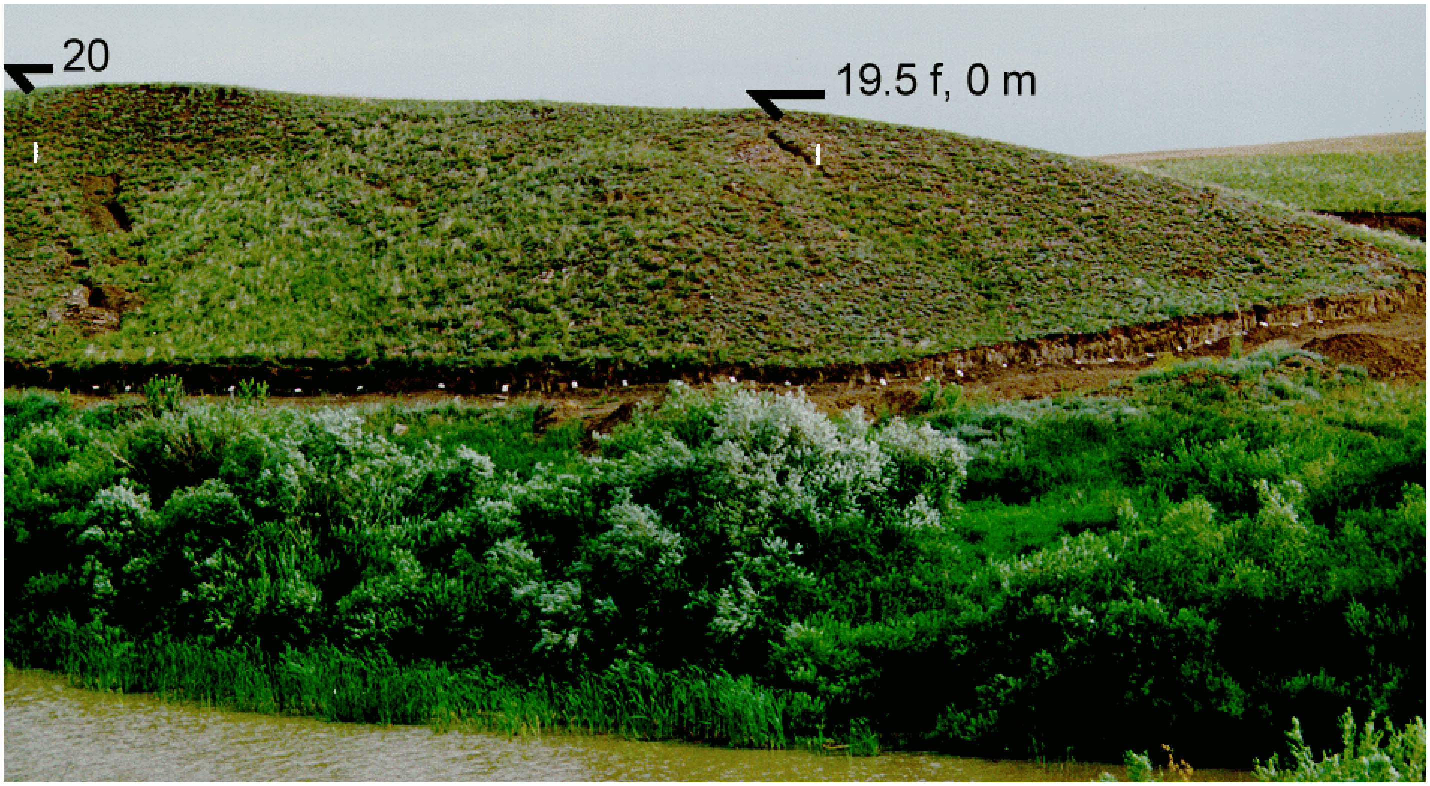
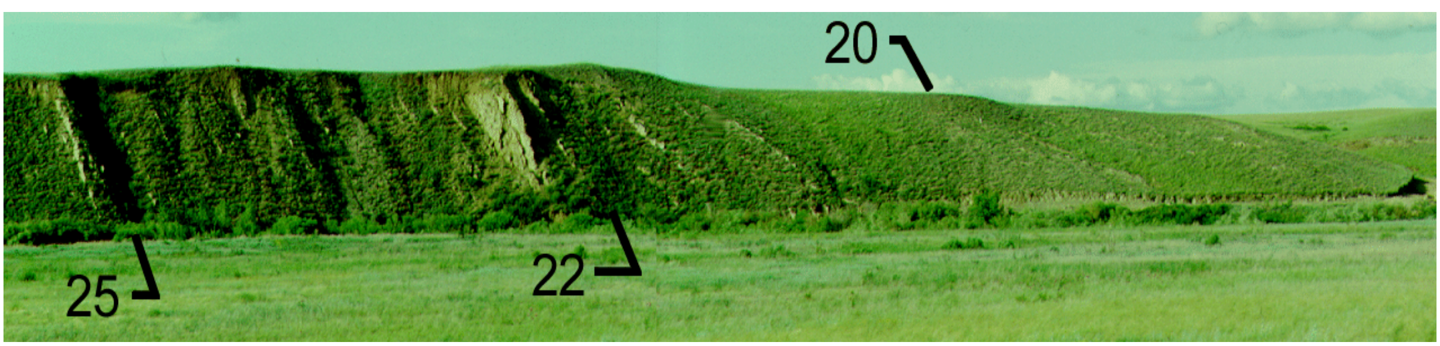
Permophi

Number 30 June 1997
A NEWSLETTER OF THE
SUBCOMMISSION ON
PERMIAN STRATIGRAPHY





SUBCOMMISSION ON PERMIAN STRATIGRAPHY

INTERNATIONAL COMMISSION ON STRATIGRAPHY

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES (IUGS)

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Cover Page:

Upper figure:

Close-up of GSSP for base of the Permian System and coincident Upper Carboniferous boundary, Aidaralash Creek, Aktöbe (formerly Aktyubinsk) region, southern Ural Mountains, northern Kazakhstan. Boundary occurs at base of Bed 19.5 and is marked temporarily by white pipe, to be replaced by appropriate monument. The road excavated in the base of the section exposes essentially every bed and any covered interval can be cleared readily. White dots along the road are conodont sample bags. Bed 20 is marked by another white pipe near the trenches on the left end of the photograph.

Lower figure:

Aidaralash Creek section; view is to the north across vegetated creek bed. Beds dip approximately 70 degrees to the west reflecting regional folding. Sequence boundaries at Beds 22 and 25 stand out as prominent sandstone outcrops west of the GSSP. No other sequence boundary occurs within this part of the section.

Fold out:

Stratigraphic column and ranges of selected representatives of significant fossil groups in the GSSP for the base of the Permian System, Aidaralash Creek, Aktöbe (formerly Aktyubinsk) region, northern Kazakhstan. The base of the Permian was defined there (Davydov et al., 1995) on the first occurrence of the conodont *Streptognathodus isolatus* Chernykh et al. (1997) in the evolutionary morphocline of *Streptognathodus wabaunsensis*. Traditional boundaries for fusulinaceans and ammonoids are closely adjacent (6.3 m and 26.8 m, respectively) and are coincident for practical purposes. No sequence boundary has been recognized to be coincident with the GSSP at this site (Davydov et al., 1995, in press; Snyder et al., 1996).

EXECUTIVE NOTES

Notes from the SPS Secretary

By Claude Spinosa

I take this opportunity to thank all who contributed to this issue of ***Permophiles*** and those who assisted in its preparation. We are indebted to John Utting, Brian Glenister, Vladimir Davydov and Bruce Wardlaw who reviewed manuscripts. Joan White who typed much of this issue and coordinated the compilation. Dale Kerner did the scanning. We are truly indebted to these individuals. The next issue of ***Permophiles*** is scheduled for December 1997. Contributions should arrive before December 1. It would be best to submit manuscripts on diskettes prepared with WordPerfect or MSWord; printed hard copies should accompany them. Word processing files should have a minimum of personalized fonts and other code. Journal of Paleontology reference style is preferred. Maps and other illustrations must be camera-ready, i.e., clean copies, ready for publication. Typewritten contributions may be submitted by mail as clean paper copies; these must arrive well ahead of the deadline as they require greater processing time. We can also receive contributions via E-mail, Fax or through FTP; the latter is an especially useful and simple method for transmitting illustrations.

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SPS 2nd Vice Chairman Dr. C. B. Foster Australian Geol. Surv. Org. GPO Box 378 Canberra 2601, Australia cfoster@selenite.agso.gov.au	**SPS Secretary** Prof. Claude Spinosa Dept. of Geosciences Boise State University Boise, Idaho 83725, USA fax: 208-385-4061 voice: 208-385-1581 cspinosa@trex.idbsu.edu

Subcommission on Triassic Stratigraphy

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Dalongkou and Meishan

We write as the elected executives of the bodies responsible for the designation of a Global Stratotype Section and Point (GSSP) for the base of the Permian. We express our regret at the damage to the progress toward establishment of the Triassic GSSP that resulted from the breakdown of relations between scientists involved in a multi-national investigation of a potential auxiliary boundary section at Dalongkou, China; we urge reconciliation of the parties involved. It is our view that the apparent failure in this particular collaborative venture should not prejudice consideration of other potential GSSP in that country.

Work on the candidate GSSP for the base of the Triassic at Meishan, China, has become recognized as a model for international cooperation, which together with the scientific merits of the section is reflected in the response of members of the Permian-Triassic Boundary Working Group (PTBWG) of the Subcommission on Triassic Stratigraphy (STS) to a questionnaire issued in June 1995. The response, published in the STS newsletter (Albertiana 16, November 1995) showed an overwhelming preference amongst Voting Members of the PTBWG for the Meishan section as the candidate GSSP for the base of the Triassic. Informal assessments conducted as recently as August 1996, during the 30th IGC in Beijing, revealed the same preference.

It is our view that events associated with Dalongkou should not be allowed to influence the progress that had clearly been made in the process of selecting a GSSP for the base of the Triassic. We therefore urge the Chairman of the PTBWG, Professor Yin Hongfu, to conduct a formal vote on the candidate section preferred by the PTBWG voting membership, as a first step in the process of establishment of a GSSP for the base of the Triassic and coincident upper boundary of the Permian (Yin et al. 1996, Newsl. on Strat. 34: 81-108)

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Note from Bruce Wardlaw the SPS Chairman

Working Groups of The SPS

It is the intention of the SPS chair to consolidate the current activities of the Subcommission into the following five working groups.

1. **The Carboniferous/Permian boundary working group, chair: Brian F. Glenister.**
2. **The Cisuralian working group, chair: Boris I. Chuvashov.**
3. **The Guadalupian working group, chair: Brian F. Glenister.**
4. **The Lopingian working group, chair: Jin Yu-gan.**
5. **The continental-marine correlation and the traditional Upper Permian of Russia working group, chair: Vladlen Lozovsky.**

The first, the Carboniferous/Permian boundary working group, will be disbanded as soon as its results are published in *Episodes* and a permanent monument is erected at Aidaralash Creek. The second, the Cisuralian working group is the combination of the working group of the Asselian, Sakmarian, Artinskian stratotypes and the post-Artinskian-pre-Roadian working group. The third and fourth are continuing established working groups. The fifth is the combination of the extant continental-marine correlation working group with the formalization of an active group on the traditional Upper Permian of Russia.

I request a report on the accomplishment of any existing working group, those mentioned above, or any others that may exist by December 1, 1997 and the report will go into the next issue of ***Permophiles***. It appears that there may be a few working groups that have been intermittently active that were not listed as working groups by the previous chair and I would like to know about their accomplishments. I would also appreciate any suggestions for any other working groups that are thought to be needed.

I will be in contact with the designated chairs to formalize the membership of each working group, which will be reported in the next ***Permophiles***. Please send me any suggestions.

Proposed new chronostratigraphic units for the Upper Permian

By Amos Salvador

The efforts of the Subcommission on Permian Stratigraphy (SPS) of the IUGS International Commission on Stratigraphy (ICS) to select stratotypes (boundary stratotypes) for stages of the Upper Permian Series outside of the classical Volga-Urals type region of the Permian System have been seen with disfavor by several Russian stratigraphers. Their objections have been expressed in letters (Permophiles No. 29) to Dr. Jin Yu-gan, then Chairman of the SPS, from A. I. Shevelev (1996), Chairman of the Commission on Natural Reserves of the Republic of Tatarstan (CNR-RT), B. V. Burov et al. (1996) of the Kazan University and the CNR-RT, V. Ganelin et al. (1996), of the Geological Institute and the Paleontological Institute of the Russian Academy of Sciences in Moscow, and the VSEGEI in St. Petersburg, and S. Lazarev (1996) of the Paleontological Institute of the Russian Academy of Sciences in Moscow.

The SPS has proposed to select stratotypes for the Upper Permian units of the Standard Global Chronostratigraphic Scale (SGCS) outside the Volga-Urals region because in this region the Upper Permian section is mostly nonmarine, and less suitable, therefore, for the selection of units of the SGCS. The above-mentioned Russian stratigraphers believe that the Volga-Ural section is adequate for the purpose.

Since I am not an expert on Permian stratigraphy, my comments on this difference of opinion will be restricted to the general principles for the selection of stratotypes of units of the SGCS. I admit, however, that my lack of familiarity with the details of Upper Permian stratigraphy may make these comments somewhat debatable.

I will start by saying that I am not aware that stratigraphers dealing with the selection of stratotypes for units of the SGCS are in any disagreement concerning the preference of marine sections for this purpose. The International Stratigraphic Guide is very clear in this respect (Salvador, 1995, p.90-91). It states **"The selection of chronostratigraphic units [of the SGCS] is best accomplished ... by the selection of boundary-stratotypes of their lower boundaries". It further states that these boundary-stratotypes "must be selected in sections representing essentially continuous deposition ... in marine, fossiliferous sections without major vertical lithofacies or biofacies changes ... in an area of minimal structural deformation", etc. The Guide also states: "To insure its acceptance and use over wide areas, preferably worldwide, a boundary-stratotype should be selected to contain as many specific good marker horizons or other features favorable for long-distance time correlation (chronocorrelation) as possible." Marine sections are most likely to contain such desirable marker horizons, to represent essentially continuous deposition, and to contain abundant, distinctive, well preserved, cosmopolitan and diverse fossils making them, therefore, more valuable for worldwide correlation. Nonmarine sections, on the other hand, by the nature of their processes of deposition and accumulation, commonly include numerous breaks in the section, and contain predominantly endemic faunas and floras of limited value in long-distance correlation. (Editorial emphasis)**

I know that the proposals for the selection of stratotypes for the Upper Permian made by the SPS, a group of Permian experts from many countries in the world, were made after considerable study and discussion. They do not represent the desire of American (or Chinese) geologists for "national prestige", as stated by Ganelin et al., as I am sure such is not the reason for the desire of the Russian stratigraphers to preserve the Kungurian, Ufimian, Kazanian, and Tatarian stages as the sole Upper Permian units of the SGCS. The SPS proposals will not lead, as this group of Russian stratigraphers fear, to "the rejection of the classical stratotype of the Permian System", or "to the refusal of the name 'Permian' ". Even if some new stages are established for the Upper Permian outside of the system's type region, the Permian System will continue to be recognized as the uppermost system of the Paleozoic Erathem. There never will be any question about that.

Furthermore, even when new stages, based on marine sections, are selected for the Upper Permian, the Upper Permian stages of the classical Permian type locality in the Volga-Urals region can continue to be used for the nonmarine section of the region, and perhaps for other regions into which these units can be correlated. Shevelev, himself, agrees that "a new approach ... would allow for the Permian continental sediments and preservation of the stratotypes along with creation of a marine scale". Similar procedures have been developed for other parts of the stratigraphic scale; for example, the mammalian stages used for the Tertiary nonmarine sections of North America, and the subdivision of the upper part of the Carboniferous System. In this last case, while the stages selected in marine sections in Russia (Serpukhovian, Bashkirian, Moscovian, Kasimovian, and Gzhelian) are now accepted as reference units for the upper part of the Carboniferous section of the SGCS, the units recognized since the late 1880's for the predominantly nonmarine sections of western Europe (Namurian, Westphalian, and Stephanian), have long been, and still are, used in the literature when their use seems preferable and adequate. The recognition of the Russian marine stages for the upper part of the Carboniferous did not force the complete abandonment of the Western European nonmarine stages.

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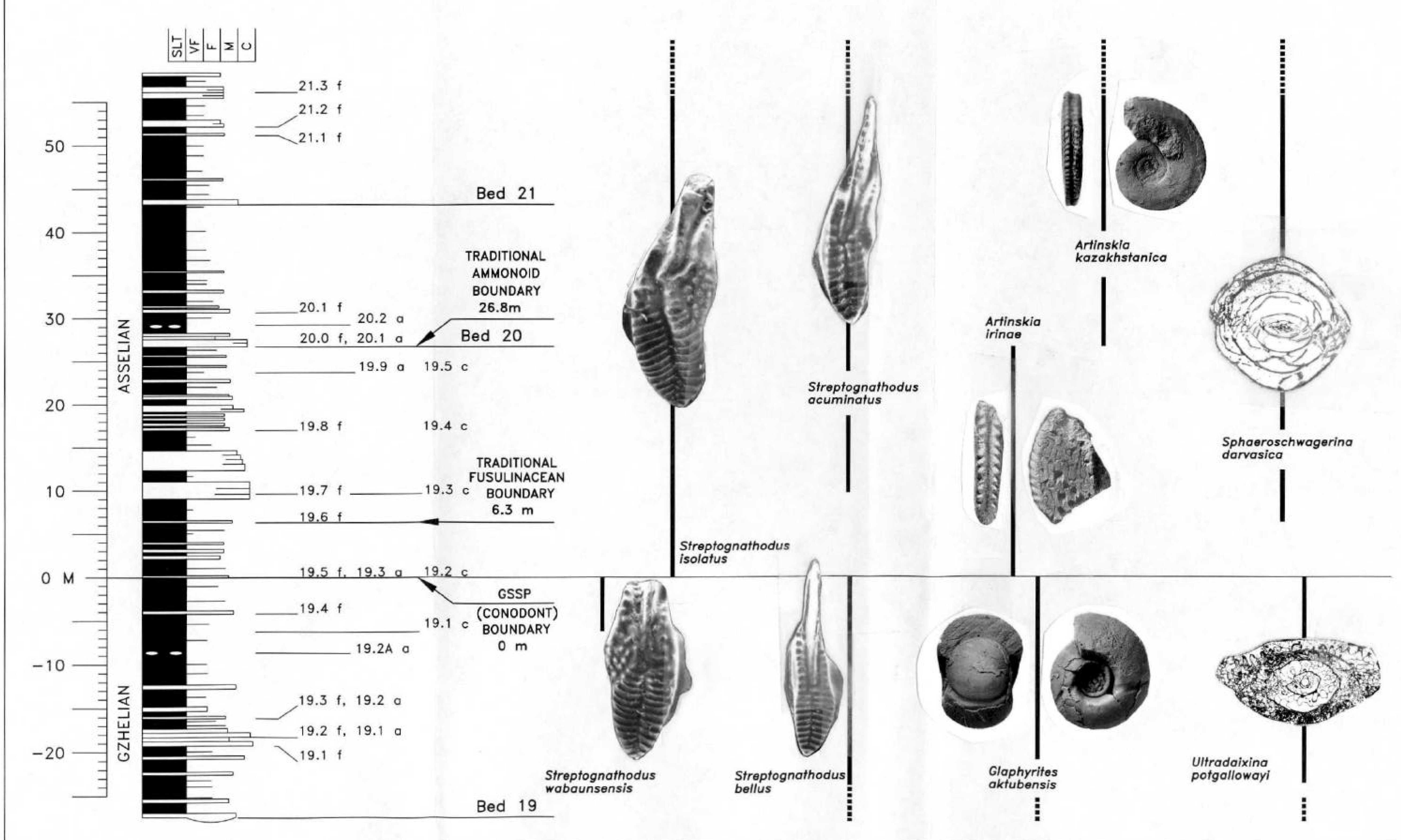
STRATIGRAPHIC DETAIL C/P GSSP, AIDARALASH CREEK



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Lazarev (1996) admits that "substantial modification of any scale is necessary and inevitable procedure" but believes that such modification "should not be connected with the replacement of the traditional terminology". Retention of traditional terminology, while desirable, may, however, not always be possible or preferable. A historical review of stratigraphic terminology will clearly document that since the early days of stratigraphic investigations, many terms had to be abandoned and replaced by better, more adequate, and precise ones. Fortunately, in the case of the modifications of the Upper Permian part of the SGCS proposed by the SPS it is possible, as discussed above, to introduce new units based on marine sections and more adequate, therefore, for worldwide correlation without necessarily abandoning the traditional, but more local units of the Volga-Urals region based on predominantly nonmarine sediments. Lazarev and his Russian colleagues advise against haste in the acceptance of the recommendations of the SPS. I think they can be assured that these recommendations have been reached after long and careful consideration and discussions going back to the 1960's among a group of worldwide stratigraphers. It is time to formally propose the acceptance of the new stages and to subject this proposal to the consideration and criticism of the international stratigraphic community.

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Comments on Subdivisions of the Permian and a Standard World Scale

by Neil W. Archbold and J. Mac Dickins

In the proposals for recognizing the Guadalupian and the Lopingian as the basis for the upper part of the Permian for a world standard scale there has been little input from workers in a number of parts of the world and there has been virtually none from the southern (Gondwana) regions. At the outset two basic questions need to considered:

1. How should the Permian be divided?
2. Is the Guadalupian suitable for a world standard?

In our opinion the most important subdivision is the twofold in two series, Lower and Upper, based on the traditional Russian type sections. These also appear to be the most practical and widely used. The use of Lower and Upper can form the framework with the potential of further subdivision into subseries, although we see no compelling case for this. We also consider that the Guadalupian is not suitable for use in the world scale.

There has been general agreement that for the lower part of the Permian, the traditional type area of the Permian in the Urals and the Russian Platform should be used as the standard. The established stages here are the Asselian, Sakmarian, Artinskian and Kungurian. The usefulness of the Kungurian has long been advocated by Russian colleagues and this was summarized by Dickins et al. (1989) and the conclusion made that it had a world-wide value. Its usefulness for the Australian sequences was emphasized. Although these conclusions about the Kungurian have not been disputed, there has been criticism of the validity of the Kungurian, see Grunt 1996, page 13 (Permophiles 29), for a summary of the exclusion of the Kungurian during the early 1990's. Use of the Kungurian has gained wide support and fundamental work in the northern Urals demonstrates the increasing validity of recognizing the Kungurian (see Pukhonto 1996, Permophiles 29). We wonder if the answers to the questionnaire (Permophiles 29, 1996) indicate this matter is now resolved. We have some doubts as to how meaningful seeking simple Yes or No answers is, in a complicated context where no explanatory alternatives or qualifying material is presented.

The most significant boundary within the Permian is that recognized in the traditional type area between the Lower and Upper Permian and its equivalent in other parts of the world. We, therefore, advocate the continued usage of a major twofold subdivision into two series, the Lower and Upper. This has been adopted in many parts of the world including throughout Gondwana where such a subdivision is readily recognized (Archbold 1993, Archbold and Dickins 1996).

We see little value for the term Cisuralian although this term has been widely used for Ural sections. We note that the classical Ufimian still requires some resolution (as reviewed in Dickins et al. 1989).

The Upper Permian requires a flexible approach. The Upper Permian Working Group (Permophiles 27, 1995: 2-3) reached a general agreement on the suitability of five-fold stage subdivision for the Upper Permian (of the classical two-fold 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. The position does not seem to have changed up to the present and we wonder why this consensus has been ignored. Three lower stages of the Upper Permian still remain to be adequately defined, be it in the Tethyan or other regions.

A different proposal has been advanced by Archbold and Dickins (1989,1996) and Archbold (1993) to use the sequence in the traditional type areas as a standard with a supplementary Tethyan/ Chinese standard (as in Archbold and Dickins 1996). This seems likely to obtain considerable support until there is better and more reliable information on the subdivision and correlation in the Upper Permian (or until a better solution can be advanced).

The term Middle Permian (except for Japan where it is well-based) is fraught with difficulty and confusion. It is a misnomer in that it is not the Middle Permian in any real sense as demonstrated by recent refinements of the radiometric timescale. Lopingian in China has been used for the upper subseries but according to the answers of the questionnaire (Permophiles 29, 1996:2), Dzhulfian is preferred over Wuchiapingian by almost half of the respondents. This needs to be discussed further. Guadalupian is not suitable for the lower subseries since its faunas are too different to most other parts of the world to be satisfactory as a world standard. Its subdivisions are not readily recognizable in other parts of the world despite the proposals of some conodont workers. Conodonts are a rare component of faunas in the Permian, of low diversity, strongly restricted to warm waters and specific lithologies and they can exhibit pronounced provincialism (Wardlaw, 1995). As a group they clearly have potential as a correlation tool but their use is best considered to be in a developmental phase. World Permian marine faunas are all subject to pronounced provincialism (e.g., Archbold and Shi, 1996). Tropical North American faunas, in the sense of provincialism, are analogous to the coldest water faunas of eastern Australia (Gondwana) and hence represent an extreme variant of Permian faunas for correlation purposes. Uralian and Tethyan faunas represent good cases of mixed faunal assemblages and hence can be correlated more easily to these extreme variants. Hence these regions offer the best support for inter-regional correlations, the very reasons for the Guidelines of ICS as indicated by Remane (Permophiles 29, 1996).

We look forward to continued discussion on these and other problems of the Permian during the symposium in Melbourne, November/December, 1997.

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Permian Chronostratigraphic Subdivisions

by Jin Yugan, Bruce R. Wardlaw, Brian F. Glenister and Galina V. Kotlyar

Names and boundary levels for series and stages of the Permian System, based on marine successions, have been approved by the Permian Subcommission, ICS. These, as illustrated below, are the Cisuralian, Guadalupian, and Lopingian Series and their constituent stages standardized respectively in the Urals, Southwest USA, and South China for the Lower, Middle, and Upper Permian.

SYSTEM	SERIES	STAGES
TRIASSIC		GRIESBACHIAN
PERMIAN	LOPINGIAN	CHANGHSINGIAN
		WUCHIAPINGIAN
	GUADALUPIAN	CAPITANIAN
		WORDIAN
		ROADIAN
	CISURALIAN	KUNGURIAN
		ARTINSKIAN
		SAKMARIAN
		ASSELIAN
CARBONIFEROUS		GZHELIAN

The Permian Time-Scale

By J. B. Waterhouse

Congratulations are due to the Permian Subcommission for decisive action over the Permian time-scale, especially to Professor Brian Glenister, and also to Jin Yugan who has kept us well informed of progress. Professor Glenister has devoted much of his career to ammonoids, but that did not stop him from seizing on conodonts as offering the best prospects for widespread paleotropical correlation, and best suited to delineation of hopefully precise boundaries with a minimum of non-fossiliferous intervals. The selection of Guadalupian may upset a number of colleagues, who rightly point out that the Kazanian Stage lay at the heart of the proposal of the Permian Period by Murchison in 1841. The difficulty is that the Kazanian not only has meager fusulines, ammonoids and conodonts, but is followed by non-marine sequences that mandate a switch to fossiliferous marine successions, and the Lopingian is by far the best alternative for Tatarian Series. The Kazanian is too short a time interval on its own to make up a series, and the Maokou in China, which some might think could be appended to Lopingian as an underlying series, is not that well known in modern terms, and possibly has faunal gaps. Thus the Guadalupian constitutes an excellent choice, and hopefully will open up funding opportunities for extensive and detailed paleontological study.

The Wuchiapingian-Capitanian nexus

The tie between Capitanian and Wuchiapingian requires more study, because one model is being suggested that seems to suggest equivalence between the two. Jin (1996) has quoted Dr. Bruce Wardlaw as identifying an early Wuchiapingian conodont in the upper Wargal Formation of the Salt Range, presumably meaning Kalabagh Member. (If upper Wargal means pre-Kalabagh beds, then the implications became even more manifestly out of kilter with the new proposals). The Kalabagh and overlying lower Chhidru and nearby Himalayan macro-invertebrate faunas are generally considered equivalent to Capitanian (Grant & Cooper 1973, Waterhouse 1976). They are not limited to the Salt Range, but are found widely through the former “Tethys” as far as New Zealand. Eastwards, they extend into southeast Asia (e.g. Sisophon, upper Maokou Limestone, and various faunas in Japan), that include the significant fusuline *Yabeina*. The ammonoid *Timorites*, known in the Capitanian, is found in the lower Kanokura beds of the Kitakami Massif, and in the Basleo faunas of Timor, that share a number of Kalabagh brachiopods. The Chandalaz Suite of South Primoyre has Kalabagh-Chhidru brachiopods, with *Timorites* and *Yabeina*, and was correlated with Basleo and Capitanian in Popeko (1978). Westwards from the Salt Range, the upper Wargal - lower Chhidru faunas extend through levels 1, 2 and 5 of the Ruteh Formation, Elburz Mountains, Iran, as far as the Hachisk- Gnishisk faunas of Armenia, below Djulfian (=Wuchiapingian) faunas, as summarized in Waterhouse (1976).

The lower Chhidru beds of the Salt Range are overlain by the Ganjaroh Member, with a distinctive fauna matched in the Popa Member of Nepal, some north Karakorum faunas of Merla, and upper Ruteh Formation of Iran, considered to be lower Wuchiapingian in age. These are followed in clear stratigraphic succession by fully developed Wuchiapingian faunas of the upper Djulfian in Armenia, Pija Member of Nepal, Nesen Formation of Iran etc. (Waterhouse 1982).

If the upper Wargal is really Wuchiapingian, the upper Permian Wuchiapingian-Changhsingian becomes crowded with zones and faunas, and the Capitanian becomes impoverished, widely absent, or, <u>most likely, substantially to entirely equivalent to Wuchiapingian</u>. So further work appears to be required on this matter. Before the upper Wargal can be allocated to lower Wuchiapingian, as opposed to lower Capitanian, the reliability of the conodont ranges need to be underpinned by discovery of Capitanian conodonts in the same Salt Range sequence, allowing the age to be determined by more than isolated spot dates. Without sequential identifications, the possibility of long or variant ranges, reworking, leakage, or misidentification cannot be set aside. The position may even turn out to be like that of early Triassic Gangetian conodont determinations, where Orchard (1996, Orchard et al. 1994) has reinterpreted conodont identifications in a way that makes them conform better with the ages indicated by accompanying ammonoids and the bivalve *Claraia*. That is not to denigrate conodonts, but does show that macro-invertebrate fossils also offer prime and reliable data, set aside erroneously in some instances. If Jin’s 1996 world time-scale is correct, it seems likely that *Cyclolobus* commenced in the Capitanian, overlapping *Yabeina - Lepidolina* and *Timorites*, and extends into equivalents of upper Wuchiapingian. *Timorites* also commences in the Capitanian, and either died out in late Capitanian, or early Wuchiapingian, depending on the age of the Lamar beds. It would seem, to judge from major Permian benthos distributions throughout Asia, that if the conodont *Clarkina dukouensis* and ammonoid *Cyclolobus* are restricted to Wuchiapingian, the Capitanian Stage must go, or be severely deflated, and that in turn jeopardizes the Guadalupian Series. Yet in terms of widespread and often rich brachiopod faunules, reinforced by fusulines and ammonoids, the Capitanian and Wuchiapingian are clearly separable, although individual genera overlap, and some show long ranges. That in turn justifies the Guadalupian Series, as distinct from the Lopingian Series.

Roadian- Kungurian-Cathedral Mountain

It is of considerable advantage to include the Kungurian Stage as coming at the top of the Cisuralian Series, as set out in the global scheme. On the one hand, this means that much of the historic Russian Permian remains as world standard. It also means that what appears to be a relatively full succession of benthonic zones is present in the world standard. Even though fusulines and ammonoids are patchy, and sometimes absent, or not diagnostic, there are several strongly developed brachiopod levels in the upper Cisuralian Series: the upper Artinskian Sarginian and Krasnoufimian-Saranin (or now Kungurian?) levels (substages), followed by the Filippovian, Nevolin and minor Elkin faunal levels. The Roadian and Cathedral Mountain faunas seem to represent only two faunal levels, as if there were gaps in the succession of benthos in the Glass Mountains, a matter that demands closer enquiry. It seems from some brachiopod evidence that the Roadian might prove to overlap with Kungurian, perhaps only the Elkin level, perhaps involving even the Nevolin level. But on the other hand Jin (1996, figure 2) shows *Misellina claudiae* as occurring in upper Kungurian, which would certainly point to a pre-Roadian age.

Kungurian brachiopods at least suggest closer ties to Kazanian rather than Artinskian and even older genera, to imply the Kungurian would be better allied with Kazanian rather than Artinskian. In other words, it may be that we are sacrificing some degree of biological reality, in order to achieve convenience in geological correlation, given the present emphasis on Agolden spikery.@ But that may only become an issue if the Capitanian is collapsed into Wuchiapingian, leaving us the problem of re-establishing a satisfactory middle Permian series.

Implications for Gondwana and Arctic

The designation of the standard Permian provides a fully marine succession greatly superior to the old "Tatarian." The concept and names are fine. But the new standard does not make correlation any easier for the vast bulk of Gondwana, nor much of high northern latitudes throughout much of Siberia and Canada. In these regions conodonts are rare or completely absent, and fusulines and ammonoids are far too sporadic to allow close correlation, offering as a rule mere point-source data or slim horizons. Their ranges frequently seem inconsistent, or out of phase with palaeotropical successions, possibly because of factors influenced by lag-times of migration or temperature regime. Instead, the emphasis must remain on palynospores, small foraminifers, bivalves, gastropods and brachiopods especially, and links sought with their allies in world stratotype successions. For these non-paleotropical regions, the stratotype boundaries are not significant. Consequently, selection for world stratotype of successions devoid of, or sparse in macro-faunal components might be deemed disdainful of real correlation problems over the greater part of marine fossiliferous sequences over a substantial part of the globe. A thick carbonate succession with full succession of microfaunal zones and rare macro-faunas will be of academic interest only, if it cannot be related to successions beyond paleotropical regions. What matters, as far as paleontological correlation is concerned, is the content and succession of faunas, the restricted species, the peculiar short-lived genera, the direction of change to warmer or colder faunas, and paleodiversities. The justified stress on fixing a golden spike is fine for world stratotype, but even so, content should not be sacrificed for boundary fixing. For that reason, the world stratotypes, many paleontologists and stratigraphers may consider, ought to contain a full succession of changing benthonic zones, the major ones at least being named as substages. Otherwise those paleontologists may find it necessary to refer to a chronostratotype for the temporal divisions, and a nearby biostratotype for correlation. Perhaps that is the answer. I do believe that in the search for stratotypes, recognition should be given to what may be called the archetype concept, in which a small region, such as pre-Urals, and Russian Platform, or the West Texas Permian, could serve to offer various sections for various purposes, and enable faunas and beds to be traced along strike, so as to incorporate variation, and locally flawed outcrop. Alternatively, judicious care, more study and collecting, under a set time-frame, might be able to designate stratotypes that also serve as biostratotypes, sections that are satisfactory for more than boundary constraints.

Series	Stage	Substage, subdivision
Lopingian	Changhsingian	Meishan
		Baoquing
	Wuchiapingian	upper Lungtan
		lower Lungtan
Guadalupian	Capitanian	(Lamar fauna)
		Rader - Hegler faunas
	Wordian	Apple Ranch fauna
		Willis Ranch fauna
		China Tank fauna
	Roadian	
Cisuralian	Kungurian	(minor Elkin level)
		Nevolin fauna
		Filippovian
	Artinskian	Krasnoufimian Saranin
		Sarginian
		Aktastinian
	Sakmarian	Sterlitamakian
		Tastubian
	Asselian	Kurmaian
		Uskalikian
		Surenian

International standard for Permian stages, showing principal subdivisions of benthonic faunas, summarized in Waterhouse (1976, table 1, p. xiv), and based primarily on fusulines and brachiopods. The upper Kungurian may overlap with Roadian. Krasnoufimian is believed to match Saranin. Lopingian summarized from Waterhouse (1982).

The start of the Triassic Period

I suggest the Triassic Period remain in the hands of ammonoid subdivisions, rather than conodonts. The Mesozoic was the era of ammonoids, and ammonoids, at least within my experience, are numerous enough to allow genuine world-wide correlation, with a minimum of non-fossiliferous intervals. Certainly, the early Triassic in north-central Nepal provides sequentially continuous sections, with minimal gaps, and stocked with abundant ammonoids throughout Early Triassic and well into Middle Triassic. The ammonoids appear to offer zones much finer and more consistent than conodonts, with ammonoid genera much shorter lived than conodont "genera". I would also offer what may seem a curious suggestion, that the top of the Permian Period be distinguished from the start of the Triassic Period. This conflicts with the golden spike proposals that assert the end of one is the start of the next. Such an assertion raises intriguing philosophical and semantic questions, and is not quite as accurate nor indisputable as some would pretend. The golden spike principle is surely only an initial and quick fix approach to designating time boundaries. In fact, the end of one time interval can be distinguished from the start of the succeeding time interval. The very last fossil of the Permian Period and Paleozoic Era should not be the very first fossil of the Triassic Period, and Mesozoic Era. Therefore, to my mind, a conodont species at the height of its Permian range may be desirable as the marker for latest Permian in the Changhsingian chronotype. But it is the ammonoid *Otoceras* which should mark the start of the Mesozoic Era. I see no harm at all in moving now to anticipate a fresh wave of study that the top of the Permian Period be distinguished from the start of the Triassic Period.

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Sequence Stratigraphy along Aidaralash Creek and the Carboniferous/Permian GSSP

By Walter S. Snyder and Dora M. Gallegos

Upper Paleozoic strata of Aidaralash Creek, northern Kazakhstan, southern Ural Mountains (Fig. 1, Davydov et al., this volume) were deposited on a narrow, but persistent shallow marine shelf that formed the western boundary of the Uralian orogenic highlands. The sequence stratigraphy reflects repeated shelf to fluvial-deltaic cycles. Our general mapping and detailed measurement of stratigraphic sections build on the pioneering work of Ruzhencev (1951, 1952, 1956) and Khvorova (1961). Only a summary of the stratigraphy along Aidaralash Creek is presented here; a general sequence stratigraphic model of the Lower Permian of the southern Ural Mountains region is in progress. The Cisuralian stages will be formally defined in the southern Urals, thus documenting this sequence stratigraphy is important because: (1) GSSP for bases of these stages cannot be defined at unconformities, and (2) well-dated, eustatic sequence boundaries should be powerful adjunctive stratigraphic markers for global correlation of Cisuralian stages.

Permo-Carboniferous strata exposed along Aidaralash Creek can be described using a series of lithofacies (Table 1). A mudstone-siltstone (MS) facies, containing abundant fine plant debris, is interpreted as the background, offshore sediment; this facies reflects the abundant terrigenous input from deltaic sources. Fine (SS1), medium (SS2), and gravelite (SS3) sand facies represent event beds. Some sandstone beds display simple grading with rippled tops which may represent unreworked sediment gravity flows. However, most sandstones are horizontally stratified, amalgamated beds 5 to 30 cm thick; the stratification is defined by 0.5 to 5 cm thick graded intervals and many of the beds have rippled tops. These horizontally stratified sandstone beds are interpreted as storm deposits or as wave- and storm-reworked sediment gravity flow deposits. Paleocurrent data suggest that a large and persistent delta complex developed to the northeast which supplied sand that was periodically transported southwestwardly to the Aidaralash area as sediment gravity and storm deposits. The preservation of storm beds and hummocky cross stratification suggests that much of the section was deposited below fair weather wave base. The coarse grain size and sedimentary structures of SS4 gravelite beds suggest sediment gravity flow deposition and reworking of the upper portions of the beds by waves and strong currents. The sandstone beds occur in thickening upward cycles with or without discernable coarsening. Fusulinaceans tend to occur near the base of SS3 and SS4 sandstone beds. Polymictic pebble to cobble conglomerate form conspicuous beds 10 to 50 m thick fining upward successions. These interbedded conglomerate and

TABLE 1 AIDARALASH CREEK LITHIFACIES	
FACIES	DESCRIPTION
MS	Siltstone-claystone-mudstone.
SS1	Very fine, structureless sandstone, interbedded with siltstone-mudstone.
SS2	Fine sandstone beds; grading apparent in some beds with medium to coarse bases; parallel laminations common in most beds, ripple tops occur abundantly; lenticular beds with lateral dimensions of a few to 30 meters and thickness of a few centimeters, typically 15 to 30 cm, and up to 1.5 meters in amalgamated beds.
SS3	Medium (coarse to fine) sandstone; typically graded and parallel laminations; with rippled tops common, but not ubiquitous; erosive bases with flutes, tool marks, load structures; local hummocky cross stratification.
SS4	Gravelites; coarse grained to granulite sandstones of very fine pebble conglomerates; erosive bases.
CG1	Polymictic pebble to cobble conglomerate; matrix and clast-supported; disorganized to indistinctly stratified beds; some weakly aligned elongate clasts; local slump structures and channels; some outsized clasts 1 to 4 m in diameter; poorly cemented. Limestone and well indurated sandstone clasts predominate, but also include metamorphic, granitic, rhyolite to andesitic volcanic, greenstone clasts. Basal contact is typically scoured into underlying shelf sandstone successions. Fining upward successions 10 to 100 m thick that may contain variable thickness of lenticular sandstone.

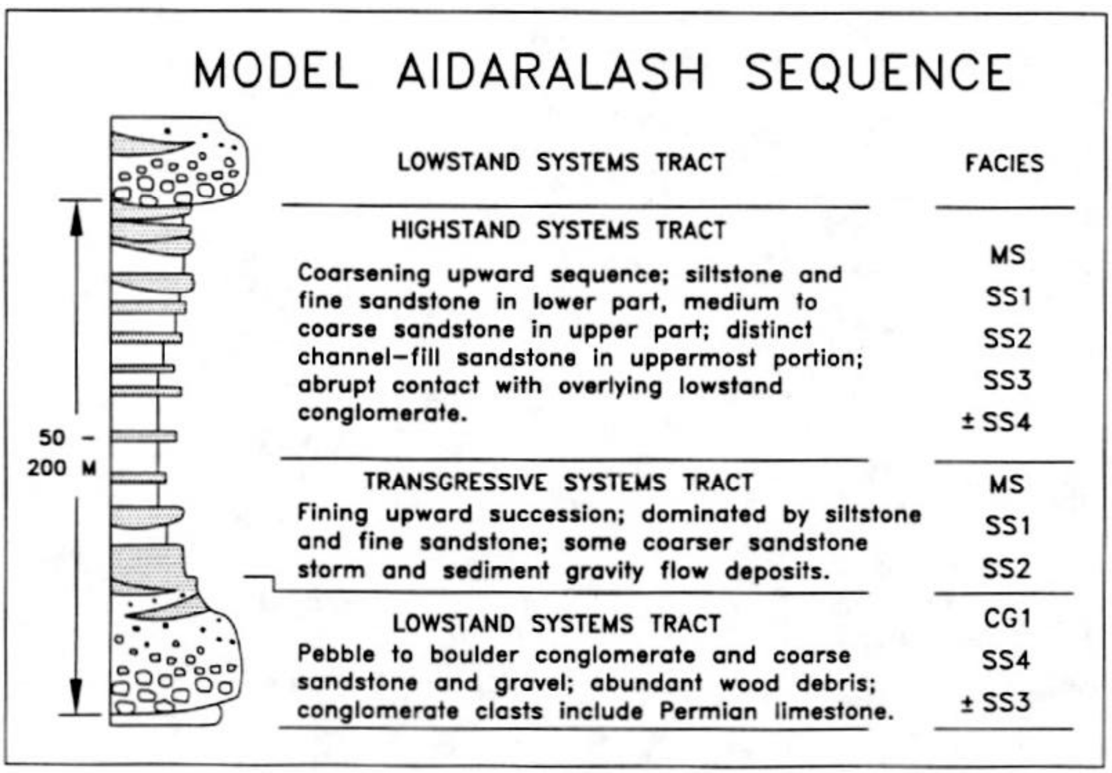

Figure 2. Model stratigraphic sequence for Lower Permian, Adiaralash Creek.

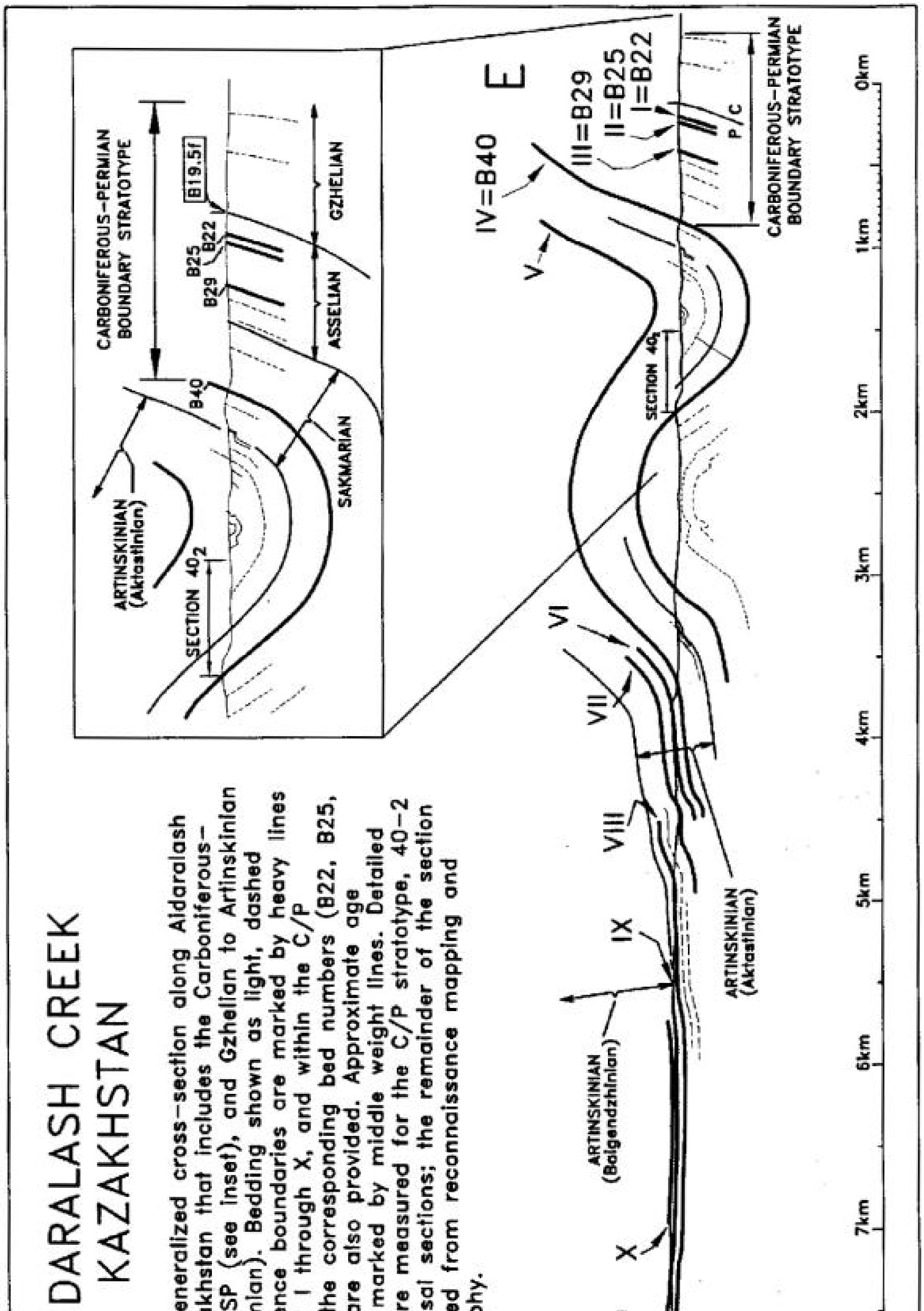

Figure 2. Generalized cross-section along Aidaralash Creek, Kazakhstan that includes the Carboniferous–Permian GSSP (see inset), and Gzhelian to Artinskinian (Baigendzhinian). Bedding shown as light, dashed lines. Sequence boundaries are marked by heavy lines and labeled I through X, and within the C/P stratotype, the corresponding bed numbers (B22, B25, B29, B40) are also provided. Approximate age boundaries marked by middle weight lines. Detailed sections were measured for the C/P stratotype, 40–2 and Tuscansai sections; the remainder of the section was compiled from reconnaissance mapping and biostratigraphy.

sandstone beds are typically poorly cemented. Limestone and well indurated sandstone clasts predominate, but also included are metamorphic, granitic, rhyolite to andesitic volcanic, and greenstone clasts. Basal contacts are typically scoured into underlying shelf sandstone successions.

The typical Aidaralash sequence is depicted in Figure 1. The conglomerate beds mark the most obvious Aidaralash sequence boundaries (sequence boundaries IV through X, Figure 2). These fluvial-deltaic conglomerate-sandstone successions grade upward into transgressive marginal marine sequences (beach and or upper shoreface), to a maximum flooding unit (typically with ammonoids, conodonts, and radiolarians). This gradation usually occurs within a stratigraphic thickness of a few to 10 meters. The maximum flooding zone is overlain by a regressive sequence (offshore to shoreface to delta front), which in turn is capped by an unconformity with the overlying conglomerate.

Within the stratotype section, (Fig. 2, and Fig. 2 of Davydov et al., this volume), no sequence boundary occurs within 50 m stratigraphically of the Carboniferous-Permian boundary. The 5-15 m thick SS3 sandstone at beds 22, 25, and 29 reflect relative shallowing to above fair weather wave base but show no evidence of subaerial exposure. These sands have been interpreted as possible sequence boundaries I, II and III in Figure 2, but it is unclear whether these reflect true eustatic sea level lowstand deposits, autogenic fluctuations in sediment supply, or perhaps, merely decreased tectonic subsidence rates. It is clear that within the Aidaralash stratotype section there is no sequence boundary recorded from 555 m below to 75 m above, and no major break in deposition from 555 m below to 685 m above the Carboniferous-Permian boundary point.

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Upper Paleozoic Fusulinacean Biostratigraphy of the Southern Urals

By Vladimir I. Davydov, Walter S. Snyder and Claude Spinosa

Introduction

Upper Paleozoic strata of the Pre-Uralian foredeep in the southern Urals occur between the Uralian orogen (*sensu stricto*) and the shallow-water carbonate of the Russian Platform (Fig. 1). The Pre-Uralian foredeep is genetically associated with a series of collisions of the East European continent and several microcontinent plates and island arcs. Overthrusting of the eastern margin of the East European continent by tectonic elements of the Uralian Highlands is interpreted to have produced the flexural load that created the Pre-Uralian foredeep - a classic foreland basin (Snyder et al., 1994).

The southern Ural Mountain region is the type area of the Cisuralian Series, comprising the Asselian, Sakmarian, Artinskian and Kungurian stages. The Orenburgian, equivalent of upper Gzhelian (*sensu lato*), was also established in the southern Urals. These stages initially were defined and widely recognized on ammonoid phylogenies (Karpinsky, 1889; Ruzhencev, 1937, 1951, 1956), however, stage boundaries and subdivisions were established on the basis of fusulinaceans, the most abundant and best studied upper Paleozoic fossil group of the southern Urals.

The southern Pre-Uralian foredeep, paleogeographically situated between Boreal and Tethyan provinces, comprises taxa of Boreal and Tethyan affinities and thus is a key for resolving problems of upper Paleozoic global correlation.

Lower Permian body and boundary stratotypes for the Cisuralian stages will be established in the Ural Mountains; it is expected that these will be formally proposed in the near future (Chuvashov, 1997). Fusulinacean biostratigraphy historically has employed the biozone concept. Fusulinacean zones utilized in the study of the Russian Platform and of the Urals were established in southern Ural sections - however, without reference to any particular section. In light of this, an opportunity exists to re-examine Lower Permian fusulinacean zones to help develop the GSSP definitions for the Cisuralian stages.

Fusulinacean biostratigraphy in the Southern Urals

The recently accepted definition of the Carboniferous-Permian boundary at Aidaralash Creek (Davydov et al., 1995) approximates the horizon proposed by Ruzhencev (1952). In contrast, Pnev et al. (1978) erected lower Asselian fusulinacean zones approximately 400 m lower. Similarly, the Asselian-Sakmarian boundary in the Sakmarian stratotype at Kondurovsky was established at the base of Kurmainskaya Formation by Ruzhencev (1951) and at the top of the same formation by Movshovich et al. (1978). Fusulinaceans in the southern Urals largely occur in clastic strata - tempestites and gravity flows - suggesting that fusulinaceans were redistributed from their original habitat. There are, however, different views regarding this process. Some specialists have suggested that all fusulinacean occurrences in the southern Urals were reworked and represent mixed assemblages of different ages (Rosovskaya, 1952; Rauser-Chernousova, 1965; Chuvashov, 1993). Our view is that the fusulinacean assemblages we have studied from the southern Urals were Aredistributed@ from their living habitat to the site of deposition. We contrast Aredistribution@ that occurred within a brief period of time to Areworking@ of geologically older faunas into younger sediments. We acknowledge that some species are reworked (in the sections we studied, fewer then 0.005% i.e., 5 specimens out of 10,000), but these are easily recognized. Our interpretation suggests that there has been no appreciative reworking and mixing of fusulinacean species in the Upper Carboniferous and Lower Permian of the southern Urals.

The following model of fusulinacean redistribution is suggested. It is generally accepted that Fusulinaceans lived near shore, within the photic zone. As is the case with recent benthic foraminifera, fusulinacean tests accumulated on the sea floor after death and subsequently were redistributed to different locations on the shelf by wind, storms or gravity flows. The time required for redistribution must have been short as must have been the distance of transport because tests generally lack abrasion and other signs of damage. The redistributed tests tend to occur at the base of sandstone beds and contain fine-grained sand and silt, particularly in outermost volutions. Significant features that demonstrate redistribution rather than reworking include:

1. The fusulinacean successions and evolutionary patterns in southern Uralian sections correspond to those occurring in sections with normal carbonate sedimentation of the Pre-Caspian, Central Asia, the Donets Basin, and the Carnic Alps.

2. The southern Ural fusulinacean assemblages generally do not include obviously older taxa.

3. Fusulinacean tests contain fine-grained sand and silt, consistent with surrounding matrix, suggesting that tests and matrix are contemporaneous.

Gzhelian-Asselian fusulinacean faunas of the southern Urals show strong affinities with typical Tethyan faunas of Central Asia, the Pre-Caspian, Northern Iran, the Pre-Donetz trough, and the Carnic Alps. During the Gzhelian-Asselian, the boundary between the Tethyan and Boreal provinces coincided with the paleolatitude of the present-day city of Ufa. The highest fusulinacean taxonomic diversity in the southern Urals occurs in these Gzhelian-Asselian assemblages because of the connection that existed between the Pre-Uralian foredeep and the Tethyan basins. However, progressive isolation of the Pre-Uralian foredeep and Pre-Caspian Basin from the Tethys lead to a marked decrease in taxonomic diversity from approximately the beginning of Sakmarian to the Kungurian. From middle Tastubian to Kungurian only Boreal fusulinacean faunas occur in the southern Urals and Pre-Caspian. By early Kungurian time fusulinaceans disappeared from the Pre-Uralian foredeep. Effective barriers to fusulinacean dispersal appears to have resulted from the formation of orogenic highlands to the east and from the accretion of Tethyan terranes to the south, resulting in faunal isolation of the Pre-Uralian foredeep from Tethyan basins to the south.

Fusulinacean zones

The evolutionary framework for most late Paleozoic fusulinacean lineages of the southern Urals is well established. Fusulinacean zones we utilize for the southern Urals are based on evolutionary successions and are defined by assemblages of species (Fig 2). The base of each zone is established by the advent of significant evolutionary changes in several lineages. The top is defined by the base of the next zone. Each fusulinacean zone is characterized by 30-70 species, and 5-15 genera.

The fusulinacean zones from any single section reflect the character of local, regional, provincial, and global environmental changes. Occurrence or absence in a section or even a region may differ from true first appearance and extinction. The occurrence of a species in a section or region may be influenced by local environmental factors. However, origination and extinction of species are generally influenced to a greater degree by global rather than by local forces. The study of phylogenetic successions can be used to help distinguish between local occurrences and true speciation. The southern Urals fusulinid zonation is based on phylogenies, it thus reflects true speciation and extinction events.

The correlation of southern Ural zones with sequence boundaries for the Aidaralash Creek section is shown in Figure 2. Most sequence boundaries coincide with the bases of fusulinid zones. We can suggest that sequences I, II, III, IV, VII, VIII and IX are eustatic. Sequence boundaries V and VI, located within fusulinid zones, perhaps reflect local tectonism or local climatic changes; conversely the fusulinid phylogenies for those particular zones may be still poorly understood or poorly documented. It is interesting to note, however, that some important stage boundaries, such as the base of Asselian and the base of Sakmarian, do not coincide with recognized sequence boundaries. We can suggest from this that fusulinid speciation appears to be associated with both highstands and lowstands. Sea level lowstands may have been very stressful for fusulinid assemblages and may have been a catalyst for both speciation and extinction. Highstands also may have created environmental opportunities and appear to be more closely associated with fusulinid speciation than extinction.

Graphic correlation

Graphic correlation provides an opportunity for refined assessment of fusulinacean biostratigraphy and for incorporating sequence stratigraphy. Preliminary graphic correlation applications indicate great similarity in the biostratigraphic distribution of fusulinacean species from the southern Urals, Darvas (Central Asia), Dneiper-Donets trough and the Carnic Alps; precise correlation of Upper Paleozoic strata from these regions is suggested.

Acknowledgments

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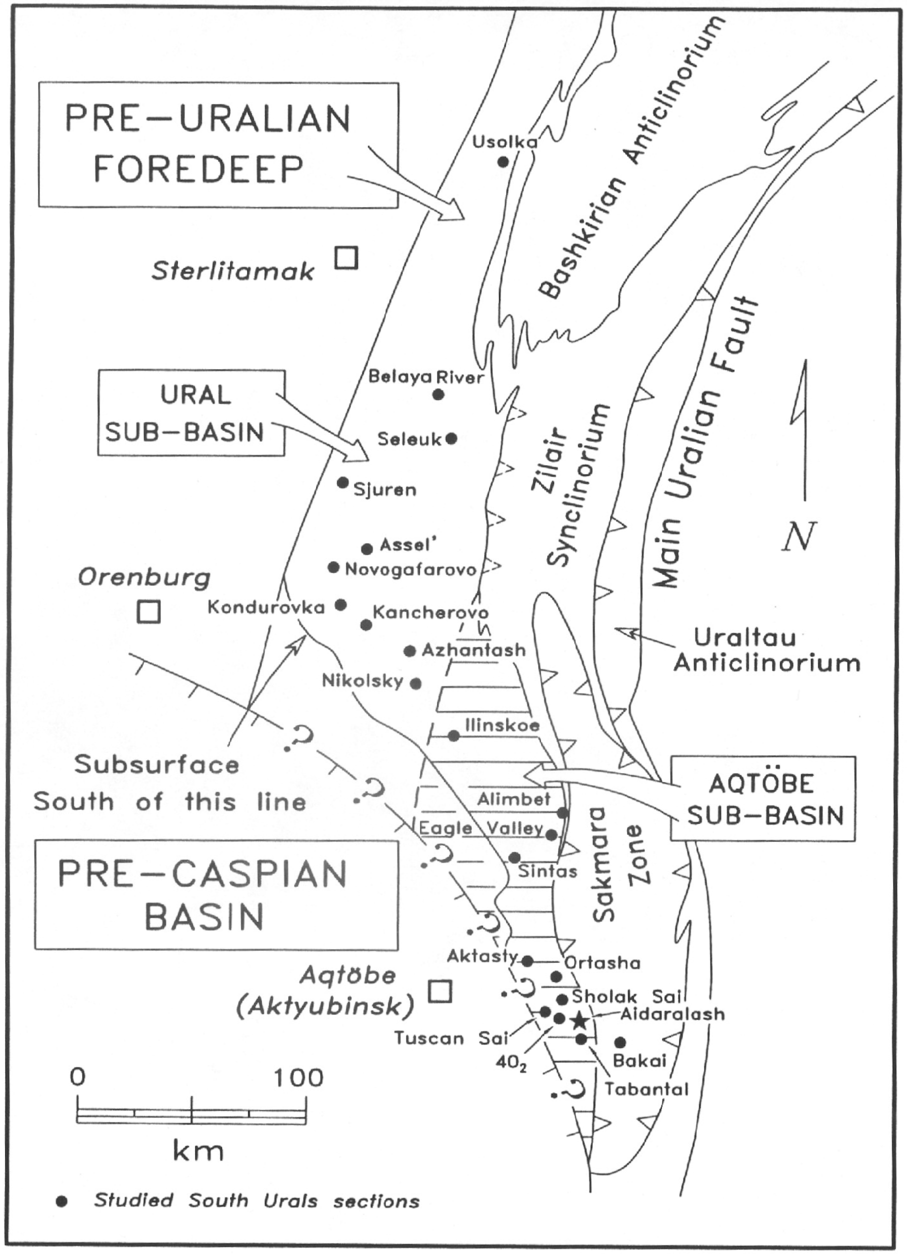

Figure 1. Sections studied in Southern Urals.

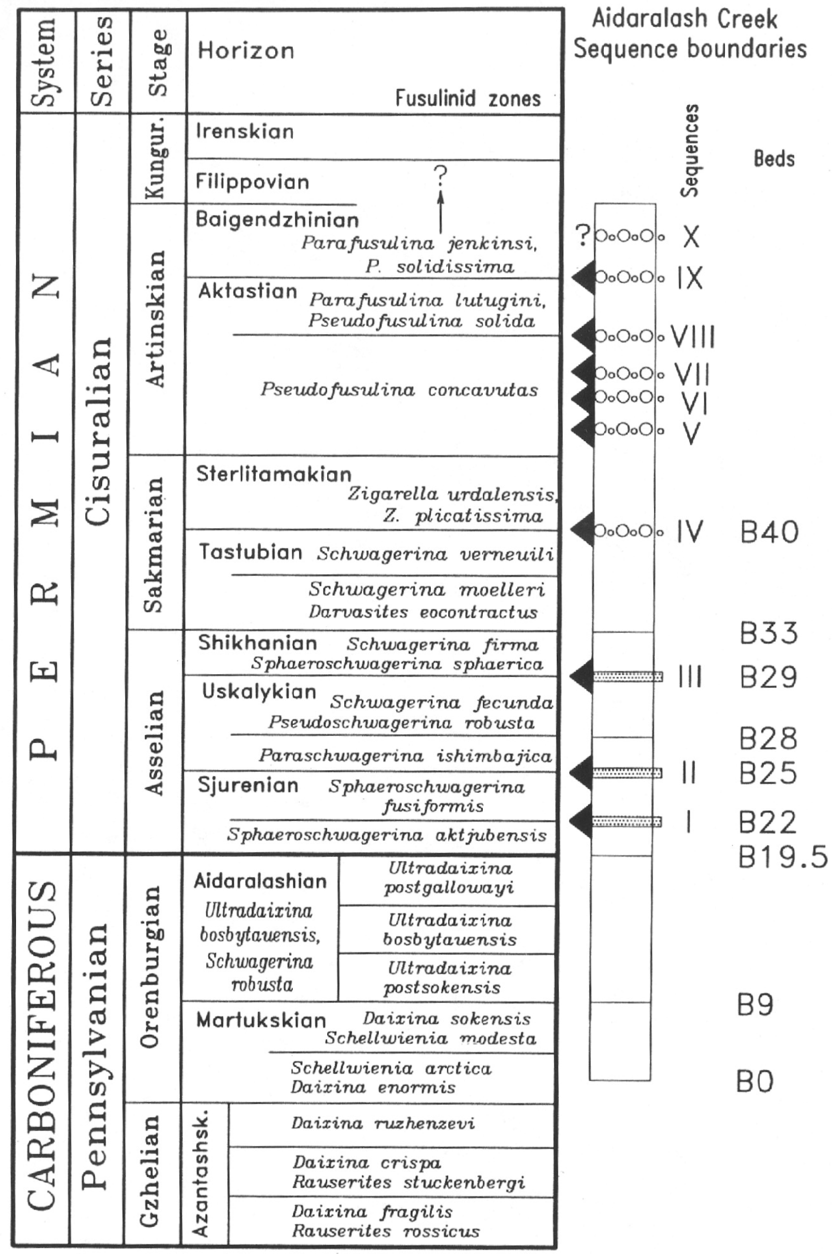

Figure 2. Gzhelian-Artinskian fusulinid succession and sequence boundaries in Southern Urals.

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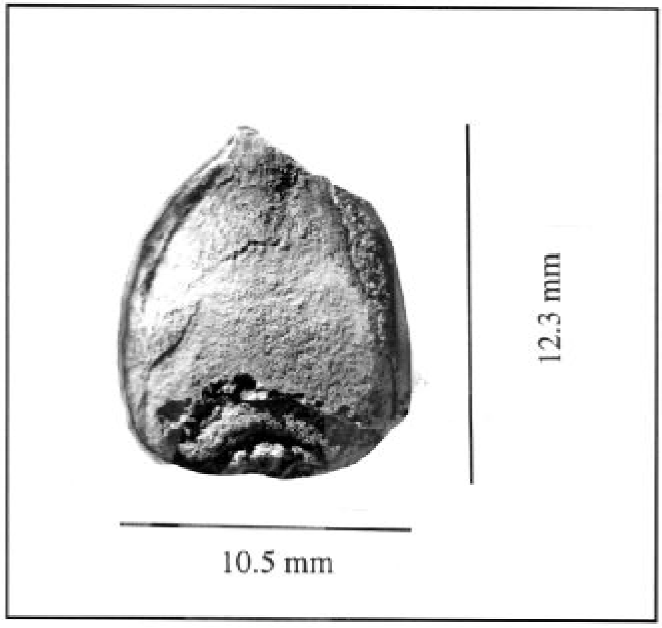
Cordaitalean Seeds From Baighendzhinian Strata of Aidaralash Creek, Southern Ural Mountains

By Michael T. Dunn

In excess of thirty-five well preserved Cordaitales seeds have been recovered from Artinskian strata exposed along Aidaralash Creek, Aktöbe (formerly Aktyubinsk) region, southern Ural Mountains, northern Kazakhstan. The disarticulated seeds were recovered from a poorly cemented sandstone lens that occurs in a fluvial deltaic, conglomerate interval (map point 28, Snyder and Gallegos, this issue).

Pending analysis of thin sections, seeds have been tentatively assigned to the form genus *Cardiocarpus* Seward, 1917. Seeds (Figure 1) range in size approximately from 7 mm X 7 mm to 19 mm to 19 mm and average 12.3 mm X 14.7 mm (ú=32). Specimens exhibit bilateral symmetry, are cordate-shaped and attenuated at the micropyle end; several specimens bear remnants of a stalk at the chalazal end. The integument, where visible, is distinctly three-layered. One specimen features a wing fragment.



Cardiocarpus is distinguished from the similar Cordaitales seed *Mitrospermum* by the internal structure of integumentary bundles (Taylor and Stewart, 1964, fide Stewart and Rothwell, 1993); Representatives of *Cardiocarpus* occur rather abundantly in Upper Carboniferous coal balls of Iowa, Kansas and Europe (Andrews, 1961) and in Siberia (Cyxob, 1969); they are known to have survived well into the Permian. Permian age is consistent with Baigendzhinian (upper Artinskian) assignment of strata at map point 28 (Snyder et al., this issue) by V. E. Ruzhencev (1956). Seeds were secured by W. S. Snyder

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Late Permian Palynomorph Assemblages from Ufimian and Kazanian Type Sequences in Russia, and Comparison with Roadian and Wordian Assemblages From the Canadian Arctic

By J. Utting, N.K. Esaulova, V.V. Silantiev, and O.V. Makarova

Palynological work has been carried out on a number of sections from the type sequences of Russia and comparisons made with possible age correlatives in the Canadian Arctic. Below is the abstract from a recent paper published in the Canadian Journal of Earth Sciences, vol. 34, 1-16 (1997).

Tentative biostratigraphic correlations, based on marine faunas, have been made by various workers between Ufimian and Kazanian sequences in their type areas in the Volga/Urals region of Russia, and Roadian and Wordian sequences in their type area in Texas, USA. Unfortunately, palynological correlation between the Russian and USA sequences is not possible, due to lack of data from the latter. However, detailed palynological data are available from rocks of Roadian and Wordian age in the Canadian Arctic Archipelago, and indirect correlations are possible. Palynomorph assemblages from the Canadian Arctic and other circum-polar areas, such as the southern Barents Sea and Greenland, are different from those of the Ufimian and Kazanian Russian sequences in their type areas. This is likely to be the result of variations in the parent flora in response to significant paleoclimatic differences. For example, the climate of the Volga/Urals region in late Permian times was probably hot and arid, whereas that of the Canadian Arctic, Barents Sea and Greenland was cooler and probably more humid.

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The Earliest Permian Palynological Event in Gondwana and its Palaeoclimatic Implication

By Yang Weiping

The discovery of palynomorphs in a glacially derived sequence in Tengchong, West Yunnan S. W. China, and correlation with assemblages elsewhere in Gondwanaland, has led to the recognition of an earliest Permian palynological event. This particular event might indicate a deglaciation in terms of palaeoclimatology.

Kemp (1973) established four stages describing the distribution of microfloras within the glaciated Gondwana area. These are Pre-Stage 1, Stage 1 microflora, Stage 2 microflora, Stage 3 microflora. Among these, microfloras of Stage 2 are the most widespread in their geographic distribution, occurring on all continents. The palynological evidence in Tengchong is just one more case to support the above claims.

An early Permian palynological assemblage was obtained from the rocks of dark and black shales, silty mudstones in a well-exposed section of the Kongshuhe Formation belonging to the Menghong Group. The palynological assemblage in Tengchong is dominantly represented by Microbaculispora tentula, Jayantisporites pseudozonatus, Punctatisporites gretensis, Verrucosisporites subsaccata, Vittatina fasciolata, Horriditriletes tereteangulatus, Protohaploxypinus sp., Propinguispora praetholus, Procoronaspora spinosa, Brevitriletes sp., Cordaitina sp., Spelaeotriletes sp., Retusotriletes sp. This assemblage is called TP zone (Yang et. al., 1996), which stands for Microbaculispora tentula, Jayantisporites pseudozonatus. The age of this assemblage could be dated as early Permian (about upper Asselian and lower Sakmarian) based solely upon the correlation with assemblages from Gondwanaland. One more interesting thing is that the horizon yielding spore and pollen is just at the top of the glacially derived strata and can be regarded as the deglaciation stage according to Wofpner and Jin (1993) if we accept the possible existence of Late Carboniferous and Lower Permian glaciation in the Tengchong massif. In the Bonaparte Gulf Basin, Western Australia, the black, carbonaceous/bituminous marine Treachery Shale representing the deglaciation sequence was dated by Foster (1986) as Asselian with the finding of the Granulatisporites confluens Oppel-zone (Wopfner, 1994). The current TP Zone, correlative to G. confluens in the Tengchong massif is also extracted from the black mudstone, shales which can be regarded as deglaciation sequence by Wopfner. Now the P. (Granulatisporites) confluens has been put at the top of the former Stage 2 (Backhouse, 1991). The age of this P. confluens could be regarded as late Asselian and early Sakmarian. Now it is becoming apparent that Stage 1 in Eastern Australia or unit I in Western Australia might be useless in biostratigraphy. Powis (1984) already stated that Stage 1 is probably a facies controlled palynoflora. Foster (1988) also claimed that there is no other time-significant spore-pollen indices in Stage 1. These impoverished palynological assemblages might well represent a specialized, environmentally restricted communal plant-subset. From the above claims together with the actual localities of palynofloras in the whole Gondwana continents, we would like to accept Stage 2, unit II? G. confluens and the current TP zone as the remarkable earliest Permian palynoflora throughout the Gondwana although the following two things are still un-

certain. The first is whether or not the lower boundary of this palynoflora event coincides with the lower boundary of Asselian Stage. The second is no palaeoclimatic implication of P. confluens comparable zones or Stage 2 in Gondwanaland except the one in Bonaparte Gulf Basin. The consistent co-occurrence of Microbaculispora tentula together with Horriditriletes ramosus and H. (Acantotriletes) tereteangulatus was once regarded by Powis as the most distinctive primary feature of his redefined Stage 2 in Australia. Based upon the current palynological data, M. tentula has been recorded from the horizons above the glacially derived sequences in Australia, Africa, India, West Yunnan, China; South America and Antarctica. Therefore, M. tentula could be defined herein as the index fossil of the earliest Permian palynological event throughout the Gondwana. Jayantisporites pseudozonatus is thought to be the other key taxon in this earliest Permian palynoflora in the southern hemisphere. Due to the fact that most palynoflora have been recorded from the horizons claimed by sedimentologists (Wopfner and Jin, 1993) to be the deglaciation sequence, the earliest Permian palynoflora event is hereafter also called the earliest Permian deglaciation palynoflora event.
Obviously, this kind of claim needs more work on biostratigraphy and paleoclimatology.

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Insect and Insect Activities in Permian Gondwana of India

By A. K. Srivastava

It is rather intriguing to note that in spite of well known assemblages of plant fossils of the *Glossopteris* flora in Permian sequence, the flora which contributed most to the formation of Indian coal has not yet been studied to demonstrate the animal-plant relationships. Lack of data on this topic, in my opinion, may reflect either a lack of interest or more likely an uncertainty of what data might prove useful. Positive observation of fossils in this direction and encouraging discoveries of insect wings in association with plant fossils from Barakar Formation (Lower Permian) of Raniganj Coalfield demonstrate direct and indirect evidences of insect and insect activities signifying the insect - plant relationship in Permian Gondwana of India.

Insects

Insect remains are mainly recorded by their wings and they are classified on the basis of venation patterns in different groups:

Blattoidea

1. *Gondwanablatta reticulata* Handlirsch, 1906
2. *Kashmiroblatta marhomensis* Verma 1967
3. *Prognoblattina columbiana* Schudder 1895
4. *Rajharablatta laskarii* Dutt 1977
5. Hind wing of the family Archimylacridae Srivastata 1988
6. Body fossil of Cockroach Kapoor et. al 1993

Homomptera

1. *Prosbolecicada cf.gondwanica* Pinto 1987
2. *Parosbole cf. iratiensis* Pinto 1987

Mecoptera

1. *Asiachorista neuburgae* Martinova 1985
2. *Petromantis cf. evansi* Pinto 1972

Coleoptera

1. *Kaltanicupes* sp. indet.

(For detail see Pinto et. al. 1992; Srivastava, 1996)

Insect Activities

Insect activities have been evidenced from the plant fossils, especially leaves of *Glossopteris* showing characteristic morphology and possessing distinct insect structures over their surface.

One of the common activity recorded in the flora is feeding traces of insect in the form of distorted or nibbled margin of leaves. Occurrence of egg-like structures over the leaf in two rows along midrib and sometimes over the surface of leaves compares closely with the depositional site of insect eggs. Presence of linear blotch over the surface of *Glossopteris* leaves indicates the possibility of mining activity of insects, small outgrowth or disfigurement of lamina suggests the presence of gall inducing insect. Records of circular-hellicoidal structures over fossil axes demonstrate the burrowing behavior of insects (morphological features of such activities are described by Srivastava 1988, 1996).

Insect-plant relationship is well established in the Late Palaeozoic flora of Northern Hemisphere (Scott & Taylor 1983; Scott, 1991); however, in spite of well documented insect fauna of South America and Australia (Tillyard, 1926; Tasch, 1977; Pinto et. al., 1980) the study has not yet been emphasied in Gondwana continents. The available information compiled herewith suggests that there is enough scope to examine the insect-plant relationship in Gondwana flora of the Southern Hemisphere.

Wealth of data generated by Prof. Iraja Damiani Pinto and his colleagues has been a source of inspiration and guidance in identifying Gondwana insects. I am grateful to him for giving me an opportunity to study the insect fauna in his laboratory at Porto Alegre, Brazil.

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Fusulinid Biostratigraphy in Upper Carboniferous (Gzhelian) and Lower Permian (Asselian-Sakmarian) Successions of Spitsbergen, Arctic Norway

By Inger Nilsson and Vladimir I. Davydov

Introduction

Spitsbergen is the main island of the Svalbard Archipelago, which is located in the northwestern corner of the Barents Shelf (Fig. 1), next to the Greenland and Arctic sea basins. It represents an uplifted part of the otherwise submerged Barents Shelf. Upper Paleozoic strata are present throughout the archipelago, although the largest outcrops occur in the central parts of Spitsbergen. The succession is rather condensed but remarkably complete, apparently with few depositional breaks. In this area the Carboniferous-Permian succession is slightly affected by post-Paleozoic tectonic activity. This Upper Paleozoic fusulinid study in Spitsbergen was part of IKU's Fusulinid project 1989-1993. The fusulinid faunas of Spitsbergen are considered to have important palaeobiogeographic implications, because they act as faunal links between the rich fauna known from Russia (e.g. Russian Platform, Timan-Pechora Basin) in east of Boreal province and Northeast Greenland (Wandel Sea Basin) and Canadian Arctic (Sverdrup Basin) in the west of Boreal province .

Geological framework

Middle Carboniferous to Lower Permian deposits of Spitsbergen form a part of the sedimentary basin covering most of today=s Barents Shelf. Westwards this shelf is connected to North Greenland (Wandel Sea Basin) and Canadian Arctic (Sverdrup Basin), and eastwards it borders to Arctic Russia (Barents Sea shelf and Timan-Pechora Basin). The Middle Carboniferous to Lower Permian succession of Spitsbergen is characterized by shallow marine carbonates and sabkha evaporites reflecting the arid climate during this period. In central Spitsbergen this succession belongs to the Gipsdalen Group, which is divided into three formations: Ebbadalen Formation (?Serpukhovian-Bashkirian), Wordiekammen Formation (Bashkirian-Sakmarian) and Gipshuken Formation (Sakmarian-Artinskian).

Thickness and facies pattern of the sedimentary units of Spitsbergen are mainly related to a series of NNW-SSE-trending lineament (Figs. 1), which were active due to tensional stress during the Carboniferous (Steel & Worsely 1984). Sedimentation during Carboniferous and Permian time was controlled by the Nordfjorden Block, bounded by two fault belts which have given rise to distinct block- and basinal deposits. This high (uplift) was transgressed during the late Moscovian (Nilsson 1988), but a marked uplift/sea-level fall close to the Carboniferous-Permian transition resulted in a depositional break on structural highs, with subsequent deposition of transgressive sandstones or intraformational conglomerates (Steel & Worsley 1984). Shallow marine carbonates and reefs were developed under warm climatic conditions. Bituminous limestones with abundant fusulinids (Brucebyen Beds) occur below and between the *Palaeoaplysina* bioherms. Bioherms generally develop along shelf margin, reflecting ongoing structural control on sedimentation. The following regressive phase during arid conditions resulted in the formation of thick evaporites of the Gipshuken Formation (Sakmarian-Artinskian) on structural highs.

Material

This study is based on fusulinid samples collected from five localities in the Wordiekammen Formation in central Spitsbergen. The Tyrrellfjellet- and Boltonbreen sections are located in the Billefjorden Through. These sections were described and sampled during 1990 summer field work. The Kolosseum-, Trollfuglfjella- and Skansen sections are located on the Nordfjorden High. Fusulinids from these localities have been previously studied by Nilsson (1988). A part of that collection (Gzhelian-Sakmarian fusulinids) has been re-studied, and included into this work. The present study is based on approximately 75 samples and more than 400 orientated thin-sections.

Fusulinid zonation

***Rauserites rossicus* zone (early Gzhelian)**

Definition: The base of this zone is marked by the first appearance of *Rauserites rossicus* (Schellwien), and first representatives of *Rugosofusulina*. The top coincides with the base of the overlying *Jigulites jigulensis* zone.

Composition: *Rauserites rossicus* (Schellwien), *Rugosofusulina aktjubensis* Rauser, *R. flexuosa* Rosovskaya and *R. serrata* Rauser.

Remarks: The fusulinid assemblage of this zone is very poor. *Rauserites, Daixina* and *Jigulites*, which are widely characteristic in lower Gzhelian of the Russian Platform and Urals, are absent in Spitsbergen. In the Urals *Rugosofusulina* species first occur at the beginning of the Gzhelian and range into the Sakmarian. Representatives of this genus are usually characteristic of the facies formed in low energy hydrodynamic environment. *Rauserites rossicus* (Schellwien) is an index species for the lower Gzhelian on the Russian Platform but ranges higher in the middle Gzhelian. Based on the occurrence of *Rauserites rossicus* and first *Rugosofusulina* at the base of *Rauserites rossicus* zone in Spitsbergen and the presence of middle Gzhelian *Jigulites jigulensis* at top (see discussion below), the *Rauserites rossicus* zone in Spitsbergen s regarded as early Gzhelian.

Occurrence in Spitsbergen: The uppermost part of the Kapitol Member at Trollfuglfjella and the uppermost part of the Cadellfjellet Member at Boltonbreen.

***Jigulites jigulensis* zone (middle Gzhelian)**

Definition: The base of *Jigulites jigulensis* zone is placed by the first occurrence of *Jigulites jigulensis* (Rauser) and *J. oviformis* (Schlykova). The top of this zone coincides with the base of the overlying *Daixina sokensis* zone.

Composition: *Jigulites jigulensis* (Rauser), *J. major* Rosovskaya, *J. longus* Rosovskaya, *J. procullomensis* (Rosovskaya), *J. dagmarae* Rosovskaya, *J. oviformis* (Schlykova), *J. longus*

Rosovskaya and *Rauserites* aff. *postarcticus* (Rauser).

Remarks: Fusulinid assemblage of this zone is represented by advanced *Jigulites* species, which first appear in Spitsbergen at middle Gzhelian time. All recognized species are characteristic only of the Boreal province. The assemblage of *Jigulites jigulensis* zone in Spitsbergen does not contain *Rauserites* and *Daixina*, whereas in the Russian Platform, Urals and particularly in Central Asia in the middle Gzhelian both genera are numerous. Consequently, taxonomic diversity of middle Gzhelian fusulinids in Spitsbergen appears to be low at this time. The above mentioned middle Gzhelian fusulinid fauna of Spitsbergen is considered to correspond to the fauna in Middle Gzhelian *Jigulites jigulensis* zone in the Russian Platform, Urals and Timan-Pechora Basin.

Occurrence in Spitsbergen: The uppermost part of the Kapitol Member and lowermost part of the Tyrrellfjellet Member at Trollfuglfjella. Uppermost part of the Cadellfjellet Member and the lowermost part of the Tyrrellfjellet Member at Kolosseum.

Daixina sokensis zone (late Gzhelian)

Definition: The base of *Daixina sokensis* zone is marked by the first appearance of several *Daixina sokensis* subspecies and closely related *Daixina* species, and first of *Schellwienia*. The top of this zone coincides with the base of the overlying *Schwagerina robusta* Zone.

Composition: *Daixina sokensis uchtaensis* Konovalova, *D. sokensis symmetrica* Scherbakova, *D. sophiae* Grozdilova, *D. timanensis* Konovalova, *D. dualis* Echlakov, *D. lata* Alksne, *D. recava* Zolotova, *D. scherbovichae* (Mikhailova), *D. scherbovichae laevis* Alksne & Polozova, *Schellwienia arctica* (Schellwien), *S. aplicata* (Alksne), *S. krushiensis* (Alksne), *S.* ex. gr. *jakshoensis* Davydov, *S. porrecta* (Sjomina), *S. tenuiseptata* (Scherbovich), *S. malkovskyi* (Ketat), *S.* aff. *delicata* (Alksne), *S. delicata* (Alksne), *S. singularia* (Sjomina), *S. grata* (Konovalova), *Jigulites dagmarae* (Rosovskaya), *J.* aff. *magnus* (Rosovskaya), *Quasifusulina cayeuxi* (Deprat) and *Q. kaspiensis* Scherbovich, *Jigulites longus* Rosovskaya, *J. eliseevi* (Mikhailova), *J. dagmarae* Rosovskaya, *Daixina dualis* Echlakov, *Zigarella acuminulata* Echlakov, *Z. praegregaria* (Scherbakova) and *Z. simplex* (Konovalova).

Remarks: *Schellwienia* species, which are abundant in the upper Gzhelian of the Tethyan province, also first appear in upper Gzhelian strata in Spitsbergen. The taxonomical diversity in this zone increases. The fusulinid assemblage of *Daixina sokensis* zone in Spitsbergen is similar to the upper Gzhelian assemblages of the Russian Platform, Timan-Pechora Basin and northern and central parts of the Urals. Based on close similarities to the *Daixina sokensis* zone in the stratotype section of the Russian Platform, the *Daixina sokensis* zone in Spitsbergen is assigned to be of a late Gzhelian age.

Occurrence in Spitsbergen: The lowermost part of the Tyrrellfjellet Member at Kolosseum and Tyrrellfjellet, and the lower part of the Brucebyen Beds of the Tyrrellfjellet Member at Trollfuglfjella. At Boltonbreen, this zone occurs within the uppermost part of the Cadellfjellet Member and lowermost part of the Tyrrellfjellet Member.

Schwagerina robusta zone (latest Gzhelian)

Definition: The base of the *Schwagerina robusta* zone is marked by first occurrence of *Schwagerina robusta* (Rauser), *S. gracilis* (Ketat), *S. cybea* (Sjomina) and *S. insignis* (Jagofarova). The top of this zone is marked by the base of the overlying *Zigarella anderssoni* zone.

Composition: *Schwagerina gracilis* (Ketat), *S. insignis* (Jagofarova), *S. robusta confinis* (Sjomina), *S. robusta robusta* (Rauser), *S. acris* (Sjomina), *S. lilia* (Konovalova), *S. vozhgalensis* (Rauser), *S.* aff. *biconica* (Scherbovich), *S. fireri* (Konovalova), *S. cybea* (Sjomina), *Zigarella simplex* (Konovalova), *Z. acuminulata* (Echlakov), *Schellwienia recta* (Konovalova), *S. arctica* (Schellwien), *S. modesta* (Scherbovich), *S. salakaensis* (Konovalova), *S. malkovskyi* (Ketat), *S. cognata* (Konovalova), *S. grata* (Konovalova), *S. vozeinsis* (Konovalova), *S. subundulata* ((Konovalova), *S. visotchnajaensis* (Konovalova), *S. emaciata* (Konovalova), *S. plena* (Konovalova), *S. salebrosa* (Konovalova), *S. signata* (Konovalova), *S. cognata* (Konovalova), *S.* cf. *oblonga* (Bensh), *S. singularia* (Sjomina), *S. porrecta* (Sjomina), *S. grinnelli* (Thorsteinsson), *S. kharjagaensis* (Konovalova), *S.* cf. *visotchnajaensis* (Konovalova), *Daixina* ex. gr. *sokensis* (Rauser), *Quasifusulina kaspiensis* Scherbovich, *Pseudofusulinella zelleri* Thompson and *P. delicata* Skinner & Wilde.

Remarks: Species which are characteristic of the Boreal province, still predominate in the assemblage of the *Schwagerina robusta* Zone. Species which are common in the Tethyan province are more abundant in this zone then in the underlying beds. The *Zigarella* genus first appears in *Schwagerina robusta* Zone of Spitsbergen. However, in the central and southern parts of the Urals *Zigarella* first appears earlier then in Spitsbergen in the *Daixina sokensis* zone. *Pseudofusulinella* species which are common and characteristic of the Midcontinent-Andean province, first appear in the *Schwagerina robusta* Zone of Spitsbergen. This zone correlates with the latest Gzhelian *Ultradaixina bosbytauensis-Schwagerina robusta* Zone in the Urals, Russian Platform and Central Asia. Similar assemblage is also reported from the Timan-Pechora Basin (Konovalova 1991, Remizova 1995) and Kolguev Island (Davydov 1994).

Occurrence in Spitsbergen: The lower part of the Tyrrellfjellet Member, including the uppermost part of the Brucebyen Beds, at Trollfuglfjella. The lower part of the Tyrrellfjellet Member, including Brucebyen Beds, at Skansen. The lower part of this assemblage occurs in the Brucebyen Beds of the Tyrrellfjellet Member at Boltonbreen, while the upper part occurs above these beds. In the Tyrrellfjellet section, this zone is defined in the lower part of the Tyrrellfjellet Member, including the Brucebyen Beds.

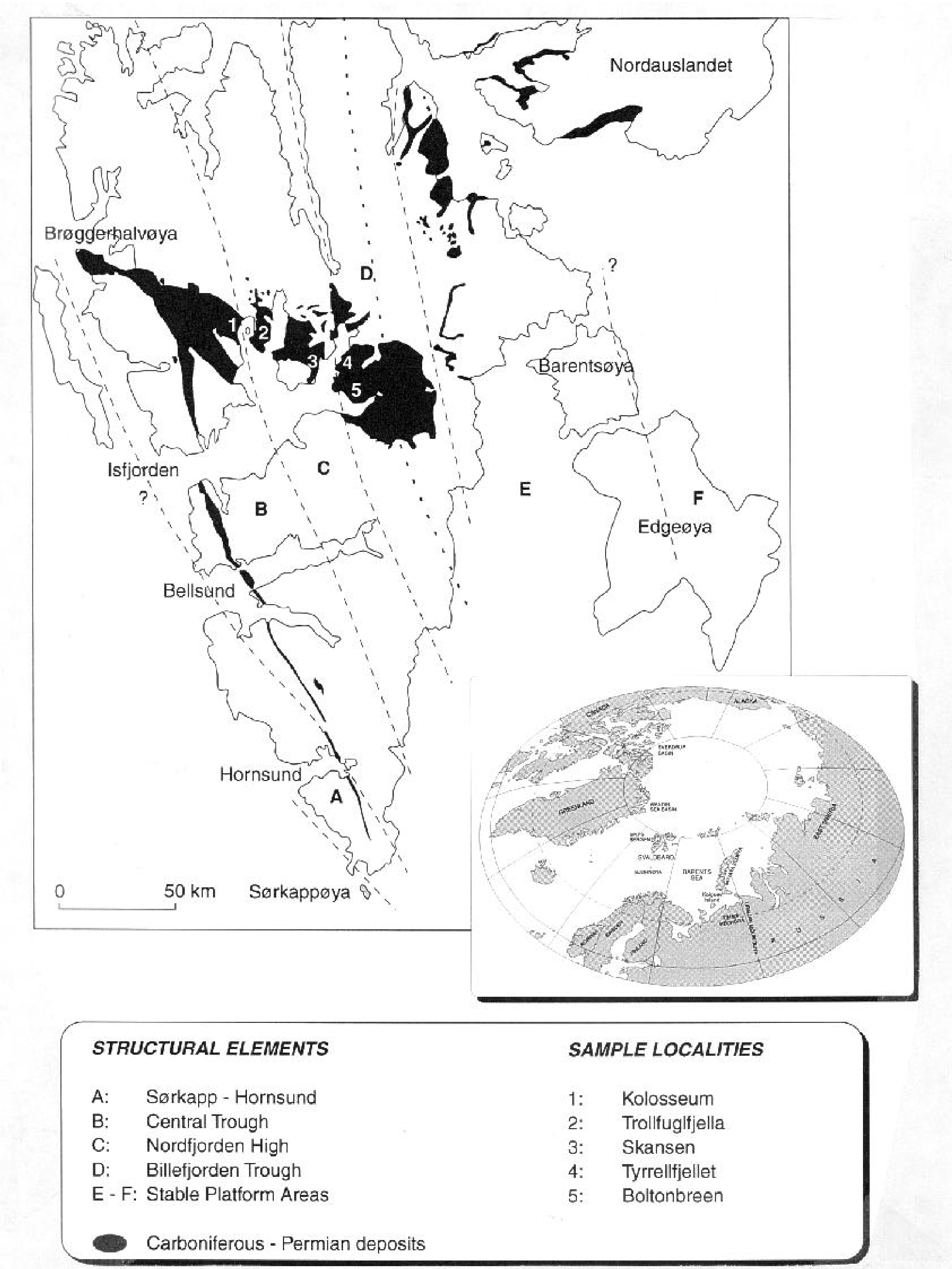

Figure1. Regional map showing the Svalbard Archipelago, outcrops of Caroniferous-Permian deposits, major structural elements and sample localities.

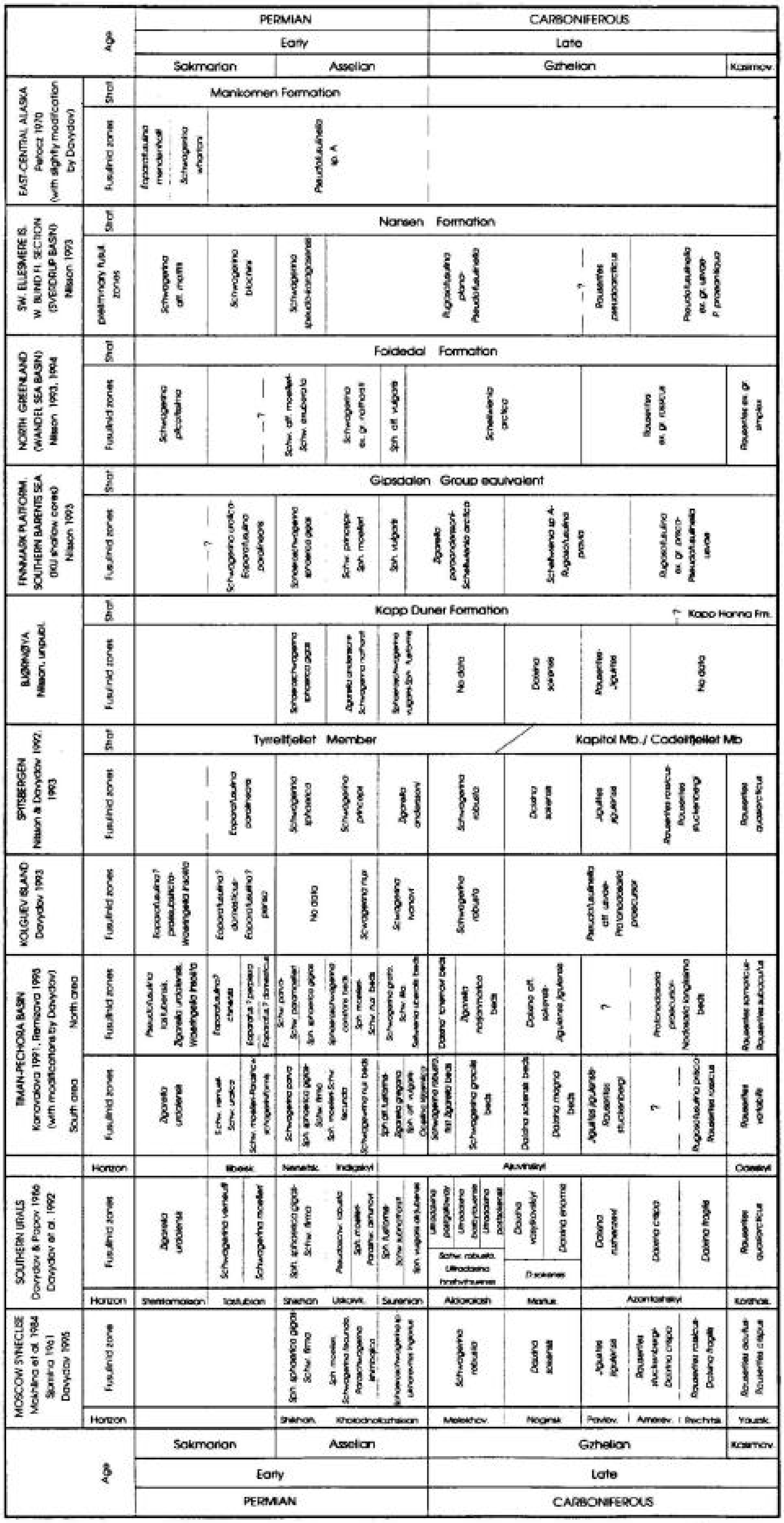

Figure 2. Correlation of fusulinid zones of Spitsbergen (this work) with fusulinid subdivisions of adjacent regions.

***Zigarella anderssoni* zone (early Asselian)**

Definition: The base of *Zigarella anderssoni* zone is marked by first appearance of *Zigarella anderssoni* (Schellwien, s. str.), *Z. simplex* (Konovalova), *Z. pseudoanderssoni* (Sjomina), *Z. inconstans* (Scherbovich) and *Occidentoschwagerina "fusulinoides"* (Schellwien). The top of this zone coincides with the base of the overlying *Schwagerina princeps* Zone.

Composition: *Zigarella anderssoni* (Schellwien, s. str.), *Z. inconstans* (Scherbovich), *Z. simplex* (Konovalova), *Z. pseudoanderssoni* (Sjomina), *Z. furnishi* (Ross), *Z. ascherinensis* (Sjomina), *Z. acuminulata* (Echlakov), *Z. excessa* (Alksne & Polosova), *Z. narjanmarica* (Konovalova), *Z. subovata* (Konovalova), *Occidentoschwagerina "fusulinoides"* (Schellwien), *Oc. ancestralis* (Echlakov), *O.* cf. *chatcalica* Bensh, *Oc. sp*., *Licharevites* cf. *sartauensis* Davydov, *Schellwienia agnata* (Konovalova), *S. arctica* (Schellwien), *S. cognata* (Konovalova), *S. emaciata* (Konovalova), *S. grata* (Konovalova), *S. grinnelli* (Thorsteinsson), *S. invisitata* (Konovalova), *S. justa* (Konovalova), *S. kharjagaensis* (Konovalova), *S. kotchmessiensis* (Konovalova), *S. nenetskensis*, *S. plena* (Konovalova), *S. recta* (Konovalova), *S. signata* (Konovalova), *S. salebrosa* (Konovalova), *S. subundulata* (Konovalova), *S. visotchnajaensis* (Konovalova), *S. voseejskensis* (Konovalova), *D. sokensis* (Rauser), *D.* aff. *recava* (Zolotova), *Sphaeroschwagerina* ex. gr. *fusiformis* (Krotow), *Schwagerina perlevis* (Grozdilova), *S.* aff. *biconica* (Scherbovich), *S.* aff. *gracilis* (Sjomina), *S. katchgortica* (Konovalova) and *S. fireri* (Konovalova).

Remarks: Some typical Tethyan taxa, such as *Occidentoschwagerina, Licharevites* and *Sphaeroschwagerina* species, first occur in this zone in Spitsbergen. However, in Spitsbergen these taxa occur later then in the southern part of the Urals and Central Asia. Boreal province species which are abundant in the Timan-Pechora Basin and northern Urals, are also predominated in this zone in Spitsbergen. Some of *Zigarella* species, which characterize *Zigarella andessoni* zone in Spitsbergen, appear earlier, in late Gzhelian time, in the central and southern parts of the Urals.

Zigarella anderssoni zone is recorded between the uppermost Gzhelian *Schwagerina robusta* Zone and middle Asselian *Schwagerina princeps* zone. The fusulinid fauna in *Zigarella anderssoni* zone assemblage is quite different from the underlying and the overlying assemblages. In addition, *Zigarella anderssoni* (Schellwien, s. str.) occurs at the base of this assemblage and is, in our opinion, a more advanced form of this species than those reported from the upper Gzhelian of the Urals (Rauser-Chernousova & Scherbovich, 1958). *Zigarella anderssoni* (Schellwien s. str.) was first described from Bjornoya by Schellwien (1908) in middle Asselian beds, as it was established by Simonsen (1988). But first appearance of this species, base on Spitsbergen data, is assigned to be in early Asselian.

Occurrence in Spitsbergen: Lower part of the Tyrrellfjellet Member at the Trollfuglfjella, Skansen, Boltonbreen and Tyrrellfjellet sections.

***Schwagerina princeps* zone (middle Asselian)**

Definition: The base of *Schwagerina princeps* zone is marked by the first occurrence of *Schwagerina princeps* (Ehrenberg, sensu Dunbar & Skinner) and several species of *Schwagerina nux* group. The top of this zone coincides with the base of the overlying *Schwagerina sphaerica* Zone.

Composition: *Schwagerina princeps* (Ehrenberg, sensu Dunbar & Skinner), *S. nux* (Schellwien), *S. sphaeroidea* (Rauser), *S. exuberata macra* (Shamov), *S. latispiralis* (Grozdilova), *S. caudata* (Rauser), *S. conspecta* (Shamov & Scherbovich), *Schwagerina princeps* (Ehrenberg), and *Zigarella pointeli* (Rauser)..

Remarks: All the recorded species mostly occur in middle-upper Asselian strata of the Boreal province, in the area from the Russian Platform through the Central Urals to Russian Arctic. Tethyan species which were noted in the underlying beds are practically absent in *Schwagerina princeps* Zone of Spitsbergen. The decrease in fusulinid taxonomic diversity in Spitsbergen in middle Asselian time is essential.

Schwagerina princeps zone in Spitsbergen is overlain by a fusulinid zone of a late Asselian age (see discussion below). Based on the occurrence of fusulinid species of *Schwagerina princeps-nux* group and stratigraphical position of described zone, the age of *Schwagerina princeps* zone in Spitsbergen is suggested to be middle Asselian.

Occurrence in Spitsbergen: The upper part of the Tyrrellfjellet Member at Kolosseum, Trollfuglfjella and Skansen.

***Schwagerina sphaerica* Zone (late Asselian)**

Definition: The base of *Schwagerina sphaerica* zone is marked by the appearance of *Schwagerina sphaerica sphaerica* (Belyaev) and *Schwagerina sphaerica timanica* (Grozdilova). The top of this zone coincides with the base of the overlying *Eoparafusulina paralinearis* Zone.

Composition: *Schwagerina sphaerica sphaerica* (Belyaev), *S. sphaerica timanica* (Grozdilova), *S. differta* (Shamov), *S. exuberata* (Shamov), *S. exuberata macra* (Shamov), *S. exuberata luxuriosa* (Shamov), *S. nathorsti* (Schellwien), *S. parva* (Belyaev), *S. paramoelleri* (Rauser), *S. paramoelleri intensefoldata* (Scherbovich), *S. princeps* (Ehrenberg), *Schellwienia urbana* (Konovalova), *Zigarella lutuginiformis* (Rauser), *Z.* cf. *marine* (Grozdilova), *Sphaeroschwagerina* ex. gr. *sphaerica* (Scherbovich), *Pseudofusulinella moorei* Skinner & Wilde and *P.* aff. *occilentalis* (Thompson & Wheeler).

Remarks: Most of these species occur only in the Boreal province, in the area from the Russian Platform through Central Urals to Russian Arctic, but some rare representatives of Tethyan taxa, such as *Sphaeroschwagerina* species, as well as some long-ranging species from Midcontinent-Andean province are also present in the *Schwagerina sphaerica* Zone in Spitsbergen.
The fusulinid assemblage of the *Schwagerina sphaerica* zone is

dominated by species which are most common in upper Asselian strata of the Russian Platform, Urals and Timan-Pechora Basin. Although some of the recorded in *Schwagerina sphaerica* zone species range into the Sakmarian. The age of described zone is, therefore, suggested to be of a late Asselian.

Occurrence in Spitsbergen: The upper part of the Tyrrellfjellet Member at the Kolosseum, Trollfuglfjella and Skansen sections.

Eoparafusulina paralinearis assemblage zone (early Sakmarian)

Definition: The base of *Eoparafusulina paralinearis* zone is marked by the appearance of *Schwagerina blochini* (Korzhinevskyi), *S. blochini vicina* (Grozdilova), *S. parajaponica* (Korzhinevskyi) and *Eoparafusulina tchernyshevi longa* (Grozdilova) while the top is not marked due to the lack of productive samples in this part of the succession.

Composition: *Eoparafusulina paralinearis* (Thorsteinsson), *E. tchernyshevi longa* (Grozdilova), *E. tchernyshevi acuta* (Grozdilova & Lebedeva), *E. recondita* (Grozdilova & Lebedeva), *E. regularis* Skinner & Wilde, *E. gracilis* (Meek), *Schwagerina* aff. *blochini* (Korzhinevskyi), *S. blochini vicina* (Grozdilova), *S. parajaponica* (Korzhinevskyi), *S. uralica longa* (Grozdilova & Lebedeva), *S. uralica volongaensis* (Grozdilova & Lebedeva), *S.* aff. *moelleri* (Schellwien), *S. confusa* (Rauser), *S. parva* (Belyaev), *S. sphaerica sphaerica* (Belyaev), *S. sphaerica timanica* (Grozdilova & Lebedeva) and *S.* ex. gr. *schwageriniformis* (Rauser & Belyaev).

Remarks: Almost all taxa of *Eoparafusulina paralinearis* zone are characteristic only of the Sakmarian of the Boreal province. *Eoparafusulina* species which occur in this zone in Spitsbergen are known only in Sakmarian in the Timan-Pechora Basin, Russian Arctic, Northeast Greenland and Canadian Arctic. In the Midcontinent-Andean Province similar *Eoparafusulina* species also occur in Sakmarian, while more advanced species occur in the Artinskian and Kungurian/Leonardian. Based on close similarity to the lower Sakmarian fauna of Northern Russia, *Eoparafusulina paralinearis* zone is assigned to be of an early Sakmarian age.

Occurrence in Spitsbergen: The upper part of the Tyrrellfjellet Member at Kolosseum.

Summary and conclusions

Eight fusulinid zones (*Rauserites rossicus*, *Jigulites jigulensis*, *Daixina sokensis*, *Schwagerina robusta*, *Zigarella anderssoni*, *Schwagerina princeps*, *Schagerina sphaerica* and *Eoparusulina paralinearis* zones), from early Gzhelian to early Sakmarian have been defined in the upper part of the Wordiekammen Formation in central Spitsbergen. This part of the Upper Paleozoic succession has been also dated previously by fusulinids, but zonation done in the present study gives a much more detailed subdivisions of Gzhelian-Sakmarian deposits and provides precise correlation with standard Upper Carboniferous and Lower Permian scale of the Russian Platform and Urals. Important biogeographical data have been discovered as a result of present investigation.

Many fusulinid species which also are distributed in southern Barents Sea, Bjornoya, North Greenland (Wandel Sea Basin), Arctic Canada (Sverdrup Basin) and Russia (i.e. Timan-Pechora Basin, Kolguev Island, Russian Platform) ((Fig. 2) where recognized in Gzhelian-Sakmarian of central Spitsbergen and reported in this paper. Close similarity in fusulinid faunas between Spitsbergen in one hand and in the area of Russian Platform, North and Central Urals, and Timan-Pechora Basin in the other hand supports that Spitsbergen during Late Carboniferous-Early Permian time formed part of the Boreal fusulinid biogeographic province that distributed westwards to the Wandel Sea Basin and Sverdrup Basin, and eastwards to the Timan-Pechora Basin and farther south into the Russian Platform, North and Central Urals. Lower-Middle Gzhelian fusulinid assemblages of Spitsbergen show high provinciality and relatively low taxonomic diversity. From the beginning of late Gzhelian up to early Asselian the diversity of fusulinids in Spitsbergen increases and some typical Tethyan taxa appeared. In the middle-late Asselian, as well as in Sakmarian time, taxonomically low diverse Boreal fusulinid fauna again predominated in Spitsbergen. Influence from Midcontinent-Andean province was not significant. The only long ranged *Pseudofusulinella* which has adopted to the cold water environment (*Pseudofusulinella*) periodically, i.e. in later most Gzhelian, later Asselian and early Sakmarian, migrated from the Midcontinent-Andean basin to Spitsbergen.

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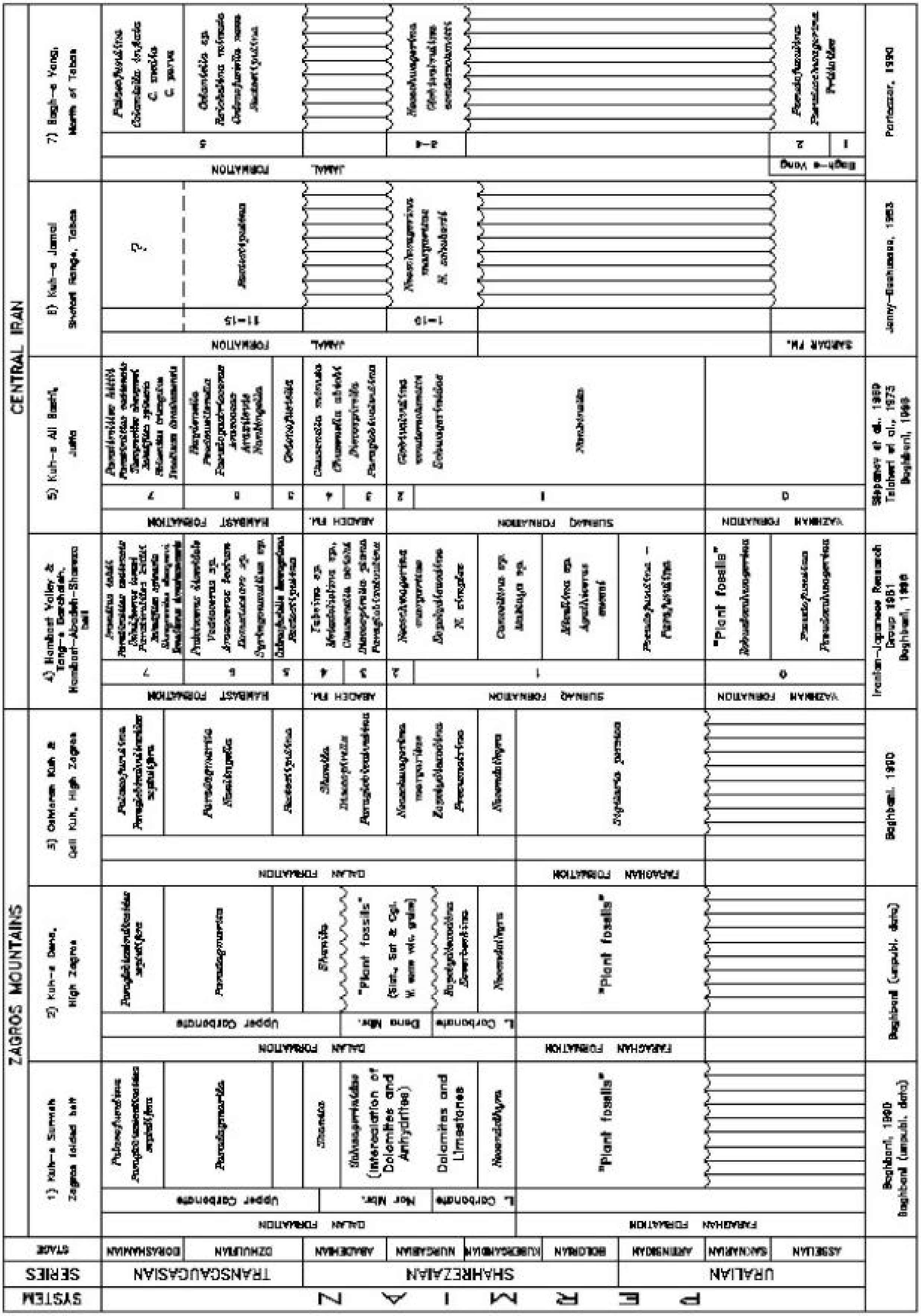
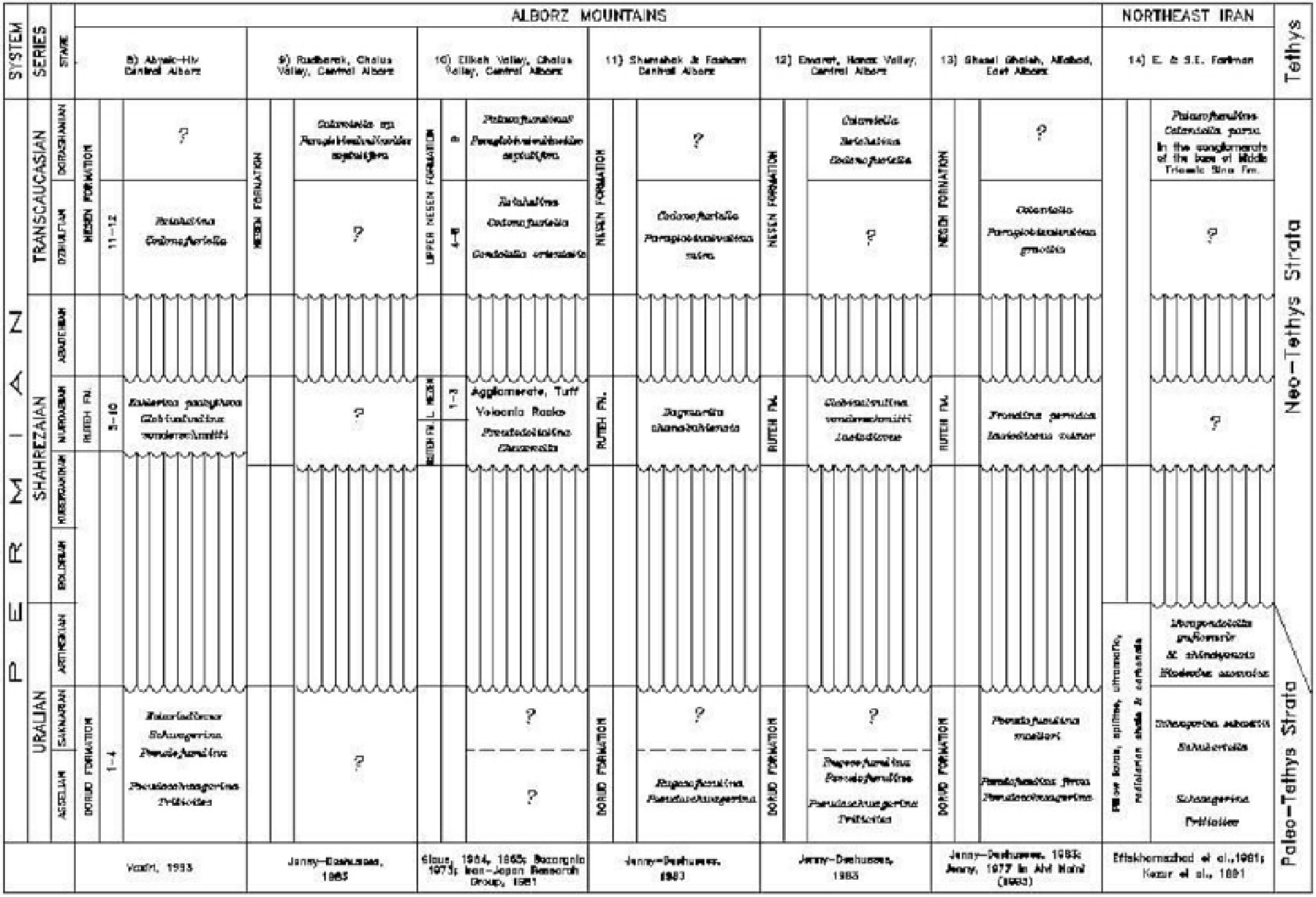

SYSTEM
SERIES
STAGE
ZAGROS MOUNTAINS
CENTRAL IRAN
1) Kuh-e Surmeh
Zagros folded belt
2) Kuh-e Dena,
High Zagros
3) Oshtoran Kuh &
Gell Kuh, High Zagros
4) Hambast Valley &
Tang-e Darchaleh,
Hambast-Abadeh-Sharezo belt
5) Kuh-e Ali Bashi,
Julfa
6) Kuh-e Jamal
Shotori Range, Tabas
7) Bagh-e Vang,
North of Tabas
P E R M I A N
TRANSCAUCASIAN
SHAHREZAIAN
URALIAN
DORASHAMIAN
DZHULFIAN
ABADEHIAN
MURGABIAN
KUBERGANDIAN
BOLORIAN
ARTINSKIAN
SAKMARIAN
ASSELIAN
DALAN FORMATION
FARAGHAN FORMATION
Upper Carbonate
Nar Mbr.
L. Carbonate
Dena Mbr.
HAMBAST FORMATION
ABADEH FM.
SURMAQ FORMATION
VAZHNAN FORMATION
JAMAL FORMATION
SARDAR FM.
Bagh-e Vang
11-15
1-10
3-4
"Plant fossils"
(Intercalation of Dolomites and Anhydrites)
Dolomites and Limestones
(Silt., Sst & Cgl. W. some vic. grains)
?
Baghbani, 1990
Baghbani (unpubl. data)
Iranian-Japanese Research Group 1981
Baghbani, 1986
Stepanov et al., 1969
Teichert et al., 1973
Baghbani, 1986
Jenny-Deshusses, 1983
Partoazar, 1990



CORRELATION CHARTS OF SELECTED PERMIAN STRATA FROM IRAN
BY DARIOUSH BAGHBANI, Iranian Oil Company, Tehran, Iran

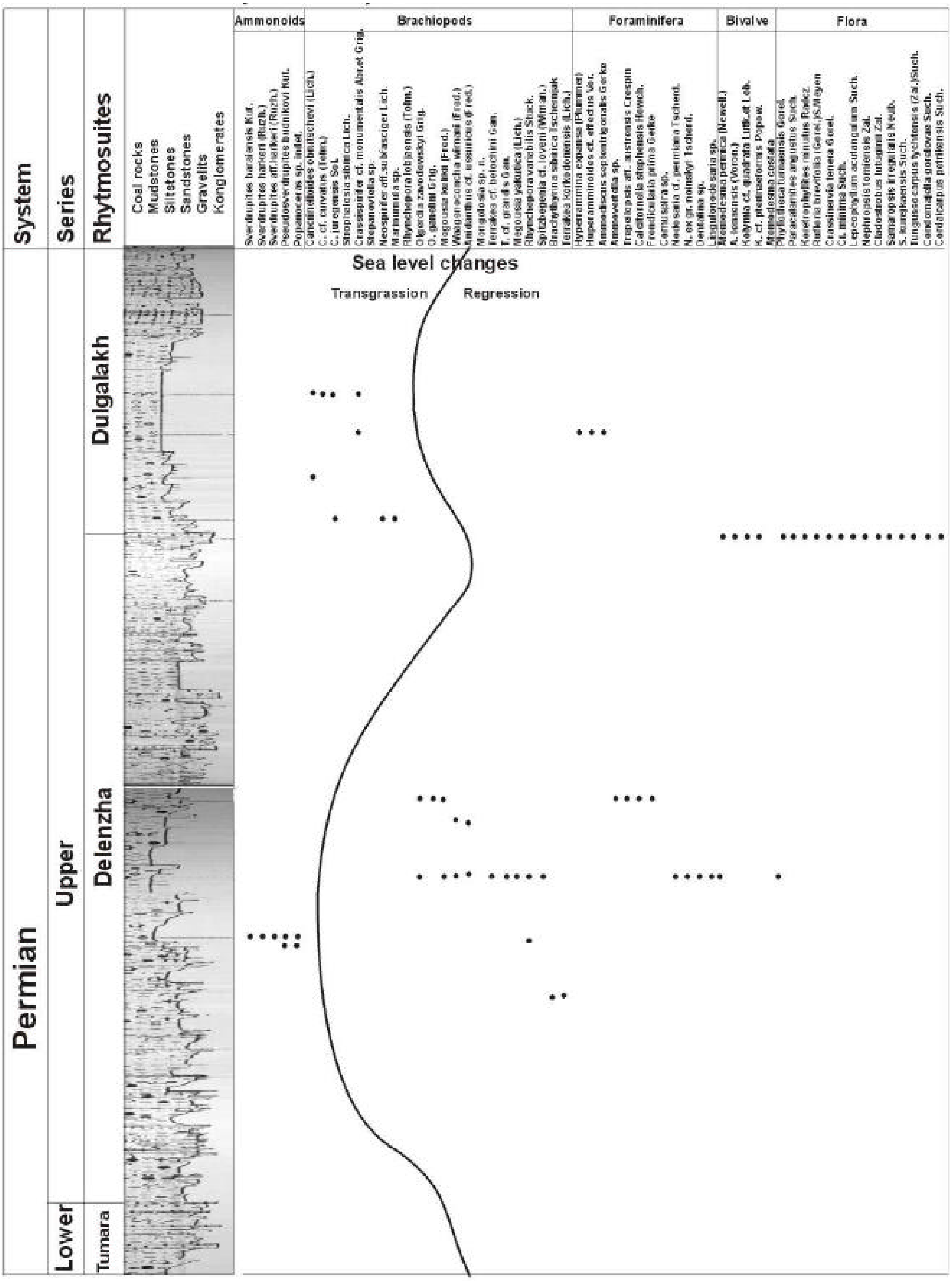


Figure 1. Section of Permian deposits along the Barai River.

palaeographical evolution. In: Spencer, A.M. et al. (eds.). Petroleum Geology of the North European Margin. Norwegian Petroleum Society (NPF), Graham & Trotman Ltd., 109-136.

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Permian Deposits of the Barai River, West Verkhoyanie

By Igor V. Budnikov, Aleksander G. Klets,Vitaly S. Grinenko and Ruslan V. Kutygin

Permian strata of the East-Siberian platform are represented by a powerful wedge of largely coarse-grained terrigenous deposits of the thick Paleo-Viliuy delta. These deposits grade regularly eastwards through the delta front complex and out onto the paleobasin, where they incise deeply into mainly fine-grained deposits of the far off-shore, open part of the marine paleobasin. These strata form the sections of the eastern slope Verkhoyansk Mountains. The most representative section is in the upper basin of the Barai River where Permian strata can be precisely divided into two transgressive-regressive successions. The lower succession is a reflection of the powerful Ufimian or Roadian transgression; see Figure.1.

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WORKING GROUP REPORT

Permian-Triassic Boundary Working Group Newsletter No. 6 (3 September, 1996)

By Yin Hongfu

1. The 30th IGC

More than 30 abstracts contributed on the PTB problem, mostly presented in the Symposium 1-7, and 1-1, 1-11 as well. About 20 of them (References 1) refer to Meishan section of Changxing, Arctic Canada, Iran, Himalaya and general discussion of the GSSP. Topics include multidisciplinary approaches, carbon isotope excursion, volcanics, sedimentary rates, the *parvus* lineage and other conodont successions of PTB, especially that of Meishan. There is a possibility to establish interregional correlatable subdivision of PTB at the resolution of 10^4 years (Yin). Discovery of double carbon isotope excursion and new evidence of extraterrestrial origin of PT sphaerules are interesting (Wang).

Because final decision of PTB in marine sequences will be taken in the near future, corresponding terrestrial PTB becomes a new field of interest(References 2). Among about 10 abstracts in this respect, half of them concentrates on tetrapods (South Africa, China, Russia and overview). It seems generally agreed upon that the Late Permian-Early Triassic tetrapods are well correlatable throughout Pangea.

Workshop meeting of the PTBWG was held in August 5 evening with 21 attendants. Yin, Baud, Henderson, Ezaki, Zakharov, Lucas and Lozovsky reported advancements on PTB in South China, Arctic Canada, Spiti, Japan, Russian Far East and terrestrial deposits. The same questionnaires mentioned in Newsletter no. 5 were asked. The results are:

1. Do you think it is now time to make a decision on the GSSP of the PTB? 18 yes, 1 no.
2. If yes, which level will you recommend for the base of the Triassic? 13 *Hindeodus parvus (Isarcicella parva)*, 1 *Otoceras*, 1 favored the base of Bed 27 at Meishan (top of ‘Boundary Clay=).
3. If yes, which section will you recommend for the GSSP? 16 Meishan, others none.

Based on this and previous results, members strongly urged a final resolve of this important boundary in the near future. Drs. Remane, Chairman of the International Commission on Stratigraphy, and Gaetani, Chairman of STS, also agreed that the time is ripe for a final decision. Yin, the chairman of PTBWG, declared that a joint recommendation by 9 members of PTBWG will be published in Newsletter on Stratigraphy recommending the base of 27c at Meishan as GSSP of PTB and a voting of the PTBWG will be taken soon after.

2. Other advancements on the PTB problem

The book of Yin et al. (1996) including 10 papers provides a comprehensive overview of the candidates of Permian-Triassic boundary stratotype. Some papers concerning the PTB appear in Tran (1995). A study on Permian-Triassic pectinoid bivalves has been published with elegant figures (Newell and Boyd, 1995). Reef researches have been published by Ezaki (1995) on corals. Conodont papers include Kozur (1995), Lai et al. (1996) and Mei (1996), plus a few papers in Yin (ed., 1996), mostly concentrated on the P/T boundary.

Carbon isotope is another observed area. Papers include Zakharov et al. (1995) on Russia, Baud et al. (1996) on Indian margin and Gorter et al. (1995) on Western Australia. New data reconfirm the general conclusion reached previously that a worldwide carbon isotope negative excursion occurred at the P/T boundary.

3. Membership

Addition of four nominees for new voting members of PTBWG, recommended in PTBWG Newsletter no. 5, was discussed in the workshop meeting during 30th IGC and three of them were generally accepted. They are:

Professor B.F. Glenister (already corresponding member of PTBWG), Geology Department, University of Iowa, Iowa City, Iowa 52242, USA.

Dr. Yugan Jin, Nanjing Institute of Geology and Palaeontology, Nanjing, Jiangsu Province, 210008, China.

Dr. M. J. Orchard, Geological Survey of Canada, 100 West Pender Street, Vancouver, British Columbia, V6B 1R8, Canada.

Nominees are asked to reply whether they accept the nomination or not, and members are asked to express their opinions on involvement of all three or anyone of them. Please write to Yin Hongfu.

4. Forthcoming meeting

The next workshop meeting will be held during the following meeting and members are urged to attend.

GEOTHAI=97—International Conference on Stratigraphy and Tectonic Evolution of Southeast Asia and the South Pacific
Date: 19-24 August, 1997
Venue: Bangkok, Thailand
Organizer: The Department of Mineral Resources, Thailand, jointly sponsored by IGCP no. 359
Subjects: Scientific programme from 19-21 August, followed by 3 excursion routes on 22-24 August to observe stratigraphy and tectonic evolution of eastern, western and northeastern Thailand respectively.
Correspondent: Mr. Phisit Dheeradilok, Director of Geological Survey Division, Department of Mineral Resources, Rama VI Road, Bangkok 10400, Thailand

References 1 (GSSP - General Discussions)

Andreichev V. L., Basalts from the Polar Pre-Urals as a Reference Object for Isotopic Geochronological Determination of the Permian-Triassic Boundary.

Atudorei V. et al., the Carbon Isotope Record of the Himalayan Permo-Triassic.

Baghbani D., the Permian Sequence and P/t Boundary of the Zagros Basin, Southwest Iran.

Baud A., the Blind Fiord Transgression (Canadian Arctic Islands), a Key to the Permian-Triassic Boundary.

Dagys A., Some Problems in Determination of the Permian-Triassic Boundary.
Golshani F., the Upper Permian to Lower Triassic Sequence in Iran.
Henderson C. M. and Baud A., Correlation of the Permian-Triassic Boundary in Arctic Canada on the Basis of Molluscan and Conodont Distribution..
Holser W. T., Separating Carbon Isotope Shifts into Carbon Storage and Productivity Components, and a Reinterpretation of the Carbon Isotope Profile Across the Permian/Triassic Boundary.
Kozur H., the Permian-Triassic Boundary (Ptb) in Marine and Continental Beds-possible Causes for the Ptb Biotic Crisis.
Lai Xulong et al., Sedimentation Rates Across the Permian-Triassic Boundary.
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Mei Shilong, Combining the Gssp with the Sequence Boundary: a Promising Approach to the Natural Chronostratigraphic Boundary.
Mei Shilong, Conodont Succession Around the Permian-Triassic Boundary and the Natural Permian-Triassic Boundary.the 30th Igc Scientific Programme Committee, 1996, Abstract Volume of the 30th Igc, Vol. 1, Beijing China.
Wang K. et al., Organic Carbon Isotope Variations in Three Leading Candidate Sections for the Permian-Triassic Boundary Global Stratotype (Meishan, Shangsi and Huangsi, South China).
Yao Huazhou and Zhang Renjie, Sedimentary Facies and Volcanic Event of Permo-Triassic Boundary Strata in Yangtze Gorges Area.
Yin Hongfu, Multi Disciplinary High-resolution Correlation of Permian-Triassic Boundary.
Yin Hongfu, Recommendation of Meishan Section as the Global Stratotype Section and Point (Gssp) of Permian-Triassic Boundary (Ptb).
Zhang Kexin et al., Conodont Sequences in the Permian-Triassic Boundary Strata at Meishan, Changxing, Zhejiang, South China and its Correlation over the World.

References 2 (Gssp - Terrestrial Facies)

Cheng Zhengwu and Li Jinling, Implications of Shaanbeikannemeyeria from the Triassic Heshanggou Formation of North China.
Esaulova N. K., Correlation of the Upper Permian Floristic Complexes of the Volga-urals Region of Russia with Dalongkou Section of China.
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Lozovsky V.r., the Permian-Triassic Boundary in the Continental Series of Eurasia.
Lucas S. G., the Dicynodon Biochron and the Unity of Late Permian Pangaea.
Lucas S. G., Triassic Tetrapod Biochronology.
Shishkin M.a. et al., Re-appraisal of Vertebrate Biozonation of the Beaufort Group (South Africa) and Global Correlation of Continental Triassic Deposits.
Vijaya, Benchmark Permian-Triassic Palyno-events on Peninsular India and Northwest Tethys Himalayas.
Zan Shuqin et al., Significance of the P-t Stratigraphic Comparison Between South and North Flanks of the Bogeda Mt.. Xinjiang Zhou Tongshun et al., Research on the Non-marine Permian-Triassic Boundary Stratotype in China.

References 3 (General)

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NOTES

BOOKS

THE CARBONIFEROUS OF THE WORLD VOLUME III: THE FORMER USSR, MONGOLIA, MIDDLE EASTERN PLATFORM, AFGHANISTAN, & IRAN, (IUGS Publication No. 33)

Institutio Tecológico Geominero de España, Ríos Rosas, 23, 28003 Madrid, Spain Phone: 34(9).1.3495750. Fax: 34.1.3495762. 526 pp., 80 plates, 99 figs.

STRATOTYPES AND REFERENCE SECTIONS OF THE UPPER PERMIAN OF THE VOLGA AND KAMA RIVER REGIONS.

Editors: Nataliya K. Esaulova and Vladlen R. Lozovsly,
Kazan= State University; Commission of mineral resources of Tatarstan; Geological-Exploration Department of Joint-Stock Oil Company ATatneft@. Kazan=. 1996, 539 pp., 49 plates, 165 figs., 553 ref.

This book provides the most recent and extensive data concerning the Upper Permian and its regional stages in the classical area where the Permian System was established; the information is both detailed and comprehensive included are complete descriptions of stratotypes and reference sections for the Ufimian, Kazanian and Tatarian. The book is logically divided into three parts. The first provides, physical geology data, such as details of stratotype and reference sections, facial and petrographic analysis. The second includes biostratigraphy (zonal subdivisions) and paleontology (new taxa description) of almost all fossil groups known in the Ufimian, Kazanian and Tatarian (bivalves, marine and nonmarine ostracods, foraminifera, fishes, ichthyolites, charophytes, macroflora, miospores, terrestrial vertebrates) from the whole Russian Platform and from Arctic to the Urals and Precaspian. Detailed magnetostratigraphy is also included. The third part presents correlations of Ufimian, Kazanian and Tatarian provided by both macroflora and miospores from the stratotype area, and by paleomagnetostratigraphy. The great value of this book is availability of current data, as establishment of the Global Permian Scale proceeds. Although written in Russian, short abstracts in English accompanying each article, make the book useful for the world Permian community.

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THE PALAEOZOIC-MESOZOIC BOUNDARY —CANDIDATES OF THE GLOBAL STRATOTYPE SECTION AND POINT (GSSP) OF THE PERMIAN-TRIASSIC BOUNDARY

Edited by Yin Hongfu (1996)
137 pages, 13 plates

Overview
1. Global correlation and definition of the Permian-Triassic boundary (PTB). The Meishan section, Changxing County, Zhejiang, South China
2. The Meishan section, candidate of the Global Stratotype section and Point (GSSP) for the Permian-Triassic Boundary (PTB)
3. The *Hypophiceras* ammonoid fauna near the Permian-Triassic boundary at the Meishan section and in South China
4. Conodont sequences of the Permian-Triassic boundary strata at Meishan section, South China
5. Evolution of *Clarkina* lineage and *Isarcicella* lineage at Meishan section, South China.
6. Sequence stratigraphy near the Permian-Triassic boundary at Meishan section, South China
7. Eventostratigraphy of Permian-Triassic boundary at Meishan section, South China
The Guryul Ravine section, Kashmir
8. The Guryul Ravine section, candidate of the Global Stratotype Section and Point (GSSP) of the Permian-Triassic boundary (PTB)
The Shangsi section, Guanyuan County, Sichuan, South China
9. The Shangsi section, candidate of the Global Stratotype Section and Point (GSSP) of the Permian-Triassic boundary (PTB)
The Xishan(west hills) section, Selong, Xizang(Tibet)
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NECROLOGY

With deep sorrow I inform you that the former director of Nanjing Institute of Geology and Paleontology, former Secretary-General of the Palaeontological Society of China, and the former Chair of the International C/P Boundary Working Group, Professor Wu Wangshi died of cancer at 4:30 AM, January 15, 1997 at the age of 66. We are deeply grieved over the loss of an eminent colleague and friend.

Professor Mu Xinan
Director of Nanjing Institute of Geology and Paleontology

Russian nautiloid specialist Professor Viktor Nikolaevich Shimansky died May 19, 1997, at the age of 89, after a long and productive research association with the Russian Academy of Sciences, Palaeontological Institute of Moscow. He collaborated with distinguished ammoniod specialists, V. E. Ruzhencev and B. I. Bogoslovsky, but specialized in nautiloids. Some of his most notable contributions dealt with the classic Permian sections of the Ural Mountains of Russia and Kazakhstan.

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