The first appearance of the shallow water *Sweetognathus subsymmetricus* is near to this level as well.

The first appearance of *Neostreptognathodus exsculptus* and *M. glenisteri* in the Sosio Valley area allows the correlation with the base of the Cathedralian Stage s.l. (base of the Leonardian Series) in the proposed standard of Jin Yugan et al. (1994) in North America and with other Tethyan sequences in which this species occurs in faunas that belong either to the Yaktashian or to the Bolorian fusulinid ages (not exactly correlatable with the fusulinid ages, because in this level fusulinids are missing in the Pamirs and other Tethyan regions with *N. exsculptus*). In North America, but not in the Tethys, the first appearance of *N. exsculptus* coincides with the first appearance of *N. previ* with the cline *N. pequopensis* - *N. previ*, an ideal and correlatable Artinskian-Kungurian boundary. Through correlation with the proposed standard in North America, the top of the Artinskian (base of the Cathedralian) is correlatable in the Sosio Valley sequences.

The Rupe del Passo di Burgio block of the Sosio Klippes, the type locality of the type species of the Wordian ammonoid index genus Waagenoceras, contains the richest Wordian ammonoid fauna of the world and also rich Wordian conodont faunas (*M. siciliensis* of the unserrated *M. idahoensis* - *M. phosphoriensis* cline and Yuleodus catalonoi). However, the fusulinids and small foraminifers determined by Dr. Davydov and Dr. Pronina (St. Petersburg) indicate an early Midian age. Consequently, the Tethyan stages, which are in reality fusulinid ages, cannot be correctly correlated with pelagic faunal complexes even within the Tethys. Because the Tethyan fusulinids are unknown in the Boreal realm and in North America (except in terranes of Tethyan origin), only pelagic faunas can be used for correlation. Consequently, the Tethyan scale, based on fusulinids, is unsuitable as a world standard. It should only be used to determine fusulinid ages for fusulinid-bearing rocks of the Tethys.

H. Kozur
Résü u 83
H-1029 Budapest
Hungary

15. INTERNATIONAL SYMPOSIUM "EVOLUTION OF PERMIAN MARINE BIOTA"

(with field-trip on the Permian of the Kozhim River, Near Polar Uralskomi Republic) August 15-25, 1995

The International Symposium on the problems of evolution of Permian marine biota with a field excursion to the Permian section of the Kozhim River in the Near Polar Urals was held in Russia on August 15 to 25.

The Abstracts are published in Russian and English versions. The guidebook on the Permian of the Kozhim River was published only in Russian.

The start point of the above symposium was a field trip on the Kozhim River. Fifteen excursion participants had an excellent opportunity to observe this unique section and to collect fossil remains from carbonate and terrigenous rocks of Late Carboniferous-Late Permian age.

The location of the Kozhim section is shown on Figure 1. The Upper Sakmarian - Ufimian part of the section comprises the following units (in ascending order):
Kosyinsk Suite. It can be subdivided into two subsuites: Siltstone subsuite (lower) and Sandstone (upper).

Siltstone Subsuite (Sakmarian Stage, Sterlitamakian Horizon-Artinskian Stage, Burtzevskian Horizon. The thickness of this subsuite is 400 m.

Sandstone Subsuite (Artinskian Stage, Irginian and Sarginian Horizons).

Sandstone subsuite is represented by 200 m of alternating rather thick bands of argillite and siltstone with sandstone beds. Ammonoids: *Paragastrioceras jossae* ex gr., *P. kirghizorum* Voin, *Sakmarites vulgaris* (Karp.), *Artinsicia artiensis* (Grun.), *Medlicottia orbingnyana* (Vern.), *Waagenina subinterrupta* (Krot.), *Uraloceras suessi* (Karp.) have been found in the middle part of the subsuite.

Chernorechensk Suite. (Artinskian State, Irginian and Saranian Horizons-Kungurian Stage, Filippovskian Horizon).

Chernorechensk suite is represented by a thick sequence of dark gray to greenish gray aleurolites with subordinate sandstones and intermittent micritic limestone or marl interlayers. Carbonate concretions sometimes containing ammonoids occur at many levels. Ammonoids (*Paragastrioceras* sp., *Uraloceras* cf. *involutum* (Voin.), *Uraloceras* sp.) are present at a level 395 m above the bottom of the Chernorechensk suite. This level corresponds to the upper boundary of the Sarginskian horizon.

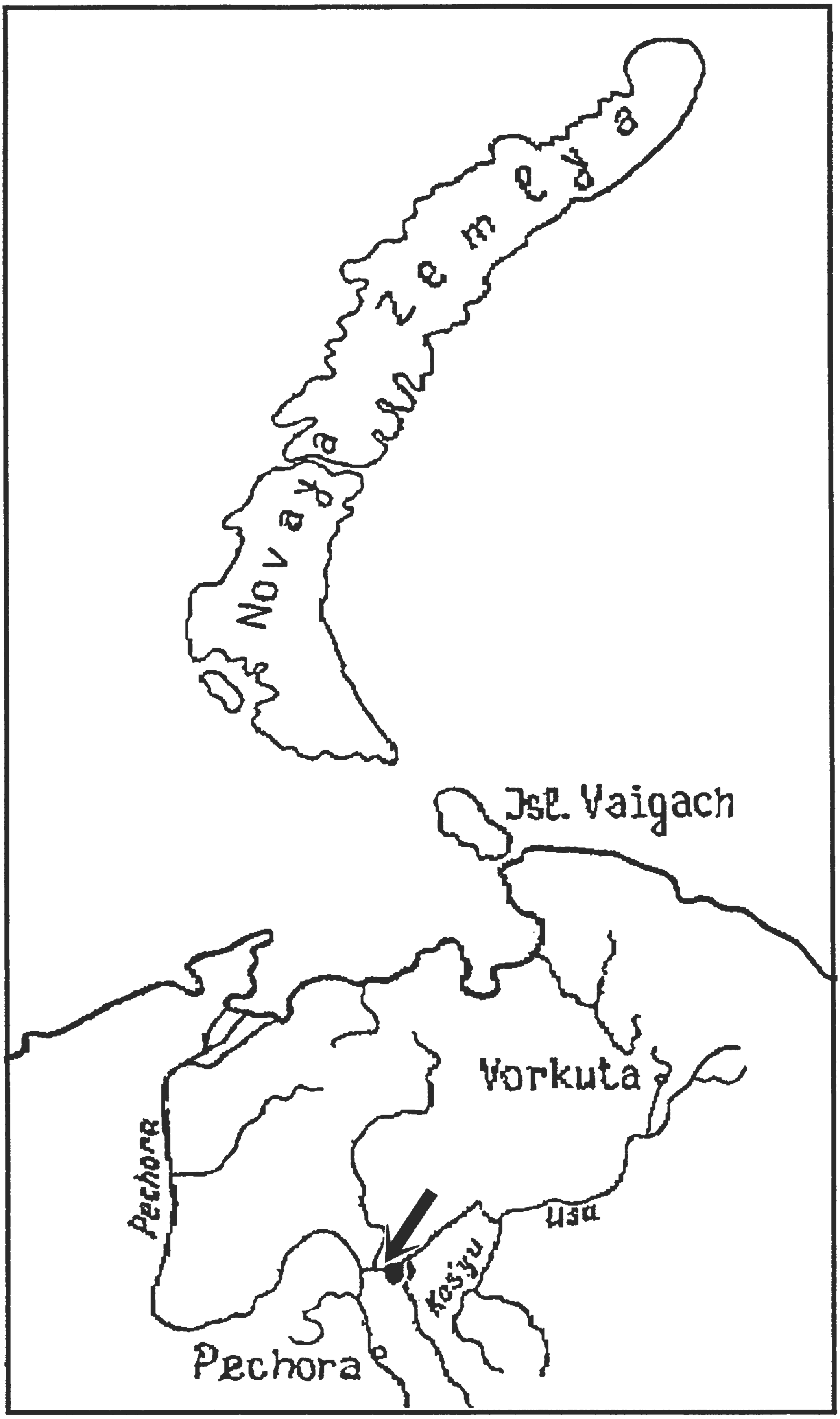

Figure 1. Location of Kozhim section (shown by arrow).

The upper part of the Chernorechensk suite (385 m thick) correlates with the Saraninskian horizon of the Artinskian stage and the Filippovskian horizon of the Kungurian. Some ammonoids (*Paragastriocera* sp.) and abundant bryozoans were collected within this interval. Bryozoans include: *Ramiporidra* sp., *Goniocladia* cf. *compacta* (Schulga-Nest.), *Laxifenestella sublatericrescens* (Schulga-Nest.), *L. mariae* (Trizna), *Alternifenestella pseudobifida* (Schulga-Nest.), *Parseptopora uralica* (Nikif.), *Polyporella trigonocella* (Schulga-Nest.). The uppermost part of the suite (about 140 m thick) can be correlated with the Filippovskian horizon of the Kungurian on the basis of miospore assemblage (Guides to Geological Excursion, 1993).

Kozhim Suite. (Kungurian Stage, Irenskian Horizon).

Kozhim suite is subdivided into two parts. The lower (105 m thick) is composed of sandstones with subordinate argillite and aleurolite beds and packets. Upper part of the suite 257 m thick) is represented by alternating thin interlayers of sandstone and argillite or aleurolite. Rare sandstone packets and aleurolite beds and packets. Upper part of the suite (257 m thick) is represented by alternating thin interlayers of sandstone and argillite or aleurolite. Rare sandstone packets (2-5 m thick) are also present. Brachiopods are especially abundant in the Kozhim suite, including representatives of the following genera: *Derbya, Neochonetes, Krotovia, Kochiproductus, Sowerbina, Anemonaria, Thuleproductus, Waagenoconcha, Kaninospirifer, Spiriferella, Rhynchopora, Stenoscisma, Pinegathyris* and others. Brachiopods could be used for correlation with the stratotype section of the Kungurian as well as with the sections of the Canadian Arctic, Svalbard, Inner Mongolia and Australia.

Numerous foraminifers have been recovered from ten stratigraphic levels. Bivalves are present at seven levels; miospore assemblages were studied from eleven levels. Bryozoans, ostracods, ganoid fishes, crinoids occur at some stratigraphic levels as well. A Kungurian age of these groups is certain.

Kozhim-Rudnitsk Suite. (Ufimian Stage, Solikamskian Horizon).

Kozhim-Rudnitsk suite (542 m thick) composed of thin bands (5-25 cm) of argillite, aleurolite and sandstone. Beds may attain thickness of 15-75 m. Packets of laminar or crossbedded sandstone 2-18 m thick are distributed throughout the section. Rather thin (0, 1-1 m) interlayers of coal and freshwater limestones also occur.

Numerous organic remains (foraminifers, bryozoans, brachiopods, bivalves, fishes, plants, miospores) occur throughout the suite. A Solikamskian age for this stratigraphic interval is supported by the majority of specialists.

Intinsk Suite. (Ufimian Stage, Solikamskian and Sheshminskian Horizons).

Intinsk suite (582 m thick) is composed by relatively thin alternating beds of sandstone, aleurolite and argillite with some coal seams (0, 5-1, 5 m). Thick packets (up to 36 m) of crossbedded sandstones with tree trunks are interpreted to be fluvial stream deposits. Organic remains are represented by nonmarine bivalves, fish, tetrapods, plants and miospores.

The stratigraphic and correlative potential of the Kozhim River section was carefully discussed during the symposium. In the academic session more than 50 specialists took part. More than 30 reports dealing with the problems of evolution of different marine invertebrates groups were presented, as well as several talks on palynological data.

The following recommendations for further investigations on the Permian were adopted.

The standard of the Permian stages has been worked out on the basis of sections in the Urals and the Russian Platform. The Kungurian, Ufimian and Tatarian stages are represented by nearshore marine or continental deposits. Accordingly, these stages cannot currently be adopted as global standards.

Admitting in principle that a global scheme of Permian chronostratigraphy must be based on marine sections we nevertheless would note that the recent revisions of the traditional scheme and proposals of new alternative schemes seem to be of a hasty character and insufficiently grounded. The proposed alternative scale cannot be applied to the Permian sections of Russia, Mongolia or Australia.

Data obtained from recent studies show that stratotypical sections of most Permian stages in the Russian Platform and Urals are of a high correlative potential. It is important also that the stages of the Permian Standard scale have been established and substantiated within a single large region. The presence of rich palynological assemblages, as well as the wide distribution of abundant continental flora and fauna in the sections of the Russian Platform and Urals can also be considered as an advantage of the latter over the sections from other areas.

It seems possible to come to an agreement as regards the following points.

It is necessary to maintain the two-fold subdivision of the Permian system for the sake of stability and priority. Such subdivision reflects the geological history of the stratotypical area and evolution of the Permian biota as a whole. Taking into account that the Kungurian stage is most completely represented in normal marine facies in the north of the Russian Platform and in the Polar Urals, it seems justifiable to maintain the originally accepted sense of all the stages of the Lower Series of the Permian system (which includes the Asselian, Sakmarian, Artinskian and Kungurian stages).

The Lower and Upper Permian boundary sequence of the Kazhim River could be considered as a parastrototype (or neoparastratotype) of the Kungurian and Ufimian stages.

The correlative potential of stage boundaries in the Kozhim section could be established by tracing them into other sections both within and outside the stratotypical area. An International Symposium with a field trip on the Permian near Vorkuta Town will be convened 22-31 July, 1996. Participants will see a Permian section ranging from the Carboniferous-Permian boundary to the top of the Late Permian. The Artinskian, Kungurian and Ufimian stages are represented here by a similar sequence of sediments as in the Kozhim section. The Vorkutian sequence contains similar assemblages of faunal and floral remains.

Several Working Groups were organized with the aim of clarifying biostratigraphic relationships within the Kungurian-Ufimian interval. Group leaders include: Dr. Margarita Bogoslovskaya (Artinskian-Ufimian ammonoid zonal scale), Dr. Tatyana Grunt (brachiopod zonal scale), Dr. Gennady Kanev (bivalves), Dr. Nina Koloda (miospores) and Dr. Svetlana Pukhonto (plant remains).

The Roadian and Kubergandian stages are considered by the majority of stratigraphers to be coeval to the Ufimian stage. Accordingly, we consider it very critical to initiate a joint project "Global correlation of the Ufimian stage", which would include a restudy of the U.S. stratotype of the Roadian, the Tethyan stratotype of the Kubergandian, and other key sections in Arctic Canada and Russia (Novaya Zemlya) as well.

The problems of intercontinental correlation of the Kungurian-Ufimian interval for the standard section will be addressed by working groups under the leadership of: Dr. Galina Kotlyar (Far East region), Prof. Ernest Leven (Tethyan regions), Dr. Igor Manankov (Mongolia), Prof. Neil Archbold and Dr. Guan R. Shi (Australia), Dr. Marina Durante (Angara Land region). In addition a recommendation was made to organize a working group under the leadership of Dr. Natalya Esaulova to gather more precise data on Upper Permian sections in the Russian Platform and Urals.

Boris Chuvashov, Corr.-Member of the Russian Academy Sciences, has been elected Chairman of the Working Groups to coordinate all these investigations.

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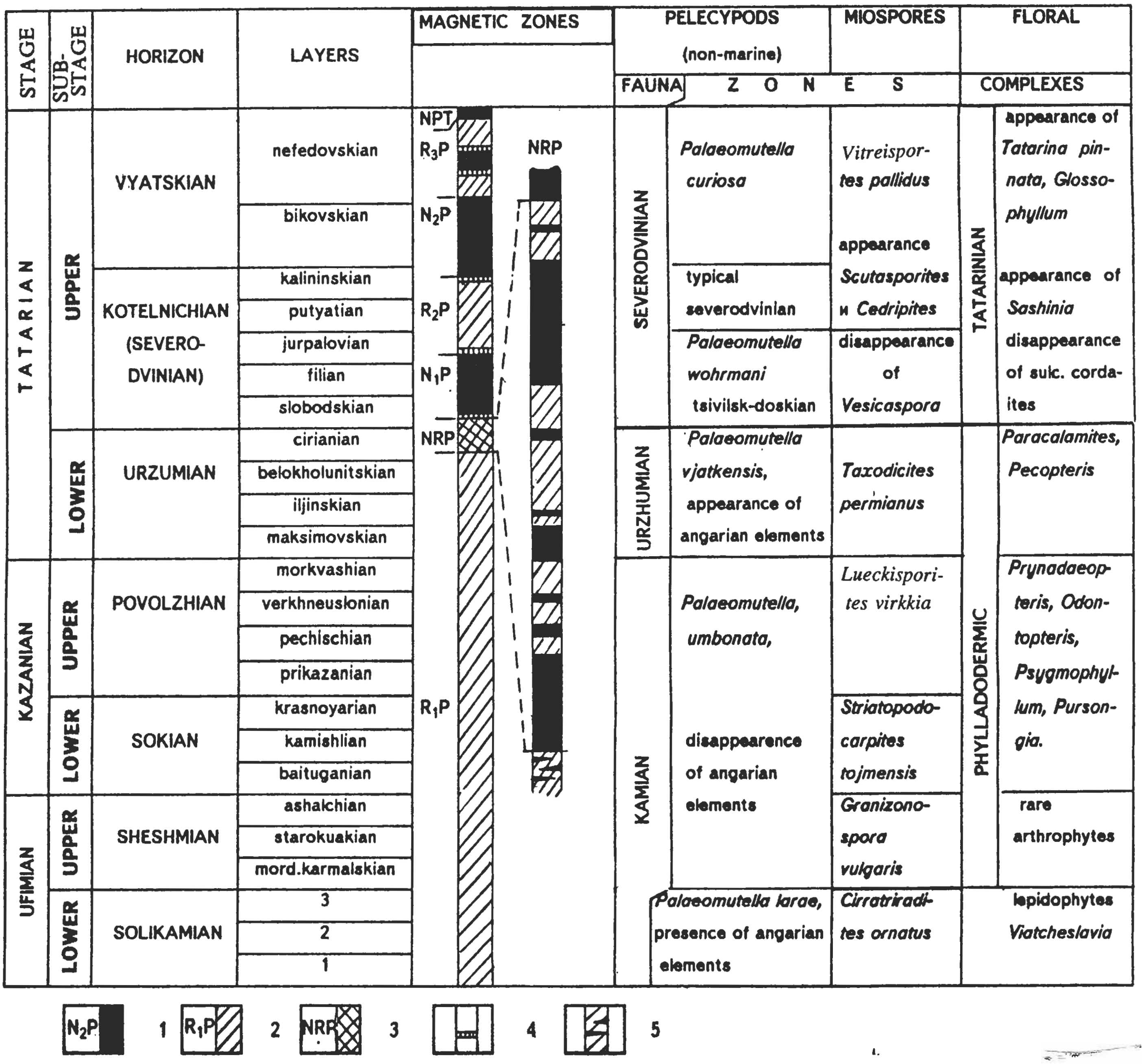
Corr.-Member of the Russian Academy of Science
Institute of Geology and Geochemistry
Urals Branch of RAS, 620219, Ekaterinburg
GSP-644 Pochtovy per. 7
Dr. Margarita Bogoslovskaya, Dr. Tatyana Grunt,
Dr. Lidia Kuzina, Dr. Tatyana Leonova
Paleontological Institute RAS, 117647 Moscow
GSP-7, Profsoyuznaya 123
Dr. Natalia Esaulova
Kazan State University, 420111 Kazan, Lenin str. 4/5
Dr. Vladimir Chermnykh
Institute of Geology, Komi Science Centre
Ural Division of RAS, 167000 Syktyvkar
Pervomajskaja str. 54

16. ON THE PROBLEMS OF THE STUDY OF THE UPPER PERMIAN STRATOTYPES

During recent years, as a result of almost complete cessation of subject works, geological survey, and prospecting in the Volga-Urals region, the level of examination of the upper Permian stratotypes considerably decreased: monographic collections should be reviewed on the basis of study of anatomical structure of flora and fauna. Trustworthiness of the Upper Permian stratotypes has been criticized, and there have been some suggestions to establish international stage standards in North America and China. Marine stratotypes are generally attractive due to the possibility of wider correlation, but most of the Permian known was formed in shallow, intra-continental basins. Unfortunately, important achievements in reconstruction of geomagnetic fields are sometimes not taken into consideration, in spite of the fact that they were obtained in present stratotypes, but not in marine sections less suitable for such investigations.



1 normal polarity zone
2 reverse polarity zone
3 sign-alternating superzone
4 transitional zones studied
5 R P subzones

Figure 1. Biostratigraphical and magnetostratigraphical zones in Upper Permian rocks of Volga-Urals region.

The Permian system was defined by Sir Roderick I. Murchinson in 1841, but the Permian rocks were studied by Russian geologists from the second half of the 18th century. The lower boundary of the Permian system was initially established at the level of Artinskian-Kungurian interface. The present Lower Permian was considered to be "Permian-Carboniferous"; and just in the 1920s, A. Nechayev proposed to include the "Permian-Carboniferous" in the Lower Permian. Stratotypical localities of the Upper Permian - Western Urals and East of the Russian Platform - represent "the only and the world's largest field of the Permian deposits with diverse formations and facies"(Main Features . . . ., 1984, p. 7). The Lower Permian consists of Asselian, Sakmarian, and Kungurian stages, respectively, 9, 9.5 and 5 m.y. (The Scale . . . ., 1985). The Upper Permian includes Ufimian, Kazanian, and Tatarian stages of 2.5, 2.5 and 5 m.y. (Fig. 1). The Permian system ends the Paleozoic Era, and corresponds to the most complicated stage of development of the earth's crust: the final Hercynian folding stage, thalassocratic-geocratic transition, sharp paleogeographic differentiation that is favourable to autonomous development of flora and fauna in separate basins. That explains the problem of correlation of the Upper Permian belonging to different facies, as well as attempts to create regional and local scales. The stage scale of E. Leven for the Tethys region includes the Caucasus, Middle Asia, and Far East (Main Features . . . ., 1984). Unfortunately, the stratotypes of these stages proved to be outside Russia, and are difficult to reach. G. Sadovnikov suggested to establish the continental Upper Permian in the south of Siberian Platform: on Taimir isle, and in Tungus basin, and in Verkhoyan region (Sadovnikov, 1994). The International Permian Subcommission suggests North American and Chinese sections to be the Upper Permian stratotypes (Yugan et al., 1994). Among many arguments for the selection of new stratotypes, we consider the two following ones to be most important: 1) Incompleteness of the section at the Permian-Triassic boundary, i.e., hiatus, and 2) Impossibility of a correlation between deep-marine and continental (shallow-marine) sections.

Completeness of the section at the Permian-Triassic boundary

Determination of incompleteness of the section using diverse faunal and floral groups is only possible on the basis of a special analysis of the phylogenetic changes in taxa at the Permian-Triassic boundary, and only with corrections for evolution's rate in different environments. There are no such publications in Russia at present. However, some suggestions can be made from recent analyses including ostracods, pelecypods, miospores, and macroflora.

The paleomagnetic method (number of zones) is also involved as an argument. Indeed, this method nowadays is the only global criterion that enables one to trace the Kiama-Illawarra hyperzone boundary in the Permian. In the Volga-Urals stratotypical zone that coincides with the zone between the boundary of the Upper Tatarian and Lower Tatarian substages (Fig. 1). The paleomagnetic section of the Tatarian Stage of the Russian Platform has been well studied in various outcrops on Volga, Vyatka, Vetluga, Yug, Luza, North Dvina rivers by paleomagnetists of VNIGRI (St. Petersburg), Kazan University, Saratov University, all the stratotypes of stages, horizons, and layers being studied.

The beginning of Tatarian time was accompanied by the reverse polarity geomagnetic field which was going on from the Carboniferous-Early Permian and including the Ufimian and Kazanian (R1P - Kiama). The short-term breaks of R polarity (events) marks the Belokholunitskian layers in the Vyatka river basin, and the corresponding layers of the lower half of the 2nd suite of Tetyushy region near Kazan. In the upper part of the 2nd suite in a paleomagnetic section, there is relatively frequent alternation of zones and subzones with normal and reverse polarities which are included in the NRP superzone. There are up to 4 to 8 zones and subzones of polarity in different sections (Boronin, 1987). Such an alternation of N-R zones continues in the lower part of the 3rd suite of Volga region and in Slobodskian layers of the Vyatka basin. N1P zone is characteristic for the Slobodskian and Filinian layers, and its upper boundary is revealed in the bottom part of Yurpavlovskian layers. The next paleomagnetic zone - R2P - begins in Yurpavlovskian layers, includes all Putyatian layers, and has its transition into next N2P zone in Kalininskian layers. On Vyatka river, the section of Vyatskian horizon was studied in an outcrop near Putyatino village where two paleomagnetic zones N2P and R3P, overlain by basal sandstones of the Triassic Induan Stage, were defined. More complete Vyatskian horizon was determined after examination of wells near the Vyatka-North Dvina confluence, and of outcrops in Luza, Yug, and Malaya North Dvina rivers. NP-zone 20 m thick was revealed within Nefedovskian layers near Gavrino village at the mouth of the Luza river. Here transitional zones (Medvezhy Vvozok and Rogovik) were studied, which define the zone n_1R_3P (Burov et al., 1977). Instead of the single R_3P zone defined by Khramov, there had been revealed three polarity zones, i.e., R_3P is a superzone. Triassic deposits lie transgressively, and it is no wonder that on Vyatka river they lie upon r_1R_3P zone; on Vetluga river - upon N_2P, while in complete sections N_1T magnetozone is believed to divide into two NPT zones. Thus, there are at least eight paleomagnetic zones in complete sections of the Upper Permian of the Volga-Urals region, one of them being sign-alternating and consisting of a number of separate zones and subzones.

Magnetostratigraphic scales of different regions are nowadays difficult to compare because of different levels of studying. However, trustworthy tracing of, at least, the Kiama-Illawarra boundary would be favourable for the global determination of the levels of one age. Red beds, comparing with grey marine ones, were determined with greater confidence due to high accuracy of measurements, higher level of examination, determination of virtual poles' location and polarities, and detailed characteristics of polarity inversions (Burov, 1979). Completeness of stratotypical sections is proved not only with a great number of polarity zones but also with the presence of sign-alternating (a kind of transitional) horizon at the Kiama-Illawarra boundary; and the presence of almost all transitional polarity zones corresponding to inversions of geomagnetic field.

Thus, greater completeness of the Upper Permian of Tethys, Siberian Platform, North America, and China seems questionable and lacking foundation.

On the correlation between the upper Permian deposits
Impossibility of correlation between Eastern European and North American scales is adduced as the second fault of present stratotypes. This problem can be explained by the difference between shallow-marine and deep-marine environments. Stratigraphic scale of deep-marine sediments of Tethys and North America is based on the examination of ammonoids, fusulinids, and conodonts, while the stratigraphic scale of shallow-marine sediments of Volga-Urals region employ brachiopods, foraminifera, ostracods, pelecypods, radiolarians, corals, bryozoans, macroflora, miospores, and terrestrial vertebrates (Gusev et al., 1993). Biostratigraphic zones are controlled with magnetostratigraphic zones. It was found by studying the main groups of flora and fauna that the most important time of their development was the time between Early and Late Tatarian. Rejuvenation of flora and fauna coincide with this interval. That must have been connected with different state of geomagnetic field, but whatever the reason, this boundary is very sharp, and can be traced far beyond the stratotypical area.

Direct correlation of different faunal groups is impossible. Correlation of stratigraphic scales of Biarmian, Tethyan, and Angaran areas is, to a great degree, conditional. Transfer of the Upper Permian stratotypes to North America and China, and their acceptance as international standards will not solve the correlation problem, and it is likely to complicate it since this is a zone scale for deep-marine basins which are not widespread at present. That will destroy the integrity of the united basin and expediency of the system name itself. Unequivocal tracing of boundaries of the Leonardian, Guadalupian, and Lopingianian in North America and China seems questionable, as the correlation of the Guadalupian within North America and Canadian Arctic is still equivocal. Even considering this variant of the scale, it has been pointed out the possibility of "zone sliding" and to their interchangeability. After more detailed examination of ammonoids, fusulinids, and conodonts, it can be found later that boundaries, according faunal groups, do not coincide, what has been revealed in other basins. In Dalangkou section, the Lower and Middle Triassic deposits were described with the typical Permian subangaran flora (Y. Jiduan, 1991, fig. 10). One of the variants of correlation between the Upper Permian deposits of the Volga-Urals region and elsewhere is the correlation with the Sverdrup Basin of the Canadian Arctic. Here correlations have been proposed between the Sabine Bay Formation and Kungurian Stage based on *Neostreptognatodus prayi* and *Noeogondolella idahoensis* (Beauchamp et al. 1989) or alternatively between the Sabine Bay Formation and the Roadian based on the ammonite *Sverdrupites* sp. (Nassichuk, 1995); the Assistance Formation with the Solikamian horizon; the Trold Fiord Formation with the Sheshma horizon, although some workers have proposed a correlation of this formation with the Kazanian (Utting, 1994). The Capitanian Formation of Texas may be correlated with the Kazanian Stage and the Urzhumian horizon of the Tatarian Stage.

Shallow-marine Upper Permian deposits of the Volga-Urals region are transitional between deep-marine deposits with continuous deposition and the continental ones. Taking palynological and magnetostratigraphic methods as the basis, it is possible to trace the main boundaries within the Upper Permian from Volga-Urals region through Novaya Zemlya and the Canadian Arctic toward deep-marine deposits of North America and Tethys; and in the east toward continental deposits of Angarida, Far East, and China.

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Boris V. Burov, Professor
Head of the Chair of Regional Geology
Kazan State University
18 Lenin St., Kazan 420008, Russia
Natalia K. Esaulova, Assistant Professor
Chair of General Geology
Kazan State University
18 Lenin St., Kazan 420008, Russia

17. CORRELATION OF THE UPPER PERMIAN FLORISTIC COMPLEXES OF THE VOLGA-URALS REGION OF RUSSIA WITH DALONGKOU SECTION OF CHINA

Correlation of the Upper Permian of the Volga-Urals stratotypical area of Russia with Dalongkou of China is a topical problem since it was suggested to establish the latter as a stratotypical boundary between the Permian and Triassic in continental facies. Correlation both within the Volga-Urals basin and outside has been possible after detailed study of the Upper Permian flora and fauna of the stratotypical area in marine, transitional, and continental facies; and determination of biostratigraphic boundaries. The Upper Permian deposits formed in a shallow marine basin which gradually became less markedly marine, and finally became a lagoon. The Upper Permian flora has been well studied by A.V. Bogov, V.P. Vladimirovich, A.V. Gomankov, N.K. Esaulova, S.V. Meyen, L.A. Fefilova (Fig. 1). There are three great floristic complexes of the Permian period: 1) Psygmophyllum ("Bardian"-Artinskian-Kungurian); 2) Phylladoderma (Sheshmian-Kazanian-Urzhumian); and 3) *Tatarina* (Late Tatarian). Flora of the Solikamian horizon of the Ufimian Stage contains uniform remains of bark, leaves, and megaspores of lycopodium *Viatscheslavia*. Most diverse is the phylladoderma floristic complex, the Kazanian flora being a core of that. It is represented by various arthrophytes *Calamites, Paracalamites, Annularia, Sphenophyllum, Phyllotheca,* fronds of sterile *Pecopteris,* and sporophore ferns *Asterotheca, Oligocarpia, Todites, Orthoteca, Prynadaeopteris*; diverse pteridosperms *Calipteris, Odontopteris, Raphidopteris, Brongniarthites, Comia, Psygmophyllum, Pursongia, Zamiopteris glossopteroids,* and *Phylladoderma*. Cordaites, which are not numerous, are represented by *Rufloria synensis* and *Cordaites caldalepensis*. There are widespread coniferous *Pseudovoltzia, Quadrocladus, Ullmannia*; seeds of *Samaropsis, Nucicarpus, Sylvella, Cordaicarpus*. Appearance of mesophytes *Rhipidopsis* and *Taeniopteris*. Abundance and diversity of *Tatarina* genus, disappearance of sulcian cordaites, appearance of *Sashinia, Dvinostrobus, Glossophyllum*.

The Upper Permian and Triassic sedimentation of Cangfanggou Group in Dalongkou region took place in shallower and freshened basin in equivalent climatic environment (according to microflora taxa composition). Floristic complex of Cangfanggou is also represented by archaic *Calamites*, and diverse arthrophytes *Paracalamites, Phyllotheca*; lycopodium stalks *Viatscheslavia*; diverse ferns *Pecopteris, Prynadaeopteris*; pteridosperms *Callipteris, Comia, Jniopteris, Pursongia, Zamiopteris glossopteroides*. Not numerous and uniform are cordaites *Noeggerathiopsis angustifilia* and *N. derzavinii*, seeds *Samaropsis, Cordaicarpus, Cornucarpus*. Appearance of *Rhipidopsis*.

ТАБЛИЦА 1. **Флористические комплексы верхней перми Волго-Уральской области (подчеркнуты характерные таксоны).**

СИСТЕМА	ОТДЕЛ	ЯРУС	ПОДЪЯРУС	ГОРИЗОНТ	Палеоботаническая характеристика
ПЕРМСКАЯ	ВЕРХНИЙ	ТАТАРСКИЙ	ВЕРХНИЙ	ВЯТСКИЙ	Pelliotalites tataricus, Protosphagnum nervatum, Rhizinigerites neuburgae, Muscites sp., Fasciastomia delicata, стебли членисто- стебельных, Fefilopteris papilosa, Pecopteris sp., Peltaspermopsis buevichiae, Tatarina conspiqua, T. pinnata, Salpingocarpus bicornutus, Phylladoderma (Aequistomia) aequalis, P.(A.) annulata, Permotheca striatifera, P.vesicasporoides, P.vittatinifera, Pursongia belousovae, Sashinia aristovensis, Dvinostrobus sagittalis, Quadrocladus dvinensis, Q.schweitzerii, Arisada densa. (Гоманьков А.В.,Мейен С.В.,1986)
				СЕВЕРОДВИНСКИЙ	Protosphagnum nervatum, Rhizinigerites neuburgae, Fasciastomia delicata, Peltaspermopsis buevichae, Tatarina olferievii, T. conspiqua, T.pinnata, T.mira, Stiphorus biseriatus, Glossophyl- lum permiense, Lepidopteris sp., Salpingocarpus bicornutus, S.variabilis, Phylladoderma (Aaquestomia)annulata, P.(A.) tatarica, Doliostomia krassilovii, Rhaphidopteris kinntzelae, R.antiqua, Permotheca striatifera, P.vesicasporoides, P.beloussovae, Sphenarion? sp., Cordaites clercii, Sashinia aristovensis, S.borealis, Dvinostrobus saggitalis, Quadrocladus dvinensis, Q. borealis, Geinitzina subangarica, Pseudovoltzia ? sp. (Гоманьков А.В.,Мейен С.В.,1986)
			НИЖНИЙ	УРЖУМСКИЙ	Paracalamites friqidus, Annularia sp., Signacularia noinskii, Sphenophyllum (Tichvinskia) stoukenbergii, Pecopteris sp., Rhaphidopteris praecursoria, Phylladoderma sp., Permotheca sardykensis, P.vesicasporoides,Taeniopteris sp.,Tatarina sp.,Nucicarpus minutus. (Есаулова Н.К., 1986,1987)
		КАЗАНСКИЙ	ВЕРХНИЙ	ВОЛЖСКИЙ	Signacularia noinskii, Viatscheslaviophyllum kamiense, Paraca- lamites frigidus, P.kutorgae, Phyllotheca sp., Annularia pseudostel- lata, Tschernovia striata, Annulina neuburgiana, Sphenophyllum (Tichvinskia) stoukenbergii, Prynadaeopteris sp., Pecopteris anthriscifolia, Odontopteris rossica, O.tatarica, Rhaphidopteris sp., Comia macrophylla,Phylladoderma volgensis, Taeniopteris eckardti, Pseudovoltzia? cornuta, Permotheca sardykensis, Peltaspermum sp."a", Nucicarpus minutus, Sylvella heteromorpha. (Есаулова Н.К., 1986,1987)

ТАБЛИЦА 1. (Продолжение).

СИСТЕМА	ОТДЕЛ	ЯРУС	ПОДЪЯРУС	ГОРИЗОНТ	Палеоботаническая характеристика
ПЕРМСКАЯ	ВЕРХНИЙ	КАЗАНСКИЙ	НИЖНИЙ	СОКСКИЙ	Signacularia noinskii, Viatscheslaviophyllum kamiense, Paracalamites frigidus, P.decoratus, P.similis, P.kutorgae, Paracalamostachys sp., Phyllotheca deliguescens, Annularia stellatoides, Sphenophyllum (Tichvinskia) stoukenbergii, Asterotheca sp., Oligocarpia sp., Todites sp., Danaeites (=Orthotheca) sp., D.(= O.) petschorica, Pecopteris anthriscifolia, P.helenaeana, Lobatopteris sp., Brongniarthites salicifolius, Compsopteris sp., Callipteris sp., Odontopteris rossica, O.tatarica, Rhaphidopteris sp., Psygmophyllum nesterenkoi, Ps.expansum, Zamiopteris sp., Pursongia sp., Phylladoderma meridionalis, P.sentjakensis, Rhipidopsis sp., R. ginkgoides, Taeniopteris tingii, Rufloria synensis, Cordaites candalepensis, Pseudovoltzia ? cornuta, Quadrocladus sp., Hydropterangium sp., Permotheca vesicasporoides, P.sardykensis, Peltaspermum sp., Samaropsis typ.vorcutana, Nucicarpus piniformis, N.sentjakensis, Carpolithes sp., Entsovia rarisulkata, Timanostrobus? sp., Glottophyllum sp., Cordaicarpus petrikensis. (Есаулова Н.К.,1986,1987, Фефилова Л.А.,1981)
		УФИМСКИЙ	ВЕРХНИЙ	ШЕШМИНСКИЙ	Signacularia noinskii, Viatscheslavia vorcutensis (?), Viatscheslaviophyllum kamiense, Paracalamites frigidus, P .cf. similis, Pecopteris sp., Psygmophyllum expansum, Carpolithes sp., Samaropsis sp., Cordaites sp., Phylladoderma spinosa, Brongniarthites salicifolius, Prynadaeopteris anthriscifolius, Callipteris tenuinervia, Odontopteris sp., Nucicarpus piniformis. (Есаулова Н.К.,1986,1987,Фефилова Л.А.,1981)
			НИЖНИЙ	СОЛИКАМСКИЙ	Jntia variabilis, J. vermicularis, Viatscheslavia vorcutensis, Viatscheslaviophyllum kamiense, Paracalamites frigidus, Pecopteris sp., Odontopteris artipinnata, Comia rarinervia, Syniopteris expansa, Rufloria ensiformis, Entsovia rarisulcata, Permotheca sardykensis, Samaropsis vorcutana, S.extensa, S. triquetra, S. elegans, Sylvella sp., обрывки хвойных. (Владимирович В.П.,1982,Фефилова Л.А.,1981,Есаулова Н.К., 1986,1987)

<table>
<tr><th colspan="4">Volga-Urals region
(Russia)</th><th colspan="2">South Xinjing
(Jungar Basin)</th><th colspan="2">South China
(Nanshan)</th></tr>
<tr><th>system</th><th>series</th><th>stage</th><th>substage</th><th>group</th><th>formation</th><th>group</th><th>formation</th></tr>
<tr><td rowspan="8">PERMIAN</td><td rowspan="8">UPPER</td><td rowspan="3">TATARIAN</td><td>UPPER</td><td>Xiaoquangou</td><td>Karamay</td><td>Ermaying</td><td></td></tr>
<tr><td rowspan="2">LOWER</td><td rowspan="6">Cangfanggou</td><td>Shaofanggou</td><td rowspan="4">Shihchienfeng</td><td>Heshanggou</td></tr>
<tr><td>Jiucayuan</td><td>Liujiagou</td></tr>
<tr><td rowspan="3">KAZANIAN</td><td>UPPER</td><td>Guaodikeng</td><td rowspan="2">Sunjiagou</td></tr>
<tr><td rowspan="2">LOWER</td><td>Wutonggou</td></tr>
<tr><td>Quanzijie</td><td>Upper</td><td>Shihhotze</td></tr>
<tr><td rowspan="2">UFIMIAN</td><td>UPPER</td><td>Hongyanchi</td><td rowspan="2">Lower</td><td rowspan="2">Shihhotze</td></tr>
<tr><td>LOWER</td><td>Jijicao</td><td>Lucagou</td></tr>
</table>

Fig. 2 Schematic correlation between the sections of Volga-Urals region of Russia and Dalonkou of China.

Similarity of the above-described floristic complexes unequivocally indicates the Late Permian (Kazanian; Kazanian-Urzhumian but not Triassic) age of Cangfanggou Group of the Dalongkou section (Fig. 2).

N.K. Esaulova
Geological Faculty of Kazan University
18 Lenin St., Kazan, 420008, Russia

18. ON THE PROBLEMS OF THE INTERNATIONAL PERMIAN STRATIGRAPHIC SCALE

According to requirements of the International Stratigraphic Commission (ICP), boundaries of series and stages must be defined, and points of global stratotypes must be established. Nowadays, western geologists believe that "stages of the general Permian scale above the Artinskian do not meet international requirements because none of the boundaries can be determined confidently outside stratotypical area, and cannot be established as global standard". After discussion, majority of members of ICPS came to the conclusion that the Permian scale must be based on marine sections. Boundaries of series and stages must be combined with contrasting biostratigraphic boundaries, and fixed by zone conodont ones for which there is a zone standard now. The scale that contains the Urals stages of Russia as the lower series, and regional subdivisions of North America and China as the upper, is being suggested. Thus, the proposed stratotype loses the major sedimentary field formed in a single basin. Most of the correlation problems refer not to the Lower Permian that formed in normal deep marine basin, but to the Upper Permian. This sedimentary stage is connected with the final Hercynian tectogenesis, and the change of thalassocratic conditions into geocratic.

Main tasks of stratigraphy are : 1) determination of trustworthy sedimentary sequences, and 2) global correlation of the levels of the same age. The Upper Permian stage sequence of a single basin is no doubt more trustworthy. Notion of considerable discontinuities in the Late Permian of the Volga-Urals region proved, according to paleomagnetic studies, to be erroneous.

Global correlation of levels of the same age, and determination of boundaries (but not points) of global correlation must be realized irrespective of facies (marine or continental). Facies features is what paleogeographic events are reflected on. And we consider the question of creation of international scale on the basis of marine sections only to be an error in stratigraphic methods which bases itself on an utopian notion about global capability of biostratigraphic methods.

During the meeting of the Permian Commission in St. Petersburg in February, 1995, the following questions were raised in order to reveal a viewpoint of Russian stratigraphers on division of the Permian:

1. Is it timely to accept a marine-based Permian scale?
2. Which of the available scales (Eastern-European, Tethys) suggested by ICPS, or whatever else, do you prefer?
3. How many divisions should in the Permian System be?
4. Location of the Permian boundaries.

1. It is timely to accept a marine-based scale? No. In our view, international standards can only be changed in two cases: a) when the present stratigraphic subdivisions proved to be unfit, or b) when, as a result of detailed studies, more complete sections appeared which allow trustworthy global correlation. We consider the notion that "none of the boundaries above the Artinskian can be determined confidently outside stratotypical area" to be erroneous since, in spite of complicated polyfacies conditions, boundaries at the level of Solikamian and Sheshmian horizons with the Ufimian, and of Urzhumian and Severodvinian horizons with the Tatarian, reflect big stages of development of the earth's crust, biological matter, magnetic field, and are global. The suggested scale that is based on stratigraphic subdivisions of marine sections of Tethys, North America, and China is local. None of ammonitic, fusulinid, and conodont zones are revealed outside these territories. The principle of determination of these zones is unclear. If this is a phylogenetic one, is it possible for 5-6 such zones to exist in deep marine environment which is stable, as we know? It is suspicious that all zones coincide on different faunal groups being in so distant regions.

Based on the aforesaid, we believe that transfer of the Upper Permian stratotype from the Volga-Urals basin to Tethys, and, accordingly, replacement of the Upper Permian stages, cannot be accepted either in practical or in theoretical respects. Firstly, the area of the nonmarine Upper Permian rocks is several times more than the marine one. Secondly, facies affiliation of rocks matters nothing when choosing stratotypes of stages or some other subdivisions because stratigraphy deals with the study of space-and-time relations between strata, but not their paleogeographic affiliation.

Facies are only taken into account when working out special methods. Of importance also is the fact that the Permian stratotype is situated within the single area, and the relations between subdivisions are clear, or can be studied. What was suggested was to tear the Permian stratotype into parts for rather questionable reasons.

2. Which scale do you prefer? The East-European scale is the best one since it is based on sections of the shallow marine basin containing also remains of typical marine brackish and fresh-water fauna, macroflora, miospores. Thus, these sections are transitional between the deep marine and continental. Biostratigraphic boundaries are checked with magnetostratigraphic ones. Most detailed and trustworthy magnetostratigraphic scale has been made only for the Volga-Urals region. Reliability of paleomagnetic studies of marine deposits is nowadays much lower than for their shallow marine and continental equivalents. Behaviour of the magnetic field for all zones of normal and reverse polarity has been studied. Also studied are most of the transitional zones of geomagnetic polarities including transition between Kiama and Illawarra, the number of

magnetic zones in the stratotype is greater than in the Tethys sections.

Correlation of the Upper Permian stages in the West is possible through Pechora Urals, Novaya Zemlya, Canadian Arctic to North America, and through Aktyubinsk Urals, Kazakhstan, Juzbass, Far East, and China to Japan and Australia in the East.

Dominance of marine sections, as well as impossibility of their correlation with continental ones require new correlation standards. Dalonkgou section of North-West China is suggested to be continental Upper Permian stratotype. We repeatedly drew geologists and paleontologists' attention to the fact that the boundary of the Lower and Upper Tatarian Substages is considered to be the Permian and Triassic boundary. This section requires additional paleontological and magnetostratigraphic studies.

3. How many series and stages? That depends on the basic criterion. There are many factors which affect formation of the Permian. Currently, the two series reflect two stages in the basins development: Early Permian - deep marine stage, and Late Permian - shallow marine-lacustrine stage. Change of thalassocratic conditions into geocratic ones is global, and can serve as a reliable criterion.
4. Position of the Permian boundaries. A. We believe that, before solving this matter, the boundaries of global correlation should be determined. In the Late Permian, such are the boundary between the Solikamian and Sheshmian horizons within the Ufimian with change of lowering into uplifts, restructuring of biological matter, and the boundary between the Urzhumian and Severodvinian horizons within the Tatarian that practically coincides with the boundary between Kiama and Illawarra hyperzones. The Upper Tatarian Substage claims to be a Stage. Volumes of horizons, stages, series indicate, as a rule, the level of our knowledge at the present time; and unequivocal understanding of them in different regions matters much more than their correct determination.

The problem of correlation was the most complicated one which incurred criticism on the East Europe stratotypes. That is solvable for the Ufimian and Kazanian if, except conventional faunal groups, paleomagnetic, flora, and palynological methods are used, and conodonts are studied. The Tatarian is more complicated in this respect. Here, fish remains and paleomagnetic methods can help. Marking out of the third division of the Permian with Volga-Urals region is unlikely to make sense because the Tatarian formed in specific stable conditions.

A.I. Shevelev, Chairman
V.G. Khalimbadzha, Professor
B.V. Burov, Professor
N.K. Esaulova, Assistant Professor
A.K. Gusev, Assistant Professor
Tatar Republican Commission on Natural Reserves
Kazan University

19. THE UPPER PERMIAN OF THE SALT RANGE AREA REVISITED: NEW STABLE ISOTOPE DATA

The Northern part of Great-India underwent an early rifting phase in the late Paleozoic, just at the end of the large scale Gondwanian glaciation. The beginning of the rifting processes is marked by large hiatus and discontinuities (paraconformities) between the early or middle Paleozoic sedimentary succession and the discontinuous middle-late Permian Traps and transgressive sediments. The Northern Indian passive margin consists of the present High and Lower Himalaya and a small part of the Indian craton and their sedimentary cover. The Permian rift shoulder is located in the Higher Himalaya, with part being in the underthrusted Lower Himalaya. The rim basin (landward of the shoulder) is well developed in the Pottawar - Salt Range area. The late Permian sedimentary evolution is characterised by two transgressive-regressive (T-R) second order cycles. The break-up of the rift occurred during the second cycle (late Dzhulfian). In the Salt Range area, these two T-R cycles have been subdivided in five third order sequences.

At the end of Permian, hiatuses, gaps and local erosion of part of the margin are direct consequences of a first order relative sea-level fall; this is also the time of the largest extinction event of the Phanerozoic that deeply affected the carbonate productivity and the stratal patterns.

The upper Permian to lower Triassic succession is well exposed in gorges that dissect the Salt Ranges - Trans-Indus Ranges of Northern Pakistan. The main studies on this area have been summarized in (Kummel and Teichert, 1970) and part of the recent literature in Wignall and Hallam (1993).

A huge carbonate platform (the Wargal Formation) is transgressing during late Murgabian - early Midian time. The first upper Permian transgressive-regressive cycle (T-R or second order cycle) is recorded in the growth and demise of this carbonate platform (Midian time). During the early Dzhulfian, a sudden terrigenous influx occurs, marking the boundary between the lower and the upper T-R cycles and a shallow water mixed carbonate - clastic ramp, the Chhidru Formation, overlies the Wargal carbonate platform (Pakistanis-Japanese, 1985).

The carbon isotope curve for the upper Permian exhibits two positive excursions: the first one is related to the Wargal Formation, and the second one to the Chhidru Formation. Comparison of the upper Permian $\delta^{13}C$ curves with sequence stratigraphic analysis shows a close correlation, both for the second order and third order cycles. Higher $\delta^{13}C$ values usually occur within the transgressive system tracts, reflecting the deposition of greater amounts of organic matter on the continental shelves during transgressions (Woodruff and Savin, 1985).

Similar relationships between the $\delta^{13}C$ curve and eustatic level have been reported in the upper Cambrian-lower Ordovician (Ripperdan et al., 1992), in the Cretaceous

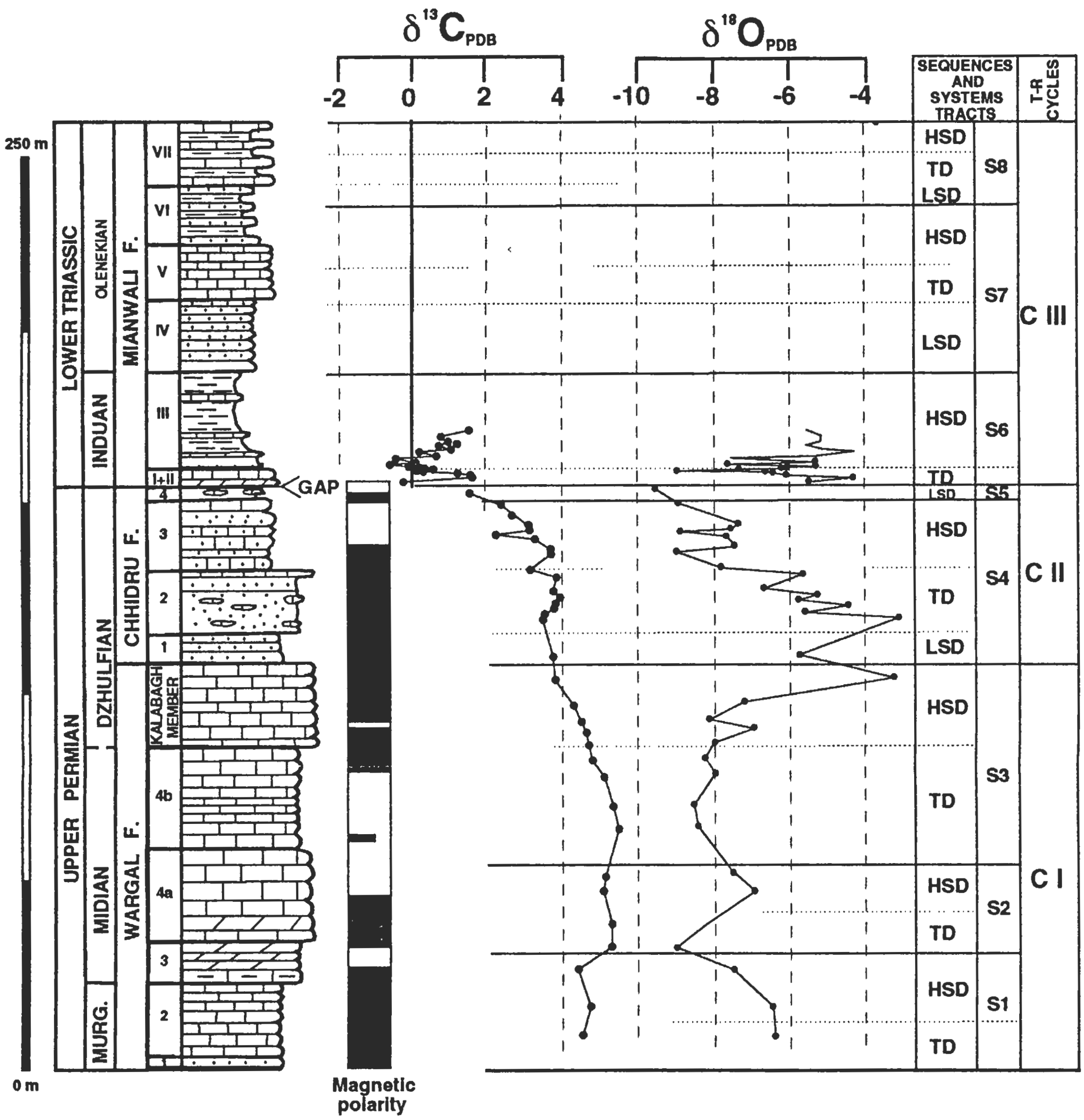

Figure 1 Carbon and oxygen isotope profiles of Nammal Gorge, Sequences, systems tracts and T-R cycles.
Magnetostratigraphy from Haag & Heller (1991).
LSD: lowstand deposits; TD: transgressive deposits; HSD: highstand deposits.

(Mitchell and Paul, 1994) and in the Miocene (Woodruff and Savin, 1985). However, similarities between long term fluctuations of $\delta^{13}C$ average values and sea level variations have been observed by Shackelton and Kennett (1975).

Oxygen isotope ratios are less consistent: in some intervals there is a crude correlation with $\delta^{13}C$ value variations, but not always. The oxygen isotope profile undergoes a major positive excursion of about 4‰ within the upper part of Kalabagh Member and the base of Chhidru Formation, but we do not believe this to reflect an original change in the isotopic composition of the seawater. Rather, it is related to diagenesis such as meteoric diagenesis, deep burial diagenesis and/or monsoon signature (Mutti and Weissert, 1995). The samples most depleted in ^{18}O are found at the top of Chhidru Formation. This indicates an exchange with ^{18}O depleted waters (James, 1984) after the end Permian regression phase and before the early Triassic transgression.

The magnetostratigraphic results for the upper Permian obtained by Haag and Heller (1991) from the Nammal Gorge section show 10 magnetic zones corresponding to the base of the Illawara mixed superchron. Due to the gaps at the base of the Wargal and at the top of the Chhidru Formations, the late Permian magnetic polarity time scale is not complete here. According to Menning (Oral comm.), the late Permian part of this Illawara mixed superchron comprises at least 15 magnetic zones, but does not specify positions.

Our interpretation of a hiatus between the Chhidru and the Mianwali Formation has been expressed in Baud et al. (1989). With respect to age, we now agree with Nakazawa (1993) that part of the early Griesbachian is recorded in the lower and middle Kathwai dolomite. This is also the opinion of Wignall and Hallam (1993), but for the PJRG (1985), the Permian-Triassic boundary occurs between the lower and middle unit of the Kathwai Member.

We can confirm the drastic drop of $\delta^{13}C$ from the high positive values that characterised the upper Permian to lower values in the lower Triassic marine sediments.

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Aymon Baud
Musée de Géologie
UNIL-BFSH2, CH-1015
Lausanne, Switzerland

Viorel Atudorei
Musée de Géologie
UNIL-BFSH2, CH-1015
Lausanne, Switzerland

Zachary Sharp
Institut de Minéralogie
UNIL-BEFSH2, CH-1015
Lausanne, Switzerland

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SECOND ANNOUNCEMENT
THE GUADALUPIAN SYMPOSIUM II
April 10-14, 1996[1]

For the further refinement of the Guadalupian Series and its establishment as an international standard.

Sponsored by the U.S. Geological Survey, Sul Ross State University, and the Permian Subcommission (OS-IUGS)

Deadline for Abstracts of oral presentations: December 30, 1995
Deadline for manuscripts: April 10, 1996

REGISTRATION	
Complete meeting, talks and field trip, four days, including Guidebook and abstracts, T-shirt, three lunches, one dinner, two continental breakfasts, transportation on field trips	$90.00 pre-register $105.00 on-site
Meeting in Alpine only, 2 days of talks, including two breakfasts, one lunch, one dinner, guidebook and abstracts, T-shirt	$50.00 pre-register $60.00 on-site
Field trips only, 2 days, transportation, 2 lunches, guidebook, T-shirt	$50.00 pre-register $60.00 on-site

Volunteered talks include several Russian and European papers on the positives and negatives of the proposed Guadalupian as an international stratotype, the sequence stratigraphy and refined biostratigraphy of the Guadalupian, and the correlation of the post-Guadalupian.

Field trip includes examination of the proposed boundary stratotype of the Guadalupian at Stratotype Canyon in the Williams Ranch area, the proposed boundary of the Wordian in Guadalupe Pass, the proposed boundary of the Capitanian on Nipple Hill all in the area of the Guadalupe Mountains National Park and a continuous outcrop of the Bell Canyon Formation (Capitanian) representing several members of the Apache Mountains.

The meetings will be on the campus of Sul Ross State University. Nearby motels include:

Best Western/Alpine Classic	(915) 837-1530
Bien Venido Motel	(915) 837-3454
Days Inn	(915) 837-3417
Highland Inn	(915) 837-5811
Siesta Country Inn	(915) 837-2503
Sunday House Motor Inn	(915) 837-3363

The field trip will overnight in Van Horn, Texas at the
Inn of Van Horn (Best Western) (915) 283-2410

The field trip should end on the top of Nipple Hill at 2:00 pm on Sunday, April 14 and transportation will be arranged for travel to El Paso, Van Horn, and Alpine. Participants should make their own lodging arrangements.

Alpine is accessible by daily flights on Dallas Express Airlines from Dallas through Abilene (214-902-0500 or 1-800-529-0925) or by many common American carriers to El Paso or Midland airports. A shuttle from El Paso may be arranged by the organizers if it is needed. Please let us know in advance.

To register, find out more, or to submit abstracts, please contact

Bruce R. Wardlaw, Chief Paleontologist U.S. Geological Survey MS 982, National Center Reston, VA 22092-0001 USA Phone: (703) 648-5288 Fax: (703) 648-5420 E-mail: bwardlaw@geochange.er.usgs.gov	OR	David M. Rohr, Chairman Geology and Chemistry Department Sul Ross State University Alpine, TX 79832 USA Phone: (915) 837-8259 Fax: (915) 837-8692 E-mail: drohr@sul-ross-1.sulross.edu

[1] **the dates of the symposium have been changed from April 4-6 to April 10-14 to avoid the transportation problems and additional expense of travelling on Easter vacation.**