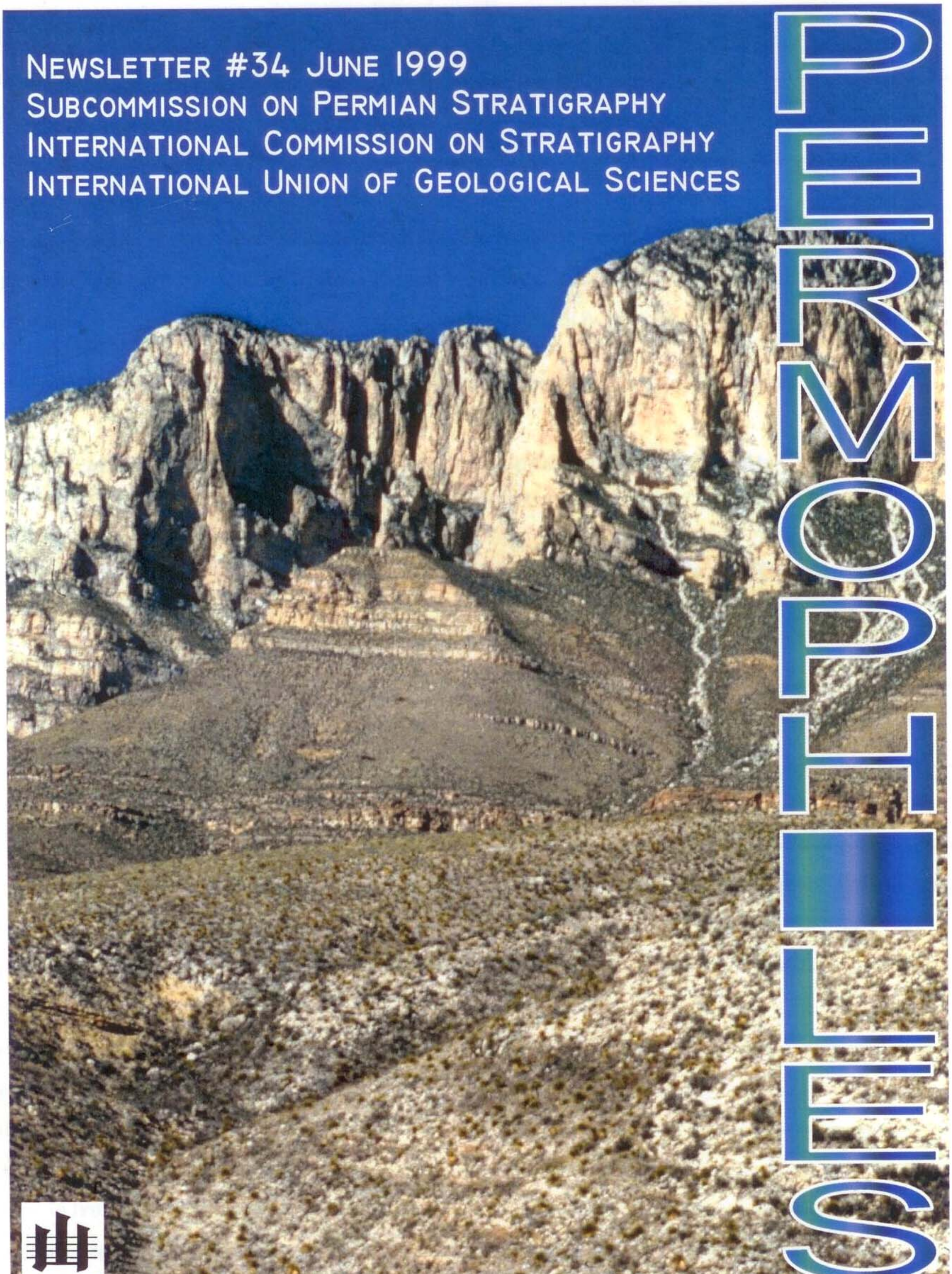
PERMOPHILES

NEWSLETTER #34 JUNE 1999
SUBCOMMISSION ON PERMIAN STRATIGRAPHY
INTERNATIONAL COMMISSION ON STRATIGRAPHY
INTERNATIONAL UNION OF GEOLOGICAL SCIENCES



EXECUTIVE NOTES

Notes from the SPS Secretary

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I want to thank all who contributed articles for inclusion in the 34th issue of Permophiles and those who assisted in its preparation. We are indebted to Bruce R. Wardlaw, Brian F. Glenister, and Vladimir Davydov for editorial contributions; to Joan White for coordinating the compilation of this issue and for design of the new cover page; Vladimir Davydov translated several submissions from our Russian colleagues. We thank William Grautin, Chang Zin Lee, and two anonymous donors for financial contribution to the Permophiles publication fund in support of this issue. Our fund is in need of additional contributions and readers are referred to the last page of this issue.

Future SPS Meetings

Following the meeting of the "XIV International Congress on Carboniferous and Permian" (XIV-ICCP) to be held in Calgary, Canada, August 1999, an SPS meeting will be held in Brescia, and Sardinia in September 1999. The latter will be in conjunction with the meeting of the "Continental Permian of the Southern Alps and Sardinia (Italy): Regional Reports and General Correlations".

In the year 2000, the SPS will meet in conjunction with the 31st International Geological Congress in Rio de Janeiro, Brazil, August 6-17. The SPS will sponsor the general symposium "International Standard References for the Permian System: Cisuralian of Southern Ural Mountains, Guadalupian of Southwestern North America, Lopingian of South China". Brian F. Glenister, Bruce R. Wardlaw, and Tamra A. Schiappa are the conveners. The general symposium consists of an afternoon poster session accommodating all accepted contributions followed by a morning oral session consisting of invited keynote speakers. Please refer to Call for Contributions to 31st International Geological Congress, page 38 of this issue. Information regarding the Congress and the SPS Symposium is also available from Tamra A. Schiappa: tschiapp@boisestate.edu and at the site: http://www.31igc.org or.

Future Issues of Permophiles

Issue 35 will be finalized by December 1999 and I request that all manuscripts be sent before December 15 – but preferably much earlier. Late manuscripts, arriving close to the deadline, cannot be returned to the author for checking after we make editorial changes. Those manuscripts that arrive early can be sent to the author for proofreading. Please note that I will not be in my office during July–December 1999; therefore the preferred method for sending manuscripts and for other communication is by E-mail (cspinosa@boisestate.edu) or by regular mail. Phone and fax will not be available. I ask all contributors to please read the section below regarding submission format. Please use the article by Glenister et. al., (page 3 this issue) as guide to correct format. References and their citation are particularly problematic and authors are requested to use the format in the above notation. Color figures can be accommodated but we require a contribution to offset the additional printing costs.

Special Permophiles Issue for 31st International Geological Congress

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

SUBMISSION GUIDELINES FOR ISSUE 35

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

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

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SUBMISSION DEADLINE FOR ISSUE 35 IS, DECEMER 15, 1999.

Notes from the SPS Chair

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The Spring has been very active for the Subcommission moving toward defining many of the subdivsions of the Permian. The Permian Subcommission met with the International Conference on Pangea and the Paleozoic-Mesozoic transition in March in Wuhan, China. It was a very fruitful meeting highlighted by the excellent field trip to the proposed stratotype for the Lopingian (Upper Permian). The proposal for the Upper Permian Series is in a very mature state and we anticipate its formal proposal soon. The Guadalupian (Middle Permian) and its constituent stages is formally proposed in this issue. In addition, a call for further discussion, based on new, refined data, is also included in this issue on the formal definition of the Sakmarian.

We hope to have very serious and lively discussions on all the stages of the Permian at the Congress on Carboniferous-Permian this summer in Calgary. The Artinskian and Kungurian still need more work and I encourage everyone to strive to assemble the necessary data to define properly these stages.

The official annual meeting of the Subcommission is at the Congress on Carboniferous-Permian this August, but the Subcommission will also be meeting with the Continental Permian of the Southern Alps and Sardinia (Italy): Regional Reports and General Correlations. As the marine international standard matures, the most important effort for the Subcommission is to create “bridges” to terrestrial and provincial depositional areas (i.e., improve the correlation). This is the spirit of the newly created working group that is working on transitional biotas to “bridge” these correlations between basins or provinces. On this note and mentioned in a letter from Dr. Grunt in this issue, the Subcommission participated in a wrap-up session during the Symposium on *Upper Permian Stratotypes of the Volga Region* last summer and endorsed a summary memorandum to the Government of Tartarstan Republic to encourage and fund further study of the classic Russian Upper Permian sections, and to preserve the traditional stratotypes to guarantee new, improved and refined correlation to marine standard sections.

Next year’s annual meeting will be held in conjunction with the IGC in Rio de Janeiro, Brasil. We hope to have a mature proposal for every stage division at that time. I look forward to a very active year.

REPORTS

Proposal of Guadalupian and Component Roadian, Wordian and Capitanian Stages as International Standards for the Middle Permian Series

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Introduction

The present proposal of the Middle Permian Guadalupian Series and component Roadian, Wordian and Capitanian stages was prepared for publication in Permophiles and concurrent distribution to SPS Titular Members for formal vote. Qualifications of the Guadalupian as international standard reference have been presented previously (Glenister *et al*., 1992), but the present new formal proposal will add critically important new data on conodont morphoclines, absolute dates, and paleomagnetics.

Historic Preamble

Prolonged deliberation of SPS members culminated in the mandated formal postal vote by Titular (voting) Members that approved subdivision of the Permian System into three series, in ascending order Cisuralian, Guadalupian and Lopingian (Report of President Jin Yugan, Permophiles #29, p. 2). The "——usage of the Guadalupian Series and constituent stages, *i.e.* the Roadian, the Wordian and the Capitanian Stage for the middle part of the Permian." was approved unanimously by 15 voting members. Proposal of the Guadalupian as a chronostratigraphic unit of series rank (Girty, 1902) predates any potential competitors by decades (Glenister *et al*., 1992). Of the three component stages currently recognized, the upper two (Wordian and Capitanian) enjoy comparable priority. Capitanian was first employed in a lithostratigraphic sense by Richardson (1904) for the massive reef limestones of the Guadalupe Mountains of New Mexico and West Texas, and the Word was used by Udden *et al*. (1916) for the interbedded clastic/carbonate sequence in the adjacent Glass Mountains. Both were used in a strictly chronostratigraphic sense first by Glenister and Furnish (1961) as substages of the Guadalupian Stage, referenced by their nominal formations and recognized elsewhere through "ammonoid and fusuline faunas". In studying the Permian faunas of Arctic Canada, Nassichuk *et al*. (1965) concluded "——that probably a separate stage between the Artinskian and Guadalupian could be recognized." The "First limestone member" of the Word Formation, Glass Mountains, was named the Road Canyon Member (Cooper and Grant, 1964) and served subsequently as reference for the post-Artinskian/pre-Wordian Roadian Stage (Furnish and Glenister, 1968, 1970; Furnish, 1973). At the same time, Wilde and Todd (1968) suggested that the basal unit of the original Guadalupian Series, the Cutoff Formation, is correlative with the Road Canyon. Wilde (1990) subsequently placed the Roadian as the basal unit of the Guadalupian Series, a practice now favored by others. The Kubergandian of Central Asia is at least a partial correlative of the Roadian. Although Kubergandian has priority as a named stage, the Roadian "Black, thin bedded-limestone" (=Cutoff Formation) forms the original base of the Guadalupian Series (Girty, 1902).

Prerequisites for GSSP Definition

The present statement contends that there is now adequate detailed information on Middle Permian boundary sequences, worldwide, that selection of Global Stratotypes Sections and Points (GSSP) for the series and component stages is fully justified and timely. We recommend sections within Guadalupe Mountains National Park (Fig. 1), Texas, southwestern United States of America, along the north-western margin of the Delaware Basin (Fig.2). Fundamental principles involved in selection and definition of a GSSP were explored fully in the pioneering investigations of the Silurian-Devonian Boundary Committee (McLaren, 1977), and are expressed clearly in the Guidelines and Statutes of the ICS (Cowie *et al*., 1986; Remane *et al*., 1996a; Remane *et al*., 1996b). SPS authors (Davydov *et al*., 1995) outlined the principles and prerequisites involved in selection of the Aidaralash section of the Southern Urals as GSSP for the base of the Permian, and these are summarized below:

1. succinct reasons for choice of the GSSP in both level and geographic location; preference is for historic priority, but subsidiary to scientific and practical merit, and advanced state of knowledge is implied;
2. continuity of sedimentation through the boundary interval, preferably in a marine succession without major facies changes;
3. freedom from structural complications and metamorphism, thereby providing amenability to superpositional interpretation and use of both magnetostratigraphy and geochemistry, including geochronometry;
4. abundance and diversity of well-preserved fossils, preferably including a chronocline that permits arbitrary selection of a point within a single evolutionary lineage;
5. adequacy and continuity of exposure, providing a succession that can be followed above and below the GSSP, and preferably laterally;
6. compatibility of accessibility with conservation, providing continuous availability without insuperable physical and/or political obstacles for access by any qualified researcher; protocols for sampling and transportation of collections are needed.

The present statement contends that the Guadalupe Mountains sections meet these same qualifications, and that overall scientific and practical merit necessitates their selection as international standards for the Guadalupian Series and component stages. Critically important is the interest the U.S. National Park Service has expressed in encouraging research, and their commitment in providing access to qualified investigators (Glenister, 1993).

Stratigraphy

The Middle Guadalupian series is perhaps the best stratigraphically studied unit in the world, serving as a major paradigm for modern sequence stratigraphy (*e.g*., Vail *et al*., 1977; Sarg and Lehmann, 1986; Sarg, 1988; Franseen, *et al*., 1989; Handford and Loucks, 1993; Hovorka *et al*., 1993; Mutti and Simo, 1993). The succession is represented by excellently exposed shelf to basin sections in the southern Guadalupe Mountains that generally exhibits shelf evaporite, shoal-water carbonate, deep-water carbonate, and basinal sandstone facies transitions. It is represented by six composite sequences, (Glenister *et al*., 1992, Fig. 1; Fig. 3 herein) in ascending order: San Andres, Grayburg, Queen, Seven Rivers, Yates, and Tansill (named for the shelf facies). The lowermost, San Andres, begins with a transgressive systems tract that consists of a series of progradational grainstones and evolves into grainstone-packstone highstand systems tract that represents carbonate ramp with decoupled, bypass basinal siliciclastics. The oldest Guadalupian platform developed during the Grayburg sequence, forming a distinct platform, shelf margin, slope and basinal facies. The Grayburg and succeeding sequences represent classic unconformity-bounded, shelf-margin-basin type 1 sequences that include distinct lowstand wedges and fans sometimes coupled with shelf siliciclastics, transgressive systems tracts, and highstand systems tracts that include coupled carbonate-siliciclastics higher-order cycles.

The stratigraphic sections selected for definition of the Guadalupian and its stages all represent basinal to lower slope carbonate deposition.

The identifier for the base of the Guadalupian (*Jinogondolella nankingensis*) occurs in the Middle San Andres sequence that begins at the unconformity/omission surface at the base of the El Centro Member of the Cutoff Formation within a monofacial succession of skeletal carbonate mudstone within a meter of the only shale break in the carbonate succession, all of which were deposited in a basinal setting proximal to the slope (Fig. 3). The identifier for the base of the Wordian (*Jinogondolella aserrata*) is within the highstand system tract of the Grayburg sequence, representing the progradation of carbonate slope sediments into the basin, and occurs in the upper part of the Getaway Limestone Member of the Cherry Canyon Formation in a monofacial succession of skeletal carbonate mudstones that represents base of the slope deposition (Fig. 3). The identifier for the base of the Capitanian (*Jinogondolella postserrata*) is the lowermost widespread highstand system tract of the Seven Rivers sequence, similar to carbonate progradation of the Getaway, occurring within the Pinery Limestone Member of the Bell Canyon Formation in a monofacial succession of skeletal wackestone/packstone that represents lower slope deposition (Fig. 3).

Conodont Definitions

The evolution of *Jinogondolella* characterizes the Guadalupian (Middle Permian Series), and the first appearances of *Jinogondolella nankingensis*, *J. aserrata*, and *J. postserrata* define the component stages.

The first member of the genus, *Jinogondolella nankingensis*, evolved from *Mesogondolella idahoensis* through a transitional succession, demonstrated by the Pa element to be a mosaic paedomorphocline (Lambert and Wardlaw, 1992). Lambert (1994) documented this transitional morphocline quantitatively, an approach expanded graphically by Lambert and Wardlaw (1996), who further pointed out that *Jinogondolella aserrata* and *J. postserrata* evolved similarly through transitional morphoclines from their respective predecessors. Wardlaw (1999) has illustrated many examples of these transitional morphotypes. Adult specimens of the Pa element of *M. idahoensis* are characterized by smooth lateral margins, fused anteriormost denticles, a large round, erect cusp, wide well-defined furrows, and a short, open anterior keel on the lower surface. The Pa element of *J. nankingensis* is characterized by common anterior serrated margins on a broad platform with a sharp anterior narrowing, a blunt posterior platform termination with a small cusp and discrete denticles, sharp, narrow well-defined furrows, and a well-defined anterior keel. The transitional morphotype shows progressively longer retention of lateral serrations with growth, increased tapering and narrowing of the anterior platform, narrowing of the lower attachment surface developing a more consistent elevated keel, denticles that progressively become less fused and more discrete, a cusp that subtly migrates posterolaterally and becomes less pronounced, and furrows that thin and become more shallow.

The Pa element of *Jinogondolella aserrata* is characterized by a broad platform with no sharp anterior narrowing, shallow, poorly-defined furrows, few anterior serrations along its platform margin, and a rounded posterior platform termination (typically with an inner lateral indentation). The transitional morphotype from *J. nankingensis* to *J. aserrata* displays a rounded posterior termination, intermediately developed furrows, and a moderately

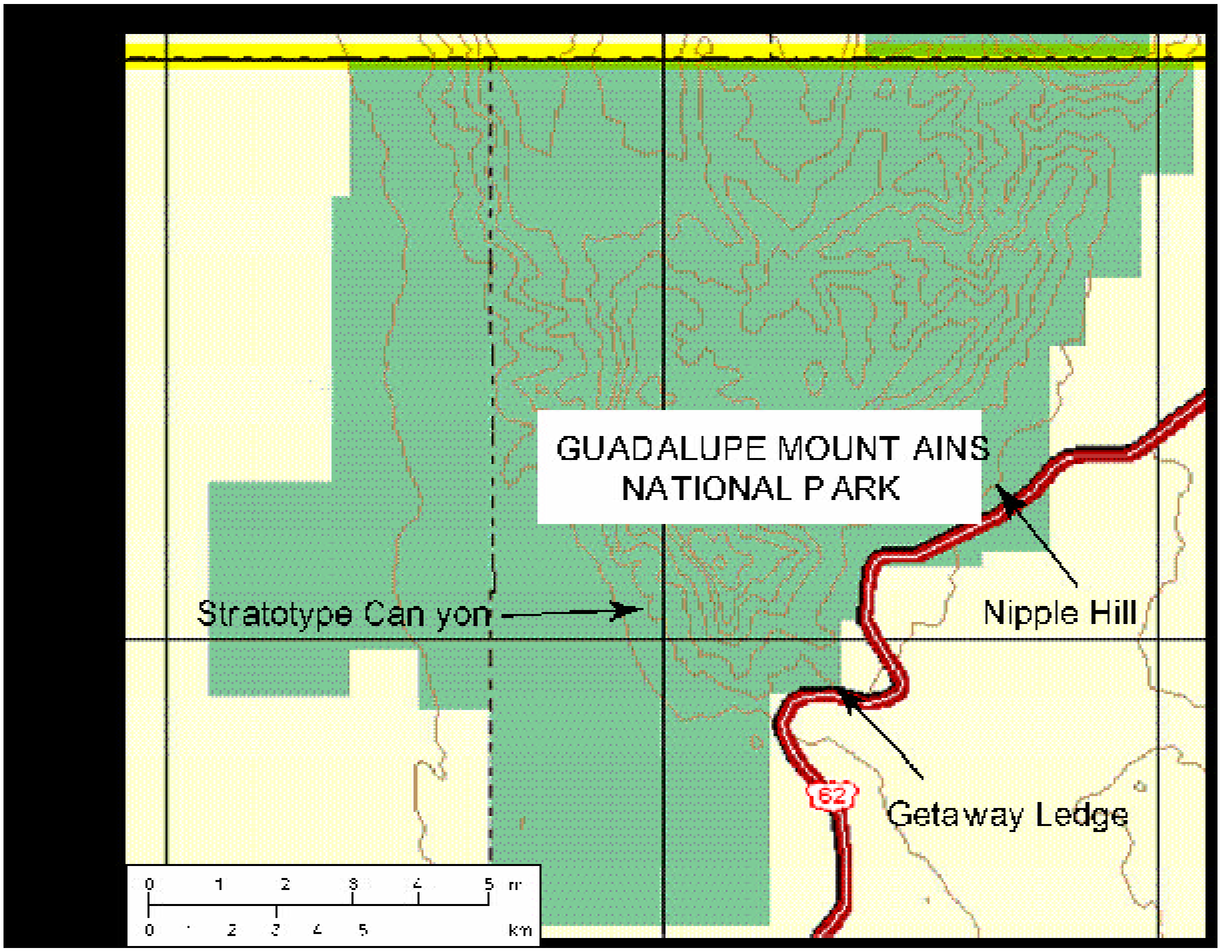

Figure 1. Map showing location of the proposed stratotypes. Guadalupe Mountains National Park is in Green. Yellow line at top of figure represents the Texas-New Mexico state line. Contour interval is 500 feet.

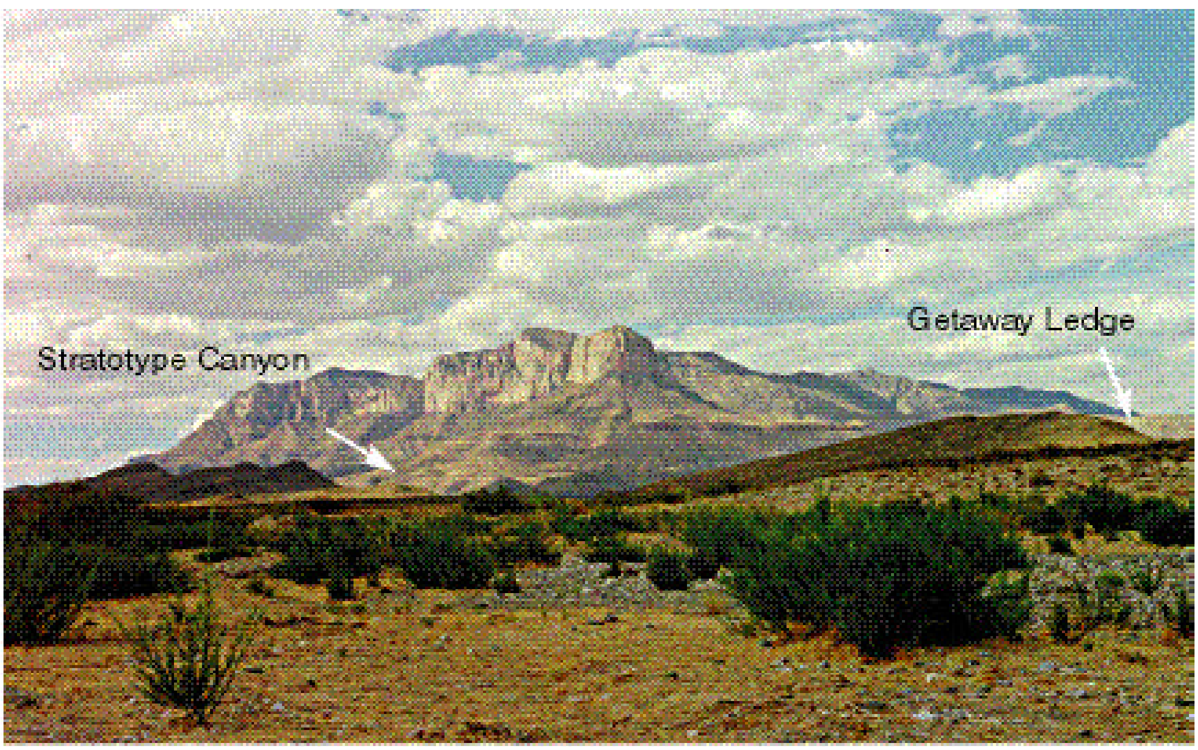

Figure 2. Photograph of the southern front of the Guadalupe Mountains showing location of Stratotype Canyon and Getaway Ledge. Nipple Hill is just outside the right sideof the photograph.

narrowing platform in the anterior with common margin serrations.

The Pa element of *Jinogondolella postserrata* is characterized by a relatively narrow platform with a marked anterior narrowing, sharp, well-defined furrows, common anterior serrated margins (restricted to the anteriorly narrowing part), and a relatively blunt posterior platform termination. The transitional morphotype from *J. aserrata* to *J. postserrata* displays a relatively blunt posterior termination, intermediately developed furrows, and a moderately narrowing platform in the anterior with few serrations on the margin.

The first appearances of adult forms that retain the characteristics of the *Jinogondolella nankingensis, J. aserrata,* and *J. postserrata* in transitional evolutionary morphoclines are used to define the base of the Roadian, Wordian, and Capitanian stages of the Guadalupian Series. Each first appearance is documented from sections that serve as stratotypes, preserved within the confines of Guadalupe Mountains National Park. Specifically, the first appearance of *Jinogondolella nankingensis* is at 42.7 m above the base of the Cutoff Formation in Stratotype Canyon (west face, southern Guadalupe Mountains, located at 31.8767° N., 104.8768° W.), 29 cm below the prominent shale band in the upper part of the limestone unit in the El Centro Member. The first appearance of *Jinogondolella aserrata* is just below the top of the Getaway Limestone Member of the Cherry Canyon Formation in Guadalupe Pass, at 7.6 m above the base of the outcrop section (U.S. Highway 62/180), with the base at 31.8658° N., 104.8328° W. The first appearance of *Jinogondolella postserrata* is in the upper part of the Pinery Limestone Member of the Bell Canyon Formation at the top of Nipple Hill (southeastern Guadalupe Mountains), at 4.5 m in the outcrop section on the south side of the hill with the top at 31.9091° N., 104.7892° W. All of these first appearances along with their respective morphoclines occur within monotonous pelagic carbonates, and are demonstrated by tight sample intervals.

Fusulinacean Biostratigraphy

Sufficient evidence has accumulated in recent years to recognize the Guadalupian Series on the basis of fusulinaceans alone, although definitions of the stage boundaries still will be based on conodonts (Lambert, 1994; Wardlaw, 1999). The long-ranging genus *Parafusulina* evolved from *Schwagerina* (*sensu* Dunbar, 1958; Dunbar and Skinner, 1936) during the Lower Permian Kungurian (Leonardian) Stage, or possibly through *Eoparafusulina* (Coogan, 1960), or a primitive *Monodiexodina* (Sosnina, 1956) such as *M. linearis* (Dunbar and Skinner, 1937). By the close of late Kungurian time, the genus was well established and many species characterize both Roadian and Wordian faunas. No Kungurian species of *Parafusulina*, however, is known to have extended into the Roadian.

The genus *Skinnerina* (Ross, 1964) appeared in the Roadian Stage, possibly derived from *Skinnerella* (Coogan, 1960), a diverse Cisuralian taxon (Skinner, 1971). *Skinnerina* has now been found in the Road Canyon Formation of the Glass Mountains (Ross, 1964); in the Cutoff Formation of the Apache Mountains (Wilde *in* Wilde and Todd, 1968; Skinner, 1971); and in the type section of the Cutoff at Cutoff Mountain in the southern Guadalupe Mountains (Wilde, 1986). In each of these localities, *Skinnerina* is accompanied by from one to all of the following: *Parafusulina boesei, P. splendens, P. attenuata, P. maleyi,* and *Rauserella*.

As noted by Wilde (1988, 1990), serious errors occurred in locality numbering in the classic study by Dunbar and Skinner (1937). These errors have tended to distort understanding of the stratigraphic position of important species of *Parafusulina* from

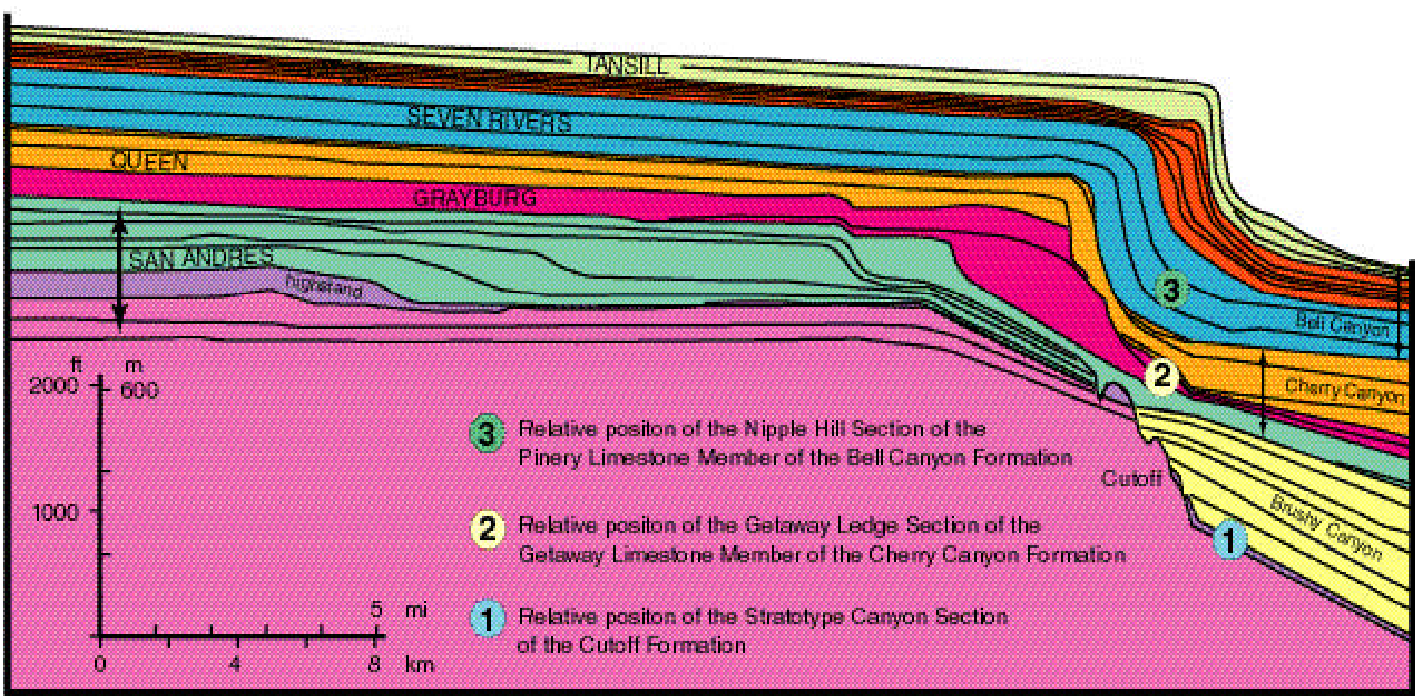

Figure 3. Sequence stratigraphy of Guadalupe Mountains showing depositional position of proposed stratotypes for the Guadalupian (and Roadian) at Stratotype Canyon (1), for the Wordian at Getaway ledge (2), and for the Capitanian at Nipple Hill (3).

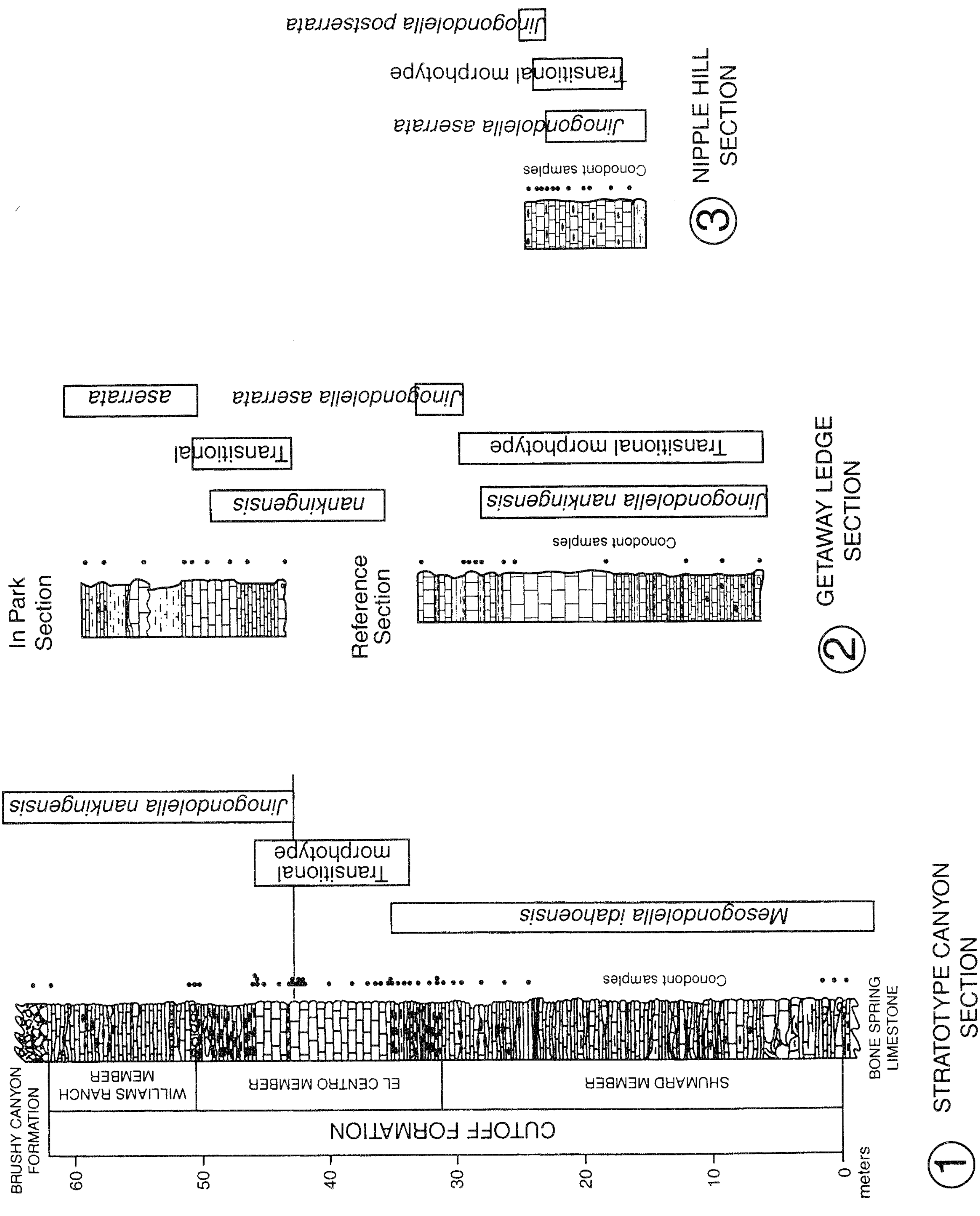

Figure 4. Columnar sections of the propsed statotypes showing conodont samples and distributions. The Getaway Ledge sections represent the entire section of the Getaway Limestone member of the Cherry Canyon Formation exposed just outside the park (reference) and just in the park, 1 km apart. The Nipple Hill section represents the entire section of the Pinery Limestone Member of the Bell Canyon Formation.

both the Brushy Canyon and Cherry Canyon intervals. Simply stated, *Parafusulina rothi* and *P. maleyi* are restricted to the Cutoff and Brushy Canyon, and *Parafusulina lineata* and *P. deliciasensis* are confined to the Cherry Canyon, commonly in association with *Leella fragilis*. *Parafusulina antimonioensis* is another late species (from Sonora, Mexico), displaying the large size and advanced nature of the highest *Parafusulina* (Dunbar, 1953).

The Late Guadalupian (early Capitanian) is characterized by *Polydiexodina*, a large fusulinacean with fully developed multiple tunnels, including a well-defined central tunnel (Wilde, 1998). Derivation was probably from a lineage of *Skinnerina* through the Asian *Eopolydiexodina* (Wilde, 1975). The last named genera developed sporadic multiple tunnels, while losing the well-defined central tunnel of most earlier *Parafusulina*. Associated with *Polydiexodina* is *Leella bellula*, and the beginning of the codonofusiellids (*Codonofusiella paradoxica*). *Codonofusiella* continues to the close of the Permian; *C. extensa* provides a significant middle Capitanian datum (Skinner and Wilde, 1954; Wilde, Rudine and Lambert, in press).

The large and complex fusulinaceans of the *Polydiexodina* zone were succeeded by advanced Neoschwagerinidae that replaced simple tunnels with foramina and parachomata. The zone of *Yabeina* characterizes the Tethys, but is poorly represented in the Permian Basin. However, several occurrences facilitate correlation to the Tethys. In the late Guadalupian the small but distinctive *Yabeina texana* is well developed and is succeeded in turn by *Paradoxiella* and *Reichelina* (Skinner and Wilde, 1954, 1955). *Paradoxiella* occurs in the Tethys with *Yabeina globosa* (Sada and Skinner, 1977), and was reported by Leven (1993) from the Caucasus. In the Guadalupe Mountains, *Paradoxiella* is followed upward by a profusion of *Reichelina* (Skinner and Wilde, 1955) near the top of the Lamar Limestone; this appears to represent the Tethyan zone of *Lepidolina*, although the zonal index has not been found in the region.

The tetrataxoid foraminifer *Abadehella* has been discovered in numerous outcrops of the Permian Basin section, but primarily from the *Reichelina* zone to the top of the non-evaporite Permian section (Wilde, Rudine and Lambert, in press). This important genus, originally described from the Abadeh beds in the Dzhulfa Region of Iran (Okimura, Ishii and Nakazawa, 1975), appears to extend to the top of the Permian, and has been reported to occur as low as the Wordian (Leven, 1993).

The youngest fusulinaceans known from the Permian Basin are abundant *Paraboultonia* from the Reef Trail Member of the Bell Canyon Formation (Wilde, Rudine and Lambert, in press), the "Post-Lamar beds" that directly overly the Lamar Limestone. The associated succession of conodonts duplicates that of the Penglaitan section of South China that will serve for definition of the base of the Upper Permian Lopingian Series, and coincident top to the Middle Permian Guadalupian Series.

Ammonoid Biostratigraphy

Ammonoid zones have served historically as the primary basis for biostratigraphic correlation of Devonian through Mesozoic strata. However, conodonts with their near ubiquity and rapid evolution have now become the preferred taxon for precise correlation and chronostratigraphic definitions for the Paleozoic. Because different taxonomic groups evolve at different rates and times, the defining conodont boundaries commonly do not coincide precisely with established ammonoid zonal boundaries. Ammonoid distributions within the Guadalupian are well known (*e.g.* Spinosa *et al*., 1975). Here we limit treatment to review of occurrences within the type Guadalupian in relation to conodont-defined boundaries.

Ammonoid faunas of the Roadian Stage are characteristically composed of the last holdovers from the preceding Cisuralian and the ancestors of increasingly more common Guadalupian forms. However, these faunas are commonly dominated by species that are provincial in distribution (*e.g.* South China *vs.* West Texas). Nevertheless, *Paraceltites elegans*, the ancestral representative of the Paraceltitina, is present in most faunas and dominant in West Texas, and its appearance near the base of the Roadian Stage in the type region (type Road Canyon Formation) serves to faunally distinguish the Guadalupian as encompassing the appearance and initial diversification of the Ceratitida. Similarly, the concurrent appearance of *Demarezites*, the ancestral representative of the Cyclolobaceae, marks the initiation of diversification of this group throughout the remainder of the Permian. Finally, the paragastrioceratid Subfamily Paragastrioceratinae that distinguishes the entire Cisuralian Series became extinct prior to the Roadian, where the previously obscure Subfamily Pseudogastriocertinae diversified to characterize the remainder of the Permian up to the Permo/Triassic boundary (Mikesh *et al*., 1988).

The basal boundary of the Wordian Stage was recognized traditionally as the lithologic base of the Delaware Mountain Group (Pipeline Shale Member, basal Brushy Canyon Formation). That horizon is well marked by an ammonoid assemblage with mixed morphologic characteristics of latest *Demarezites* (the ancestral cyclolobin) and earliest *Waagenoceras* (Lambert *et al*., 1999). Although this population is interpreted to denote the evolutionary transition between these genera, the conodonts range through apparently unchanged. However, the cyclolobins also diversify markedly near the younger conodont-defined boundary, with the lowest reported occurrences of the genera *Newellites* and *Mexicoceras*, and more advanced species of *Waagenoceras*, including *W. dieneri*.

The boundary marking the basal Capitanian Stage has traditionally been drawn at the base of the Hegler Member of the Bell Canyon Formation. It has come to be recognized more by preceding ammonoid last occurrences than by evolutionary appearances. Originally characterized as marking the base of the *Timorites* Zone, that rare cyclolobin has also been recovered from the preceding Manzanita Member (upper Cherry Canyon Formation). The conodont boundary near the top of the Pinery Member of the Bell Canyon Formation is not associated with an abundant ammonoid fauna in the type region, but is delineated near the first occurrence of the ceratitid ammonoid *Xenaspis*, and follows several last occurrences in the Hegler and lower Pinery members (lower Bell Canyon Formation).

U/Pb Dating

Numerous volcanic ash beds have been recognized in the southern Guadalupe Mountains of Texas since first detailed by King (1948). One such occurrence lies within the proposed type section for the Upper Guadalupian Capitanian Stage, and has recently been dated by U-Pb isotope dilution mass spectrometry applied to zircons (Bowring *et al*., 1998). The ash occurs within the undifferentiated lower unit of the Bell Canyon Formation, below the Pinery Limestone Member, at Nipple Hill in Guadalupe Mountains National Park (Fig. 1, note that these occurrence data supersede those available to previous authors). It is 6-8 cm thick and lies approximately 2 m above the top of the Manzanita Limestone Member of the underlying Cherry Canyon Formation. The horizon is 37.2 m below the base of the *Jinogondolella postserrata* conodont zone, the latter within the Pinery Limestone Member, which defines the base of the Capitanian Stage. Six zircon fractions were analyzed to define a concordant cluster. The best estimate for the age of the ash, based on five fractions, is 265.3 +/- 0.2 Ma, which provides a maximum estimate for the base of the Capitanian Stage. The upper boundary of the Capitanian is currently poorly constrained in terms of absolute age. The next available younger date is for the base of the Changhsingian Stage in South China, which has been dated at the type section as 253.4 +/- 0.2 Ma (Bowring *et al*., 1998). Several additional beds within the lower part of the type Lopingian and elsewhere in South China are currently being investigated.

Magnetostratigraphy

Initial investigations on magnetostratigraphy within the Delaware Basin were focused on the back-reef facies of the Guadalupe Mountains (Peterson and Nairn, 1971), the Seven Rivers Formation demonstrating reversed polarization and the overlying Yates Formation normal polarity. Projecting these data into the interfingering slope facies that would subsequently serve to define the base of the Capitanian Stage, the Illawarra Reversal could then be demonstrated to lie close to the Wordian/Capitanian boundary.

More detailed investigations will be needed to maximize the value of paleomagnetic studies in both the Middle and Lower Permian series, in the North American southwest as well as elsewhere, as both biostratigraphic and regional interrelationships are still problematic (*e.g*., Jin *et al*., 1997). However, current studies (Menning *et al*., in prep.) provide additional information on the type Guadalupian succession. All definitive tests of Cutoff Formation samples indicate reversed polarity, and suggest reference to the Carboniferous-Permian Reversed Megazone Kiaman Superchrone. Similarly, the Getaway Limestone and Manzanita Limestone of the overlying Cherry Canyon Formation also display reversed polarity. Finally, normal polarity has been demonstrated for a few samples from the Pinery Limestone and Lamar Limestone of the Upper Guadalupian Bell Canyon Formation, confirming the approximate position of the Illawarra Reversal.

Summary

Formal Proposal. For the reasons cited, the first appearance of the conodont *Jinogondolella nankingensis*, in the evolutionary continuum from *Mesogondolella idahoensis*, at 42.7 m above the base of the Cutoff Formation in Stratotype Canyon, west face of southern Guadalupe Mountains, is hereby proposed as the GSSP for the base of the Middle Permian Guadalupian Series and coincident Roadian Stage. The first appearance of *Jinogondolella aserrata*, in the transitional continuum from *J. nankingensis*, at 7.6 m above the base of the Guadalupe Ledge (in Park) outcrop section in Guadalupe Pass, southeastern Guadalupe Mountains, is hereby proposed as the GSSP for the base of the Middle Guadalupian Wordian Stage. Finally, the first appearance of *Jinogondolella postserrata* within the transitional continuum from *J. aserrata*, in the upper Pinery Limestone Member of the Bell Canyon Formation at 4.5 m in the outcrop section at the top of Nipple Hill, southeastern Guadalupe Mountains, is hereby proposed as the GSSP for the base of the Upper Guadalupian Capitanian Stage. The coincident tops of the Guadalupian and Capitanian will be recognized, primarily on conodont evidence, to correspond to the GSSP for the bases of the Upper Permian Lopingian Series and coincident Wuchiapingian Stage, expected to be defined in the Penglaitan sections, Honghsui River, central Guangxi, South China (Mei, *et al*., 1998). Conodont successions closely similar to those to be used in the definition of the base of the Lopingian are known already in the Reef Trail Formation (and its West Texas equivalents) that overlies the uppermost Capitanian Lamar Limestone.

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Floristic Evidence of Transitional Permian-Triassic Deposits of the Volga - Dvina Region

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It was long believed that transitional Permian-Triassic deposits did not exist in the area of the classical Kazanian and Tatarian stages. The boundary between the latest Tatarian (the Upper Vyatkian Member) and the lowermost Vetlugian (the Astashikhian Member with *Lystrosaurus*) was described as unconformable (Lozovsky & Esaulova, 1998), but the hiatus might not be uniform over the basin, apparently decreasing in the central part at the Volga-Severnaya Dvina watershed. A rich fossil flora is known from the Vyatkian (Gomankov & Meyen, 1986), whereas the Astashikhian lacks any reliable plant macrofossil record. The typical Early Triassic *Pleuromeia* assemblage first appeared upsection in the Ryabian Member.

We found plant macrofossils, megaspores, and palynological assemblages in the basal Vetlugian (Astashikhian) indicating a possible transitional Permian-Triassic age. The fossil plant locality occurs on the left bank of Kichmenga River near Nedubrovo Village, Vologda Region (Fig. 1). In the Kichmenga section, the late Tatarian (Vyatkian) variegate marl - clay deposits are overlain by the Astashikhian cross-bedded sands and pebble beds (8 m) followed by the reddish brown clay (3 m) and by alternate thin-bedded greenish-gray to purple siltstones and shales (2.5 m) with abundant plant debris on the bedding surfaces. The plant remains are fragmentary but with well preserved cuticles providing epidermal characteristics that are important for classification of the Permian and Triassic gymnosperms. Of certain stratigraphic significance are the following gymnosperm taxa (Fig. 2):

Tatarina S. Meyen, a peltasperm leaf genus typical of the Tatarian flora. Morphological diversity of tatarinas increases in the Vyatkian where they form leaf mats and large accumulations of dispersed cuticles. No tatarinas were hitherto reported from any strata above the Vyatkian in the stratotype area. Stratigraphic relationships of the Vyatkian tatarinas with two species recorded from the Tungusska intertrappean deposits of Siberia remain uncertain. In the Nedubrovo locality tatarinas are abundantly represented by at least two well-defined species. Of these, *Tatarina conspicua* S. Meyen is a numerically dominant species of both the Vyatkian (Gomankov & Meyen, 1986) and Astashikhian plant assemblages. Our material from Nedubrovo, studied with SEM, shows files of irregularly spaced stomata with a distinct Florin ring. The epidermal cells are densely papillate, as in the *verrucosa* variety of this polymorphic species.

Another species, *Tatarina lobata* S. Meyen has been previously described from intertrappean deposits of Korvunchan Formation in the Tungusska Basin (Meyen & Gomankov, 1980). This species differs from the Vyatkian tatarinas in the lobed margin of the narrow lanceolate leaves as well as in the scattered stomata with proximally papillate subsidiary cells. The Nedubrovo specimens show all the diagnostic features of the species but are smaller than the type specimens and more heavily papillate - a feature shared with *T. conspicua*.

Phylladoderma Neuburg, another Late Permian peltasperm genus, is most abundant in the Kazanian, but subordinate to

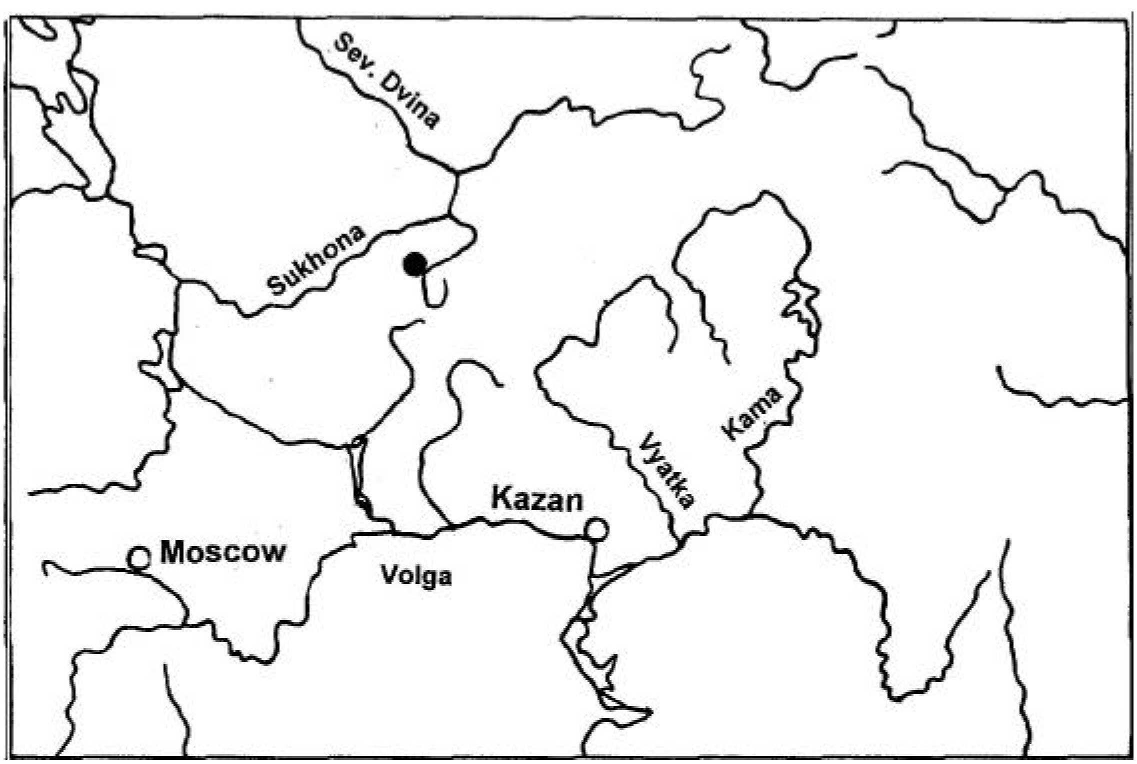

Figure 1. Sketch map of the Volga - Severnaya Dvina watershed region showing geographic position of the Nedubrovo plant locality (black circle).

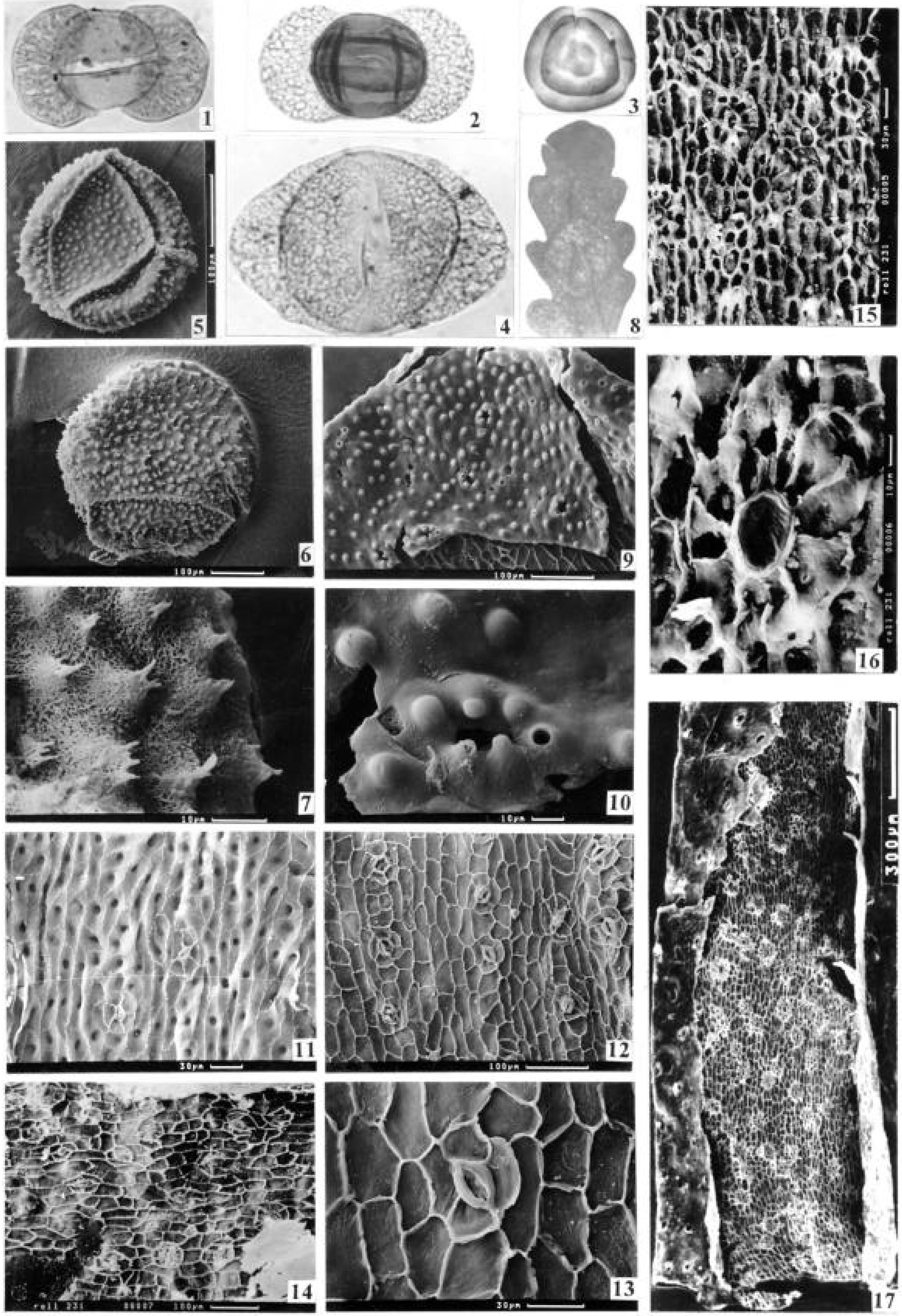

Figure 2. Characteristic plant fossils of the lower Astashikhian assemblage at Nedubrovo, light and SEM micrographs: 1 - bisaccate taeniate pollen grain Lunatisporites noviaulensis *(Leschik) Foster, 2 - bisaccate bitaeniate pollen grain* Lueckisporites virkkiae *Potonie et Klaus (Visscher (s form A); 3 - trilete spore* Polycingulatisporites *sp. 4 - bisaccate non-taeniate pollen grain* Klausipollenites schaubergeri *(Potonie et Klaus) Jansonius, 5-7 - megaspore* Otynisporites eotriassicus *Fugl., proximal and lateral views, appendages, 8-10 - peltasperm* Tatarina lobata *S. Meyen, leaf fragment, cuticle, papillate stoma; 11-13 - peltasperm* Tatatrina conspicua *S. Meyen, cuticle of typical and heavily papillate varieties, stoma; 14 - conifer* Quadrocladus solmsii *(Gothan et Nagalhard) Schweitzer, mid-leaf cuticle; 15-17 - conifer* Ullmannia cf. bronnii *Goepp., group of five contiguous stomata, stoma and whole leaf cuticle (light micrographs 1-4, 625x, 8, 15x)*

Tatarina in the Tatarian. In Nedubrovo it is represented by *Phylladoderma (Aequistomia) annulata* Meyen that is characterized by polygonal epidermal cells and irregularly orientated small stomata uniformly scattered over both leaf surfaces except along the leaf margins marked by narrow stomata-free zones of elongate cells. The species has been previously recorded from at least three localities in the upper Tatarian (Gomankov & Meyen, 1986).

Ullmannia Goeppert is a typical Zechsteinian conifer that has been occasionally reported also from the Volga Basin. All such finds were recently transferred to *Quadrocladus* or *Steirophyllum* that are morphologically similar to *Ullmannia*, but differ in epidermal characteristics (Meyen, 1997). Unexpectedly, some conifer leaves from Nedubrovo showed stomata in irregular files, with up to 12 subsidiary cells which are diagnostic epidermal features of *U. bronnii* Goepert. Two other conifer species from Nedubrovo belong to *Quadrocladus solmsii* (Gothan et Nagalhard) Schweitzer, a Zechsteinian species fairly distinct from the Tatarian quadroclades, and *Pseudovoltzia* similar to the Permian Alpine species *P. sjerpii* Clement-Westerhof (1987).

Notably, all the Nedubrovo gymnosperms show frequent epidermal anomalies, such as irregular epidermal topography, contiguous stomata, with up to five stomatal complexes sharing their subsidiary cells, giant stomata, etc. Since these plants grew at the time of massive Siberian trap volcanism and since aerosol particles form volcanic eruptions enhance destruction of stratospheric ozone, the abnormal epidermal features might have been related to an excess UV radiation.

The diverse megaspore assemblage comprises *Otynisporites eotriassicus* Fugl. (Fig. 2), index species of the *Otynisporites* zone comprising the basal Suboolitic Member of Buntsandstein immediately above the Zechstein (Fuglievich, 1977 and elsewhere). Outside Europe *Otynisporites eotriassicus* occurs in the upper Guodikeng Formation of the Junggar Basin, northern China (Liu, 1994) containing a mixed vertebrate assemblage with *Dicynodon* and *Lystrosaurus*.

The palynological assemblage is dominated by *Klausipollenites* and *Cycadopites* (up to 30% each). The Zechsteinian elements, such as *Striatoabieites richteri* (Klaus) Hart, *Lunatisporites noviaulensis* (Leschik) Foster, *L. pellucidus* (Goubin) Helby, *Lueckisporites virkkiae* Potonie et Klaus (form A: Visscher et al., 1973) are more prominent than in the Lower Griesbachian *Protohaploxypinus* assemblage (Balme, 1979; Utting, 1994). At the same time abundant *Tympanicysta*, fungal remains, a considerable diversity of trilete spores, including *Polycingulatisporites* and *Densoisporites*, and the asaccate *Cycadopites* give this assemblage a transitional Permian-Triassic aspect. Preliminary floristic comparisons suggest a possible correlation of the lowermost Vetlugian with the uppermost plant-bearing horizon of the Upper Changhsingian of South China. In the Tieqiao Section, Laibin County, the plant-bearing bed occurs immediately below the trangsgressive terminal Changhsingian (Jin & al., 1998 and our unpublished data).

We conclude that:

(1) The Nedubrovo plant assemblage of the lowermost Vetlugian (Astashikhian) retained a Permian aspect. It is dominated by *Tatarina* species survived from the Tatarian.

(2) On account of *Tatarina lobata* the basal Vetlugian corresponds to the lower intertrappean deposits of the Tungusska Basin. The Astashikhian gymnosperms are extremely xeromorphic. They also show frequent epidermal anomalies perhaps related to an excess UV radiation owing to contemporaneous trap volcanism and associated atmospheric phenomena.

(3) The Astashikhian conifers include *Ullmannia cf. bronnii*, *Quadrocladus solmsii* and other characteristic Zechsteinian species not known in the Tatarian.

(4) The presence of megaspores *Otonisporites eotriassicus* suggests correlation with the lowermost Buntsandstein of Central-Eastern Europe and with the upper Guodikeng Formation of Junggar Basin in China.

(5) The Astashikhian palynological assemblage is of a mixed Zechsteinian - Lower Griesbachian composition suggesting a more continuous transboundary floristic succession than in central Europe and Eastern Greenland. Correlation with the upper Changhsingian is a possibility requiring further studies.

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Astronomical Calibration of the East-Russian Plate Upper Permian Sedimentary Cycles: Preliminary Data about Duration of the Kazanian Stage

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Introduction

Rocks of Permian age are characterized by distinct cyclic recurrence in different scales: from microcyclic recurrence (0.1-3 mm) to macrocyclic recurrence (a few hundreds meters) (Ignatiev, V. I., 1962; Zhemchyzhnikov, Yu. A., 1963). In Permian continental and marine deposits cycles are revealed by changes in lithologic and chemical composition, rock color, etc. All regional stratigraphic schemes of Upper Permian strata of the East Russian plate are based on cyclic lithological recurrence (Ignatiev, V. I., 1962; Esaulova, N. K., 1998). For example, the reference Lower Kazanian substage marine section is composed of 8 members (Esaulova, N. K., 1998). Analogs of these members were revealed in the eastern continental types of sections where cyclic recurrence is more expressive. In each member it was observed, in upward succession, regular lithological change from sandstones (siltstones) to limestones (marls). The thickness of these cycles in different types of marine and continental sections changes 5-80 m. Similar cycles are observed in all Upper Permian strata of the east Russian plate. These cycles are used to distinguish and correlate regional stratigraphic units. In some cases the cycles present obstacles for stratification and correlation of the stratigraphic units.

The objectives of this paper are: 1 - to estimate the duration of some sedimentary cycles and substantiation of the possibility to create a geological time scale based on sedimentary cycles and the quasi-periodic variations of the Earth's orbit, 2 – to estimate the duration of the Kazanian Stage based on the astronomical calibration of sedimentary cycles in complete marine sections.

Objective Description

Upper Permian sections at the Melekesskaya depression and neighboring areas were chosen for investigation. The area of Melekesskaya depression is confined to the northern part of Volga, Kama and Sheshma rivers interfluve (Fig. 1). In this area the Upper Permian is penetrated by a great number of wells. The Ufimian, Kazanian and Tatarian stages represent the Upper Permian Strata in this area. Ufimian strata are present to the east of the Sheshma river line (Fig. 1). Kazanian and Tatarian

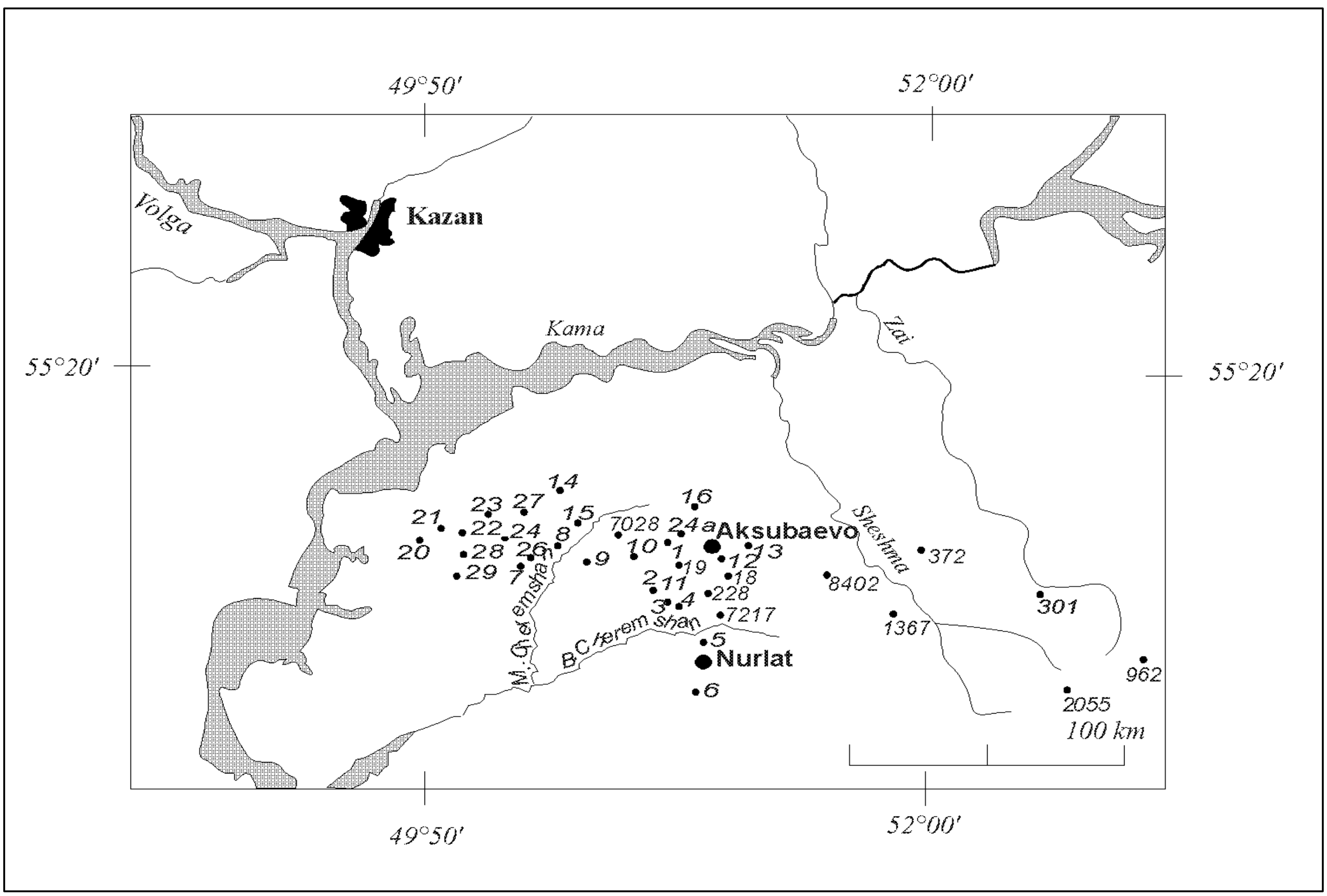

Figure 1. Map showing location of investigated wells.

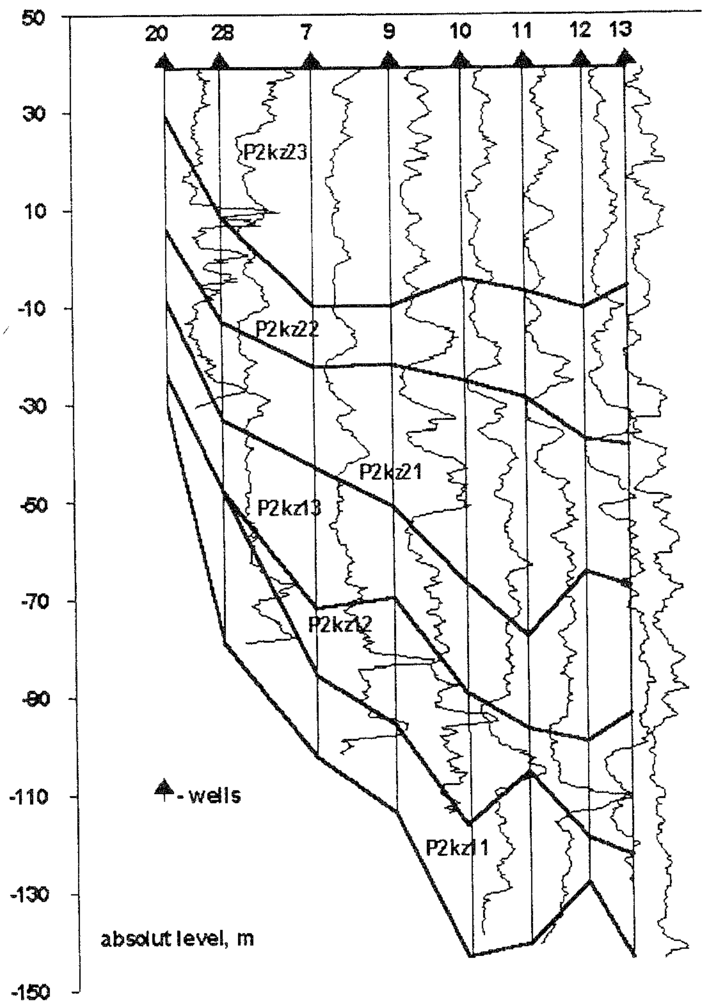

Figure 2. An example of the correlation of wells through Kazanian strata, showing gamma-ray logs and boundaries of regional stratgraphical units.

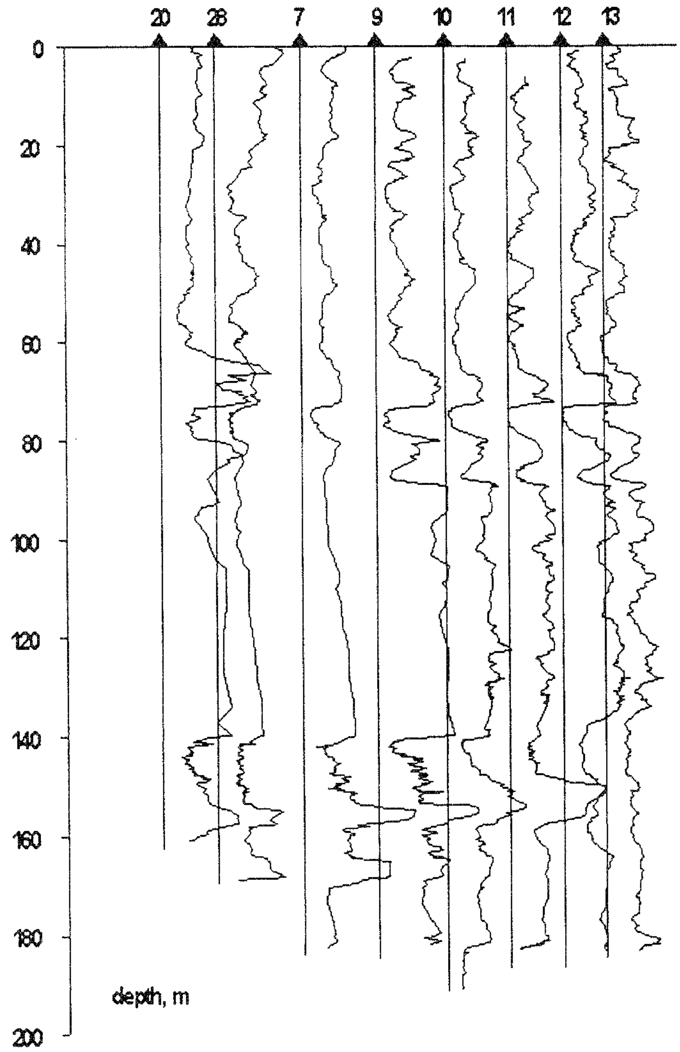

Figure 3. An example of the correlation of normalized wells sections.

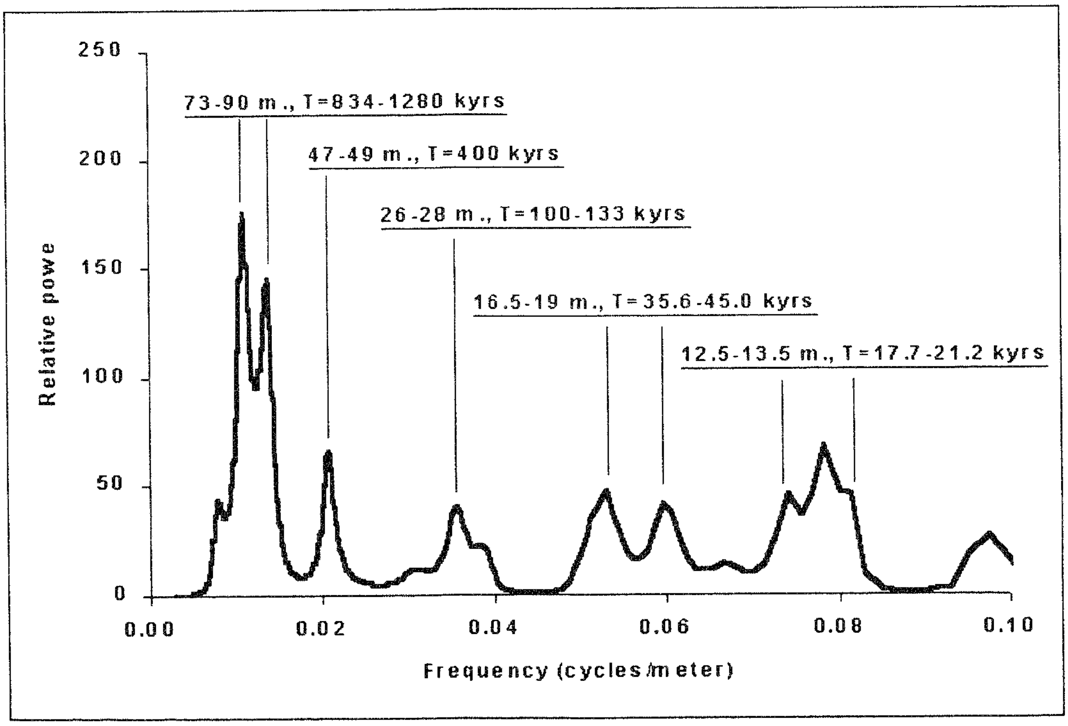

Figure 4. The generalized spectra from all well sections, showing lengths of cycles and their duration.

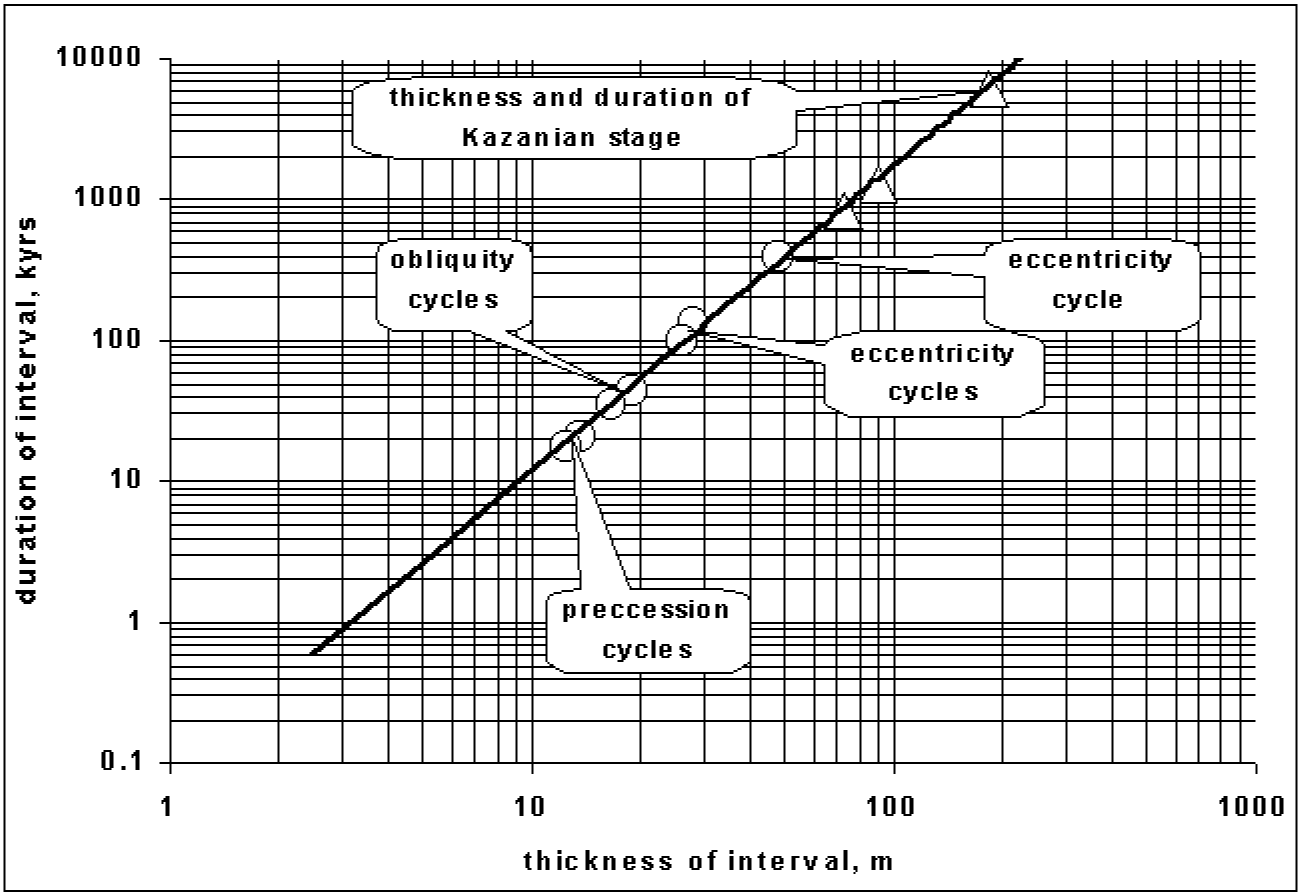

Figure 5. Duration of intervals (cycles) plotted against their thickness on logarithmic scale.

strata occur everywhere in the Melekesskaya depression. Upper Permian strata lie on the strongly eroded and leached bedding plane of grey carbonate and sulphate beds of Sakmarian, or Asselian, or Kungurian age. The Ufimian Stage is represented mainly by the Sheshmian Horizon and composed of monotonous alternations of sandstones, siltstones, and mudstones, often with thick series of sandstones and local interlayers of marls and limestones.

The Kazanian stage consists of lower (Sokian) and upper (Povolzian) horizons.

The lower Kazanian substage is represented by Baituganskie, Kamyshinskie, and Krasnoyarskie beds. Baituganskie beds ($P_2kz_1^1$) are composed of mudstones and marls with numerous *Lingula orientalis* Golow., L. Credneri (Grien.) up to 30 m in thickness. The Kamyshlinskie beds ($P_2kz_1^2$) are represented by dolomites, limestones, marls, mudstones, and sulphates with a of total thickness of 30 m. Krasnoyarskie beds ($P_2kz_1^3$) are composed of sandstones and siltstones with dolomite and mudstone interlayers. Total thickness is 25-30 m. The Upper Kazanian substage is represented by the Prikazanskie, Pechishchinskie, and Verkhneuslonskie beds. The Prikazanskie beds ($P_2kz_2^1$) comprise alternations of dolomites, limestones, marls with gypsum interlayers. Total thickness is 20 m. Pechishchinskie Beds ($P_2kz_2^2$) consist of sulphate, mudstone, marl, and dolomite beds with a total thickness of 20-25m. The Verkhneuslonskie beds ($P_2kz_2^3$) are represented by marls, mudstones, and dolomites 15-25 m., thick.

The Tatarian stage is represented by Urzhumian horizon composed of red-colored mudstone rocks with marl and dolomite interlayers 100-150 m., thick

According to Yu. V. Sementovsky (1998) Late Permian sedimentation on the eroded surface of the east European Platform was influenced by the Uralian orogeny. Several permanent river systems were the sources of fresh-water and brackish-water basins occurring in the plain, in which terrigenous material was accumulated. These basins also received chemogene material from the "White Stone Desert" in the west. In the Kazanian, these basins were mainly replaced by the sea that advanced from the north. This sea was situated in an arid zone, 20-30^{0}N, and produced saliflication zones. Sedimentation occurred in various facies: alluvial-deltaic, shelf formations of open sea, intermediate and shallow-water-coastal formations. Half of the complete thickness of the Upper Permian strata corresponds with the Tatarian. Red-bed mudstones accumulated in brackish-water and fresh-water basins.

Cycles of different order are distinguished clearly on lithologic composition that corresponds well with electrical resistivity and gamma-ray (GR) logs. GR logs are considered as most informative and simplest. Natural radioactivity of rocks depends on the content of clay component that adsorbs the main radioactive elements. In part, distribution of the clay component in sediments of continental basins and epicontinental seas depends on distance from offshore, i.e., sea level position. Thus, GR logs have distinct geological significance. Lower radioactive levels correspond with sandstone, limestone and dolomites. Mudstones are characterized by greater radioactivity. On the GR logs for Kazanian part of section from 37 wells (Fig. 1) have been used for the analysis. There is a good correlation between GR curves in all wells (Fig. 2). We can see a great number of clay material inputs to basin.

Analysis Methods

The analytical procedure for such data is simple enough and is based on spectral analysis (Ulrych, T. J., Bishop, T. N., 1975) of

GR curves in each well. Previously we normalized all well sections to well No 13 section (reference section situated at the deepest part of basin) by using the depth relations of the corresponding biostratigraphic and lithologic horizons. The second step refined the correlation by comparing GR logs between the sections (Fig. 3). On the generalized spectra from all well sections (Fig. 4) one can see all possible cycles – their length characteristics (frequency) and amplitudes (relative power). There are five groups of cycles from spectral analysis of 37 normalized sections: 12.5-13.5 m., 16.5-19 m., 26-28 m., 47-49 m., 73-90 m.

Discussion of Results

Earlier estimates of the rate of Upper Permian mud accumulation on the east Russian plate by lamination analysis on paleosecular geomagnetic variations spectra, recorded in these rocks (Nourgaliev, D. K., Khasanov, D. I., 1992; Nourgaliev, D. K., Khassanov, D. I., Borisov, A. S., Yasonov, P. G., 1998), give values of 0.2-2.5 mm/year (at average – 1.5 mm/year). Time scales of cycles, calculated this way, can have mistakes for the following reasons:

· rate of accumulation of carbonates differs from that of muds;
· interruptions and local washout can be present in sections;
· average rate of accumulation varies in different parts of basin.

The first reason, probably, does not have great significance because the greater rate of mud accumulation can be compensate by lower rate of carbonate accumulation after statistical analysis of a large number of cycles of different length. The second reason is more significant. The effect is expressed in decreasing of cycle duration calculated using average rate of continuously accumulated muds. In which connection, the probability of lengthy interruptions (and washout) in sedimentation becomes larger depending on increasing cycle thickness (duration). The influence of third reason can be eliminated if we use only normalized sections (see above). According to the above-mentioned rates of accumulation, estimations of first group cycles duration is ~ 18,000 years, for second group is ~ 24,000 years. Preliminary estimated length of cycles are close to the duration of Milankovitch cycles resulting from variations of the Earth's orbit on global climate, ocean level and processes of sedimentation in basins, including continental (Hays, J. D., Imbrie, J., Shackelton, N. J., 1976). Milankovitch cycles for the last a few millions years have been investigated in detail (Miall, A. D., 1996). Analogous of these cycles has been obtained from Upper Triassic (Olsen, P. E., 1986). There are known data that confirm the stable character of these periods within entire Paleozoic (Berger, A., Loutre, M. F., Laskar, J., 1992). Thus, one can propose that the most frequent cycles in Permian continental sections and marine sediments with a duration ~10^4-10^5 years were also due to climatic changes associated with variations of the Earth's orbit. Average length of Milankovitch cycles for the Late Permian can be (Berger, A., Loutre, M. F., Laskar, J., 1992; Fischer, A. G., 1986; Miall, A. D., 1996): ~17.7-21.2 kyrs (precession), ~35.6-45.0 kyrs (obliquity), ~100 kyrs, ~130-140 kyrs, ~400 kyrs (all from eccentricity). Cycles revealed in GR logs of the Permian strata, at the Melekesskaya depression, can be associated with changes of water level in basin of sedimentation, i.e. with regional and global changes of climatic factors conditioned by variations of the Earth's orbit. To identify and estimate the duration of lithologic cycles, in the Upper Permian section, we used following information and suggestions:

1. There is a complete section of Kazanian stage strata in well No.13.
2. There are interruptions (gaps) and local washouts in sections. Average rates of accumulation depend on the duration of the period for which they were calculated. Average rates of accumulation decrease with increasing of the duration of period for which they were calculated (Sadler, P. M., 1981).
3. The average rate of sedimentation of continuously accumulated muds is ~ 0.2-2.5 mm/year.
4. The duration of the Kazanian stage is between 5,000 –10,000 kyrs (Harland, W. B., Armstrong, R. L., Cox, A. V., Craig, L. E., Smith, A. G., and Smith, D. G., 1990; Menning, M., 1995).

We correlated the shortest cycles (12.5-13.5 m) reflected in strata with precession periods (~17.7-21.2 kyrs), the second group of cycles (16.5-19 m) was correlated with obliquity periods (~35.6-45.0 kyrs), the next groups of cycles was correlated with eccentricity periods, respectively: 26-28 m - ~100 kyrs and ~130-140 kyrs, 47-49 m - ~400 kyrs (Fig. 4). existing gaps in sections were taken into account. Average rates of accumulation changed from 0.7 mm/year (for short cycles) to 0.12 mm/year (for long cycles). These data were controlled on the logarithmical-scale diagram (Fig. 5). There is a good logarithmical-law relation between cycle's length and it's duration. Relation (Fig. 5) based on the reference data (shown by circles) - variations of the Earth's orbit and length of Kazanian stage sedimentary cycles. But, it is possible to determine some unknown parameters (shown by triangles on Fig. 5): duration of two unknown cycles are ~830 kyrs (73 m) and ~1280 kyrs (90 m), also, duration of Kazanian Stage is ~6,000 kyrs (calculated by log-law relation for 185 m thickness of Kazanian sediments in well No.13).

Conclusions

1. We have shown the possibility of constructing an astronomically calibrated time-scale for Upper Permian (Kazanian) marine strata of the east Russian plate. There are sedimentary cycles in the sections of Kazanian stage which are a reflection of the influence of variations of the Earth's orbit (precession, obliquity, eccentricity) on climate of the Late Permian.
2. We have obtained log-law relation between the duration of Kazanian sedimentary cycles and their astronomically calibrated duration. There are great gaps in Kazanian sections of the east Russian plate. The existance of gaps is determined by average rates of accumulation depending on the duration of period for which they were calculated.
3. Preliminary estimation of the duration of Kazanian Stage is ~6,000 kyrs; this has been determined by astronomical calibration of sedimentary cycles while taking into account existing gaps (calculated by logarithmical-law relation).

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The Base of the Sakmarian Stage: Call for Discussion (Possible GSSP in the Kondurovsky Section, Southern Urals, Russia)

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Introduction

The Sakmarian is the second stage of the Cisuralian (Lower Permian) and one of the most widely used Permian stages in international practice. The base of the Permian and consequently base of Asselian was established at the Aidaralash Creek section, Kazakhstan. In this paper we are going to propose a potential definition for the base of the Sakmarian Stage and its position in the Kondurovsky section, Orenburgi Province, Russia. A detailed conodont biostratigraphic study has been conducted at Kondurovsky, southern Ural Mountains, Russia (Schiappa, 1999; Schiappa and Wardlaw, in prep.). Combined with detailed fusulinid biostratigraphy and stratigraphy these provide excellent data in support of Kondurovsky as the basal Sakmarian GSSP. A robust streptognathodid chronomorphocline exhibiting the evolutionary change from *Streptognathodus fusus* [65 meters above the base of the section (mab)] to *Streptognathodus barskovi (sensu strictu)* (75 mab) (Beds 7-9 of Chuvashov et al., 1993) can provide excellent definition for the base of the Sakmarian Stage of the Cisuralian Series. We propose to place the base of the Sakmarian within Bed 9 (75 mab) based on the first appearance (FA) of *Streptognathodus barskovi (sensu strictu)*, which is supported by the first appearance of the fusulinacean group of *Schwagerina moelleri*. This potential boundary is approximately 16 meters lower than the originally defined position of Sakmarian of Ruzhencev (Fig. 1). This relationship is also recognized at Aidaralash Creek, Novogafarovo and other sections of the southern Urals.

History of Asselian/Sakmarian Boundary Definition in Southern Urals

Karpinsky (1874, 1890) was the first to notice an ammonoid fauna older than the typical Artinskian in the Sakmara River area and designated the strata that contained this ammonoid fauna as the "lower belt of Artinskian Stage". Ruzhencev (1937) fully described this ammonoid fauna and along with Gerasimov (1937) recognized that this fauna and containing strata belong to the Permian System.

Ruzhencev (1951,1954) and Ruzhencev & Bogoslovskaya (1978) established the Sakmarian age based on the first appearance of new ammonoid genera (*Synartinskia*, *Propopanoceras*, *Synuraloceras*, *Kargalites*, *Parametalegoceras*, *Thalassoceras*, *Uraloceras*, *Paragastrioceras*, *Metalegoceras*, *Medlicottia*, and *Crimites*). Six of these genera belong to three families that were first derived in Asselian time. *Synartinskia*, *Propopanoceras*, *Synuraloceras* occur only in the Sakmarian of Russia. Subsequently they recognized the extinction of many ammonoid genera in the Sakmarian that appeared in Orenburgian – Asselian time. Ruzhencev recognized that the Sakmarian was an important stage in ammonoid evolution, but not as significant as the period of Permian ammonoid evolution during the Asselian.

The Sakmarian Stage was proposed by Ruzhencev in 1936. However, at first the Sakmarian included everything between the top of the Orenburgian (latest Pennsylvanian) to approximately mid-Artinskian (Ruzhencev, 1936, 1938). Later, the Sakmarian was divided into two substages: the Asselian and Sakmarian (Ruzhencev, 1950) and subsequently both units became independent stages (Ruzhencev, 1954). Both ammonoids and fusulinids have made the Sakmarian well known in the world stratigraphy (Ruzhencev, 1938, 1951; Rauser-Chernousova, 1940, 1949, 1965).

Although Ruzhencev did not share the concept of a stratotype, he described the Kondurovsky section as a type section for the Sakmarian Stage (Ruzhencev, 1950). His definition of Sakmarian was based on the evolution of ammonoids and fusulinids and lithologic characteristics. He established the Asselian/Sakmarian boundary at the base of Karamurunskaya Formation because of the correlation of latest Asselian ammonoids occuring in the Shikhanian Horizon (Gerasimov, 1937) in the Shikhans (eastern margin of Russian Platform) to the underlying Uskalikskaya and Kurmainskaya Formations of the southern Urals (Ruzhencev, 1951). Typical Sakmarian ammonoids were found in the Sarabilskaya Formation. No ammonoids (except long ranging *Agathiceras uralicum*) were described from by Ruzhencev from the Karamurunskaya Formation. However, the Karamurunskaya Formation was included in the Sakmarian because of significant changes in lithofacies and fusulinid faunas.

Indeed, over most of the Russian Platform Asselian marine carbonates of the are replaced by sabkha evaporites of the Sakmarian. In the southern Urals (particularly in the Ural subbasin) predominately carbonate sedimentation is replaced by predominantly siliciclastic sedimentation (Ruzhencev, 1936, 1950; Snyder et al., 1996).

The Schwagerina Horizon (in sense of stage) has been used in the Russian literature since the last century (Nikitin, 1886). The top of this "stage" is marked by the extinction of "*Schwagerina*" (= *Sphaeroschwagerina* in modern sense). In the southern Urals it was believed that the *Sphaeroschwagerina* extinction occurred at the top of the Kurmainskaya Formation (Rauser-Chernousova, 1940, 1949, 1965). "*Pseudofusulina*" *moelleri* (= *Schwagerina moelleri* in modern sense) was chosen as the index for the base of Sakmarian (Rauser-Chernousova, 1940, 1949, 1965). Therefore, the disappearance of *Sphaeroschwagerina* and appearance of *Schwagerina moelleri* at the base of the predominantly siliciclastic Karamurunskaya Fm. marked the Asselian/Sakmarian boundary. This definition is widely accepted by most stratigraphers and geologists. However, our data shows that the first appearance of the *Schwagerina moelleri* group is actually in the uppermost part of the Kurmainskaya Formation (see fusulinid section).

New ammonoids recovered from Bed 12 (172.5 mab) in the Karamurunskaya Formation contain typical Sakmarian species including *Artinskia nalivkini*, *Propopanoceras postsimense*, *Sakmarites postcarbonarius*, *Neopronorites tenuis*, and *Paragastrioceras sintasense* (Schiappa, 1999).

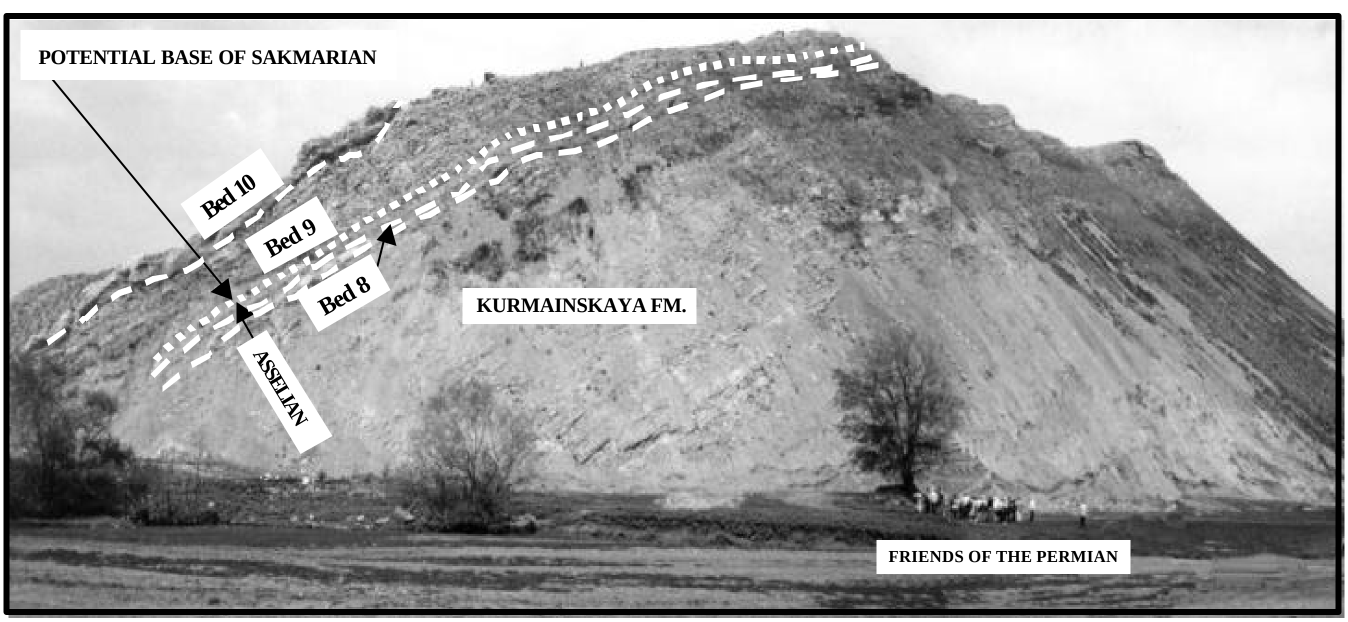

Figure 1. Potential Sakmarian type section at Kondurovsky, Russia.

Stratigraphy and Sedimentology of the Asselian-Sakmarian Boundary Units at Kondurovsky, Russia

Tamra A. Schiappa and Walter S. Snyder

General Lithostratigraphic Framework

The Kondurovsky section was originally described by Murchison et al. (1845), and Karpinsky (1874) with subsequent descriptions by Ruzhencev (1950; 1951), Rauser-Chernousova (1965) and Chuvasov et al. (1993). Ruzhencev and Rauser-Chernousova subdivided the section into several units; the Asselian Kurmainskaya Formation; the Sakmarian (Tastubian) Karamurunskaya and Sarabilskaya formations and the Sakmarian (Sterlitamakian) Maloikskaya and Kondurovskaya formations. Lowermost Artinskian strata are represented in this section. Bed numbers have also been assigned (Chuvasov et al., 1991, 1993) to the different units which make up each formation.

Sedimentary Facies Description

The Cisuralian strata at Kondurovsky are divided into several major lithofacies, modified from Schiappa and Snyder, 1998 to reflect the mixed siliciclastic-carbonate nature of each lithofacies (Table 1). Sedimentologic, stratigraphic, and petrographic information indicates that the lithofacies reflect a mixed siliciclastic-carbonate, middle and outer ramp depositional environment consisting of fine to coarse silty to sandy limestones, occasional rudstones and floatstones, and very fine to coarse allochemic sandstones (Table 1).

Asselian-Sakmarian Facies Sequence

Asselian - Shikhanian Substage

Shikhanian strata are exposed from the base of the section to 75 mab (meters above base) at Kondurovsky section II and III; this corresponds to Beds 1 through the lowermost part of Bed 9. This interval is dominated by sM lithofacies interbedded with sev-

FACIES	DESCRIPTION
Carbonate-dominated	
sM	Light brown to brown silty micrite with pellets, sponge spicules, radiolaria, minor amounts of organic detritus; silt content up to approximately 25%.
s/ssWPe	Fossiliferous silty to sandy wackestone - packstone, fine to medium grained, with variable amounts of silt and fine sands, fusulinaceans, small forams, bryozoans, pelmetozoan fragments, peloids, and carbonate mud intraclasts. Bed thickness varies from a few centimeters to several meters.
ssGe	Fossiliferous sandy grainstone, fine to coarse grained, with fusulinaceans, small foraminifera, bryozoan, pelmetozoan, brachiopod and cephalopod fragments (allochems), peloids, carbonate mud intraclasts, and variable amounts of extraclasts. Alignment of grains is visible in some samples. Laminar beds with lateral dimensions of a few centimeters to 0.75 meter in thickness.
ssWPGe	Wackestone-packstone-grainstone event beds ("e"); medium to coarse grained, locally graded and scoured bases with rare flute casts and load structure and rippled tops. Constituents same as s/ssWP and ssG. Beds vary from a few centimeters to several meters thick.
RFL	Gray black and brown limestone pebble rudstone and floatstone, with minor fossiliferous debris (fusulinacean, pelmetozoan and bryozoan fragments) comprised of carbonate mud clasts. Fine-grained micrite matrix. Carbonate mud clasts vary in size from 1 mm to several tens of cm, tend to be well rounded and oblate. Minor component of wackestone clasts with fusulinacean, small foraminifera and pelmetozoan fragments. Bed varies in thickness from 30 centimeters to several meters.
Siliciclastic-dominated	
mS	Micritic siltstone with sponge spicules, radiolaria and minor amounts of organic debris, carbonate mud content up to approximately 30%.
aSS1	Very fine, structureless allochemic sandstone, interbedded with siltstone-mudstone with up to approximately 30% fossiliferous debris and a silty carbonate mud matrix.
aSS2	Fine allochemic sandstone with up to approximately 30% fossiliferous debris and a silty carbonate mud matrix, grading apparent in some beds; parallel laminations common in most beds, thickness of a few centimeters, typically 15 to 30 cm, and up to 1.5 meters in amalgamated beds.
aSS3	Medium (coarse to fine) allochemic sandstone with up to approximately 30% fossiliferous debris and a silty carbonate mud matrix, typically graded and parallel laminations; rippled tops common, but not ubiquitous; some exhibit erosive bases with flutes, tool marks, load structures and local hummocky cross stratification.
aSS4	Coarse grained allochemic sandstones to very fine pebble conglomerates with up to approximately 30% fossiliferous debris and a silty carbonate mud matrix, thickness of several centimeters to 1 meter.

Modifiers:
m = micritic; applied to siliciclastics with < 50% carbonate
s/ss = silty/sandy; applied to carbonates with < 50% sand/silt
a = allochemic; carbonate bioclasts and lime clasts

Table 1. Lithofacies description for Kondurovsky, southern Ural Mountains, Russia.

eral 30 centimeters to 1 meter thick s/ssWPe and ssGe and 1.5 m RFL of Bed 8. A shallowing upward, outer ramp deposition is interpreted for this stratigraphic interval with the influx of event deposits possibly initiated by storms (Fig. 2).

Sakmarian - Lower Tastubian Substage

The basal units of the Sakmarian Stage (early Tastubian) are exposed from 75 to 220 mab in sections II and III, Kondurovsky and are grouped into four lithofacies, sM, s/ssWPe, ssGe, and RFL. The sM facies dominates this interval interbedded with numerous 30 centimeters to 1 meter thick s/ssWPe and ssGe units and 30 centimeters to several meters thick RFL bed (Bed 10) (Fig. 2). The RFL lithofacies of Bed 10 vary in thickness from one to several meters and contain large carbonate mud clasts, ranging from centimeters to meters in size. This is probably related to lateral variation within the sediment gravity flow or perhaps this interval represents a succession of gravity flow deposits. The covered intervals in Beds 11 and 12 are interpreted to represent sM facies. Outer to middle ramp deposition is interpreted for this stratigraphic interval with the incursion of event deposition, possibly driven by storms. The RFL bed may represent a period of sea level lowstand and collapse of a portion of the distally steepened ramp.

Depositional Environment

The Kondurovsky Asselian-Sakmarian succession reflects mixed siliciclastic-carbonate deposition on a storm-dominated, open, outer to middle ramp. The stratigraphic record does not contain any time-significant stratigraphic discontinuities, however, a sea level lowstand may be represented by the RFL unit of Bed 10 (Fig. 2).

The lithofacies recognized at Kondurovsky reflect normal background, hemipelagic to pelagic sedimentation and episodic event deposition (see Table 1 for details). The sM and mS successions are interpreted as background deposition on the mid-outer ramp. The sM and mS lithofacies record continuous deposition with no evidence of subaerial exposure even during periods of relative sea level lowstands. This suggests that subsidence was uninterrupted, keeping up with eustasy or that relative sea level changes were only a few ten's of meters in magnitude. Ramps behave differently to changes in relative sea level than rimmed shelves. A minor sea level fall will result in a basinward shift of depositional facies, leaving only the old inner ramp exposed, while on flat-topped rimmed shelf, the whole platform interior will be exposed (Burchette and Wright, 1992).

The silty-sandy wackestone/packstone (s/ssWPe) and sandy grainstone (ssGe) lithofacies appear abruptly throughout the section. The clastic components (bioclasts and siliciclastic lithoclasts) were derived from the inner to middle ramp and accumulated during event deposition. Systematic study of sedimentary structures was not conducted, but the majority of these event beds appear to lack sedimentary structures such as, sole marks, hummocky cross stratification and wave ripples. This lack of sedimentary structures has made reconstruction of sedimentary dynamics difficult. However, the most plausible interpretation is that these event beds were storm-induced accumulating below storm wave base. The offshore directed bottom currents reflect contemporaneous transport of pelmetozoan ossicles, bryozoan fragments, fusulinaceans, carbonate mud clasts and siliciclastics from near shore and deposit them as event beds. There is no significant time-reworking of the bioclastic debris.

The unique occurrences of the rudestone/floatstone (RFL) units suggest that some major event triggered their deposition and that the mixed siliciclastic-carbonate ramp may have been distally steepened. A series of RFL beds occur at the same stratigraphic position in the Karamuruntau Range along the edge of the Sakmara River valley (minimum of 10-30 km long along strike). Unlike the event beds, the RFL units are oligomictic. These units are laterally extensive, typically 0.5 to a few meters thick and are characterized by well rounded, oblate carbonate mud clasts varying in size from 1 mm to several tens of cm (long dimension) and minor fossiliferous debris (fusulinacean, pelmetozoan and bryozoan fragments) in a carbonate mud matrix. Storm deposition of these units is unlikely because they lack sedimentary structures and are oligomictic as opposed to the polymictic nature typical of storm induced strata. Storm induced strata are typically matrix-poor and better sorted than the mud-rich and poorly sorted RFL lithofacies. Therefore, two other possible interpretations for the origin of this lithofacies are suggested:

1). The RFL units were the result of slope collapse. During sea level lowstands, the exposed or shallower portion of the ramp is weakened by physical and chemical processes, and collapse of the distally steepened ramp results in limestone conglomerate accumulations (Burchette and Wright, 1992; Coniglio and Dix, 1992). Accumulation of coarse limestone sediments is enhanced on distally steepened ramps. This interpretation for the mechanism of deposition would indicate that the Pre-Uralian ramp is distally steepened and not a homoclinal ramp.

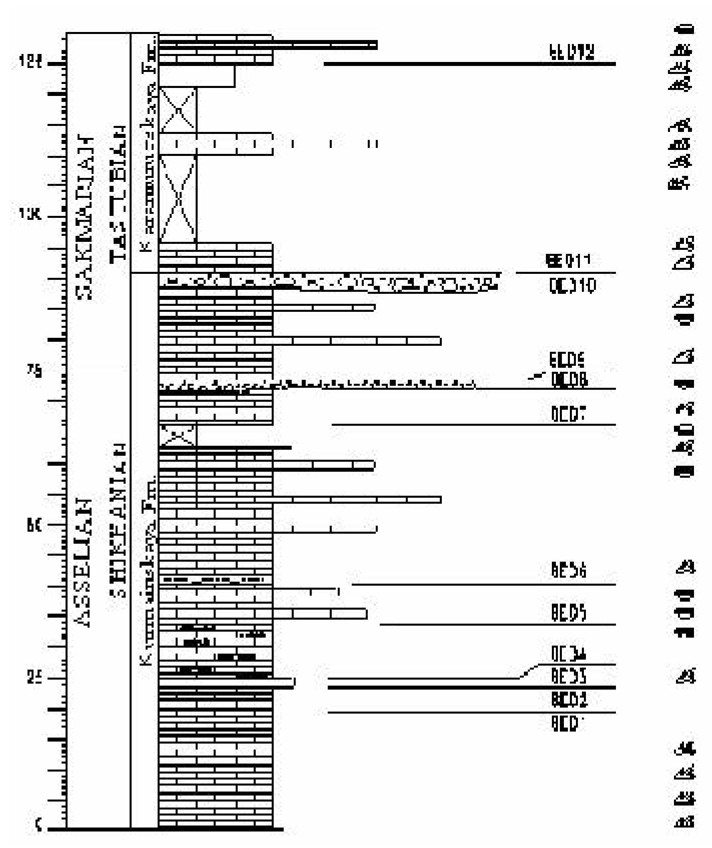

Figure 2. Stratigraphic column of section II and III, Kondurovsky, Russia. Conodont and fusulinid distribution indicated by and symbols.

2). Another plausible scenario for production of these units is slope failure due to tectonism. Seismic activity may induce a slide and the carbonate mud blocks and clasts are rafted along in a mud slurry down a very low angle slope (Burchette and Wright, 1992; Coniglio and Dix, 1992). Because the entire southern Uralian region was tectonically active from Upper Carboniferous through late Cisuralian, it is possible that these units were seismically induced.

Fusulinid Biostratigraphy at the Asselian-Sakmarian Transition in Kondurovsky Section

Vladimir I. Davydov and Ernst Ya. Leven

Fusulinids are important and most widely used as biostratigraphic tools for defining the base of the Sakmarian in the Russian Platform and Urals. Rauser-Chernousova in the Preurals (Rauser-Chernousova, 1940) and Shamov et al. (1936) in the subsurface of Russian Platform margin (Ishimbay oil-field area) introduced fusulinid biostratigraphic succession of Asselian and Sakmarian. The boundary between these stages was placed at the base of the horizon characterized by "*Pseudofusulina*" *moelleri* [= *Schwagerina moelleri* (Schellwien) in terms of modern taxonomy]. In the Preurals this boundary was defined between Kuraminskaya Formation with advanced *Sphaeroschwagerina, Pseudofusulina* (*Ps. sulcata*, *Ps. declinata*), and *Schwagerina* (*S. idelbajevica, S. parajaponica, S. sphaerica* and *S. firma*) and Karamurunskaya Formation with "*Pseudofusulina*" *moelleri* and relative species. *Sphaeroschwagerina* is believed to have gone extinct by the end of Asselian (Rauser-Chernousova, 1940, 1949, 1965). Although Ruzhencev (1951) and Rosovskaya (1952) listed the occurrence of "*Pseudofusulina moelleri*" in Kurmainskaya Formation and therefore the Kurmainskaya Formation should be included within Sakmarian, however this data has never been included in the definition of the base of Sakmarian.

Fusulinid studies for last decade (Davydov et al., 1995, 1997, 1998) have recognized several new aspects on fusulinid biostratigraphy at the Asselian-Sakmarian transition at the Kondurovsky section. In Beds 5-7, the assemblage is represented by typical late Asselian fusulinids including *Schwagerina firma* (Shamov), *S. idelbajevica* (Shamov), *S. parva*, *S. exuberata* (Shamov), *Schwagerina? declinata* (Korzhinskyi), *Schwagerina? composita* (Korzhinskyi), *Pseudofusulina sulcatiformis* Leven et Scherbovich, *Schwagerina? gareckyi* (Scherbovich), *Zigarella lutuginiformis* (Rauser), and numerous and diverse *Rugosofusulina*. Two poorly oriented and preserved specimens of Tethyan fusulinid ?*Zellia* sp. were identified as well.

Within bed 6 two specimens of *Schwagerina* sp. 1 relative to the fusulinids of the *Schwagerina moelleri* (Schellwien) group were identified. Their four and a half volution test is relatively small size (5 mm and 8.5 mm in length), and coiled smoothly throughout the growth. Irregular septal fluting is significant just in the inner volutions and in the outer two volutions fluting is intense mostly in the polar regions. Only rare (one or two) phrenotheca in outermost volution of these specimens were recognized.

In Bed 8 the fusulinid assemblage is generally the same as in the underlying beds. However two specimens of *Schwagerina* sp. 2, which we will describe as a new species, very similar and certainly relative with *Schwagerina moelleri* (Schellwien) were found. These forms are similar to *Schwagerina moelleri* by shape of the test in all volutions, similar non-regular coiling – compact in the first three-four volution and high in the fourth-fifth and following volutions. However these specimens differ from real *Schwagerina moelleri* (Schellwien) by smaller size of corresponding volutions, and less developed septal fluting particularly around the tunnel area. These forms also have phrenotheca, but they are rare. Another specimens of this species were found near the base of Kurmainskaya Fm. at the Novogafarovo section together with *Streptognathodus barskovi* (see conodont section).

One more specimen of this new species was found in bed 30 at the Aidaralash section. In 1986 this bed was included in Sakmarian (Davydov & Popov, 1986, Davydov, 1986) because of the occurrence of this *Schwagerina* sp. 2 and particularly because of the occurrence of many taxa (first primitive *Darvasites*, and numerous new species of *Pseudofusulina* and *Rugosofusulina*) described from Sakmarian beds in Darvaz region (Leven & Scherbovich, 1980). However, later the base of Sakmarian at Aidaralash was tentatively placed at the base of Bed 34.

In Bed 12 at Kondurovsky, the fusulinid assemblage includes some species that appeared in older strata, but most of the Asselian *Schwagerina* species disappeared and *Schwagerina* sp. 2 become numerous in this bed. Typical *Schwagerina moelleri* (Schellwien) first appeared only in the very top of the Karamurunskaya Fm.

Based on all this new data and with agreement of new conodont data we suggest to define the base of Sakmarian in terms of fusulinid biostratigraphy by first appearance of *Schwagerina* sp. 2. Therefore the boundary will be placed at the base of Bed 8 in the Kondurovsky section, at the base of Bed 30 at Aidaralash section and at 551 mab in Novogafarovo section. In the Usolka section this boundary probably should be placed between Beds 25 and 26.

Replacement of the boundary from base of Karamurunskaya Fm. (Bed 10) into Bed 8 or 9 within Kurmainskaya Fm. reflects our understanding of Asselian-Sakmarian fusulinid biostratigraphy. First of all, one of the most significant criteria for definition of the base Sakmarian – the *Sphaeroschwagerina* disappearance – should be changed. It should be change not only because of boundary replacement but also because of new data accumulated over the last decade. Konovalova (1991) reported the occurrence of *Sphaeroschwagerina sphaerica* in the lower Sakmarian in the Timan-Pechora Basin. Walhman et al. (1995) and Nilsson and Davydov (1997) found rare *Sphaeroschwagerina* in Spitsbergen and Barents Sea subsurface. A few specimens of *Sphaeroschwagerina sphaerica* were found in our latest studies in Bed 36 at Aidaralash together with typical Sakmarian ammonoids. Therefore the paradigm about the extinction of *Sphaeroschwagerina* by the end of Asselian in the Urals and Arctic should be changed with an agreement with data from the Tethys region where occurrence of the *Sphaeroschwagerina* in Sakmarian was reported long ago (Leven, 1965; Bensh, 1972).

Transitional character in the evolution of fusulinid fauna near the Asselian-Sakmarian boundary exhibits similar features in fusulinid evolution observed across the Carboniferous/Permian boundary. Because this fusulinid transitional in the Urals and Kansas coincides with high stand system tract we can propose that the suggested Asselian/Sakmarian boundary at the Kondurovsky section also coincides with a high stand which is fully supported by the stratigraphic data. That is likely supported by data from Kansas where *Streptognathodus barskovi*, the index for the base of Sakmarian, occurs at the base of Bader Limestone (Eiss Limestone) indicating high stand (Boardman et al., 1998).

The Base of Sakmarian at Kondurovsky, Russia: New Conodont Data

Tamra A. Schiappa and Bruce R. Wardlaw

A detailed conodont biostratigraphic study has been conducted at Kondurovsky, southern Ural Mountains, Russia (Schiappa, 1999; Schiappa and Wardlaw, in prep.). Conodont faunas were collected throughout the Kondurovsky section from Asselian through basal Artinskian strata. Conodont collections sampled throughout the Sakmarian boundary interval, from 0 to 95 meters above the base (Beds 1 through the base of Bed 11), are dominated by Pa elements of *Streptognathodus.* This new conodont data may facilitate the decision process for defining the base of the Sakmarian stage.

A well preserved and abundant robust streptognathodid chronomorphocline has been identified that may provide excellent definition for the base of the Sakmarian Stage of the Cisuralian Series. The change from *Streptognathodus fusus* to *Streptognathodus barskovi (sensu strictu)* has been identified between 65 to 75 mab (Beds 7-9) and would provide a convenient boundary placement. We propose to place the base of the Sakmarian within Bed 9 (75 meters above the base) based on the first appearance (FA) of *Streptognathodus barskovi*, approximately 16 meters lower than the originally defined position. Placement of this boundary is supported by the first appearance of the fusulinacean *Schwagerina moelleri* and this relationship is also recognized at Aidaralash Creek section and other sections studied in the southern Urals.

The Sakmarian Stage was named by Ruzhencev (1936) at the Kondurovsky section based on sedimentologic and ammonoid and fusulinid faunal changes. In 1940, Rauser-Chernousova provided a more precise definition for the Asselian/Sakmarian boundary based on the extinction of the fusulinacean genus *Sphaeroschwagerina* and the first appearance of *Schwagerina moelleri*. At the Kondurovsky section, the originally defined position of the Asselian/Sakmarian boundary is at the top of Bed 10, which coincides with a sequence boundary and is unacceptable for an internationally defined boundary. Historically, fusulinaceans and ammonoids have been used for boundary definitions but tend to be provincial at the species level and, therefore, are not suitable for global correlation. Conodonts have proven to be useful for defining boundaries because they exhibit subtle morphologic changes within a stratigraphic continuum that can be correlated precisely world wide.

Streptognathodus barskovi as described by Kozur (1976) has been problematic because of poor taxonomy and the misuse of this form in many southern Ural Mountain sections. This may be due to poor illustrations, miscommunication among conodont workers and poorly developed taxonomy of Lower Permian conodonts. For example some workers may have synonymized *Streptognathodus postfusus* Chernykh and Reshetkova into *S. barskovi* Kozur, however based on careful examination of the poor illustrations it appears as though *S. postfusus* is truly *S. fusus* Chernykh and Reshetkova. The original paradigm for *S. barskovi* was poorly established and illustrated (Kozur, 1976); one of the figured specimens was from Bed 12 of the Ajdaralasi (Aidaralash) section, occurring well below the Permian, where the holotype was from ammonoid matrix from the Tabantal River, well above the base of the Permian. Hence, there has been a lot of confusion about *S. barskovi*. Almost every form that we place into a robust lineage of *Streptognathodus* species has been placed in *S. barskovi* at one time or another. Recently, Kozur rephotographed the type specimen (personal commun., 1997) and Chernykh and Ritter (1997) illustrated several topotypes clarifying the true nature of *S. barskovi*. We use these newly illustrated specimens as the paradigm for *S. barskovi (sensu strictu*).

S. barskovi (sensu strictu) differs from its predecessor, *S. fusus*, by having a longer carina, a longer, high but less flared inner adcarinal parapet, parapet declinations are more unequal, the inner extending further anteriorly than the outer, especially in dextral elements, and the declinations are more denticulate anteriorly. The types of *S. postfusus* are considered gerontic specimens of *S. fusus* and not recognized as a separate zone or predecessor by us.

Streptognathodus barskovi (sensu strictu) evolved from *S. fusus* through a transitional morphocline that highlights a progressive anterior lengthening of the inner adcarinal parapet, increasing denticulation of the anterior declining portion of the parapets, and lengthening of the low anterior extensions of the parapets. *S. barskovi (sensu strictu)* also follows *S. fusus* in our material from Kansas, where it first occurs with *Sweetognathous merrilli* in the Eiss Limestone.

We would like to propose that the base of the Sakmarian be defined by the first appearance of *Streptognathodus barskovi (sensu strictu)* for several scientifically valid reasons, that include: 1) *Streptognathodus barskovi (sensu strictu)* belongs to the robust streptognathodid chronomorphocline, 2) the first appearance of *Streptognathodus barskovi (sensu strictu)* agrees with the first appearance of the transitional *Schwagerina* form referred to as *Schwagerina* sp. 2 (above), 3) *Streptognathodus barskovi (sensu strictu)* has been identified from basal Sakmarian strata elsewhere in the southern Urals, North America, China and the Arctic, and 4) its first appearance is close to the historically placed boundary that was initially designated based on lithologic characteristics.

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Upper Permian of Angaraland (Series and Stages Boundaries)

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The age determination of the Upper Permian plant-bearing stratigraphic successions of the central part of Angaraland (Siberian palaeofloral area) is a great problem. The new chronostratigraphic scale, based mainly on conodonts, can not be applied to these subdivisions. On the other hand it is not easy to trace the boundaries of the classical Upper Permian stages (Ufimian, Kazanian and Tatarian) from their stratotype area (Cisural and eastern part of the Russian platform, the Subangara palaeofloral area) to the Siberian area.

The Subangara area consists of four Kungurian-Upper Permian floras shown in an ascending order in Figure 1.

1) The rich and diverse Kungurian Barda flora, consisting of different pteridosperms, horsetails, ferns, conifers and cordaiteans,
2) The Viatscheslavia flora predominantly with arborescent lycopsids of the mentioned genus (Solykamsk horizon of the Ufimian Stage),
3) The diverse *Phylladoderma* flora that existed from the second part of Ufimian to the eary Tatarian,
4) The upper Tatarian *Tatarina*-flora consisting of peltaspermous and cardiolepidean pteridosperms and conifers mainly of the genus *Quadrocladus*.

There are only two cordaitean floras at the Kungurian-Late Permian age interval in the Kuznetsk coal basin stratotype region of the Siberian palaeofloral area. The older flora is composed nearly entirely of the cordaitean Verkhnjia Balakhonka. The younger flora is more diverse - fern pteridosperm-cordaitean Kolchugino.

The Verkhnaja Balakhonka series consists of four suites (Promezhutochny, Ishanovo, Kemerovo, Usjat or Usa layer) with peculiar plant assemblages. According to Gluchova (1984) the Ishanovo Suite is of Kungurian age because there is a great similarity of cordaitean complexes in both subdivisions. However a good connection did not exist between Subangarian and Siberian floras during Late Permian. That is why tracing the Upper Permian stage boundaries from Cisural and Russian platform to Siberia is very problematic.

Certainly the Subangaran and Siberian Upper Permian floras have absolutely different composition and constitution. The rare plants that occur in common do not solve correlation problems because they appeared later in the latter region than they did in the Subangara area. The best example of this phenomenon is the distribution of *Psigmophyllum* and Callipterids. Both plant groups are known from the Cisural Artinskian. Callipterids appeared in Siberia at the middle Ufimian and *Psigmophyllum* appeared here close to the beginning of Tatarian.

Therefore it is very difficult or impossible to determine the age of the Upper Permian plant-bearing subdivisions of Siberia by correlation with Cisural and Russian platform stages. That is why it is necessary to find another solution to this problem. Some solutions are discussed below.

Relation of the Angaran Floral Assemblages and the Boreal Marine Fauna

Permian marine basins are widely distributed around the Siberian platform; at the northern (Taimyr Peninsula), northeastern (Verkhoyansk Mountains, Kolymo-Omolon area) and the southern (Mongolo-Okhotsk belt) margins. The marine fauna of these regions (eastern part of the Boreal Realm) is represented mainly by ammonoids, brachiopods, pelecypods and small forams. The Omolon massif marine section is regarded as the key (Key section.... 1990). Some shallow marine measures of the regions mentioned above contain plant-bearing layers at different levels from Kungurian to the uppermost Permian. Summarizing data of the relationships of these faunal and floral assemblage M. V. Durante

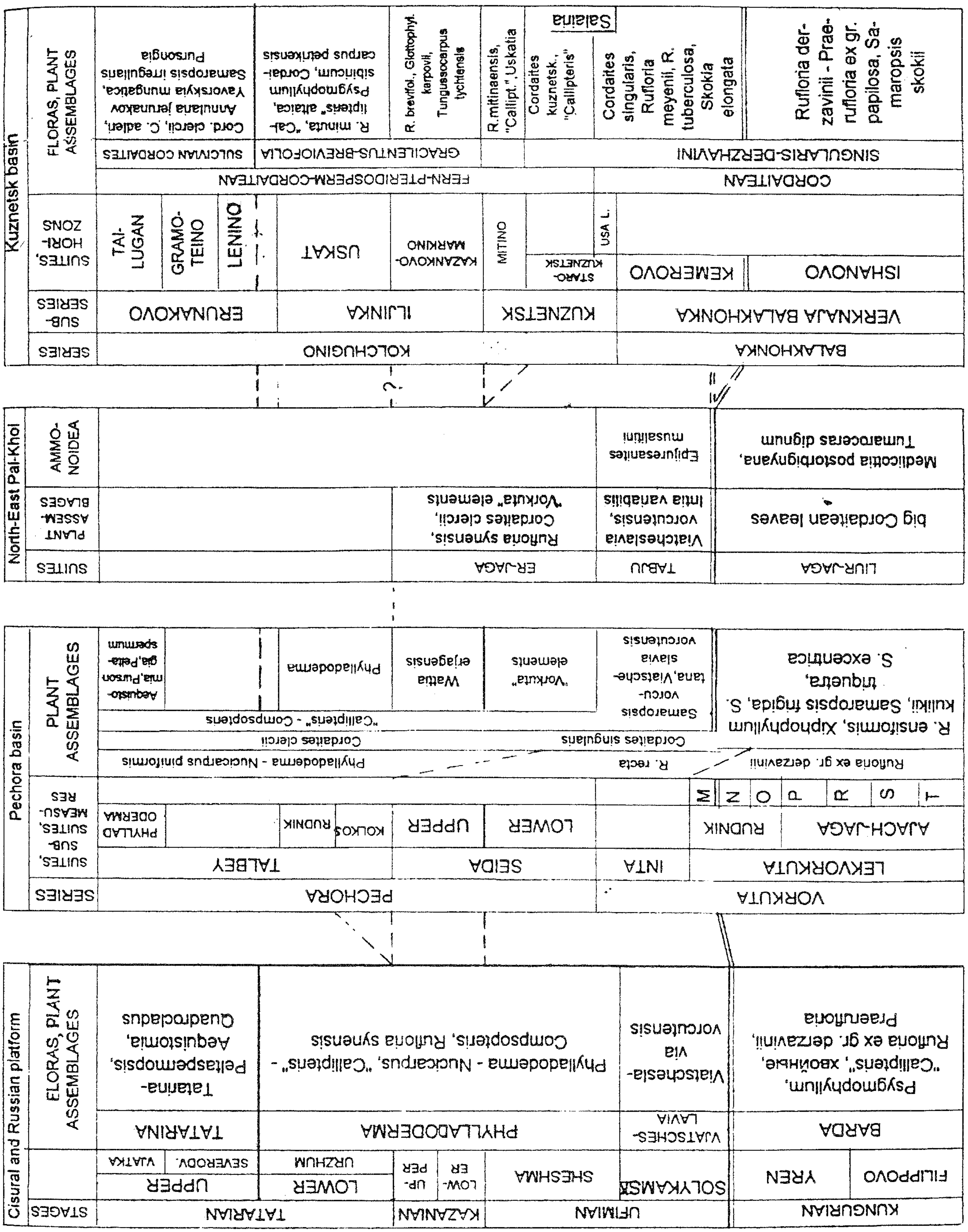

Figure1, 2. Correlation chart of Angaraland Permian classical sections in the Ural Mountains and the Russian Platform.

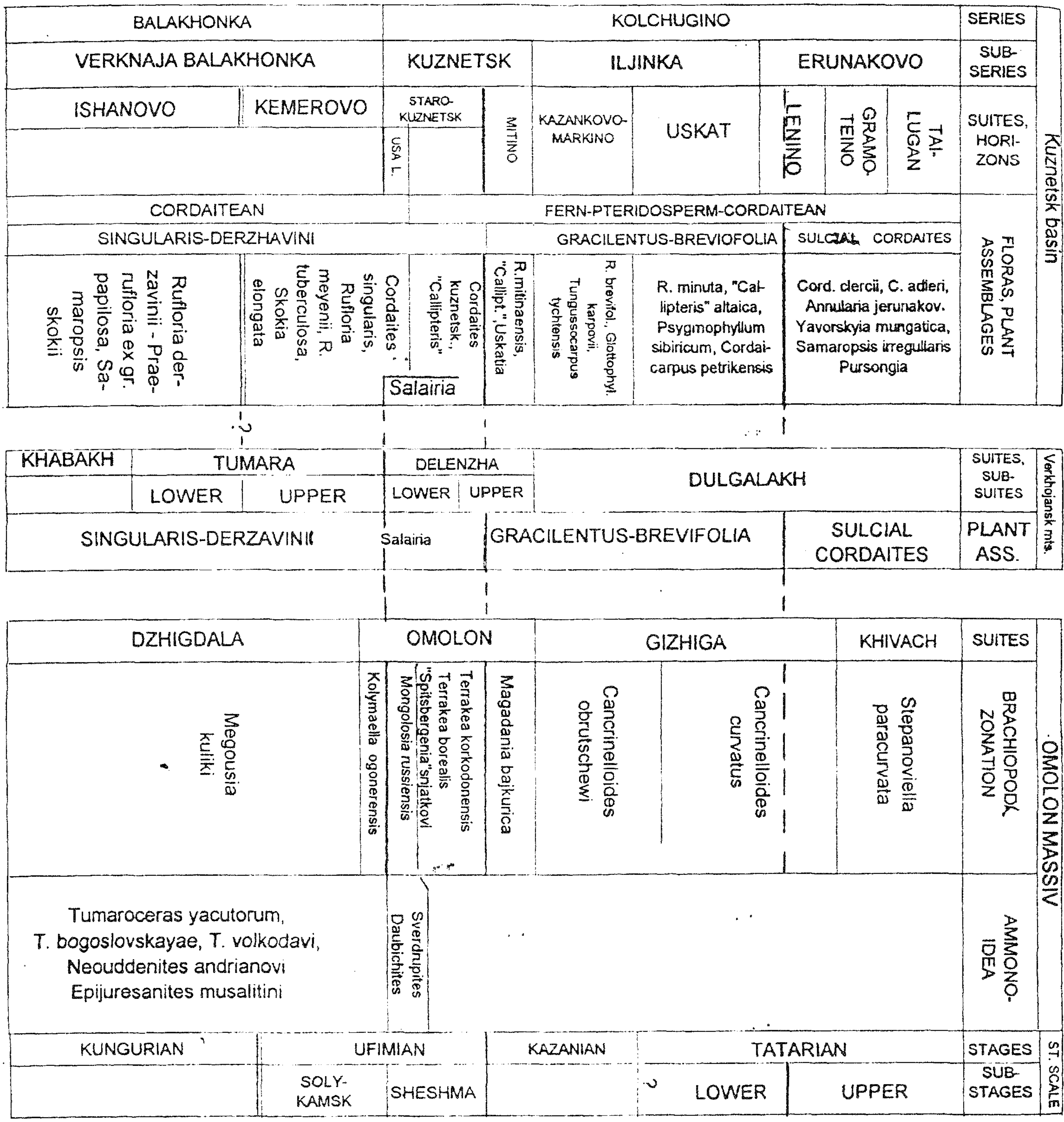

Figure 2.

concludes that every important Siberian (Kuznetsk basin) Kungurian - Upper Permian plant assemblages may be correlated with boreal marine faunas (Fig. 2).

The most important faunal change in northeastern Russia occurs at the boundary between the "Kungurian" (*Tumaroceras*) and the "Roadian" (*Sverdrupites - Daubichites*) ammonoid assemblages. It took place at the Tumara/Delenzha suite boundary of the Verkhoyansk Mountains and near the base of the Omolon massif Omolon horizon (Fig. 2). This level is regarded in this region as the Lower/Upper Permian boundary. It will be demostrated below that change in the ammonoid assemblages occurs at a higher stratigraphic position than the Kungurian/Ufimian boundary.

Moreover the appearance of the *Sverdrupites-Daubichites* assemblage is regarded as the marker for the base of the Roadian, the lower stage of Guadalupian (Jin Yugan *et al.*, 1994; Jin Yugan, 1996). It is incorrect, because the first *Sverdrupites* in Arctic Canada occurs together with the pre-Roadian conodonts (Nassichuk, 1975; Henderson, 1981). It is necessary to note that the *Sverdrupites-Daubichites* assemblage has been distributed globally.

Younger ammonoids are very rare in the eastern part of the

Boreal Realm. *Paramexicoceras* occurs in the Omolon massif but in uncertain stratigraphic position (Ganelin, personal communication) and *Timorites* is found at the Togotu Suite of the Transbaikal region (Okuneva, Zhakharov, 1992). According to G. V. Kotljar (1997) the brachiopods and pelecypods of the Togotu Suite permit correlation of this suite with the Gizhiga horizon of the Omolon massif.

In contrast to ammonoids, other marine invertebrates (brachiopods, pelecypods) were distributed in the eastern part of the Boreal Realm during Kungurian-Upper Permian time. Figure 2 shows the relationships between Kuznetsk basin plant assemblages and the brachiopod zonal scale proposed by V. G. Ganelin (Ganelin and Kotljar, 1984) for the Permian of the Omolon massif. This scale is applicable to Permian deposits of different regions of the eastern part of the Boreal Realm.
Following are the main results of this correlation:

1) The Tumara Suite of the western Verkhoyansk Mountains contains the Verkhnaja Balakhonka plant assemblage. The top of the Tumara Suite may be correlated with the base of the Usjatsk Suite (Usa layer according to the new terminology), because here the mosses *Salairia* were first found. This plant appears at the base of Usjatsk Suite. If we remember that the top of the Tumara suites is near the *Turnaroceras*/*Sverdrupites* ammonoid assemblage boundary, it is possible to say that this boundary coincides with the base of the Usa layer.

2) The plant assemblage of the Starokuznetsk horizon overlaps the Usa layer and occurs together with the *Terrakea* brachiopod assemblage of the Omolon massif type of Central Mongolia (determination by V. G. Ganelin).

3) So we correlate the Kuznetsk basin Mitino horizon with the *Magadania baicurica* brachiopod zone (uppermost part of the Omolon massif, Omolon horizon). In some sections of the Verkhoyansk Mountains, plant-bearing deposits containing the Mitino assemblage occur below diamictites, which are characteristic for the Gizhiga horizon and its analogs of the Russian North-east.

4) There are no data concerning the association of the younger ("*gracilentus*"-*brevifolia*) plant assemblage with marine faunas. The stratigraphic position of deposits characterized by this plant assemblage (between Mitino and sulcial cordaiteans) permit correlation with the lower-middle parts of the Omolon massif Gizhiga horizon.

5) Outside the Kuznetsk Basin the youngest Permian cordaitean assemblage (sulcial cordaiteans) are fully represented at the key section of the Tschemye Jary regional horizon (Taimyr peninsula, central part). This horizon contains marine faunas but its stratigraphic position (just above the rather thick succession that overlaps the marine Baicur horizon - the analogs of the *Cancrinelloides obrutschewi* brachiopod zone, V. G. Ganelin, personal communication) shows that the base of the Tschemye Jary horizon is located within the interval of the *Cancrinelloides curvatus* brachiopod zone (upper part of the Gizhiga horizon). Therefore, the youngest Siberian cordaitean assemblage may be correlated with the uppermost part of the Gizhiga and Khivach horizons of the Omolon massif.

As shown above, all the Kuznetsk basin floral assemblages have more or less precise Boreal marine faunal equivalents. However, our knowledge of the relationships between the floral and faunal assemblages does not help solve the problem of the age of the Siberian phytostratigraphic subdivisions because of the high degree of the boreal marine faunal endemism. Only one level (the appearance of the ammonoids *Sverdrupites* and *Daubichites*) has global correlation potential, but this level has not been reflected recently in any chronostratigraphic standards.

Therefore, correlation of Siberian floral assemblages with marine faunas is not a productive method to resolve the problem of age determination.

Significance of the Pechora Basin Section for an Age Determination of the Kuznetsk Basin Plant-Bearing Subdivisions

According to S. V. Meyen (1971) the Pechora basin belongs to a separate province of the Siberian palaeofloral area. Certainly, the Permian floras of this region are mainly cordaitean and have many common features with other Siberian floras. They consist of two great floras: the Vorkuta flora, which is very similar with the Kuznetsk basin Verkhnaja Balakhonka plant assemblage and the Pechora flora strongly resembles the Kolchugino flora.

On the other hand because of the geographical proximity of the Pechora basin to the stratotype region of the Permian System its floras contain many characteristic Subangaran plants. The presence of typical genera of the four stratotype floras (*Barda*, *Viatscheslavia*, *Phylladoderma* and *Tatarina*) permits recognition of these floras here. The combination of Siberian and Subangaran features at the Pechora basin Permian floras is the basis for correlation of Central-Angara phytostratigraphic subdivisions with the classic Cisuralian standard strata.

The position of main chronostratigraphic boundaries traced from Cisural through the Pechora basin to the central part of Angaraland is next:

1) The Lower/Upper Permian boundary. In the Kuznetsk basin the base of the Kolchugino series has been regarded as the boundary til the beginning of 90s. In the Pechora basin it occupies the lower position at the middle part of the Vorkuta series (the measure M base at the uppermost part of the Lekvorkuta Suite), where the Viatscheslavia flora has appeared. The change of *Barda* flora to Viatscheslavia marks the Kungurian/ Ufimian boundary in the Cisural stratotype section. S. K. Pukhonto (1998) followed this level to the lower part of the Kemerovo Suite in the Kuznetsk Basin. This opinion is in agreement with L. V. Gluchova (1984), who considers that the Kungurian/Ufimian boundary coincides with the base of the Kemerovo Suite.

2) The Ufimian/Kazanian boundary. During the last three decades the position of this boundary has been changed. In the beginning of seventies the predominaht point of view was that it coincided with the base of the Pechora series (Ustritsky, 1971). According to recent correlation with the stratotype section, the Ufimian/Kazanian boundary in the Pechora basin has been located in the middle part of the Seida Suite. Here the last "Vorkuta" species disappeared and the Pechora types began to dominate (Pukhonto, 1998). In the Kuznetsk Basin the same situation occurs near the base of the Mitino horizon. That is why we think that this level coincides with the Ufimian/Kazanian boundary.

3) The base of the Tatarian stage was traced to the lower part of the Talbei Suite in the Pechora basin but in the Kuznetsk basin its exact position is uncertain. We can only suppose that it lies near the middle part of the Lljinka subseries.

4) The base of upper Tatarian substage has the highest correla-

tion potential because besides the prominent floral change (*Phylladoderma* flora to *Tatarina*) it is marked with the great palaeomagnetic event - the boundary between the Kiaman and Illawarra hyperzones. In the Kuznetsk basin this palaeomagnetic change was recorded in the middle part of the Lenino Suite (Aparin *et al*., 1970), but according to the opinion of some palaeomagnetism specialists (E. A. Molostovsky, personal communication), these data must be checked further. The upper Tatarian age of the major portion of the Erunakovo series is supported by the findings of ostracods, conchostraca (Bogomasov *et al*., 1995) and the single Tatarina type *Pursongia* (*Tatarina* without cuticle). In the middle part of the Lenino Suite, near the possible palaeomagnetic boundary, the noticeable palaeofloral change ("*gracilentus*" - *brevifolia* to sulcial Cordaiteans assemblages) takes place. Therefore, the Tatarian substages boundary is recognizable throughout Angaraland.

The Possibility of the Cisural Upper Permian Stages Outstanding at the Marine Deposits of the Boreal Realm Eastern Part

On the basis of our knowledge concerning the relationships of the marine faunas and the floral assemblages (Fig.2) we will try to understand what stage boundaries may be traced from the Kuznetsk Basin to the marine sections of the Omolon massif and the Verkhoyansk Mountains.

1) The position of the Kungarian/Ufimian boundary at the Northeastern Russia is uncertain. The Verkhnaja Balakhonka (Ishanovo+Kemerovo) plant assemblage is known from the Tumara Suite of the western Verkhoyansk Mountains. There are insufficient data here to separate the Shanovo and Kemerovo plant assemblages. The Khabakh Suite, underlying the Tumara Suite, contains some Ishanovo species and its top is correlated with the base of the Usa layer. Therefore, it is possible to propose that the Ishanovo/Kernerovo suites boundary lies at the lower or the middle part of the Tumara Suite. Therefore, it is impossible to determine the exact position the base of the Ufimian (i.e. Lower/Upper Permian boundary) in the northeastern Russian marine sections.

As it was mentioned above, the other level, the Tumara Suite in the Verkhoyansk Mountains and the base of the Omolon horizon, is now regarded in this region as the series boundary. This level, marked by the change in ammonoid assemblages, has great correlation potential, but it can not be used as the chronostratigraphic boundary - neither at the classic Cisural standard, nor as the new cisequatorial one. This is why it is necessary to regard the Ufimian base as the Lower/Upper Permian boundary in Angaraland and the eastern part of the Boreal Realm.

2) According to our data the Ufimian/Kazanian boundary occurs near the base of the *Magadania baikurica* brachiopod zone in the uppermost part of the Omolon horizon.

3) The Tatarian base can not be recognized in the northeastern Russian marine sections but the Lower/Upper Tatarian substages were located in the upper part of the Omolon massif Gizhiga horizon. Here the paleomagnetic event (Kiaman to Illawarra hyperzones transition), coinciding with the substage boundary is noticed.

Therefore, the next subdivisions of the Cisural standard scale can be seen in the marine deposits of the Verkhoyansk Mountains and the Omolon massif: Ufimian, Kazanian and Lower Tatarian, and upper Tatarian. On the other hand, none of the subdivisions of the new Equatorial standard scale have been found here.

Conclusion

Two Permian standards are available now:

1) The classical Cisuralian standard scale based on the section, located at the transition area between the Equatorial and Boreal Realms;

2) The new standard scale proposed by the International Permian Subcomission, which is based only on the Equatorial sections and biota (Jin Yugan *et al*., 1994; Jin Yugan, 1996).

The aim of this report is to understand what standard scale is better for the age determination of phytostratigraphical subdivisions of the central part Angaraland. In spite of great difficulties in correlation, all the Cisuralian stage boundaries may be recognized (more or less precisely) in the Siberian palaeofloral area. It is very important to mention that most of these boundaries may be traced to marine sections of northeastern Russia.

The Equatorial standard subdivisions are based on conodonts, fusulinids and ammonoids, but really only the conodont zonation has been taken into consideration. Because of the absence of conodonts in the eastern part of the Boreal Realm the series and stage boundaries of the new standard are not recognized here.

Only the change of the ammonoid assemblages (*Tumaroceras* to *Sverdrupites* - *Daubichites*) permits realization of global correlation, but it has no chronostratigraphic significance because it is outside of any standard scale.

It is clear that the Upper Permian biota demonstrates a pattern of high degree of biostratigraphic differentiation. This situation requires the existence of at least two parallel independent standard scales for the Equatorial realm and the Boreal.

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A Serious Question for the Voting Members of SPS

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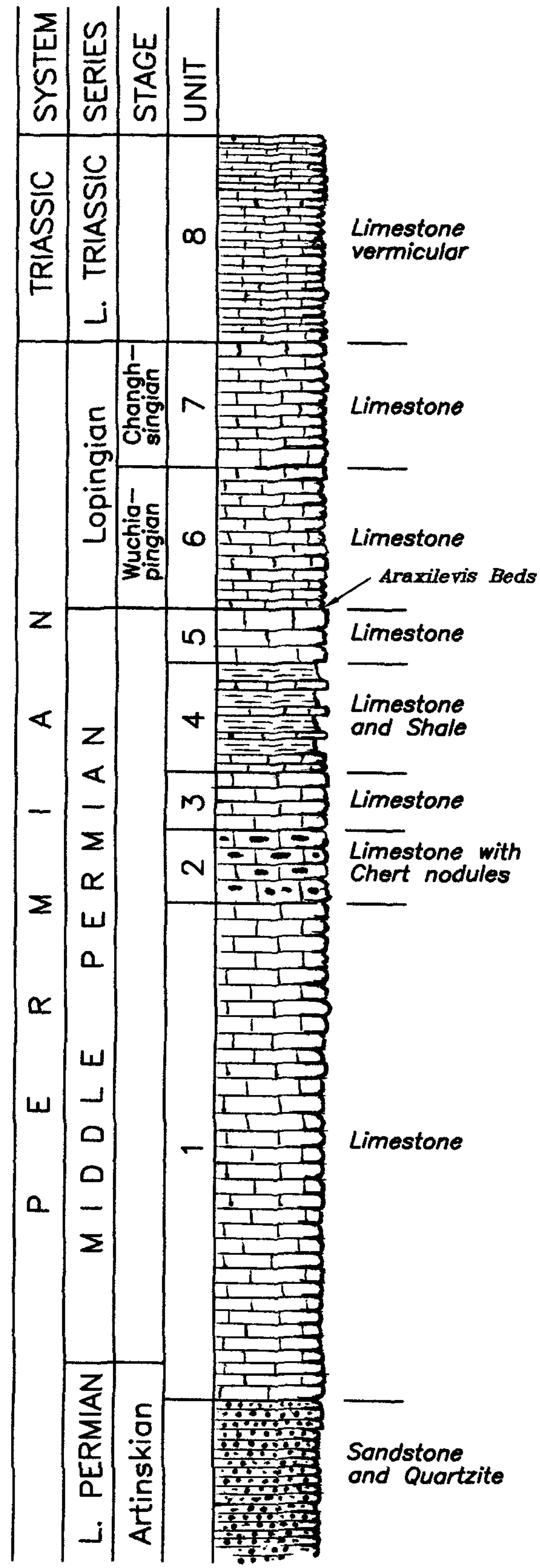
The article (The Permian Lopingian and Basal Triassic Sequence in Northwest Iran) by Dr. Walter Sweet and Dr. Shilong Mei in Permophiles #33- Jan. 99, encouraged me to bring up once more the stratigraphic significance of the Middle Permian marine rock outcrops of the Abadeh Section in Central Iran to the attention of my colleagues.

According to Sweet & Mei in that article "well-preserved conodont elements confirm that an almost complete Lopingian sequence may exist in the Kuh-e-Ali Bashi region of NW Iran" and "Beds in the Permian-Triassic succession at Kuh-e-Ali Bashi may also be correlated bed by bed with those at Meishan, Changxing, South China, and turn out to be another very important reference section for the Permian-Triassic boundary" They also conclude that "As a result, the section at Kuh-e-Ali Bashi, is another important reference section for the base of Triassic" and "it would be important to make a detailed restudy of bed I and underlying beds at Kuh-e-Ali Bashi, locality 4, to establish a candidate section for stratotype for the base of the Lopingian series in Iran."

These statements based on the "well-preserved conodont elements" confirm that a complete Lopingian sequence is present in the Kuh-e-Ali Bashi, NW Iran. Sweet & Mei also refer to the (Iranian-Chinese Research Group, 1995) that the basal bed of the Wuchiaping Limestone in South China correlates with the basal part of the Araxilevis Bed in the Central Iran (Permophiles #33, p.15). This statement supports geological and paleontological studies which conclude that the Lopingian sequence of the Kuh-e-Ali Bashi region in NW Iran is almost identical with units 6 and 7 of the Abadeh Section in central Iran, and consequently any geologic statement which may apply to Kuh-e-Ali Bashi, NW Iran would also be applicable to the Abadeh Section in Central Iran.



This means that:

Complete Lopingian sequence may also exist in the Abadeh region, Central Iran.

Beds in the Permian-Triassic succession of the Abadeh Section may be correlated bed by bed with those at Meishan, Changxing, South China, and consequently the Abadeh Section is another important reference section for the base of Triassic.

The basal bed of the Lopingian Series correlates with the Araxilevis Bed (the basal bed of unit 6) of the Abadeh Section, in Central Iran.

What is the Abadeh Section?

The Iranian-Japanese Research Group -1981 (page l24) describes the Abadeh Section as a "nearly continuous sedimentary sequence ranging from Artinskian up to the Middle Triassic, well documented in the Hambast Range, Abadeh region, Central Iran." As is shown in the figure below, the lower part of this Section consists of continuous marine sedimentary rocks of the Middle and Upper Permian age. The basal beds of unit 1 are of Artinskian age and unit 6 in the middle part of it, is of Wuchiapingian age.

The Iranian-Chinese Research Group restudied the Abadeh Section in May 1995 (Permophiles #27, Nov. 95, p. 5-6) and discovered *Clarkina postbitteri* and *C.Dukouensis* at the basal level of Araxilevis Bed and correlated the base of unit 6 of the Abadeh Section with the base of the Lopingian Series. Consequently, they conclude that "... it is one of the most promising regions in which a candidate section for global stratotype of the basal boundary of the Lopingian Series can be found." They also confirm that " The Guadalupian and Lopingian sequences were fully developed, and there is no obvious sedimentary evidence of depositional gap between the sequences of these two epochs."

Thus, the units 1,2,3,4 and 5 of the Abadeh Section which represent a continuous marine sedimentary sequence, younger than Artinskian and older than Lopingian, would be a perfect stratotype section for the Middle Permian in the center of the Tethyan Province.

Based on the above-mentioned evidences, the writer is asking his SERIOUS QUESTION, that is: In search of a stratotype section for the Middle Permian, why Subcommission on Permian Stratigraphy ignored completely the Abadeh Section in Central Iran, and went out of the Tethyan Province, in West Texas, to choose the relatively incomplete Guadalupian sections? Why SPS dismissed the report of the Iranian-Japanese Research Group-1981), and never discussed the Abadeh Section? Is there any specific reason for it?

Suggestion to the ICS Chairman

Either encourage the Geological Survey of Iran to participate seriously in a detailed investigation of the Abadeh Section under ICS guidance with the help of non-American geologists who can surely and easily participate in such a research in the Islamic Republic of Iran.

Or, put a hold on SPS decision concerning adoption of Guadalupian as Middle Permian Stratotype Section, until political atmosphere in Iran is improved and the American geologists can get permission to go to Iran and visit the Abadeh Section.

The writer believes that a scientific matter should be free of, and immune from the political and personal bias.

Response from the SPS Chair.

The Abadeh section is an important marine section that has been considered seriously by the SPS. Former Chair, Jin Yugan, set up the Iranian-Chinese working group specifically to improve the biostratigraphic information of the Abadeh section to improve its worldwide correlation. However, it was also under Jin's leadership that the SPS unanimously voted for a three part division of the Permian based on the marine successions in Russia, USA, and China. The SPS selected the best sections at the time and the next step is to improve the correlation to other sections. That the Chinese Lopinigian conodont succession can be correlated bed by bed to Kuh-e-Ali Bashi and Abadeh is proof that it serves as an appropriate standard. Though the Iranian-Chinese research team stated "the Guadalupian and Lopingian sequences are fully developed, and there is no obvious sedimentary evidence of depositional gap between the sequences of these epochs." in a *Permophiles* article (no. 27, p. 5-6) does not make it so. It needs documentation. The *C. postbitteri* reported in the same article (*Permophiles*, no. 27, p. 5-6) was examined by the Chair and found to be *C. dukouensis* suggesting that the *C. postbitteri* Zone is missing from Abadeh–But that is not the point. The point is the Abadeh section is not sufficiently studied or documented, especially the Guadalupian portion to serve as an international standard nor can it be guaranteed free international access. On the other hand, the Guadalupian, the birth place of sequence stratigraphy, is one of the most documented set of rocks in the world. It has a vast and documented biota, again one of the best in the world, giving it great correlation potential. The Guadalupian rocks are also wholly contained within a national park with guaranteed preservation and access. So, we should not throw out the Guadalupian for an, as yet, incompletely known section in the heart of Iran. No, we should move forward to improving correlation. But, we must remember that in moving forward our aim is in increasing our understanding, and, in that aim, I agree with Dr. Taraz that we should work on better understanding the Middle Permian succession at Abadeh and its correlation potential.

MEETING REPORTS

A Report from the International Conference on Pangea and the Paleozoic Mesozoic Transition

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The International Conference on Pangea and the Paleozoic-Mesozoic Transition was held on March 9-11, 1999 at the China University of Geosciences, Wuhan, China. sixty-six geoscientists from eleven countries participated in the symposium in Wuhan and some joined the pre-conference excursions to examine the Permian and Triassic sequences at Meishan section in northern Zhejiang, or at Xifanli section in southeastern Hubei, or at Penglaitan section in eastern Guangxi, and/or the post-conference excursion to visit the geology in the Yangtze Gorges areas.

During the three-day symposium in Wuhan, 44 addresses, including 5 key addresses, and 17 posters were presented, referring to the stratigraphy, paleontology, geochemistry, plate tectonics, paleogeography and sedimentology during the transition. The following are cited from the closing remarks given by Professor Yin Hongfu, the organizer of the conference, as the summary of this symposium.

Variety and contents of the contributions are such that it is beyond my knowledge to give a summary. However, I would like to take this opportunity to indicate just a few of them, which must be incomprehensive, so I beg your pardon if many of the valuable contribution are not mentioned in this short talk.

One interesting aspect of the talks concerns eastern Pangea and especially Tethys. Was Tethys a vast ocean that disappeared in later subduction? Or was it an archipelagic ocean? Or moreover, although not presented in this conference, was it merely a seaway especially between Karakorum and Turkey? Was South China for example an integrated microplate or a mosaic of blocks? Several authors mentioned polycyclic orogeny or riftogenesis in Kunlun, Yidun and Three Rivers regions. The idea of non-Wilson cycle characterized by archipelagic ocean, soft collision and multi-phase orogeny was suggested. These need further investigation.

Pangea paleobiogeography attracts certain interest. Cool water conodonts are mentioned, especially *Vjalovognathus*. Cosmopolitanic distribution of *Hindeodus parvus* evoke some suggestions. Also the occurrences of elements of *Glossopteris* flora in South Primorsk, SE Mongolia, and probably North China, and temperate fauna in Kitakami, do they represent bipolar distribution, or biotic expansion due to some factors, or evidences of Gondwanan dispersal and Eurasian accretion? Answers of these questions probably will result in reinterpretation and reconstruction of eastern Pangea and Tethys very different from the traditional views indicated in current literature.

Permian-Triassic transition, extinction and boundary formed a highlight of our conference. Keeping Meishan as the reference site, PTB sections of Arctic Canada, Oman, Australia, Iran, China and other countries were discussed, using many new methods other than bio- and lithostratigraphy, such as organic carbon isotope. Cerium and other geochemical elements, peat mire ecosystem, isotopic dating, paleomagnetism, and attempts on bed by bed high-resolution, inter-regional correlation. Development, extinction and recovery of ammonoids, forams, conodonts as well as radiolarians and other deep-water fauna were indicated and discussed. Isotopic dating at the boundary of Meishan section is quite in order bed by bed according to recent publication, but the absolute values are still open to debate by some. Two points of the extinction were emphasized: (1) It was mainly “a havoc from within”, although recent publication showing extraterrestrial impact can not be totally neglected; (2) Consequently, it was stepwise rather than just one stroke. But how many steps? Two phases or multi-phases? And more importantly, was there a major phase right at the Permian and Triassic boundary? If these two points are real, we still need to know the dynamics. Is it due to global stress-release event or eustatic control as indicated in ammonoids? Why did volcanism, anoxia, delta carbon 13 excursion, great R-T turning point, paleomagnetism anomaly and extinction granddaddy occurred together? And among them anoxia theory is doubted by oxygen-dependent bioturbation at the Permian and Triassic boundary. Clarification of the causality of these events will greatly enhance our ability to predict the human future since the world is now undergoing another biotic crisis.

Permian and Triassic stratigraphy is another highlight. Take the Permian for example. Chronostratigraphic subdivision, sequence stratigraphy, biostratigraphy and biota including plants, reefs, trace fossils, ammonoids, etc. have been discussed in detail. It is worthwhile mentioning that a proposal to set Penglaitan section and *Clarkina postbitteri* as GSSP of Guadalupian and Lopingian boundary was set forth. In the Permian 31 conodont zones have been established based on the correlation of South China, U.S., Salt Range, Kazakh and Iran. This gives a higher resolution of the Permian subdivision than by other fossils, ca. 1 ma per zone. The conodont zonation coincides to the amplitude frequencies of sea level change. Some papers cast doubts on the Exxon model of sequence stratigraphy based on passive margin with slope, emphasizing the tectonic control, and relative rather than eustatic sea level changes, i.e. in Spitzbergen, and different tract subdivision within a sequence.

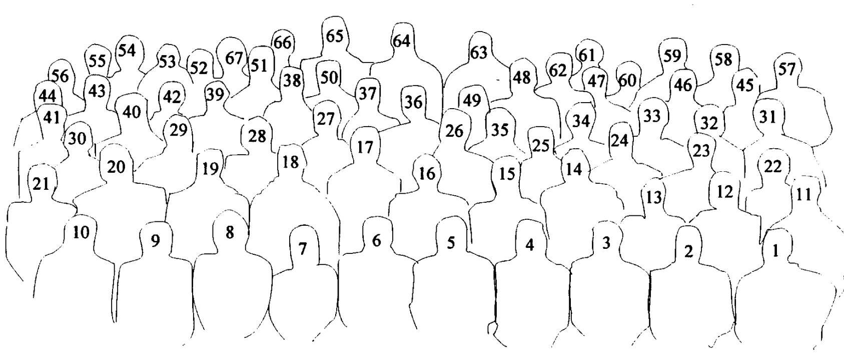
I also appreciate many paleontological discoveries shown in this conference. For example, the first vertebrate, a fish-like fossil, Cyclostomata?, discovered in lowermost Cambrian in SE Yunnan (Chengjiang Fauna). The initiation of Mesozoic Pumellina, possible Nassellina radiolarians were already in Late Permian.

As in other symposia, this conference has resulted in more questions than answers. However, scientifically raised questions lead the way toward success. Thus, for example, we need more investigations toward a better understanding of Pangea and Tethys. We need new approaches for high-resolution stratigraphy, in this regard susceptibility is noteworthy. Megafossils like ammonoids prevailed for nearly one Century, microfossils like conodonts replaced them in recent two decades, still it can only give a resolution of 1 ma per zone, and it is not enough. Stratigraphy seems to develop in an upward spiral way from biostratigraphy dominance to decoupled multi-disciplinary stratigraphy and then back to more or less sequence stratigraphy dominance now, and what is the postsequence stratigraphy stage? In future the most difficult challenge lies in Precambrian strata, mute or dumb strata, and orogenically deformed strata. Who knows if molecular paleontology like biomarkes and DNAs, geochemical and paleomagnetic markers and Milankovitch cycles will provide higher resolution, and resolve the mute strata problem in the future? In short, I hope this meeting will give an impetus to research these important aspects of the geosciences. In this regard I would like to mention that our Australian friend John Rigby has suggested to hold the next Pangea and Tethys meeting in Brisbane within next 3-5 years, and he is also trying to organize a new IGCP project.

This conference was co-sponsored by the National Natural Science Foundation of China (NSFC), Global Sedimentary Geology Program (GSGP), Paleontological Society of China (PSC), Subcommission on Permian Stratigraphy (SPS) of ICS, Subcommission on Triassic Stratigraphy (STS) of ICS, International Paleontological Association (IPA), and China University of Geosciences (CUG), financially aided by the NSFC, PSC and CUG.

The "Proceedings of the International Conference on Pangea and the Paleozoic-Mesozoic Transition" was formally published by the China University of Geosciences Press in Wuhan, including 14 full papers and 58 abstracts.

Pangea And The Paleozoic-Mesozoic Transition
China University Of Geosciences, 9-11 March 1999



1. Yugan Jin, 2. Hongfu Yin, 3. Aymon Baud, 4. Charles Henderson, 5. Brian Glenister, 6.Bruce Wardlaw, 7. Benoit Beauchamp, 8. Shu Sun, 9. Zunyi Yang, 10. Taosheng Li, 11.Zijian Xue, 12. Yongqun Gao, 13. Hongmei Wang, 14. Tatyana Leonova, 15. Igor Manankov, 16. John Rigby, 17. Degan Shu, 18. Yuri Zakharov, 19. Dinghua Huang, 20. Robert Nicoll, 21. Kuwahara Kiyoko, 22. Wei Wang, 23. Guoping Zhu, 24. Dorothee Mertmann, 25. Valentin Krassilov, 26. Gerhard Bachmann, 27. Shuzhong Shen, 28. Masayuki Ehiro, 29. Ian Metcalfe, 30. Benpei Liu, 31. Changquan Cao, 32. Qinghua Shang, 33. Yue Wang, 34. Zhizhong Huang, 35. Zhongqiang Chen, 36. Vladimir Davydov, 37. Shilong Mei, 38. Jonathan Glen, 39. Monica Campi, 40. Yuntang Pan, 41. Xiaosong Xu, 42. Ning Zhang, 43. Yoshitaka Kakuwa, 44. Lu. Wang, 45. Donglal Xu, 46. Shunbao Wu, 47. Kexin Zhang, 48. Chengyuan Wang, 49. Guanghua Liu, 50. Huazhou Yao, 51. Xiaoying Shi, 52. Ge Yan, 53. Paul Milroy, 54. Songzhu Gu, 55. Yiming Gong, 56. Xulong Lai, 57. Yuansheng Du, 58. Yuanqiao Peng, 59. Quanguo Li, 60. Fengqing Yang, 61. Qinglai Feng, 62. Weiping Yang, 63. Hans Hansen, 64. Tadeusz Peryt, 65. Roland Mundil, 66. Yusen Dong, 67. Jinnan Tong

Report of the Working Group "The Continental Sequences of the Permian"

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During the International Symposium "Upper Permian Stratotypes of the Volga Region", 28th July - 3rd August, in Kazan, Tatarstan, Russia, a meeting of the working group was held and the following report was given by Chairman V. Lozovsky:

The installation of this working group was proposed during the International Congress "The Permian System of the World" held in 1991 in Perm, Russia. It was formally founded at the SPS meeting during the Pangea Conference 1993 in Calgary, Canada. Since then the following meetings and field workshops took place:

- meeting of the WG during the XIII International Congress on the Carboniferous and Permian on the 31st August in Krakow, Poland, with 18 participants of 8 countries
- meeting and field workshop "Stratigraphy, Sedimentation and Basin Development" during the annual colloquium of the Freiberg Mining Academy, Germany, 19th-20th June 1997, with 22 participants of 6 countries
- a field workshop "Bohemian Permocarboniferous Basins" together with the French Association of Permian Geologists (AGP) was held in the Czech Republic on the 13th-17th July 1997 with 22 participants of 4 countries.
- The personal work of Chairman V. Lozovsky was focused on the study of the P/T boundary beds in the continental series of Eastern Europe, the classical region of the Permian System and one of the potential stratotype areas for Upper Permian stages. The results are summarized in the collective monograph "The Permian/Triassic Boundary in the Continental Series of East Europe". Unfortunately, this very informative 245-page book is written in Russian, the strongly requested translation into English is missing because of the lack of financial support.

Besides the lower and upper boundary of the Permian, future work of the group should be focussed on the following tasks:

- paleomagnetic investigations and correlations of continental and continental/marine sections
- establishing continental biostratigraphic zonations, primarily based on tetrapods, insects, conchostracans, fishes, ostracods, palynomorphs etc.
- investigation of mixed continental/marine sections for the correlation of exclusive continental profiles with marine standard scales.

For the last point**,** a special task was adopted during the XIII ICCP: the C/P boundary in continental series and marine/non-marine correlations (responsible J.W. Schneider). The basic idea is, to compile the relevant data and information by a computer based cooperative correlation chart via www. It is proposed by the Chairman to hold a special session on "The Continental Permian of the World" during the XXXI IGC in Brazil in 2000. This session should focus on the following problems:

1. stratigraphy of the continental series of the Permian of different parts of the world
2. biostratigraphical methods for the zonation and correlation of the continental Permian
3. lithological, geochemical and geophysical research of the continental Permian
4. marine/non-marine correlations of the Permian

After the Kazan meeting, further activities should be mentioned:

- start of the revision of the Novoshilov collection of Carboniferous, Permian and Triassic conchostracans in Moscow (300 type specimens and about 1,500 published specimens) as the basis for the computer-based taxonomic and stratigraphic analysis of this group Q. Goretzki, Freiberg, Germany, organized by Lozovsky/Leonova/Schneider)
- start of the investigation of unusual fossiliferous Upper Permian red beds in the Lodève basin, France (organized by Gand/Schneider)
- a 1999 meeting of the WG is planed during the French AGP field workshop in Sardinia, organized by G. Cassinis.

CORRESPONDENCE

Fascination of the South China Sections

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In March 1999, we joined an international group led Shen Shuzhong and Bruce Wardlaw for a visit to the Permian sections of Laibin-Heshan area, South China. We were fascinated by surrealistic karst landscapes, the bustleing cities, the tranquillity of the riverside rural life, the marvelous hospitality of Laibin officials, but most of all by the quality of the sections and the work done by our Chinese colleagues and their international associates. On the banks of Hongshui River we could see one of the world's most complete, continuously exposed Permian section with the Sakmarian - Artinskian Maping bioclastic limestones at the base and topped comformably by the Triassic Louluo turbidites (Jin et al., 1998; Shen et al., 1999). The facies range from hemipelagic carbonates and cherts with black shale interbeds to sponge-algal reefs to paralic coals and volcanoclastics. The distinctive lithologies of recurrent sea-level sequences, as well as the extraordinary diversity of organic remains provide for recognition of stratigraphic levels that reflect major events of geological history.

Thus, the proposed stratotype of the Guadalupian - Lopingian boundary on the Penglai Tan of Hongshu River corresponds to the megasequence boundary between the shoaling Maokou and transgressive Heshan formation, a supposedly pan-Tethyan sea-level event. The conodont zonation over the boundary is closely paralleled by the fusulinid, brachiopod and ammonoid successions. With the advance of paleontological research, evolutionary events in cyclolobids, a phylogenetically well understood ammonoid group may add significantly to the conspicuousness of the boundary.

From a chronostratigraphic point of view facial diversity is often seen as a disadvantage, but it opens opportunities of correlation over different facies domains, which presents a major problem of the Permian stratigraphy. Our attention was naturally focused on the features of potential importance for correlation with the Boreal realm. Incidentally, the shelf carbonates of Chihsia Formation contain spectacular ikaites (calcitic pseudomorphs of celestine aggregates) indicating a cold water environment. At this level a mild anoxy owing to upwellings is suggested by the frequent black shale interbeds, while the brachiopod diversity, considerable below and above, is reduced to a single species *Tyloplecta nankingensis* Muir-Wood et Cooper. But where did the cold deep water came from? One potential source might be the Ufimian cold-water transgression of the Boreal realm. The ikaites horizon of Chihsia then corresponds to the Ufimian of Cisuralian area, but more work on brachiopods is needed to support this suggestion.

As is well known, the classical Tatarian equivalents of the Lopingian are non-marine redbeds. Their correlation with marine sequences is based on magnetostratigraphic data alone (Jin et al., 1998). Some findings in the Penglai Tan Section seem relevant to this problem. Terrestrial plant remains were found at two levels in the Heshan and Talung formations. We added two more levels in the lower and upper Talung members. Notably, in both the mid-Wuchiapingian sapropelite horizon and in the lower Changhsingian black shale bed the ammonoids are crowded on the bedding planes suggesting mass mortality. The associated plant fossils indicate an influx of fresh water with terrestrial organic material that might cause eutrophication and algal blooms. The mid-Wuchiapingian plant assemblage includes the last appearence of the Cordaites morphotype. In the Volga Basin, European Russia, this morphotype, dominant over most of the Permian, disappeared at the boundary of Severodvinian and Vyatkian horizons, the upper Tatarian substage.

In the lower Changhsingian, we collected conifer shoots of *Quadroclaus* morphology that is common in the Vyatkian Horizon. Upsection, the Talung Formation consists of Milankovitch-scale cyclothems, with conifers preserved as impressions of leafy branching systems in tuffaceous shales with ripple marks. This conifer assemblage of a late Zechsteinian aspect has no exact equivalents in the type Tatarian. The Zechsteinian flora penetrated the Northern Cathaysian Province in the latest Permian apparently reaching to the southern Cathaysia at the peak of Changhsingian regression.

The lowest stand of Talung basin is marked by a thin coal bed overlain by shales with *Gigantonoclea - Gigantotheca* assemblage about 50 m below the Permian – Triassic boundary. The assemblage also contains a few conifer remains comparable to *Ullmannia* of the European uppermost Permian, but an admixture of Mesozoic forms, such as the osmundaceous genus *Todites*, suggests correlation with the lowermost Buntsandstein of Central Europe and the basal Vetlugian of the Volga Basin. These preliminary correlations are yet to be confirmed by detailed plant morphological studies.

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Letter from Tatjana A. Grunt

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I would like to present my personal impressions concerning the International Symposium "Upper Permian Stratotypes in Volga Region" hosted in Kazan in July 28-August 3, 1998. The main purpose of the Symposium was the introduction of the newest data on biostratigraphy, paleontology, litho-and magnetostratigraphy from stratotypes and key-sections of the Upper Permian of Volga-

Urals province.

Some important decisions, accepted by the participants of the Symposium, were made during numerous, sometimes hot and sharp, discussions that followed the talks and presentations or during the accompanying symposium meetings. The following groups conducted business meetings: Subcommission on Permian Stratigraphy (**SPS**), Working Group on Continental Permian, Interdepartmental Stratigraphic Committee of Russia (ISCR) and Russian Regional Stratigraphic Committee on Center and South of Eastern European Platform.

The main decision focused on the necessity of saving two parallel scales: the traditional East European and the "compilative' scale suggested by the International Subcommission on Permian Stratigraphy. The latter is based on sections from three different regions (Pre-Urals, North America and South China). Unfortunately, the memorandum about the two parallel scales, which was accepted by the participants of the symposium, has not been published. This circumstance has forced me once more to pay attention to some unresolved problems concerning the revision and forming of a new time scale for the Permian System:

1. I would like to stress again that a synthetic ("compilative") scale is useful only in marine Permian deposits of the pre-equatorial climatic zone. The upper portion of the traditional East European scale (Ufimian, Kazanian and Tatarian Stages), used in the study and subdivision of poly-facial deposits, occur widely in the vast territory of Boreal and Notal climatic zones. The synthetic scale suggested by the **SPS** can not be used within the territories of Boreal and Notal climatic zones because ammonoids are very rare there and there are no occurrences of fusulinids and conodonts - two major fossil groups for the synthetic Permian scale. The study and subdivision of Upper Permian strata in northern and central Eurasia and in Australia-New Zealand regions are based on different fossil groups (marine, non-marine, brackish-marine and continental). Brachiopods, ostracods, fishes, miospores and plants play the main. A very important role is also played by data recognized in the sections of Volga-Ural province concerning the stratigraphic position of the boundary of Kiama/Illawara reversal hyperzones that were initially established in Western Australia.

However, I recognize that all the plans of the **SPS** are directed towards the elaboration and support of the synthetic scale. There is not a sentence regarding the discussion and elaboration of the upper part of the traditional East European scale in the plans of SPS (see notes from the SPS Chair, Permophiles #33, p. 2). Unfortunately, there is no regulation about using parallel scales in the International Stratigraphic Guide. I believe that for some stratigraphic systems the possibility should exist.

2. The published information about the International symposium "Upper Permian Stratotypes in Volga Region" does not mention the opinion of the participants that suggests to the International Stratigraphic Committee, Commission on creating world geological maps and International Union of Geological Science that the Permian System be designated with index "R**"** instead an old index "P" which now belongs to Paleogene System. The Permian System was established in 1841, almost twenty years before the Paleogene System (in 1860). For many years different indices for indicating the Paleogene System have been used. Therefore, the suggestion to change the index for the Permian violates one of the main principles in science - the principle of priority. Some members of the Volga Symposium, including myself, were opposed to this suggestion

3. It is still unclear, how existing stage names should relate to the geographical position of GSSP. It is obvious however that at this time we need to establish nomenclature rules that would clarify the names of Permian stages. I believe that the principle of priority should be predominant in our approach. That is why the argument of B. Glenister, that Roadian has priority before Kubergandian "although Kubergandian has priority as a named stage, the Roadian... forms the original base of Guadalupian Series (Permophiles #33, p. 4)", does not convince me. Following this logic the international scientific community risks being in a legal vacuum. I deeply believe that we need to establish very firm rules before the radical revision of any stratigraphic scale.

4. Finally, I would like to express my support of Dr. H. Taraz's suggestion concerning the Abadeh section in central Iran. Certainly, this section of Permian from Artinskian to Dorashamian as well as Permian Triassic boundary beds is one of the best and complete marine section in the world. However, this section has never been under discussion as a candidate for the International standard, even though a formal proposal was published.

The establishment of global stratigraphic stratotypes and points (GSSP) is, of course, scientifically important. However, first, it should not be in self-interest, and second, it should not be the basis or case for revision right up to complete denial of prioritized stratigraphic subdivisions, including stratigraphic systems. I deeply believe that national or political motives should not, in any degree, be a consideration in resolving of scientific problems. However, this tendency clearly occurs during the revision of the stage nomenclature of the Permian System.

Tatjana A. Grunt

Response from the SPS Chair.

The International Commission on Stratigraphy has established guidelines for how chronostratigraphic units should be established. The SPS reprinted these guidelines (*Permophiles* no. 29, p. 25-30). Priority is clearly address in these guidelines and it is a principle to be considered but not the overriding principle for the major goal is for the "best correlation potential". That this has proven to be open-marine units because of the contained fossils generally wider geographic range is a matter of record (refer to all the accepted GSSP's). Even in the very provincial Middle and Upper Permian, marine biotas generally provide a wider geographic correlation than marginal marine and continental biotas. This is the very reason the SPS has unanimously adopted a marine scale for the Permian standard. This scale was not developed on political or nationalistic grounds, but on the best marine successions available. The Abadeh as well as the Dzhulfa sections were considered as potentially suitable marine sections and are invaluable references for correlation of marine faunas.

The overall sense of the Kazan meeting was one of bridging, from basin to basin, province to province, researcher to researcher. This was evidenced by the unanimous adoption of the new working group "Using Permian transitional biotas as gateways for global correlation". In this sense, work in the Volga Upper Permian was strongly encouraged to form those necessary bridges to the marine standard accepted by the SPS.

ANNOUNCMENTS

New Book Release:

The Permian System: Stratigraphy, Palaeogeography and Resources

(Proceedings of the Strzelecki International Symposium on the Permian of Eastern Tethys: Biostratigraphy, Palaeogeography and Resources, 30 November - 3 December 1997, Deakin University, Rusden Campus, Clayton, Victoria, Australia)

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Introducing the 'Permian Research Group of Southeast Asia'

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At the recently held international conference of Shallow Tethys 5 in Chiang Mai, Thailand (1-5 February 1999), an informal body, named 'The Permian Research Group of Southeast Asia', was established in response to the increasing demand, at both regional and international levels, for improved knowledge and understanding on the Permian of the broad Southeast Asian region and neighboring countries. The group held its an inaugural meeting in Chiang Mai with some 12 attendees. At the meeting it was agreed that the group should aim at consolidating research efforts from both individuals and research institutes who are interested in the Permian of the region to facilitate the following activities:

1. joint field expeditions to areas of common interest
2. research collaborations (eg., one coral specialist may have fusuline samples to pass on for identification)
3. dissemination of data and information among members of the group
4. organising regional workshops or meetings (either independently or in association with other regional geological conferences) with a view to ultimately producing a synthesis on the Permian System of the region: regional distribution, global correlation, and palaeogeographical/plate tectonic evolution.

We would welcome any individuals who are interested in any aspects of the Permian of SE Asia and adjacent regions to join in the group. In the first instance, please address all your queries to Dr. Guang R. Shi (see address below). At the moment, we have established a communication network through email among the existing participants.

Call for Contributions to 31st International Geological Congress

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Geosciences Department
1910 University Dr.
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31st International Geological Congress
International Standard References for the Permian System: Cisuralian of Southern Ural Mountains, Guadalupian of Southwestern North America, Lopingian of South China

Date: August 6th through 17th, 2000
Venue: Riocentro Convention Center
Rio de Janeiro - Brazil
Subject: The International Commission on Stratigraphy and Subcommission on Permian Stratigraphy will sponsor an international symposium at the 31st IGC meeting in Rio. The symposium is designed to showcase progress on final recommendations for Permian series and stage definitions. This symposium creates the forum for the working groups of the SPS to present their findings and conduct an open discussion on the Permian System. The symposium will consist of both an oral and a poster session held during the scientific program of the 31st International Geological Congress. The poster session will accommodate all accepted contributions (afternoon) followed by an oral session (following day). The oral session will consist of the convener's address, about 5 invited

keynote speakers and an open discussion. The keynote speakers will present papers on the Cisuralian, Guadalupian, and Lopingian Series, Tethyan and Boreal Province Correlation and Marine Continental Correlation. Proceedings of the symposium as a special issue on the Permian System will be published. A paper must be presented at this symposium before being considered for publication. All manuscripts will be subjected to the normal review procedures. Guidelines for manuscript preparation and deadlines will follow in subsequent issues.

Abstract contributions should be sent to the Scientific Program Committee of the 31st IGC. Abstract deadline is September 1, 1999. Each contribution must be in English and are limited to 250 words. Each contribution must be submitted to the Organizing Committee in camera-ready form; by mail or Internet form no later than September 1, 1999. The Internet form can be obtained from the 31st IGC site – www.31igc.org. A sample abstract with instructions can be found on the special insert of the second circular of the 31st International Geological Congress or at www.31igc.org. Abstracts can be mailed to:
31st International Geological Congress
Scientific Program Committee
Av. Pasteur, 404 – Casa Brazil 2000
Urca - Rio de Janeiro- RJ- Brazil – Cep 22.290-240

Or submitted online @ www.31igc.org

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

Correspondent: Tamra A. Schiappa, Permian Research Institute, Boise State University, Boise, Idaho, 83725, USA. Email: tschiapp@boisestate.edu.

Oman Pangea Symposium and Field Meeting First announcement

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

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

Scientific Organizers of the Symposium and Field Meeting:
Dr. Aymon Baud and Prof. Jean Marcoux with the help of the BRGM and other experts.

Objective:
With the presentation of recent new results on Permian and Triassic strata of Oman, the aim of the Symposium and field meeting is to provide a forum for geologists interested in the time interval of Pangea for discussing global changes related to the formation of Pangea and the evolution of North Gondwana and Central Tethys. It will be a unique oportunity for sedimentologists, stratigraphers and paleontologists working on the Permian and Triassic time interval, biotic crisis, extinction, recovery and evolution at the Paleozoic- Mesozoic transition, to discuss, examine, and sample the spectacular Permian and Triassic outcrops of the Oman former continental margin, from shallow shelf to deep marine strata and sea mounds.

General Theme:
Pangea and Tethys, Moving Plates and Environmental Changes.

Secondary Themes:
Progress in Permo-Triassic Stratigraphy and Paleontology of the Central Tethys and its margin on Gondwana; Comparison between the Permo-Triassic continental margins of Oman, north India (Himalaya) and north Australia.

Proposed Field Excursions:
Pre-symposium: " Lower to Middle Permian sedimentation on the Arabian Platform: 5 days in the Khuff-Saiwan area ", organized by Dr. Lucia Angiolini and Prof. Jean Broutin.
Pre-symposium: " From slope to basin and sea mounds Permo-Triassic deposits: 5 days in Wadi Wasit, Alwa and Djebel Misht areas "; organized by Dr. Aymon Baud, Prof. Fabrice Cordey, Prof Leopold Krystyn, Prof. Jean Marcoux.
Post-symposium: " From shallow shelf to base of slope Permo-Triassic deposits: 4-5 days in Djebel Akdar and Sumeini areas ", organized by Dr. Aymon Baud, Prof. Fabrice Cordey and Prof. Jean Marcoux.

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And after mid July 99, directly on web site:
http://www.geoconfoman.unibe.ch

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