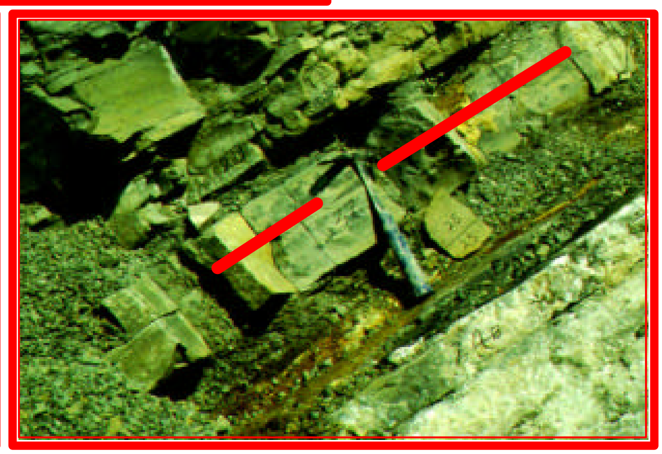
Permophiles

Number 31
January 1998

Newsletter of the Subcommission on Permian Stratigraphy



International Commission on Stratigraphy

International Union of Geological Sciences

CONTENTS

Cover Photos

top:

Permian/Triassic boundary, Section D, Meishan, Changhxing County, Zhejiang Province, China, recommended as GSSP for the base of the Triassic System (Yin, H., Sweet, W. C., Glenister, B. F., Kotlyar, G., Kozur, H., Newell, N. D., Sheng, Z. Y., and Zakharov, Y. D., 1996, Newsl. Stratigr. 34(2), 81-108). Three geologists, high on the quarry face near the center of the picture, are collecting the P/T boundary interval.

center, right:

Details of P/T interval, Section D. The base of Bed 27c, 8 cm above the base of Bed 27, marks the first occurrence of the conodont *Hindeodus parvus*, chosen arbitrarily within an evolutionary continuum for boundary definition. Beds 25 and 26 are the "White clay" and "Black clay", respectively; Bed 27, 16 cm thick, is limestone; Bed 28 (number not visible in photograph) is illite-montmorillonite clay; and Bed 29 is a 26 cm thick argillaceous calcimicrite containing ophiceratid ammonoids.

bottom:

Peng Lai Tan section, proposed stratotype for the Guadalupian-Lopingian boundary several kilometers down river from Laibin on the Red River; showing location of boundary contact based on the first appearance of the conodont *Clarkina postbitteri*.

center, left:

Close-up of Guadalupian-Lopingian (G and L, respectively) boundary exposed at Tieqiao reference section along the Red River, Laibin, China.

EXECUTIVE NOTES

Notes from the SPS Secretary

by Claude Spinosa

I take this opportunity to thank all who contributed to the 31st issue of Permophiles and those who assisted in its preparation. We are indebted to Brian F. Glenister and Bruce R. Wardlaw for editorial contributions and Joan White for coordinating the compilation of this issue. The next issue of Permophiles is scheduled for June 1, 1998. Contributions should arrive before May 15. It would be best to submit manuscripts on diskettes prepared with WordPerfect or MSWord; printed hard copies should accompany the diskettes.

Word processing files should have a minimum of personalized fonts and other code. Journal of Paleontology reference style is preferred. Maps and other illustrations must be camera-ready, i.e., clean copies, ready for publication. Typewritten contributions may be submitted by mail as clean paper copies; these must arrive well ahead of the deadline as they require greater processing time. We can also receive contributions via E-mail, Fax or through FTP; the latter is an especially useful and simple method for transmitting illustrations.

We are indebted to Edward C. Wilson, Karl Krainer, Ernest H. Gilmour, Jerry Lewis, Charles Ross, June Ross, J. B. Waterhouse, Kozo Watanabe, Gordon D. Wood, Lucia Angiolini, Boris Chuvashov and Carmen Virgili as well as seven anonymous donors for contributing over $400 to the Permophiles publication fund.

Minutes of the 1997 meeting of the Subcommittee on Permian Stratigraphy

The Subcommittee on Permian Stratigraphy (SPS) held a meeting in conjunction with the Strzelecki International Symposium, Melbourne, Australia; 30 November - 3 December 1997. The meeting was held at Deakin University on November 30.

The following individuals were in attendance at the meeting: Neil W. Archbold, Robert Nicoll, Cliton Foster, Ian Metcalfe, John Filatoff, Vince Palmieri, John Backhouse, Mac Dickins, Tatyana Leonova, Natalia Esaulova, Bosis Burov, Yoichi Ezaki, Masayuki Ehiro, Danis Nurgaliev, Anatoly Shevelev, Rafael Sungatullin, Walter Snyder, J.M.C. Kellar, Heinz Kozur, Mafred Menning, Jin Yu-gan, Bruce Waterhouse, John Rigby, Hossein Partoazar, Shuzhong Shen, Claude Spinosa and Bruce Wardlaw.

Announcements were made by Bruce R. Wardlaw:

Meetings of the SPS

The next SPS meeting will be held in conjunction with the meeting of the Upper Permian Stratotypes of the Volga Region. A more detailed announcement of the meeting is included in this newsletter. The 1999 SPS meeting will be held in Calgary, Canada in conjunction with the XIV International Congress on Carboniferous and Permian. The year 2000 meeting will be held in conjunction with the 31st International Geological Congress in Rio de Janeiro, Brazil.

Working Groups

The Carboniferous-Permian boundary working group will be officially dismissed with publication of the working group's final report in a forthcoming issue of ***Episodes***.

The Cisuralian Stages working group is chaired by Boris I. Chuvashov.

The Guadalupian Working Group is chaired by Brian F. Glenister.

The Upper Permian Working Group is chaired by Jin Yu-gan.

The UPWG group has investigated two important sections near Laibin on the Red River of South China (see cover illustration explanation).

The Continental Permian Working Group is chaired by Vladlen Lozovsky and Joerg W. Schneider.

Report of Recent Work by the SPS

The SPS spent in excess of $20,000 more than the small sum allocated by the ICS. The funds were used to facilitate the several accomplishments listed in the annual report (this newsletter), especially the field work in the southern Urals. Details are presented in the report by Kerner and Davydov (this newsletter).

Open Discussion

Permophiles will retain its open discussion format. Permophiles will be distributed free of charge to any one requesting it. Back issues of Permophiles will be made available in conjunction with the publication of the next issue of Permophiles - June 1, 1998.

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International Union of Geological Sciences
International Commission on Stratigraphy
Subcommission on Permian Stratigraphy
Annual Report 1997

by Bruce Wardlaw

Overall Objectives:

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

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Subcommission on Triassic Stratigraphy

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Accomplishments:

Jin Yu-gan, Wardlaw, Bruce R., Glenister, Brian F., and Kotlyar, Galina V., 1997, Permian chronostratographic subdivisions: *Epsisodes*, v. 20, no. 1., p. 10-15.

Davydov, V.I., Glenister, B.F., Spinosa, Claude, Ritter, S.M., Chernykh, V.V., Wardlaw, B.R., and Snyder, W.S., in press, Proposal of Aidaralash as Global Stratotype Section and Point (GSSP) for the base of the Permian System, *Episodes*, submitted Nov. 3, 1997.

Supported successful field trips:

1. To better document and further collect potential stratotypes for the Cisuralian stages.
2. To find a continuous carbonate succession for a reference section for the uppermost Carboniferous and Lower Permian in Nevada. A team of American, Chinese, Canadian, and Russian scientists found and measured two sections from upper Kasimovian through Kungurian within 20 km of each other replete with conodonts and fusulinids.
3. To do the necessary microsampling of boundary intervals to solidly establish the Lopingian and constituent stages in China.

Developed accurate apparatal evolution plan for *Hindeodus* in the Late Permian to aid the Working Group on the Permian-Triassic boundary of the Subcommission on Triassic Stratigraphy to root the proposed base of the Triassic in a solid evolutionary lineage.

Established the Special Project "The Permian: From Glaciation to Global Warming to Mass Extinction" to use detailed biostratigraphy and numerical age dates to create an initial framework for correlating and evaluating global events of the Permian. This special project will help in the development of the Permian GSSP's by providing important stratigraphic, biostratigraphic and numerical age dates to the specific subcommission working groups.

	Series		**Stage**
Permian	Upper	Lopingian	Changhsingian
			Wuchiapingian
	Middle	Guadalupian	Capitanian
			Wordian
			Roadian
	Lower	Cisuralian	Kungurian
			Artinskian
			Sakmarian
			Asselian

Conducted annual business meeting at the Strzelecki International Symposium in Melbourne, Australia.

Work Plan:

1998

Sponsor and conduct annual business meeting at Upper Permian Stratotypes of the Volga Region International Symposium, Kazan, Russia (July 28-August 2).

Sponsor and organize a Workshop on the marine and continental Upper Permian stages of China for November.

Continue funding for research to establish the Lower Permian stages in the southern Urals.

Compile, digitize, reprint, and distribute the first 10 issues of Permophiles.

Formally propose the Guadalupian and Lopingian and their constituent stages.

1999

Sponsor and conduct annual business meeting at the Carboniferous-Permian Congress in Calgary, Canada.

Sponsor and participate in the International Conference on Pangea and the Paleozoic-Mesozoic Transition, Wuhan, China.

Sponsor and participate in the International Field Conference on the continental Permian of the Southern Alps and Sardinia (Italy): regional reports and general correlations in Brescia, Italy.

Compile, digitize, reprint, and distribute the second ten issues of Permophiles.

Formally propose the constituent stages of the Lower Permian.

2000

Conduct annual business meeting at IGC in Rio de Janiero.

Have all stages in at least preliminary formal proposal process.

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REPORTS

Clarkina (conodont) Zonation for the Upper Permian of China.

by Bruce R. Wardlaw and Mei Shilong

Species of *Clarkina* show remarkable diversification in the Permian of South China. Detailed taxonomic examination of the faunas shows two general lineages developed in the early Wuchiapingian. One, typified by *C. leveni*, retains a large cusp, and includes the species of *postbitteri*, *dukouensis*, *asymmetrica*, *leveni*, *guangyuanensis*, *transcaucasica*, *orientalis*, and *longicuspidata*. The other, typified by *C. liangshanensis*, shows a progressive reduction of the cusp and posterior denticles, and includes the species *daxianensis*, *liangshanensis*, *inflecta*, and *demicornis*. These successions of species provide a refined zonation for the Wuchiapingian. This zonation was first proposed by Mei et al., 1994. The present zonation (Table 1) is essentially that of Mei, only modifying the *orientalis* zone by combining their *orientalis* and *inflecta* zones. The *C. inflecta* zone is recognized as a subsone of the *orientalis* zone. Though we have *C. inflecta* from South China and the *Transcaucasicus*, it appears to be a rare species that is usefull to characterized the upper part of the *orientalis* zone on a regional basis. *Clarkina demicornis* and *C. longicuspidata* also appear in the upper part of the *orientalis* zone apparently coincident with *C. inflecta*. Of the Wuchiapingian forms, *C. longicuspidata* is the only one we have recovered from bed 2 or above in the Meishan section, the proposed stratotype for the Changhsingian.

The Changxing Limestone in its type area (Meishan) shows a single succession of *Clarkina* species that can be characterized by the denticulation on the Pa element. The first species appearing at the very base of bed 2 in the Meishan section is *C. wangi* which has a high fused wall-like carina. *C. wangi* is followed by *C. subcarinata* (sensu strictu) which shows partially fused denticles on the posterior end of the carina and a relatively high discrete cusp, which is, in turn, followed by *C. changxingensis* which shows a marked reduction in the carinal height just anterior of the posterior cusp, the development of a subtle depression or sulcus, and discrete, though small posterior denticles on the carina. *C. yini* (proposed by Mei et al. 1998, as *C. changxingensis yini*) follows and is characterized by a high erect cusp and discrete posterior denticles. Finally, just above the top of the Changxing Limestone appears *C. meishanensis*, which shows a large proclined cusp and partially fused posterior denticles. This species overlaps the last appearance of *Hindeodus latidentatus*, the transitional morphotype from *H. latidentatus* to *H. parvus* and the first appearance of *Hindeodus parvus*. Each successive species in the Changhsingian *Clarkina* overlaps with its predecessor for short intervals. This detailed analysis provides significant refinement of the zonation of the Changhsingian.

A problem exists in that the first appearance of *C. wangi* is at the minor unconformity between bed 1 (a conglomerate loaded with *Clarkina orientalis*) and bed 2. Since *Clarkina longicuspidata* ranges into bed 2, we have no doubt that it is the probable predecessor to *C. wangi*. However, in each successive appearance (and also in all those in the Wuchiapingian) we have transitional morphotypes in the interval of overlap that is missing for *C. wangi* suggesting a hiatus between bed 1 and bed 2 and making the base of the lithologic unit of the

Changxing an inappropriate boundary for the stadial boundary. The first appearance of *C. subcarinata* is the commonly used boundary marker and in our revised species schemes occurs with bed 7 and provides and excellent marker for the base of the Changhsingian stage, not a sequence boundary but as the first evolutionary event following the sequence boundary.

All the species definitions for the Wuchiapingian appear in Mei et al. (1994). The initial species interpretations for the Changhsingian appear in Mei et al. (1998). The revised species descriptions and zonation are in Wardlaw and Mei (1998).

References

Mei Shilong, Jin Yugan, and Wardlaw, Bruce R., 1994, *Clarkina* species succesion for the Wuchiapingian and its worldwide correlation: Acta Micropalaeontologica Sinica, v. 11, no. 2, p. 121-139.

Mei Shilong, Zhang Kexian, and Wardlaw, Bruce R., 1998, in press, Preliminary *Clarkina* zonation for the Changhsingian: Paleo[3].

Wardlaw, Bruce R., and Mei Shilong, 1998, in press, *Clarkina* species succession of the Upper Permian: U.S. Geological Survey Digital Data Series.

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	Clarkina species Zone		Other Conodonts
UPPER PERMIAN LOPINGIAN OF CHINA	*meishanensis*		*Hindeodus latidentatus*
	yini		
	changxingensis		*Hindeodus latidentatus*
	subcarinata		*C. wangi*
	wangi		*Hindeodus julfensis, C. longicuspidata*
	orientalis	upper	*C. inflecta, C. demicornis, C. longicuspidata*
		lower	*C. liangshanensis*
	transcaucasica		*C. liangshanensis*
	guangyuanensis		*C. liangshanensis*
	leveni		*C. asymmetrica, C. daxianensis*
	asymmetrica		*C. daxianensis*
	dukouensis		
	postbitteri		

Evolution in the *Hindeodus* Apparatus in the Uppermost Permian and Lowermost Triassic

by Bruce R. Wardlaw and Mei Shilong

The evolution of the apparatal elements in *Hindeodus* species near the proposed Permian-Triassic boundary demonstrates a valid phylogenetic morphocline in which to establish the Permian-Triassic boundary. Every element of the apparatus changes from species to species but can characterized by the Pa, Sa, and Pb elements. The Sc and Sb elements display a similar denticualtion pattern to the posterior process of the Pb element.

The Pb element shows a reduction in the number of denticles on the anterior process and a progressive change in the denticulation pattern of the posterior process to denticles of more equal size in a less regular pattern. The posterior process on the Pa element of *H. julfensis* typically has four denticles; those of *H. typicalis* and *H. latientatus* typically have three; that of *H. parvus* typically has two; and that of *H. erectus* has one.

The Sa element shows a progressive flattening in the bottom in lateral profile and a change in the denticulation pattern similar to the posterior process of the Pb element.

The Pa element is the element that has been the focus of most previous studies and provides the name to the apparatus. *Hindeodus julfensis* appears to give rise to *H. typicalis* by the enlarged posterior denticles forming the posterior hump becoming smaller and more discrete. As a rule all the denticles on *H. typicalis* are slightly more discrete than those on *H. julfensis*. *Hindeodus julfensis* also gives rise to *H. latidentatus* by reduction of the platform and the denticles becoming more discrete and elevated; the hump of *H. julfensis* becoming three large discrete denticles on the posterior. The cusp is also elevated more and is less broad compared to either *H. typicalis* and *H. julfensis*. *Hindeodus latidentatus* gave rise to *H. parvus* by the cusp becoming more elevated, the large discrete three posterior denticles becoming reduced in size and developing a sharp posterior drop that may or may not be denticulate. *Hindeodus parvus* gave rise to *H. erectus* by increased heigtening of the cusp becoming very erect to recurved, reduction of the number of denticles, but the denticles becoming more elevated and discrete. In abundant samples at or near the last or first appearance of species we commonly find transitional morphotypes from the predecessor to successor.

The apparatuses clearly show that *Hindeodus julfensis* gave rise to *H. typicalis* and *H. latidentatus*. In our material from the Salt Range we have, in close stratigraphic succession, in the Chhiddru Formation the last appearance of *H. julfensis* and the first appearance of *H. typicalis*. This occurs just above the last appearance of Wuchiapingian *Clarkina* (*C. longicuspidata*) implying that it occurred in the Changhsingian. In the Meishan section of the Changxing Limestone, we have recovered *H. julfensis* from the lower beds and *H. latidentatus* from the middle and upper beds. We suggest that this pattern implies that *H. julfensis* gave rise to *H. typicalis* in cool, peri Gondwana environments and gave rise to *H. latidentatus* in warm, Tethyan environments. That the Sa and Pb elements of both *H. typicalis* and *H. latidentatus* show close similarities of a Pb with three anterior denticles and an Sa with a lower profile forming a broad "w" suggests that these both evolved at about the same time. However, *H. typicalis* remains in the cool water environments throughout the Changhsingian and only becomes widespread in the Tethyan in the Triassic.

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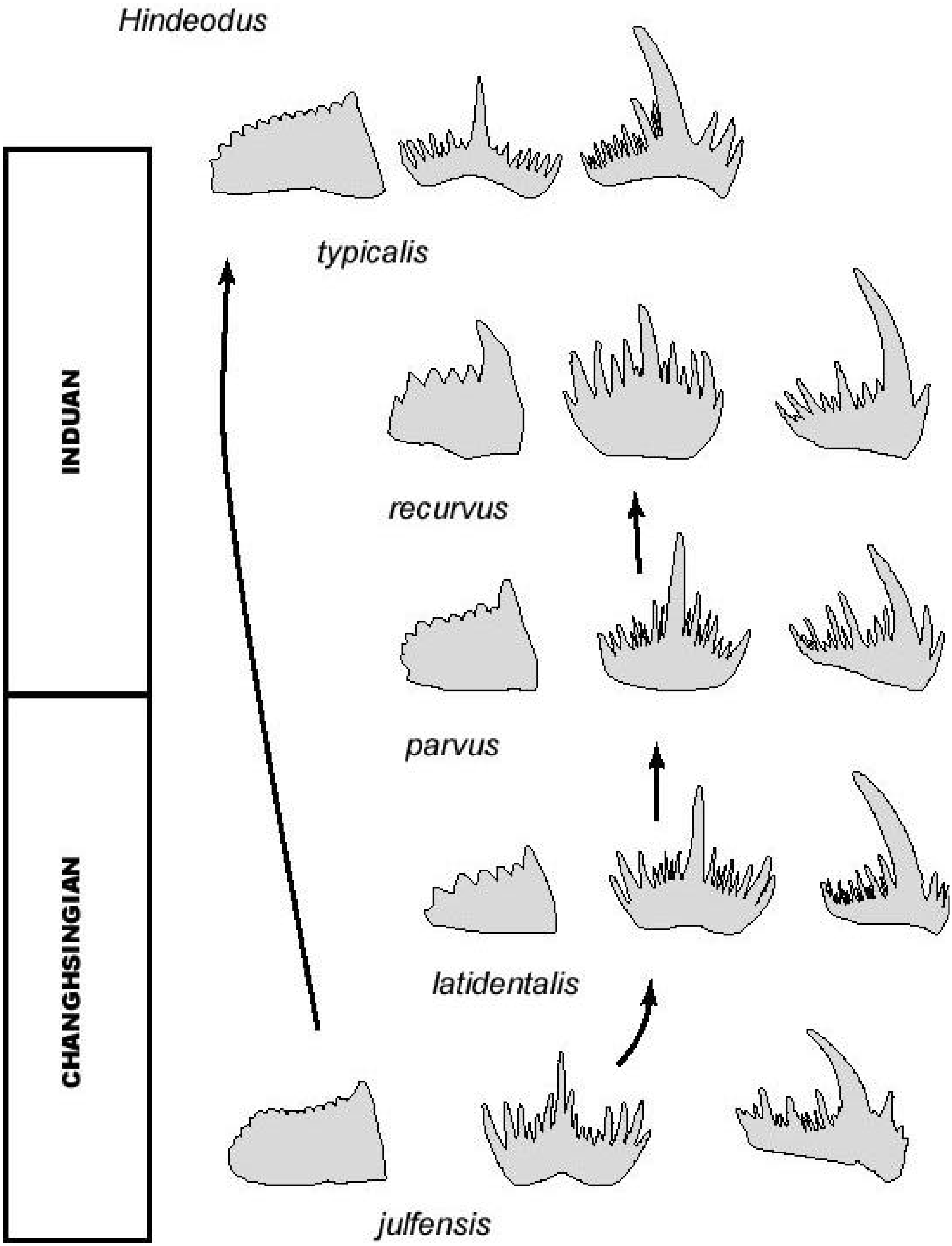
New Reference Sections for the Upper Carboniferous and Lower Permian in Northeast Nevada

by Bruce R. Wardlaw, Vladimir Davydov, Mei Shilong, and Charles Henderson

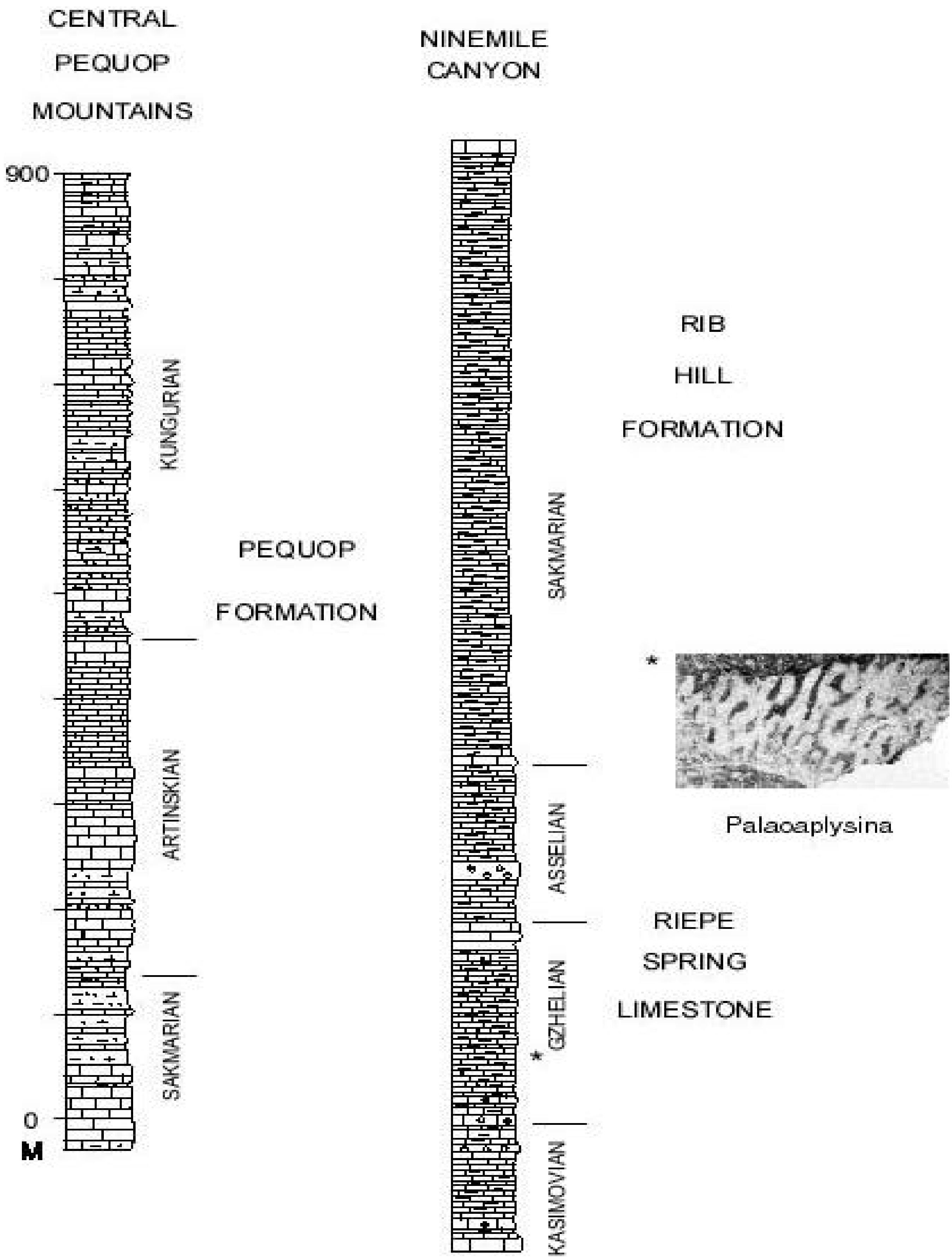
Two sections located within 20 km of each other in the Pequop Mountains, Elko County, Nevada, provide apparently continuous deposits of the Kasimovian through Kungurian. These sections are dominated by carbonates (Fig. 1) and are replete with fusulinids. Though conodont studies are only initial, they also appear to be well represented. For example, from the top bed of the Riepe Spring Limestone in the Ninemile Canyon section, we have recovered excellent examples of *Streptognathodus barskovi*. The significance of these sections is that in the basal Kungurian both *Neostreptognathodus pnevi* and *Neostreptognathodus exsculptus* (*sensu strictu*, *non* Chernykh and Chuvashov) occur.

A large, meter thick, bed of *Palaeoaplysina* occurs in the Ninemile Canyon section in the Riepe Spring Formation, 174 meters above its base. The base of the Ninemile Canyon section is at the top of a cliff of thick-bedded Ely Limestone of late Moscovian to Kasimovian age. Initial studies of the fusulinids indicate middle Kasimovian faunas occur 53 m above the base of the Riepe Spring, suggesting that initial deposition was probably Kasimovian. It appears that the fusulinid fauna from the top of the Riepe Spring Limestone at Ninemile Canyon is equivalent to the base of the Pequop Formation (0 M) at the Central Pequop Mountains section, implying that the Rib Hill Formation at Ninemile is equivalent to the lower part of the Pequop Formation at Central Pequop. The Rib Hill Formation at Ninemile Canyon is overlain by the Pequop Formation with abundant *Neostreptognathodus pnevi*, equivalent to the middle Pequop Formation in the Central Pequop Mountians.

What is important is that in this tectonic basin are two sec-



Hindeodus
typicalis
INDUAN
recurvus
parvus
CHANGHSINGIAN
latidentalis
julfensis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ASSELIAN
GZHELIAN
KASIMOVIAN
RIB
HILL
FORMATION
RIEPE
SPRING
LIMESTONE
*
*
Palaoaplysina

tions that we can piece together into a relatively complete sequence of the Kasimovian through Kungurian with nearly continuous fusulinid faunas and fairly well represented conodont faunas of Tethyan and Boreal affinities. We hope by collecting big samples of the fusulinids of the North American province we will be able to pick up smaller forams and rare fusulinids that may tie into the Tethyan fusulinid zonation, providing real insight into a combined fusulinid-conodont zonation.

The Central Pequop Mountains section continues through the Kungurian into the Roadian, but we ran out of time to measure it in this rugged mountain range. Wardlaw measured the remainder of this section and did reconnaissance sampling for conodonts in 1976 and 1984. We plan to return in the spring and continue work on these excellent reference sections.

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Preface to Compilation of Permophiles

by Brian F. Glenister and Walter W. Nassichuk

Introduction

Authorization for organization of a Subcommission on Permian Stratigraphy (originally SCPS, now SPS) was provided by the International Commission on Stratigraphy (ICS) at its 1972 Montreal meeting. The inaugural meeting was held in Moscow, three years later, but by 1978 some Permian workers were dissatisfied with formulation of objectives and progress toward their achievement. Correspondence between ICS Chairman Anders Martinsson and SPS Vice-Chairmen S. V. Meyen (also Secretary) and W. W. Nassichuk produced the consensus that the problem arose from "...a simple matter of (inadequate) communication." As a consequence, in July 1978 Secretary Meyen distributed a two page "IUGS Subcommission on Permian Stratigraphy - Current Information" statement offering to "...organize a regular issue of an informal SCPS Newsletter", and requesting submission of current information on a full range of topics of interest to Permian workers. He noted that with limited resources he could provide only 20 originals, and invited others to duplicate and distribute copies regionally. SCPS Newsletter 1, a 10-page compilation with broad geographic and subject coverage appeared in February 1979, edited and typed personally by Dr. Meyen. Other issues have followed on a more-or-less regular schedule.

Success of the SPS Newsletter in improving communication between Permophiles was essentially immediate, with the first issue precipitating a spirited exchange between R. E. Grant and J. B. Waterhouse. Scientific content and insight of even early numbers was consequential. For example, in SCPS Newsletter 1 Dick Grant anticipated much of the current consensus on subdivision of Permian time, favoring and justifying acceptance of the Southern Urals as reference for the Lower Permian Series, and the Guadalupian for the Middle Permian. Knowledge of the South China sections had not reached the present level at that time, and Grant favored the "Arax River" sections for the Upper Permian, although noting the potential of the "Changhsing Limestone" as a future reference.

Much of the recent success of the SPS is attributable directly to improvement of communication through the Newsletter (renamed Permophiles, #11, May 1986). This venue encourages workers to report new findings and to evaluate the growing database, rather than depending on exchanges at infrequent international meetings. Consequently, the succession of Newsletters represents a useful summary of the progressive growth of insight into the complexities of a vital interval of geologic time. Despite this and the fact that circulation has now increased to 250, few full sets of Permophiles are available. Consequently, the SPS executive has decided to electronically scan, reprint, and compile sets of the comparatively small editions of numbers 1-20 for purchase by researchers and libraries. In anticipation of completion of this compilation in 1998, it has been deemed appropriate to provide the following brief account of the early history of Subcommission activities.

History Prior to Newsletter 1 (1979)

The International Commission on Stratigraphy (ICS), parent to the Subcommission on Permian Stratigraphy (SPS) has roots that go back to various permanent working groups of the International Geological Congress (IGC) that discussed stratigraphic classification and terminology at the earliest Congress meetings (Paris 1878 and Boulogne 1881). One of those IGC groups was named the Commission on the International Lexicon on Stratigraphy at the IGC meeting of 1910 in Stockholm. It was reorganized as the Commission on Stratigraphy at the 1952 IGC meeting in Algiers, and was given a mandate to promote international standards and cooperation in stratigraphy.

The International Union of Geological Sciences (IUGS) was founded in 1961 and a number of permanent groups of IGC were transferred to IUGS, including the ICS in 1965. However, even to this day the ICS has continued to convene every four years in conjunction with meetings of the IGC. During the IGC meeting in Montreal in 1972, the newly elected executive of the ICS, Canadians D. J. McLaren (Chairman) and W. W. Nassichuk (Secretary-General) invited the renowned Permian specialist D. L. Stepanov (Russia) to organize a Subcommission on Permian Stratigraphy within the ICS. The inaugural meeting of the Subcommission was held in conjunction with the 8th International Congress on Carboniferous Stratigraphy and Geology in Moscow, 1975. Elections to the Subcommission were held in Moscow, and elected officers and Titular Members were subsequently approved by the full Commission early in 1976. The first executive of the Subcommission was Chairman D. L. Stepanov, first Vice-Chairman W. W. Nassichuk, (Canada), and the second Vice-Chairman/Secretary S. V. Meyen (Russia). Subsequent officers and members are listed in each issue of the SPS Newsletter/Permophiles.

Before and after the 1975 Moscow Carboniferous Congress, field trips were conducted to important stratotype areas in the Urals. During the course of the Moscow meeting, at least 20 formal presentations dealt with Permian biostratigraphy, most relating to the Carboniferous/Permian boundary. Many fossil groups were discussed in terms of their biostratigraphic value, but special emphasis was placed on fusulinaceans and ammonoids; V. N. Andrianov from Yakutsk displayed Permian ammonoids from eastern Siberia. There was some general agreement that the base of the Permian should be defined at the base of the Asselian Stage, but an equally strong opinion, particularly from fusulinacean and conodont workers, stressed that a particularly profound break occurs between the Asselian and Sakmarian.

Considerable discussion was devoted to the question of the Series subdivisions for the Permian, some favoring a three-fold and others a two-fold division. No vote was taken on these questions, but opinions seemed equally divided. There was a general concern that additional studies be carried out on faunas and rocks in potential stratotype areas before international standards were selected.

During the Moscow meetings, a Working Group on the Carboniferous/Permian boundary was convened under the leadership of Charles A. Ross (U.S.A.). Similarly, plans were formulated to convene a Working Group on the Permian/Triassic boundary in cooperation with the Subcommission on Triassic Stratigraphy. At that time Chairman Stepanov was leader of the IGC project entitled “Permo-Triassic Stage of Geological Evolution”, much broader in scope than boundary definition.

The late Sergei Meyen, in addition to being a brilliant paleontologist and stratigrapher was also a particularly vital proponent for action within the Subcommission. He initiated discussions in Moscow on the most important objectives for the Subcommission, one of which was to agree on a scheme for international correlation of both marine and nonmarine successions. To that end, he proposed that Subcommission members prepare simple correlation charts for all regions of the world showing the various divergent views on correlation for each specific region. He showed, for example, that there was little agreement amongst authors on correlation of the base of the Zechstein in Europe. Some thought it correlated with the base of the Kungurian, some with the base of the Kazanian, and still others with the base of the Tatarian. All of these views could be shown on a chart and would form the basis for discussion at future Subcommission meetings. The following Working Groups were designated at the Moscow meeting to cover a range of other important activities related to Subcommission objectives:

1. Working Group on Permian Stratigraphy of North America (Grant, Meyen, Glenister),
2. Working Group on the Continental Permian of Europe (Falke),
3. Working Group on Gondwana/Laurasia Correlation (Ustrinsky, Meyen, Dickins),
4. Working Group on Boreal Stratigraphy (Ustrinsky, Nassichuk),
5. Working Group on Tethys Stratigraphy (Leven, Minato),
6. Working Group on Fusulinid-Ammonoid Zonation (Ross, Pavlov),
7. Working Group on Conodonts and other non-fusulinacean microfossils (Kozur),
8. Working Group on Paleoclimatology (Ustritsky, Stehli, Dickins).

In 1976, members of the Subcommission met at the IGC in Sydney (Australia) for continuation of various initiatives taken in Moscow. It was agreed that the Correlation Chart Program should be kept simple in the beginning to show various ideas for correlation based on different fossil groups for each region. This allayed the fears of members who mistakenly thought that the purpose of the Correlation Program was to prepare a detailed global correlation chart much like that presented for North America by Dunbar and others (1960). J. B. Waterhouse pressed for Soviet and American workers to clarify and summarize the lithological and faunal content of Permian stages proposed for the Soviet Union and the United States. Finally, J. M. Dickins convened a meeting of the Working Group on Paleoclimatology, which recommended that a symposium on Permian climate be organized, a bibliography on world climate be prepared, and that attention should be paid to oxygen isotopes for paleotemperature studies.

Shortly after the 1977 Sydney meeting, E. Ya Leven, S. V. Meyen and M. Minato compiled and distributed a summary of fusulinacean zones for the Tethys to serve as a basis for discussions of global correlation and Upper Permian stages.

During 1978, the Subcommission was particularly active. Some members participated in the Warsaw Symposium on the Permian of Central Europe, others traveled to Nanjing (China) to participate in broad-ranging discussions of the Permian and the Permian/Triassic boundary, and to encourage Chinese scientists to participate in Subcommission activities. Subcommission members were also invited to participate in activities of the Working Group on the Unified Stratigraphic Time-Scale, led by J. E. Van Hinte, and the IUGS Program of Correlation of Coal-bearing Formations led by P.P. Timofeev. The first Newsletter appeared early in 1979, and a memorial on the first page paid tribute to the distinguished Russian paleontologists V. E. Ruzhencev and T. G. Sarycheva, both of whom died in 1978.

Richard E. Grant and W. W. Nassichuk led a meeting of the Subcommission in Washington, (D.C.), in May 1979, just prior to meetings of the 9th International Congress on Carboniferous Stratigraphy and Geology that was held in Urbana, Illinois. Physical and chemical nature of the Permian/Triassic boundary and the distribution of rocks and fossils in China formed the primary bases for discussion.

Subsequent activities of the Subcommission are covered in the 30 issues of SPS Newsletters/Permophiles published 1979-1998.

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Preliminary Palynological Assessment of Selected Horizons Across the Carboniferous/Permian Boundary, Aidaralash Creek, Kazakhstan.

by Michael T. Dunn

An abundant, diverse, and well-preserved palynological assemblage has been obtained from several horizons of strata across the Carboniferous/Permian Boundary in Aidaralash Creek, Kazakhstan. The samples span 50.2 meters of section, from 24.2 meters below to 26.0 meters above the base of Permian (base of bed 19, Fig. 1). The assemblage is dominated by disaccate pollen grains. Palynomorph populations have been assessed from a count of 300 palynomorphs per slide after Dan Der Plas and Tobi (1965).

Percentage occurrences for the sample recovered from 26.0 MAB are shown on Figure 2. Disaccate pollen grains constitute 51 percent of the sample (Table 1); common genera include *Hamiapollenites*, *Protohaploxypinus*, and *Pityosporites*. Taeniate polyplicates are second in abundance at 17.6 percent, with *Vittitina* the most common genus of this group. Monosaccate pollen grains are the third most abundant group at 11.3 percent of the population; *Cordaitina uralensis* and several species of *Potonieisporites* have thus far been identified. Trilete spores make up 10.6 percent of the sample and common genera of this group include *Punctatisporites*, and *Leiotriletes*. Trilete zonate spores are the least numerous group at 8.3 percent and include *Densosporites*, *Grandispora*, and *Knoxisporites*. Several representatives of the latter two groups of spores include reworked Devonian and Carboniferous forms (Utting, 1998, personal communication).

Acknowledgments

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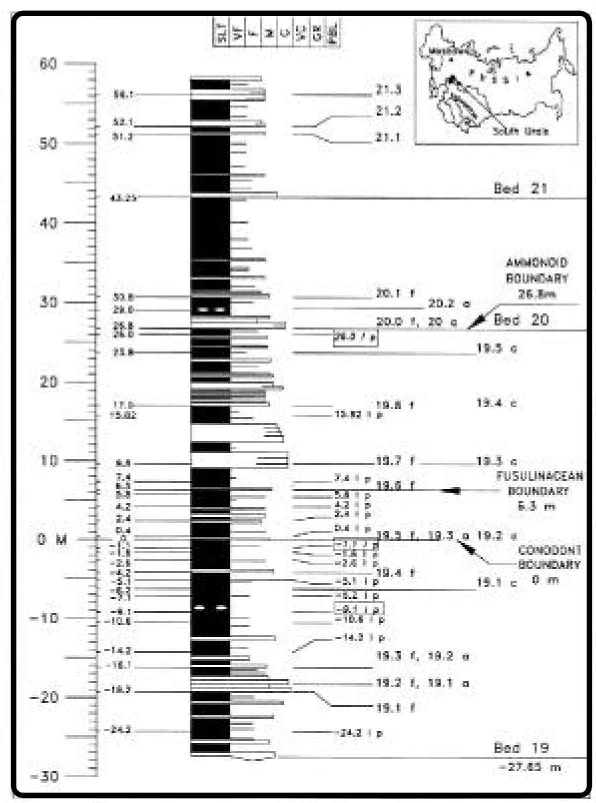


Figure 1. Stratigraphic column of portion of the section at Aidaralash Creek, Aktöbe region, Kazakhstan. Carboniferous/Permian boundary proposed on the basis of conodonts, fusulinaceans, and ammoniods, is indicated. Bed numbers (e.g., 19) and subdivisions (e.g., 19.5) represent designations widely used in recent Soviet/Russian literature; "a", "f", and "c" indicate ammoniod, fuslinacean, and conodont occurrences. Palynological horizons are indicated by "p". Zero meters marks the point defining the base of the Permian System.

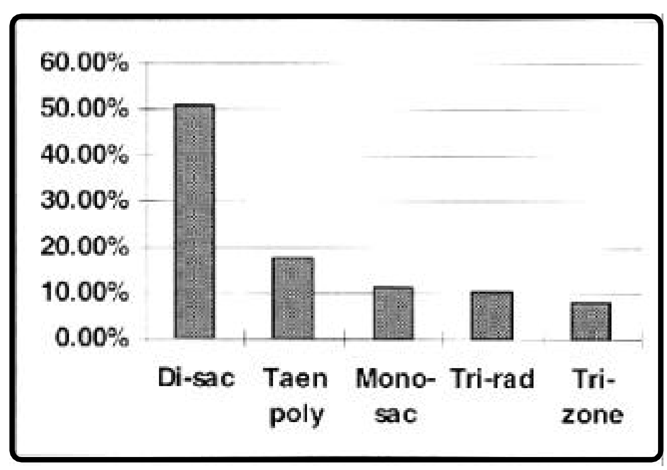
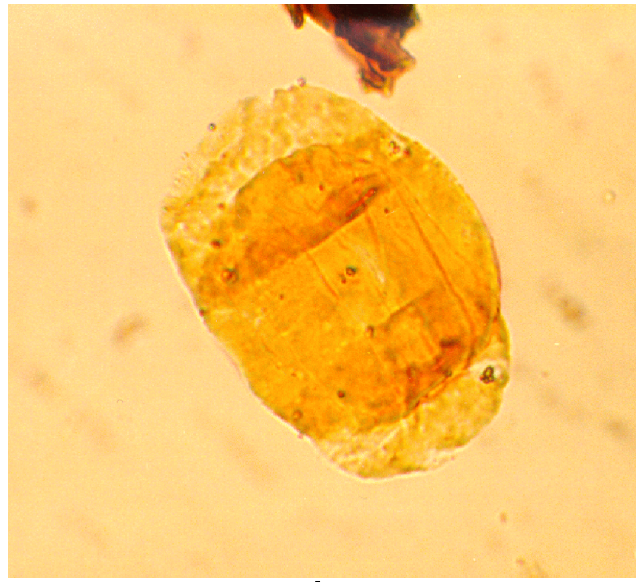


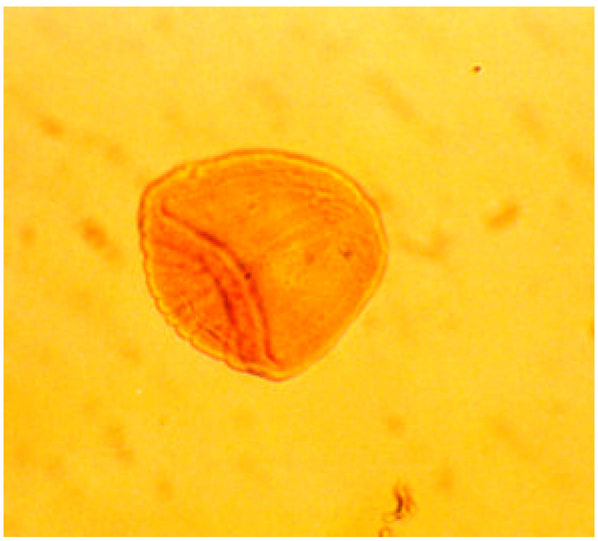
Figure 2. Percentage of major palynomorph groups from sample at 26.o MAB, Aidaralash Creek, Kazakhstan. **Di-sac** = disaccate pollen grains; **Taen poly** = taeniate polyplicate pollen grains; **Mono-sac** = monosaccate pollen grains; **Tri-rad** = trilete radial spores; **Tri-zone** = trilete radial zonate/cingulate spores.

Figure 3. Selected palynomorphs from across the Carboniferous/ Permian boundary at Aidaralash Creek. All photographs are at a magnification of approximately 500X. Stage coordinates are from an Olympus Vanox microscope, BSU# 31597. Stratigraphic coordinates are given as K meters above boundary (MAB) of the conodont boundary, Bed 19.2 (Figure 1).

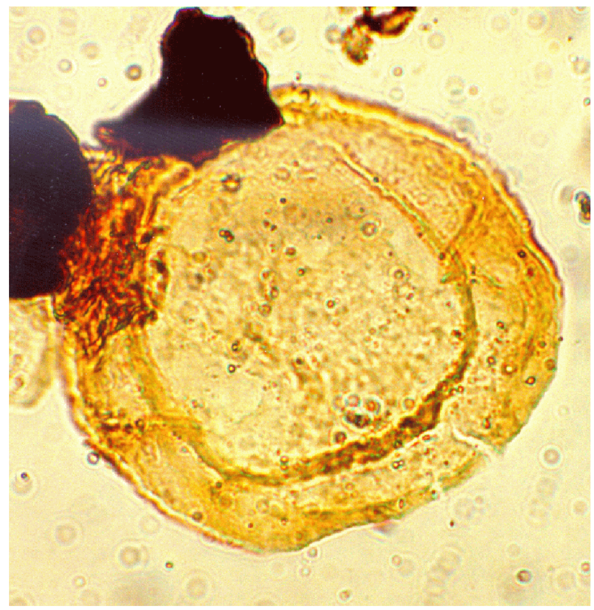
A. *Protohaploxypinus perfectus* (Naumova ex Kara-Murza 1952) Samoilovich 1953.
13 X 84, -9.1MAB.
B. *Vittatina vittifera* (Lyuber and Val'ts 1941) Samoilovich 1953.
16 X 96.5, -1.1MAB.
C. *Cordaitina uralensis* Lyuber and Val'ts 1941.
17.5 X 85, +26.0MAB.
D. *Punctatisporites gretensis f. minor* Hart 1965.
20.5 X 91, -1.1MAB.
E. *Knoxisporites* sp. Potonié and Kremp 1954.
17.25 X 82.25, -1.1MAB.



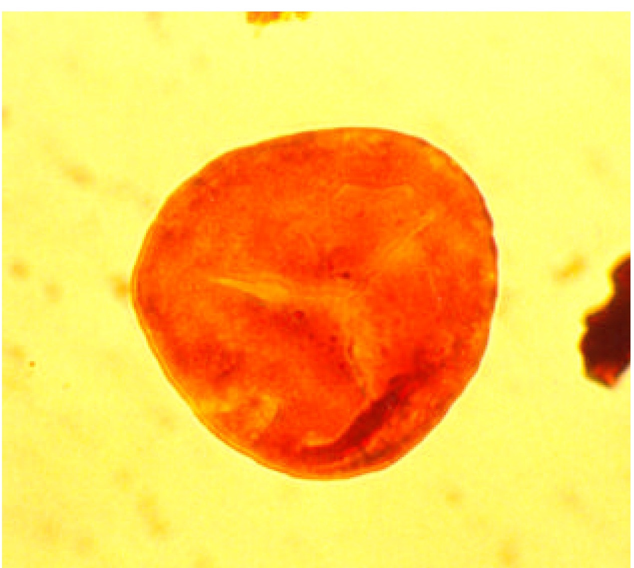
A



B



C



D

E

Miscellaneous Permian Taxa of Western North America: Paleobiogeographic, Paleogeographic, Biostratigraphic and Paleoecologic Implications.

by Rex Alan Hanger

Permian rocks are exposed throughout western North America (Fig 1) in many accreted terranes (Silberling et al., 1987). Fusulinids, conodonts and corals hold biostratigraphic primacy in these areas, but not all strata contain these groups, nor have all known faunas been described. Analysis of the paleobiogeography and paleogeography of Permian faunas has led to the recognition of a distinct McCloud Province (Stevens et al., 1990; named for the McCloud Limestone of the Eastern Klammath Mountains, Loc. 1), encompassing several accreted terranes. The McCloud Province is commonly interpreted as existing around an island arc off the coast (unknown distance) of North America during the Permian (Miller, 1987). During the preparation of the large brachiopod collections for monographic treatment, many significant supplementary groups have been recovered in the acid etched residues. These have proven to have important implications for many aspects of western North American geology and are updated here.

1)The Quinn River Formation of the Bilk Creek Mountains, Humboldt County, Nevada (Loc. 2) contains conodonts and radiolarians that date the formation as Guadalupian to Carnian (Blome and Reed, 1995). The lower part of the formation consists of light brown calcareous to cherty dolomite. The rhizomorine demosponge, *Haplistion aeluroglossa* (Finks, 1960) and an unidentifiable anthaspidellid orthocladinid demosponge have been identified from the dolomite. As with the fossil sponges recovered from British Columbia (Rigby, 1973), the Quinn River Formation fossils show affinity to those of the Boreal faunas of Arctic Canada, Spitsbergen and Russia, and suggest no major transport for the Black Rock Terrane, although they are distinct from coeval North American faunas (Rigby and Senowbari-Daryan, 1995). (Research with Dr. J. Keith Rigby, Brigham Young University.)

2) The gastropod genus, *Actaeonina*, is among the rarest of all Upper Paleozoic molluscs. Knight (1941) counted only two known specimens, both from the Visean of Belgium. In their survey of Paleozoic opisthobranch gastropods, Kollmann and Yochelson (1976) point out that *Actaeonina*, "...has not yet been found in North America in spite of careful searching among large collections of Pennsylvanian and Permian gastropods." Acid etching of limestone samples from the Lower Permian (Wolfcampian - Leonardian) Coyote Butte Formation of Crook County, Central Oregon (Loc. 4) has produced four specimens of a new species of *Actaeonina.* (Fig. 2)

The presence of *Actaeonina* in Oregon has important implications for western North American terrane paleogeography. The Coyote Butte Formation is part of the Upper Paleozoic - Mesozoic Grindstone Terrane of Central Oregon (Wardlaw et al., 1982), and occurs as chaotically intermixed limestone blocks within cherts and volcaniclastics. The limestone is interpreted as slide and slump blocks that became detached from a carbonate shelf and incorporated into deeper-water basinal clastics in a fore-arc basin (Blome and Nestell, 1991). The exact dimensions of this basin, and specifically the longitudinal separation of the island arc from the North American continent, remain controversial, and distances of greater than 5000 km with southern hemisphere origins have been suggested (Jones, 1990; Miller et al., 1992). Presence of the only other species, *A. carbonaria*, in the plate-bound basins of Belgium, suggests general affinity with the Carboniferous-Permian Boreal faunas and a northern hemisphere position for the Coyote Butte Formation. (Research with Ellen E. Strong, George Washington University.)

3) The acid etching program of the Coyote Butte Formation (Loc. 4) has also produced several important arthropod taxa (Hengstenberg et al., 1997). Permian trilobites are limited in diversity and abundance worldwide, and personal observations suggest that they are particularly rare in western terranes. It is notable that over 30 pygidia, and assorted glabella, cheek and thoracic fragments of the trilobite *Ditomopyge* sp. are present in the collection. *Ditomopyge* is a cosmopolitan genus according to Owen and Hahn (1993), but has primarily a northern hemisphere distribution in the Early Permian.

Two unidentified species of the ostracod *Bairdia* and a possible new species of *Bairdiacypris* are also present. Both genera range throughout the Pennsylvanian and Permian and indicate deposition in three offshore environments with low terrigenous sedimentation (Melnyk and Maddocks, 1988a, b) (Research with Carey A. Hengstenberg, University of Vermont.)

4) A single specimen of the shark, *Helicoprion nevadensis* (Wheeler, 1939) was collected in the Antler Peak Limestone of Lander County, Nevada (Loc. 5). The only other specimen of this species has dubious location information at best, and no age control (Silberling, 1973). The new spiral toothrow fossil occurs with Wolfcampian fusulinids (Verville et al., 1986) in the pale grayish-orange to pale brown siliceous facies of the for-

Figure 1. Locations of reported Permian faunas, with most common formation and terrane names.

mation (Hanger and Strong, In Press). A very similar (and possibly synonymous) species, *H. californica* (Wheeler, 1939), (also of dubious provenance, but within the Northern Sierra Terrane) is evidence for open ocean connections between the North American continental margin (Antler Peak Limestone) and the allochthonous terranes to the west, but not necessarily close paleogeographic proximity. (Research with Ellen E. Strong, George Washington University.)

5) A Permian sedimentary megamictite is exposed in the West Branch area of Oroville Lake in Butte County, California (Loc. 6), part of the Foothills Terrane. The large (up to 100m diameter) limestone clasts within a diamictite matrix contain a sparse fauna of silicified and fragmented fossils. Fusulinids and corals suggest Early Permian age for the clasts, and faunal affinity with the McCloud Province (Watkins et al., 1987).

New collections reveal the brachiopods: *Composita* sp., *Crurithyris* sp. and *Rhynchopora* sp., which provide ages consistent with the other taxa, but also new paleobiogeographic information to suggest possible North American (not McCloud Province) affinity. *Composita,* specifically, is "legion" in North America, but is never found among the thousands of specimens of the McCloud Limestone collections.

This supports the new Nd isotope data of Blein et al., (1995) which shows that the igneous rocks of the Eastern Klamath and Black Rock Terranes are mafic arc-tholeiites devoid of crustal contamination (i.e. not crystallized near continental crust), where as the igneous rocks of the Northern Sierra Terrane are calc-alkaline rich indicating melting with large involvement of crustal components (i.e., crystallized near continental crust). Thus the Foothills Terrane megamictite contains limestone clasts derived from a Northern Sierra Terrane proximal to North American continent, and clasts derived from the Eastern Klamath Terrane, arc-related and distal to the continent.

6) An unnamed Permian limestone crops out in the Black Rock Terrane rocks of the Pine Forest Range in Humboldt County, Nevada (Loc. 3). The Mollusc-rich facies were sampled and acid etched. Among 21 different species is a probable new genus and species of pleurotomariid gastropod. The new taxon is noteworthy because it is distinctive in morphology (and thus easily recognized, even in distorted specimens), and is also present in the McCloud Limestone of the Eastern Klamath Terrane in Shasta County, California (Loc. 1).

In the McCloud Limestone, the new gastropod has been recovered from six horizons within the lower 200 meters of the formation. This part of the formation is latest Carboniferous to basal Permian, lying within zones A and B of Skinner and Wilde's (1965) fusulinid zonation for Permian strata of the Eastern Klamath Mountains.

In the Pine Forest Range, the gastropod has been recovered from four horizons of the lower carbonate member of Wyld's (1990) Permian limestone and clastic formation. The lower carbonate member consists of limestone with thin shale interbeds. Mollusc-bearing horizons are debris-flow beds, suggesting deposition on the lower part of a ramp slope, in deeper water or basinal environments. Other fossils include brachiopods and corals which have been broken down to sizes similar to all of the gastropods (1-4 mm diameter), presumably during debris-flow events.

The new gastropod can be easily identified in a molluscan fauna and thus serves as an indicator of the McCloud Province biota. Whereas not abundant in either terrane, it is common enough to be noticed during normal programs of acid-etching in Permian strata. Absence of the new gastropod in cratonic North America is not due to insufficient collecting in mainland North America, which is the best described Permian gastropod fauna in the world. (Research with Thomas E. Yancey, Texas A&M University; Ellen E. Strong, George Washington University.)

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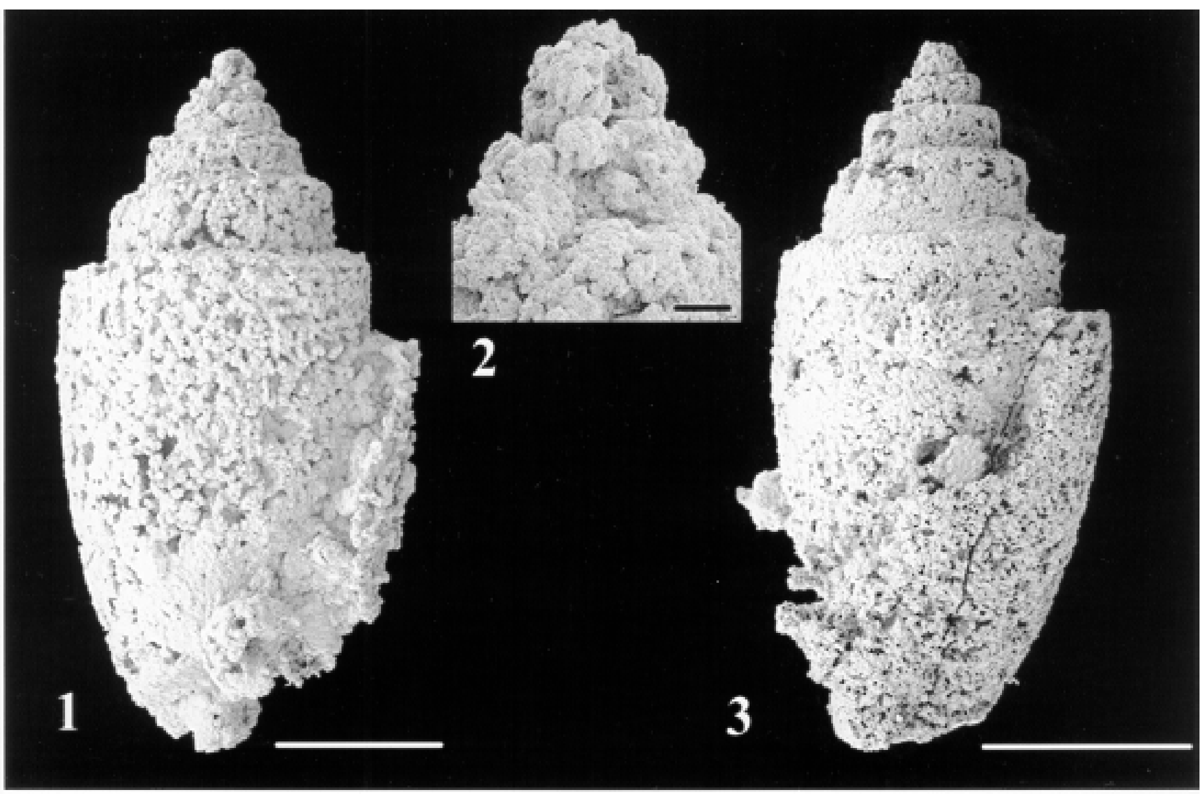

Figure 2. *Actaeonia* n. sp., Lower Permian (Wolfcampian-Leonardian), Coyote Butte Formation of Crook County, Central Oregon (Loc 4): bar for 1 and 3 is 1mm., bar for 2 is 100um. *Actaeonina* is among the rarest of all Upper Paleozoic gastropod genera. Commonly considered to be an opisthobranch, it is characterized by the *Conus*-like shell shape and the heterostrophic larval whorl.

Not *Heritschioides* in Europe Yet

by Edward C. Wilson

The colonial rugose coral *Heritschioides* Yabe, 1950 is an index fossil for uppermost Pennsylvanian and Lower Permian marine rocks of western USA plus western and Arctic Canada (Wilson, 1980 and later reports by several authors). Kossovaja (1996, 1997) referred to a Late Carboniferous coral from North Timan (NE European Arctic Russia) *as Heritschioides* aff. *H. carneyi* Wilson, 1982, but did not describe or figure it. *H. carneyi* originally was described from the Upper Pennsylvanian-Lower Permian McCloud Limestone of northern California.

This apparent intercontinental geographic range extension of the genus may not be justified. I have corresponded with Kossovaja (1995) and reviewed photographs of her thin sections of the North Timan coral. The corallites are poorly preserved and somewhat crushed and the short cardinal septum, an obligatory character for the Family Heritschioidae Sando, 1985, is not observable. The coral, therefore, cannot be firmly referred to *Heritschioides*. Furthermore, Kossovaja's coral is so unlike *H. carneyi* in numbers of septa and lengths of minor septa that it cannot be placed in the same species group (Wilson, 1982, fig. 17) even if it did belong to the genus.

Firm identification of the North Timan coral awaits examination of better preserved specimens. Until then, this range extension of such an important index coral genus should be regarded with caution.

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The Permian sequence at Wairaki Downs, Southern New Zealand

by J. B. Waterhouse

The fullest sequence of Middle Permian biozones in New Zealand is found at Wairaki Downs, an area of low rolling hills east of the Takitimu Mountains, where older Permian rocks are exposed. The mid-1950's and 1960's saw initial mapping and description of about 200 species of mostly brachiopods and molluscs, and recognition of a number of biozones (Mutch 1972, Waterhouse 1964, 1982). Subsequently the area has been mapped in more detail, using a base-map at 1:6800. It has been found that although the succession of zones has been correctly ordered, several are separated by low-angle thrusts, which have brought together rocks from different sources. Many of the thrusts involve Jurassic sediment. The new mapping and careful examination of the faunas show that claims of "broken formations" by Landis (1 987) and purported revisions and correlations in Campbell et al. (1996) may be set aside. The succession may be briefly summarized.

Wairaki Downs Group

The Wairaki Downs Group overlies the Early Permian (Cisuralian) Takitimu Group, as part of a basaltic andesitic volcanic arc and associated sediment called the Brook Street Terrane. The group contains faunas of seven successive brachiopod zones in three formations: Caravan, of very coarse clastics, Letham which grades northwards from the upper Caravan into deeper water siltstones and carbonates, and Mangarewa which grades southwards from coarse sediment into thicker carbonates and fine clastics. Landis (1987) claimed the Letham and Mangarewa were inseparable, and constituted a broken formation, but allowed he had not mapped them. Fossils are numerous and occur in biozones which may be correlated with the biozones recognized in the southeast Bowen Basin of central Queensland (Waterhouse 1987). Structural data and fossils suggest that one biozone has been substantially thinned by a low angle thrust just above the base of the Mangarewa Formation. New overviews of east Australian ages by Roberts et al. (1996) and Jin and Menning (1996) suggest that the biozones range through Kungurian and Guadalupian, based partly on Australian ammonoid data, radiometric values and paleomagnetic lllawarra Reversal. Of course the correlations with world stratotypes must be putative and indirect, because no conodonts are present.

Glendale Formation

The Wairaki Downs Group is overlain unconformably by Jurassic conglomerate of the Elsdun Formation, and separated from clastics and massive limestone of the Glendale Formation by a low angle thrust. The thrust is partly intruded by the igneous Weetwood Formation. Newly found fossils belong to the *Plekonella multicostata* Zone, one of several zones correlated with Late Permian of the Himalaya and Salt Range (Waterhouse 1978). This biozone is better developed elsewhere in the New Zealand Permian, and may be poorly represented in the upper South Curra Limestone of the Gympie Basin of southeast Queensland. It seems likely that the Glendale developed as part of a separate Maitai Terrane, which converged on Brook

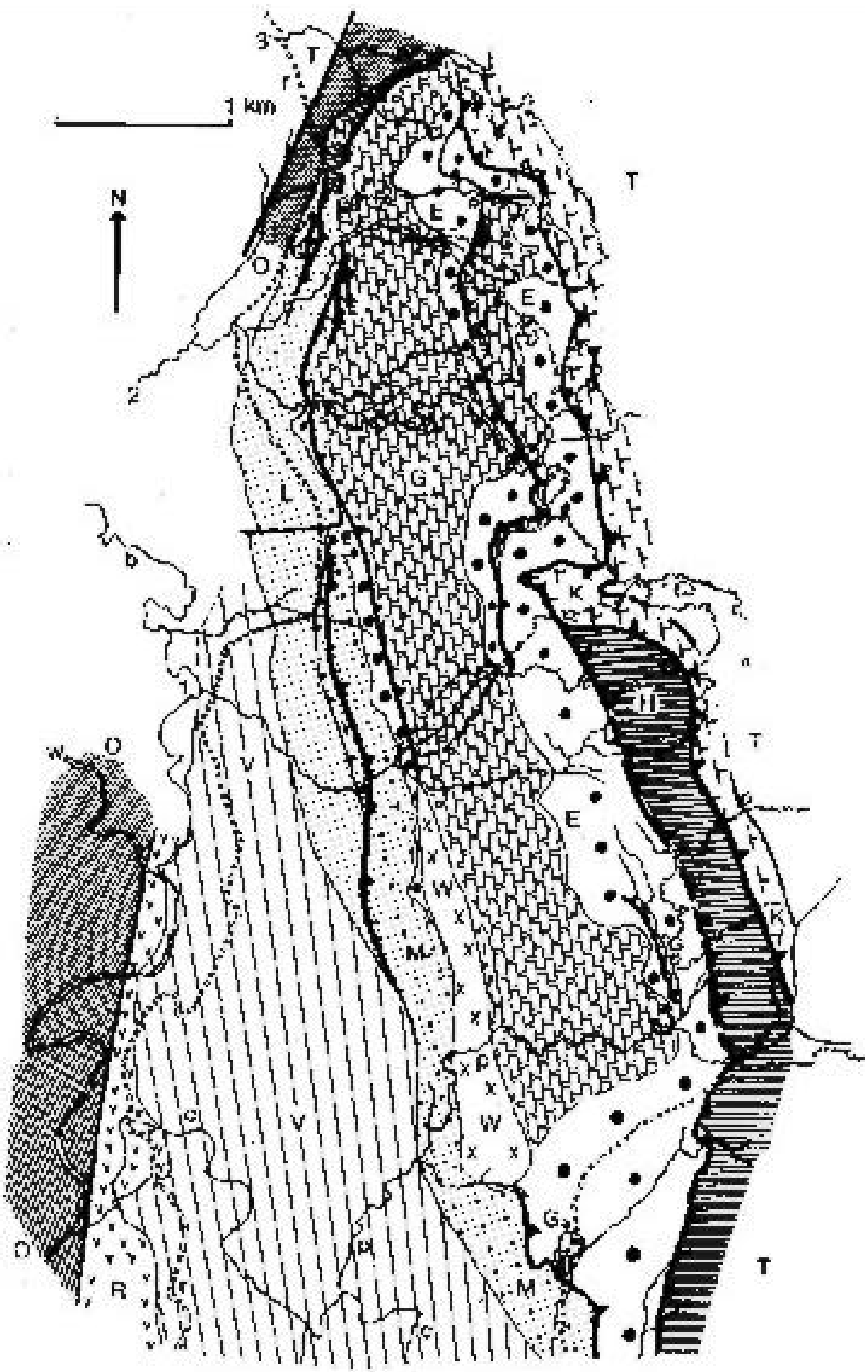

Figure 1. Permian and Mesozoic geology, much simplified, for Wairaki Downs, southern New Zealand.
Formations, with provisional ages: E - Elsdun (Jurassic), G - Glendale (lower Wuchiapingian), H - Coral Bluff Tectonic Assemblage, with Hilton (late Wuchiapingian) and ?Old Wairaki Hut (late Cisuralian), K - Wairaki Breccia-Conglomerate (late Changhsingian), L - Letham (Kungurian), M - Mangarewa (Guadalupian), O - Old Wairaki Hut (late Cisuralian), R - Elbow Creek (early Kungurian), V - Caravan (early Kungurian), W - Weetwood (?Cretaceous). Geographic features - b - Letham Burn, c - Elbow Creek, p - Productus Creek, r - Barreft's Hut track, w - Wairaki River, 1-3 major east tributaries of Letham Burn. General area 167degrees 57' east, 45degrees, 47' south - 1:50 000 NZMS 260 Sheet D 44 (1986). Map base prepared from aerial photograph no. 5215 (1978).

Street Terrane in early Mesozoic time.

The Glendale is also overlain unconformably by Jurassic conglomerate and fine sandstone of the Elsdun Formation. The two units are repeated several times by low angle thrusts.

Coral Bluff Tectonic Assemblage

Overlying the Elsdun and Glendale rocks is a tectonic complex of upper Takitimu (?late Cisuralian) beds and Hilton Limestone Formation, with a ?late Wuchiapingian fauna. The Hilton developed as bioherms and carbonate above Takitimu to the west, and the rocks have evidently slid eastwards over the rocks of the Wairaki Downs Group, and Glendale and Elsdun Formations. The zone is also well represented in the general region, and found also 150km to the east as the *Spinomartinia spinosa* Zone. New fossils include the late Permian brachiopod *Marginalosia*. The overall stratigraphic distribution, detailed mapping, fossil content, and faunal relationships to the *Marginalosia planata* Zone of east Nelson strongly discount the suggestion by Campbell et al. (1996) that this part of the succession might need to be reversed.

Wairaki Breccia-Conglomerate

Thin breccias and conglomerates at the top of the Permian sequence have an unusual *Wairakiella rostrata* Zone, possibly of late Changhsingian age, and not reworked, unlike a nearby mixed fauna to the north, confused with this zone by Campbell et al. (1996). The rocks seem to belong to the base of the Triassic sequence of the Murihiku Terrane, which has been emplaced by either strike-slip or thrusting (Paull et al. 1996, Waterhouse 1993).

Conclusions

That the Permian sequence of Wairaki Downs should turn out to be in incorrect stratigraphic order is perhaps a matter of good fortune, for early workers had no suspicion that a series of low angle thrusts or Jurassic beds were present. As well, fossil evidence did indicate a normal upward younging succession. The thrust emplacements have involved relatively thin slices, moving mostly along weak Jurassic fine clastics, and probably have not involved distances greater than a few kilometres, apart from the Triassic - late Permian Murihiku Terrane. The Maitai may also have moved further by tens of kilometres, but was reactivated in late Mesozoic. The Permian faunas in this segment of New Zealand are close enough to those of east Australia, especially the Bowen Basin for a substantial sharing of many critical species, at many levels, enabling a shared biozonal classification.

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Sequence Stratigraphy of the lower Permian along the Kosva River (Gubakha area, Central Urals, Russia)

by A. Izart, O. Kossovaya, D. Vachard and D. Vaslet

Lower Permian sediments of the Kosva River in the central Urals were deposited on the eastern part of the Russian platform, near the rim of the Ural foreland basin. The lithology and the biostratigraphy of the Kholodny and Belaya Gora cross-sections, located near Gubakha city, have been described by Ekhlakov (1993). Our paper presents the sequence stratigraphy of the Lower Permian in this area. Detailed sections were measured in order to establish precise lithostratigraphic logs, on which paleoenvironments were interpreted. A paleoenvironment model (Fig. 1) and a curve of facies/ paleoenvironments were established for determine the high frequency (not presented here), third order and second order sequences (Fig. 2).

Description of the sequences in the Gubakha area

The upper Gzhelian (Orenburgian) is characterized by *Palaeoaplysina* and Fusulinids limestones. The base of the Asselian does not exhibit traces of emersion. The Asselian is subdivided into two substages: the Kholodnian and the Shikhanian. The Asselian deposits form a second order sequence (7 M.Y.) with a maximum flooding period (MFP) during the Kholodnian and a highstand system tract (HST) during the Shikhanian. The Kholodnian shows four third order sequences (AS I to AS4, Fig. 2) and nineteen shallowing upward high frequency sequences composed of small *Palaeoaplysina* reef (thickness 1-6m)-wackestone-packstone limestones deposited on the mid-platforrn. The lower part of the Shikhanian is concealed on the Kholodny section, except for some outcrops that show packstone and wackestone limestones deposited on the mid-platform. The upper part of the Shikhanian is known on the Belaya Gora section with thirteen shallowing upward high frequency sequences consisted of wackestone-packstone-grainstone limestones with colonial corals, interpreted as mid-platform and shoal deposits. The Shikhanian deposits form a third order sequence (AS5, Fig. 2) with facies of mid-platform in MFP, and mid-platform and shoal in the HST.

The Sakmarian, studied on the Belaya Gora cross-section, is subdivided into two substages: the Tastubian and the Sterlitamakian. The Tastubian presents two third order sequences SAI and SA2 and the Sterlitamakian one third order sequence SA3 (Fig. 2). The sequence SAI exhibits thirty three shallowing upward high frequency sequences composed of wackestone-grainstone or wackestone-packstone limestones with colonial corals deposited on the mid-platform and shoal during the transgressive system tract (TST) and HST, and *Palaeoaplysina* small reef-wackestone-packstone limestones deposited on the mid-platform and shoal during the MFP. The sequence SA2 presents twenty-two shallowing upward high frequency sequences composed of *Palaeoaplysina* small reef-wackestone-packstone limestones deposited on the mid-platform during the TST and the MFP. The sequence SA3 shows twenty shallowing upward high frequency sequences composed of *Palaeoaplysina* small reef-wackestone (2-10m) and silicified wackestone-packstone limestones deposited on the mid-platform and outer platform.

The Artinskian, studied on the Belaya Gora cross-section, is subdivided into four substages : the *Burtsevkian, Irginian, Sarginian* and *Saranian*. The Artinskian presents one composite carbonate third order sequence (AR 1 -2) corresponding to the Bursevkian and Irginian deposits and one composite turbiditic third order sequence (AR3-4) corresponding to the Sarginian and Sarinian deposits. The Bursevkian exhibits three shallowing upward high frequency sequences and the Irginian thirteen composed of silicified wackestone-packstone limestones deposited on the outer platform in front of the reef located now westward of this area. For Artinskian, this analysis can be completed in the reef area of Sylvinsk (Ozhglbesov et al., 1993), where sequences AR3 and AR4 are well exposed under reef and platform facies. During Sakmarian and Artinskian, the paleoenvironments evolved from the mid-platform to the reef, outer platform and turbiditic basin (Figs.1, 2) with a migration of the reef area westwards (Chuvashov, 1983). A second order sequence (13 in. M. Y.), interpreted as tectonic origin, is observed during Sakmarian and Artinskian in this area, produced by the progression westwards of the Ural orogen and of the Ural foreland basin on the Russian platform. In the Gubakha area, the control of the sequences is eustatic and tectonic during Asselian and Sakmarian, and tectonic during Artinskian.

Comparison with the Southern Urals and Southwestern North America

Unfortunately the continuity of sequences can not be fully controlled without bore holes data between the field sections of the central and southern Urals. Second and third order sequences can be only compared between the cross-sections. In the reef area (Skakhtau Shikhan), Rauser-Chemousova and Korolyuk (1993) described Asselian as biohermal limestones with *Tubiphytes* and bryozoa and with a hiatus at the top; Tastubian as biohermal limestones with bryozoa, *Palaeoaplysina* and colonial corals and bioclastic limestones ; Sterlitamakian as massive *Palaeoaplysina* biohermal limestone (thickness 100m) and dark micritic limestone; Artinskian as bryozoa limestones filling large cracks at the top of the reef and marl with sponge spicules. Venin (1996) described four sequences composed of high frequency sequences: one incomplete in Asselian, one for Tastubian, one for Sterlitamakian and one incomplete for Artinskian. In the Ural foreland basin, in Aidalarash creek (Snyder and Gallegos, 1997), the Asselian and Sakmarian presents three sequences, the Sterlitamakian and Artinskian seven sequences. But, the sequences deposited at the eastern part of the foreland basin near the Urals are certainly tectonic controlled. Ross and Ross (1987, 1994, 1995) published the Permian sequence stratigraphy with a comparison between the Sakmar area (foreland basin, southern Urals) and the southwestern North America. They described five third order sequences during Asselian (four for the Nealian and one composite during Shikhanian eroded in USA), four or five third order sequences during Sakmarian (four for the Lenoxian and one during Sterlitamakian lacking in USA), three or four third order sequences during Artinskian (Hessian), one composite or two third order sequences during Kungurian (Cathedralian). By comparison the number of sequences in all the cross-sections is different: five during Asselian, one, three or five during Sakmarian, two composite or four during Artinskian, one or two during Kungurian. The building of a sequence stratigraphy in the Lower Permian is difficult because of the erosion of sequences, the stacking of sequences in the case of composite sequence during the maximum transgression and the tectonic control of the sequences. Thus, the Russian platform should be considered as the best area to reconstruct sequence stratigraphy, the Ural foreland basin being too tectonic to be a reference area.

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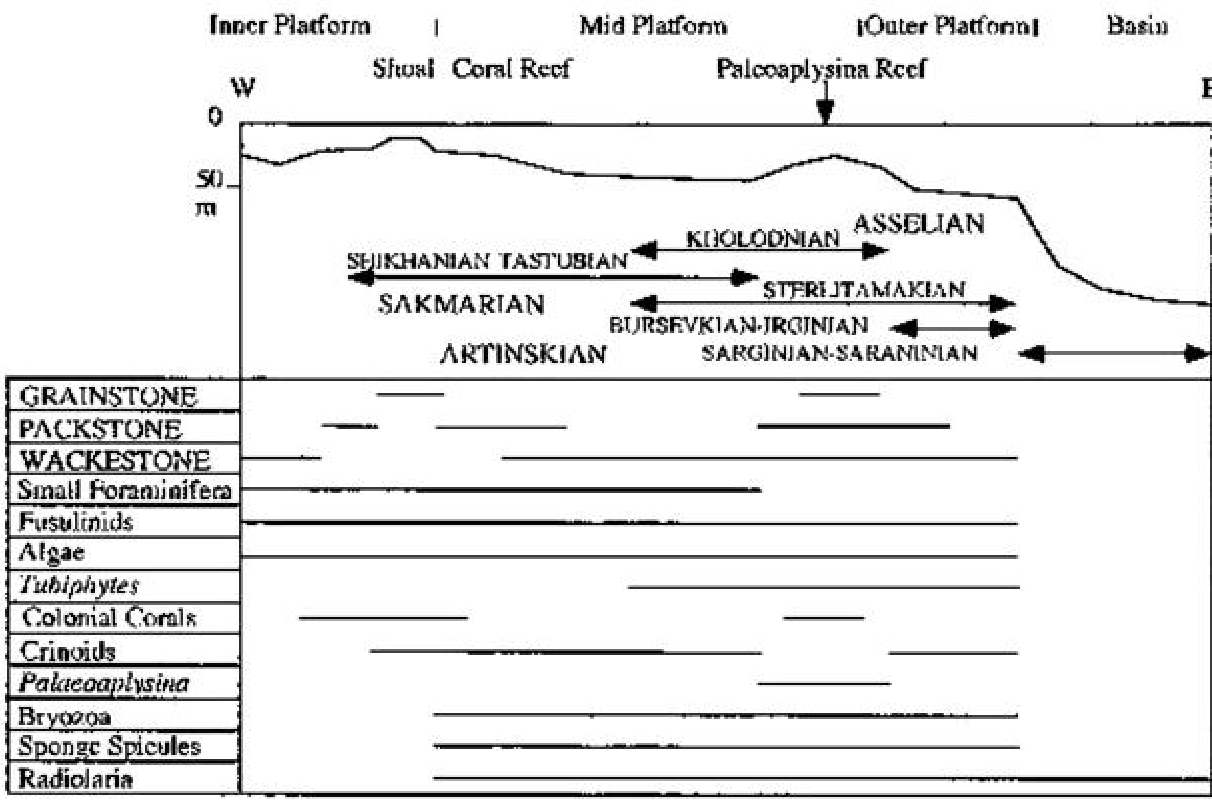

Figure 1. Facies and Paleoenvironments of the lower Permian in the Gubakha area (central Urals).

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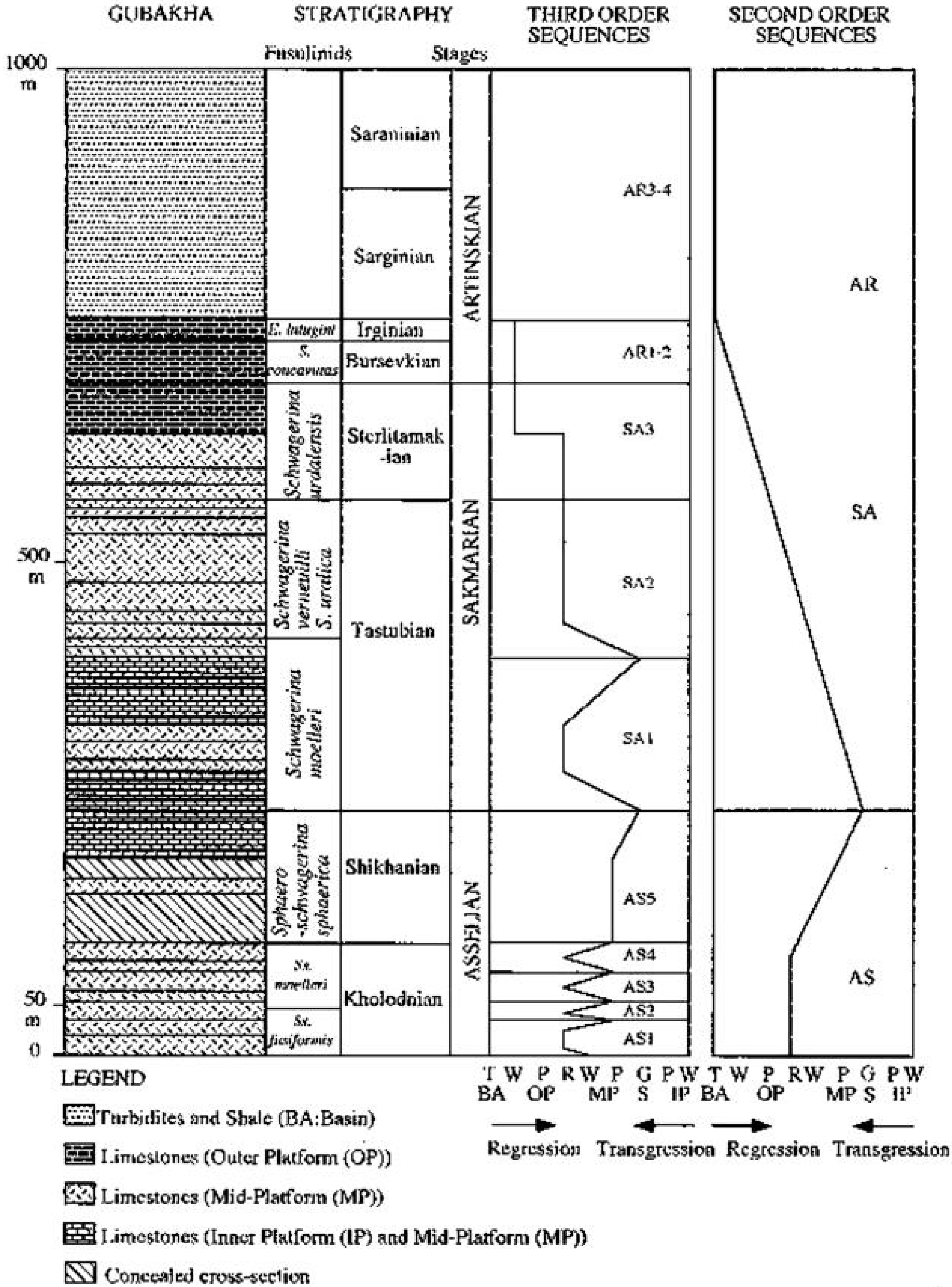


Figure 2: Stratigraphy and Sequence Stratigraphy of the lower Permian in the Gubakha area (central Urals) G: Grainstone, P: Packstone, R:Reef, S: Shoal, W:Wackestone

Interzonation of Artinskian Fusulinids And Conodonts (Western Urals, Russia)

by B. I. Chuvashov and V. V. Chernykh

The Artinskian Stage was established in 1874 by A. P. Karpinsky, based upon ammonoids, and this usage persisted until the middle 30's of the present century when researchers G. A. Dutkevich, D. M. Rauser-Chernousova, A. Ja. Vissarionova and others began designation of a fusulinacean scale for the Artinskian that was generally agreed upon by the late 40's. In later years, Artinskian fusulinid faunas were supplemented by description of many new species that could be used to mark the boundaries of stages and horizons (Rauser-Chernousova, and Chuvashov, B.I., 1980). To the present time, the fusulinids remain the primary reference group, as they are widespread throughout all facies of the Artinskian basin.

Endemism of fusulinid faunas in the Preural Basin complicates correlation of the stratotype to sections beyond the margins of the basin. For the same reason, ammonoids cannot assist materially in correlation.

Study of conodonts from the Ural region began only 25 years ago, but they have proved to be more useful for establishment of stage boundaries that can be related to those of other groups, particularly the fusulinids. The present article focuses on these relationships. To clarify the problem, we begin with the consideration of the general characteristics of the fusulinid zonal scale for the Artinskian Stage and adjacent divisions, presented in the accompanying table.

The Sterlitamakian is characterized by the following group of fusulinids: *Pseudofusulina callosa, P. plicatissima, P. confusa,* and *P. urdalensis.* However all named forms extend into the Burtsevskian horizon to provide close similarity between these two divisions (Chuvashov, 1984).

The top part of the Sterlitamakian horizon contains rare *Pseudofusulina adelpha* (Raus.), which can be considered ancestral to the typically Artinskian *Pseudofusulina concavutas* Viss. The latter in association with a group of similar forms has been accepted in recent publications as defining the lower boundary of the Burtevskian horizon and the Artinskian Stage. Another important fusulinid marking the lower boundary of the stage is *Pseudofusulina pedissequa* Vissarionova, which probably evolved from the Late Tastubian *P. jaroslavkensis frandulenta* Kireeva.

P. pedissequa is widespread in the southern part of the Preural Basin, as far north as the latitude of the City of Perm, and characterizes the carbonates of the margin of the Russian Platform. Fusulinids of the *P. concavutas* group are common in all facies of the Artinskian basin. Similar forms are known from the Artinskian of Arctic Canada and Alaska (Chuvashov, 1984).

Burtsevskian fusulinids are characterized by species with rather short shells, regular folding of the septa, and moderately well advanced axial fillings. Exceptions are large subcylindrical *P. pedissequa* and the rare associates in the top part of the horizon, the morphologically similar *Pseudofusulina concessa* Viss., *P. paraconcessa* Raus., *P. uralensis* (Raus.), and *P. juresanensis* Raus.

Massive occurrences of these forms, together with *Eoparafusulina lutugini* (Schellw.), *E. ufaensis* Tchuv., *Pseudofusulina substricta* Konov. and some others defines the lower boundary of the Irginskian horizon. A group of relatively inflated fusulinids with a different type of septal folding and weak to moderate axial filling is also moderately abundant in essentially all Artinskian facies, but is more useful in the terrigenous facies: it includes such species as *Pseudofusulina kutkanensis* Raus., *P. chomatifera* Raus., *P. kusjanovi* Raus., *P. urasbajevi* Raus., and some others. This Irginskian fusulinid fauna is in need of taxonomic revision, as even the generic assignment of some forms is questionable. First appearance of *Eoparafusulina* could possibly be considered as a main characteristic of the Irginskian horizon.

The lower boundary of the Sarginskian horizon is characterized by occurrence of a group of rather large and robust fusulinids with regularly folded septa and massive axial fillings: included are *Parafusulina solidissima* Rous. and *P. tschussovensis* Raus. These species are often accompanied by *Parafusulina acis* Tchuv., *P.? transcedens* (Raus.), *Pseudofusulina utilis* Tchuv., *P. antis* Tchuv., and *P. postsolida* Tchuv. First appearance of these forms in the Sarginskian horizon makes the lower boundary readily recognizable.

Fusulinids are not known in the Saraninskian horizon of the Artinskian, but occur within terrigenous deposits of both horizons of the Kungurian Stage and in the Nevolinskian carbonates of the Irenskian horizon (Zolotova V.P. and Barishnicov, 1978). Nevolinskian fusulinids differ from the Artinskian assemblage only in the species composition: they share such important common Artinskian species as *Parafusulina solidissima*.

The taxonomy and biostratigraphy of Artinskian conodonts in the Urals are poorly known. This is due to their relative rarity in comparison to the Asselian and older sections, to the technical difficulties of extracting conodonts from the abundant Artinskian sandstones, to the rather low diversity, and, finally, to poorly developed taxonomy of Lower Permian conodonts.

The late Sterlitamakskian, Artinskian, and Kungurian conodonts examined from various sections of the western slope of the middle and southern Urals comprise 512 specimens, 23 species (4 new) in the genera *Mesogondolella*, *Neostreptognathodus*, and *Sweetognathus*.

The general reason for difficulties in taxonomy of the stratigraphically important representatives of *Sweetognathus* and *Neostreptognathodus* is that juvenile forms of both genera are difficult to differentiate; only in adult forms being clearly differentiable into species. Species of *Sweetognathus* are easier to deal with taxonomically. The first species is *Sweetognathus merrilli* which first occurs in the Tastubian. In the upper Sterlitamakian it occurs together with *Sw. primus*, which is similar to the late Artinskian species of *Sw. inornatus* and *Sw. whitei*. *Sw. merrilli* is characterized by rather widely spaced, poorly developed carinal denticles. *Sw. primus* is distinguished by the presence of a longitudinal medial ridge and transverse ridges connecting pairs of node-like denticles. Samples of *Sw. primus* display forms more similar to *Sw. inornatus* or *Sw. whitei*, being intermediate in the carinal ornamentation. For a holotype we chose a specimen more similar to *Sw. ornatus*, but having a medial ridge (Chuvashov, Dyupina, Mizens, Chernykh, 1990), but it is difficult to differentiate on this specimen. Kozur's (Kozur H, 1995) suggestion that this specimens is probably *Sw.*

inornatus maybe due to the indistinct image of the holotype. However, in the original description of *Sw. primus* the presence of a medial ridge is clearly stated making this species easy to distinguish from *Sw. inornatus.*

Sweetognathus primus probably is an ancestral form to *Sw. whitei* rather than to *Sw. inornatus*. Both these species occur at the same stratigraphic level, in the base of the Burtsevskian horizon of the Artinskian. At the same time the first representatives of the *Sw. bogoslovskajae* occur, marked by short free blade that is high in front and sharply declines in a posterior direction and few (up to 5) unpaired nodes, divided by a deep downturn of a platform. These forms are left here in open nomenclature as *Sw.* ex. gr. *bogoslovskajae* and probably extend into the Irginskian, but these later forms have more nodes (up to 7) and poorly represented on some nodes are the rudiments of a medial ridge, showing convergence of this group with that of *Sw. whitei.*

Sweetognathus whitei (in the broad sense) is known from the Burtsevsian to the top of the Sarginskian. However only the Irginskian and Sarginskian forms of this species have the complete set of characteristic attributes (i.e., the presence of transverse and medial ridges and lateral inflated nodes). Though *Sw. whitei* ranges from the Burtsevskian through the Sarginskian, only the forms from the Irginskian and Sarginskian have the characteristic attributes of transverse and median ridges and laterally increase nodes. In the forms from the Burtsevskian these characters are more poorly expressed and the platform frequently has a comblike structure that is rather narrow and flat on the top surface and the increase pustulose ornamentation on the nodes occurs mainly downwards from the comb of the platform. The transitional form from *Sw. whitei* to *Sw. behnkeni* occurs in the Aktastinskian substage (lower Artinskian) in the southern Urals (Aktasty River).

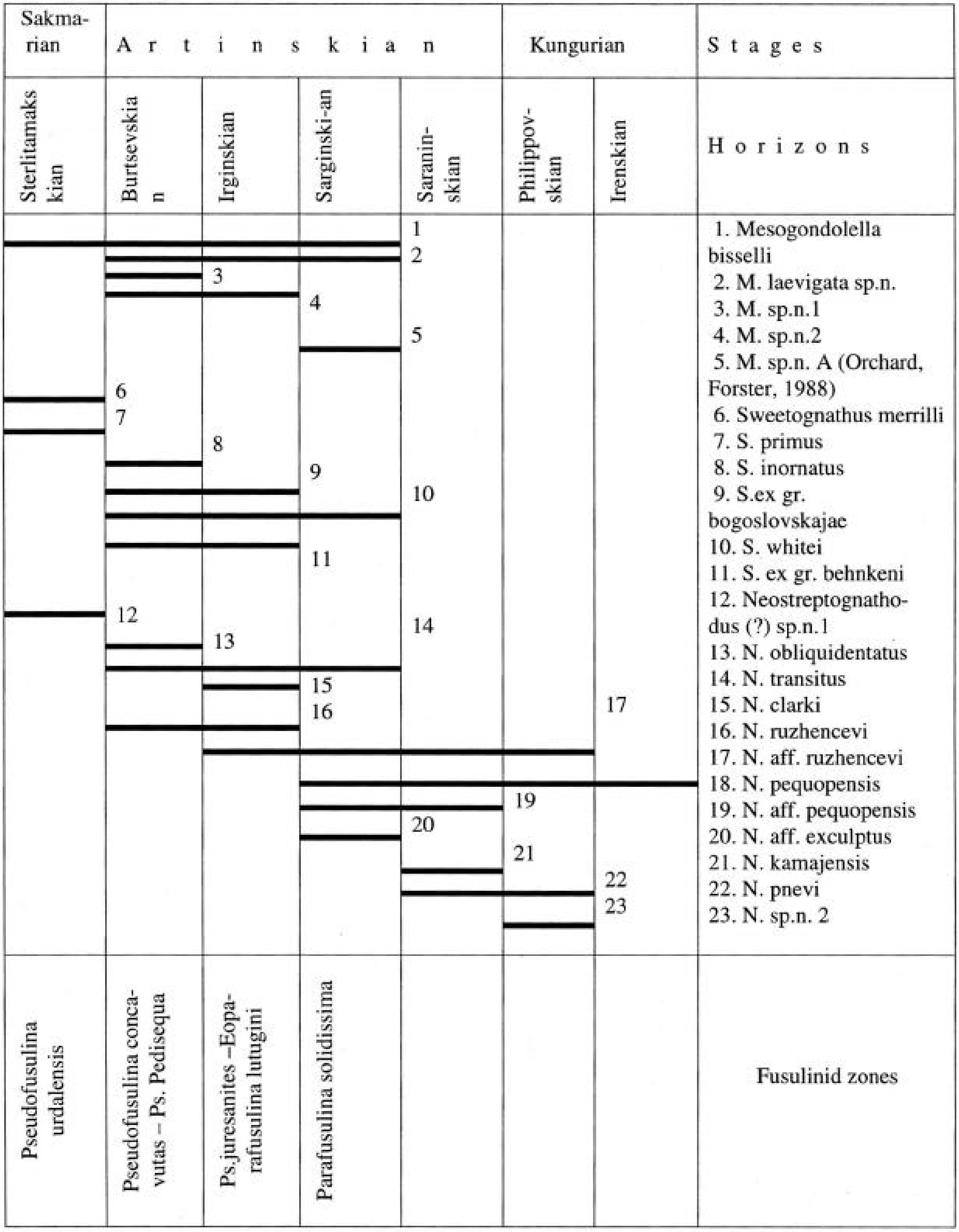
The systematics of neostreptognathodids is more difficult because of the rather small variation of morphological features, relatively slow evolution, and the poor taxonomy resulting from the poor quality image of forms in Kozur's papers, where many of the Artinskian species were first described, including some from Ural sections. The most early neostreptognathodids had mixed attributes of both *Sweetognathus* and *Neostreptognathodus* carinal structure and occur in the upper part of the Sterlitamakskian, where they co-occur with *Sw. primus*. In our collection this early form is rare, designated in the table as *N.*(?) sp. nov. 1. The carina of this form consists of 6-7 pairs of opposing low nodes, which are connected. However, the medial deepening is rather distinct expressed by the gradual downturn of height of the opposing denticles in the direction of the median; a narrow furrow is present at the boundary area between the ending of the free blade and the first denticles of the carina, and the furrow is stretched directly on the lateral thickening of the two back denticles of the free blade, which smoothly passes into the platform. The pustules are present on such forms not only on the surface of the denticles, but also the surface of the interdenticle intervals, ornamenting the entire length of the carina.

The early Burtsevsian forms keep many primitive attributes of the first neostreptognathodids, but the pustulose ornament of the inter denticle space is lost and there is a lateral thickening of the last three denticles of the free blade, forming a kind of a short posterior transverse ridge; the last three denticles of the carina are not subdivided by a furrow. With some reservation we refer these forms to *N. transitus*. Apparently, the merging of the paired denticles on the posterior of the platform reoccurs in neostreptognathodids many times. So, in the Sarginskian the forms with merging 2-3 last denticle pairs are found; however the structure of the denticles of these forms, "knolled" and round, sharply differs from the elongate-oval denticles of the Burtsevskian *N. transitus*. Kozur (Kozur and Mostler, 1976.), describing this species from the Upper Artinskian of the Aktubinsk Preurals, believed that *N. transitus* was an intermediate form between *Sweetognathodus whitei* and *Neostreptognathodus ruzhencevi*. However, we find forms in the upper Sterlitamakian, before the first occurrence of *Sw. whitei*, that are transitional between *Sweetognathus* and *Neostreptognathodus*, apparently stemming from a sweetognathid species more primitive than *Sw. whitei*.

Neostreptognathodids of the *N. ruzhencevi* group occur in the Burtsevskian that are characterized by a smooth transition of the free blade to the platform, the presence of elongate-"knolled" and (or) the short and wide carina denticles and (in later forms) the elevation of the posterior part of the platform above the ending of the basal cavity. Some forms of this group are further characterized by one row of carinal denticles that are "knolled" shaped and a second row that is short transverse drop-shaped ridges and some denticles are inverted to point to the axial furrow. Conodonts with these later features we refer to *N. obliquidentatus* which is restricted to the Burtsevskian. Kozur (Kozur H, 1995) interpreted holotypes of this species as primitive forms of *N. ruzhencevi* which we do not seriously object to. Except for the specified differences in the carinal denticles, this species is distinguished by a smooth transition of the posterior end of the platform to the posterior ending of the basal cavity whereas that of *N. ruzhencevi* is abrupt.

Apparently *N. obliquidentatus* is the evolutionary predecessor of *N. ruzhencevi*. The first representative of *N. ruzhencevi* occurs in the Urals only in the Irginskian and persists through the lower part of the Saraginskian. The later forms with well advanced ridge-shaped carinal denticles, which some authors (see comment in Orchard and Forster, 1988.) refer to *N. ruzhencevi*, differ from the holotype by a deeper deepening between the ridge like denticles; narrower, numerous, regularly placed ridges/denticles; an outline of the platform that has the maximum width displaced to the back part of the platform; and the absence of a smooth transition of the free blade to the platform. We designate such forms as *N.* aff. *ruzhencevi*. The first forms of *N.* aff. *ruzhencevi* diverge from *N. ruzhencevi* in the Irginskian and these diverging forms are marked by an increase in the number of the carinal denticles (up to 11) and a deepening of the intervals between the denticles, then by the change in the junction of the free blade with the platform: smooth transition between them partially (only one parapet is connected to a free bade) or completely disappears (with the bifurcation of the median furrow, separating the free blade ending from both parapets.

In the Saraninskian some of the forms of *N.* aff. *ruzhencevi* undergo further change: on a place in the median furrow arises a V-shaped trough and begins the reduction of the forward carinal ridges, more significant on only one of the parapets. This form is referred to the species *N. pnevi*, which continues to exist to the early Kungurian. Kozur Movshovich, Kozur,


Sakmarian
Artinskian
Kungurian
Stages
Sterlitamakskian
Burtsevskian
Irginskian
Sarginski-an
Saraninskian
Philippovskian
Irenskian
Horizons
1. Mesogondolella bisselli
2. M. laevigata sp.n.
3. M. sp.n.1
4. M. sp.n.2
5. M. sp.n. A (Orchard, Forster, 1988)
6. Sweetognathus merrilli
7. S. primus
8. S. inornatus
9. S.ex gr. bogoslovskajae
10. S. whitei
11. S. ex gr. behnkeni
12. Neostreptognathodus (?) sp.n.1
13. N. obliquidentatus
14. N. transitus
15. N. clarki
16. N. ruzhencevi
17. N. aff. ruzhencevi
18. N. pequopensis
19. N. aff. pequopensis
20. N. aff. exculptus
21. N. kamajensis
22. N. pnevi
23. N. sp.n. 2
Pseudofusulina urdalensis
Pseudofusulina concavutas – Ps. Pedisequa
Ps.juresanites –Eoparafusulina lutugini
Parafusulina solidissima
Fusulinid zones

Pavlov, and other, 1979 and Kozur, 1995) assumed a close phylogenetic connection with *N. pequopensis*, however from our large topotypical material from Kamayskian Ravine we suggest it evolved from *N.* aff. *ruzhencevi*. In one sample of *N. pnevi*, there are specimens with the reduced posterior denticles of the parapets are unequal. Placing this form in an evolutionary context, it is possible to see, that the first members of this lineage clearly have carinal denticles as short transverse ridges (not nodes), which subsequently become completely reduced in front, concurrently there is the formation of a deep V-shaped trough so that the posterior transverse ridges are placed almost vertically, and their rounded top create a kind of "knolled" parapet resembling the parapets of *N. pequopensis*. Without a complete series of the transitional forms it is possible to wrongly assume that such forms have evolved from "knolled" predecessors. The primitive *N. pnevi* have a platform with parapets that converge to the ending of the free blade and are separated from it (partially or completely) by the continuation of the median furrow, similar to some upper Irginskian forms of *N.* aff. *ruzhencevi*.

In the Sarginskian are found more typical neostreptognathodids that are characterized by the symmetrical position of a short free blade, an elongated platform with subparallel lateral margins, and the transverse carinal ridge like denticles (up to 7-8), resembling *N. exsculptus*, but distinguished from it by a smaller number of the carinal denticles and less lengthened platform; such forms are referred to as *N.* aff. *exsculptus*.

The group of *N. pequopensis* displays the diagnostic features of the presence of the nodelike carina denticles, a clearly expressed median trough, and the arrangement of the last carina denticle closely to the back ending of the basal cavity. The first representatives of this group are from the Irginskian and are characterized by a high degree of variability such that the position of the posterior of the free blade may be symmetric or asymmetric, the denticles may be rounded nodes on one side and rounded ridges on the other side, and the interval between the carinal denticles may be close for the first pair and wide for the middle part of the platform and more. Such "irregular variability" is characteristic of an early stage of any taxonomic group. Conodonts with this "irregular variability" are united under the name *N.* aff. *pequopensis*, not having sufficient material for a more detailed analysis of this group.

N. clarki appears and disappears in the upper part of the Irginskian and is characterized by a platform ornamented by two rows of nodelike denticles that are partly separated by a median furrow, and partly connected by transverse ridges, usually in the posterior part.

Representatives of purely *N. pequopensis* occur in the Sarginskian to Kungurian. Our report of this species from the Irginskian (Chuvashov, Dyupina, Mizens, Chernykh, 1990) was connected to a mistaken diagnosis of a juvenile form of *N. ruzhencevi*, undistinguished from *N. pequopensis*. The forms of *N. pequopensis* in the Sarginskian differ from typical forms (Behnken, 1975) only by more pairs of denticles (up to 8). Some Kungurian forms (Irenskian) , referred by us to *N. pequopensis*, are characterized by the presence of slightly laterally compressed and pointed denticles, of which the first two are almost smoothed, appearing like *N. pnevi*, but differ from the latter by the presence of nodelike denticles. However, also among the Irenskian neostreptognathodids are typical *N. pequopensis*. *N. kamajensis*, which we include the *N. pequopensis* group, is known only from the Saraninskian of the Urals. This species is characterized by denticles that are inwardly concave and outwardly convex; 5-6 paired denticles, separated by a deep median furrow, and commonly an unpaired last node. The species also has an ozarkodin element to the apparatus, not analogous to other species of neostreptognathodids. Clearly, the last (posteriormost) denticle on *N. kamajensis* is different than that on *N. pequopensis* in that it is high and round as opposed to ending at the basal cavity. *N. pequopensis* was described by Kozur (Kozur and Mostler, 1976.) as "the narrow platform posteriorly always is gradually reduced, is always sharp comes to an end and smoothly passes in also the pointed ending of the basal cavity, which not or unsignificantly acts behind"(p. 14).

In the Philippovskian only a single specimen of *Neostreptognathodus* was found. A narrow carina, consisting of the paired nodes, separated by a shallow furrow, is clearly expressed on the posterior part of the platform. Near the free blade nodes on one of the parapets gradually smooth out and the last 2-3 denticles become a smooth low ridge; anterior denticles on the second parapet are reduced and only discernible as widely wavy wrinkles. The platform passes to a short free blade with 3 denticles sharply increasing in height toward the front. The basal cavity is strongly inflated. We refer to this specimen, seemingly different than our other species, as *N.* sp. nov. 2.

The taxonomy of Artinskian gondolellids is even more poorly known. *Mesogondolella bisselli* occurs in the Sterlitamakskian and is characterized by a lachrymiform platform, descrete anterior and posterior denticles that do not rise off the platform, and shallow adcarinal furrows. These attributes, found in the holotype, are considered diagnostic (Orchard and Forster 1988) for the species. All of these attributes (i.e., outline of platform, the peculiarities of the carina, etc.) are used to describe *Mesogondolella* species. We offer another attribute: presence or absence of pustular sculpture [reticulate micro-ornament] in the adcarinal furrow. The first middle Asselian mesogondolellids show both forms, those with a completely smooth adcarinal furrow (*M. adentata, M. belladontae*) and those with some pustular sculpture in the adcarinal furrow, just like that sculpture that covers most of the platform surface (*M. simulata*). These two types of ornamentation of the adcarinal furrow show up in subsequent mesogondolellids until their complete disappearance in the Urals in the Sarginskian. Mesogondolellids with smooth adcarinal furrows in the Irginskian and especially the Sarginskian, where the smooth portion is as wide as or wider than the ornamented surface of the platform, are named here as *M. levigatus* sp. nov.

In the Burtsevskian mesogondolellids are characterized by an unusual outline of the posterior lateral edge of the platform appearing like an "ear"; there are left (with a less expressed "ear") and right forms. The few specimens we have recovered do not allow a complete description so we designate this form as *M.* sp. nov. 1. We identify forms as *M.* sp. nov. 2 that are characterized by an asymmetric outline of the posterior-lateral margins of the platform; one side is oriented at a sharp angle to the longitudinal axis of the platform and almost adjoins the cusp; the other side is rounded, bending around the cusp; the carina is composed of completely fused denticles. This form is found in the Burtsevskian and Irginskian. In the Sarginskian occurs a form with a wide elongate oval and flat platform, a well advanced posterior brim, and a small cusp. Similar forms were first described by Orchard and Forster (Orchard and Forster, 1988) as *Neogondolella* n. sp. A from the Leonardian of south-central British Columbia.

In summary, the stratigraphic distribution (table 1) of Artinskian conodonts is clarified. The lower boundary of the Artinskian is marked by the first appearance of various representatives of *Neostreptognathodus* (particularly, *N. obliquidentatus*) and cosmopolitan *Sweetognathus* (*S. whitei* and *S. inornatus*). These conodonts along with *Mesogondoloella bisselli* make up the characteristic Burtsevskian fauna.

The Irginskian includes the first appearances of members of the *N. ruzhencevi* and *N. pequopensis* groups (in particular, *N. clarki*). The maximum variety in *Mesogondolella bisselli* is observed and the wide smooth adcarinal furrows that distinguish *M. levigatus* develops.

The Sarginskian is marked by the first appearance of *N. pequopensis* and the continued presence of *N.* aff. *ruzhencevi* along with the primitive forms of the *N. exsculptus* group and the last appearance of *Mesogondolella* and *Sweetognathus whitei*.

The Saraninskian includes the introduction of *N. kamajensis, N. pnevi*, transitional forms from *N.* aff. *ruzhencevi* to *N. pnevi* along with the continued presence of *N. pequopensis.* Sharply different from the previous Artinskian substages is the absence of sweetognathids and mesogonodolellids in the fauna.

Kungurian faunas are poorly known. However, *N. pnevi* with relic ridge-shaped carinal denticles and *N. pequopensis* with weakly flared carinal denticles, persist.

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Some Remarks on the Late Palaeozoic Events of Bulgaria

by S. Yanev and G. Cassinis

The Basement

Recently, the pre-Upper Carboniferous basement of Bulgaria has been interpreted as a collage of two large tectonic blocks - the Protomoesian and the Thracian microcontinents - separated by a marked Variscan suture, which was later affected by Alpine diastrophism (Haydoutov & Yanev, 1997).

The Protomoesian microcontinent consists of two different parts: a nucleus (Moesia terrane) and a southwestern outer zone (Balkan terrane). The basement of the former terrane (Figs.1 and 2) consists both of Proterozoic-to-Lower Cambrian (?) metamorphic rocks, related to a continental origin (Sandulescu, 1994), and of an incomplete Palaeozoic sedimentary cover. In contrast, Precambrian ophiolites and a Cambrian island-arc assemblage (Haydoutov, 1991) form the substratum of the Balkan terrane, which is unconformably overlain by an almost regular Palaeozoic succession of sedimentary rocks that differ considerably from those of the Moesian terrane (Figs.1 and 2).

Recently, sedimentological, palaeontological, biostratigraphical, palaeobiogeographical, palaeoclimatological and palaeomagnetic investigations have supported a peri-Gondwana provenance, from undefined areas, of both the aforementioned terranes (Yanev, 1990, 1993 b; Lakova, 1993; Boncheva, 1997; Haydoutov & Yanev, 1997). Generally, the Moesian block came into contact with the Eurasia continent at the end of the Late Devonian, whereas the Balkan fragment collided with the Moesia microplate later, probably between Visean and Namurian times.

The Thracian microcontinent (presently represented by the Rhodope and Serbo-Macedonian massifs) consists of intensively metamorphosed and migmatized rocks, in which a tectonically ophiolite association also occurs (Kozoukharova, 1984; Kolceva & Eskenazi, 1988). This association differs from that of the Balkan ophiolites. However, Haydoutov and Yanev (1997) suggest that a clear correlation between these oceanic deposits from the Protomesian and Thracian blocks is not yet feasible.

In this regard, it is also worth mentioning that Kozhoukharov et al. (1980) pointed out some Thracian rock-fragments inside the "Stephanian" deposits of the Lozen mountain (south of Sofia) in Srednogorie.

The Upper Palaeozoic cover

-Upper Carboniferous

After the main compressional event of the Variscan orogeny (Sudetian phase?), the Late Palaeozoic evolution of the above assembled basements cropping out in the present Bulgaria was characterized by geological scenarios which fit fairly well with the Permo-Carboniferous framework of central and western continental Europe (e.g., Falke, ed., 1976; Cassinis et al., 1995 and references). On the basis of the available data, which are briefly outlined in this review, we can also observe that the pre-Variscan plate configuration above described played an important role in the definition of the younger fundamental structural and sedimentary lineaments of the country.

In the relatively stable Moesia, the Upper Carboniferous cover, which is known only by drillings, consists of some more or less complete and irregularly distributed detrital sequences (Fig.3). The most clear examples are found in the southern Dobrudgea and the Balkan areas. In the former region, specifically in the "Dobrudgea Coal Basin", a Namurian A (partly marine) and C, up to a Westphalian terrigenous succession unconformably overlies Devonian or Lower Carboniferous rocks. Moreover, the thick Westphalian plant-bearing sediments locally contain volcanics. In contrast, the Stephanian deposits, like everywhere in the Moesia region, lack evidence (Haydoutov & Yanev, 1997).

The Balkan Upper Carboniferous is well-developed into a number of intramontane fault-bounded troughs, where the younger "Stephanian" basins generally do not coincide with the older ones, which appear less widespread. From the latter, the famous W-E-oriented Svoge trough consists of Namurian to B/C Westphalian fluviolacustrine and fluviolacustrine deposits, about 1700 m thick. They are composed of conglomerates, breccias and other fine-grained clastic sediments, which derived from erosion, firstly, of the local folded and non-metamorphic Lower-Middle Palaeozoic basement, and secondly, in the upper part, of Variscan granitoids (Yanev, 1965). Coal layers also crop out. In particular, the Westphalian B contains fossil plants, generally represented by *Calamites* and *Lepidophytes* (Tenchov, 1966), and calcalkaline andesitic products (Yanev, 1983).

In the pre-Balkan Belogradcik anticlinorium too, basic (?)-to-intermediate volcanics ("arkose-basaltic complex", in Tchounev & Bonev, 1975) are present in the form of lava flows and tuffs, which crop out between Upper Stephanian fossiliferous clastic beds and the Variscan basement (Yanev & Tenchov, 1978). These volcanics also occur in the Berkovica anticlinorium (Balkan sector), as far as the Iskar Valley.

The Stephanian plant-bearing detritic sediments of the Balkan region infilled a large number of narrow basins (Fig.3), and reached a maximum of about 1000 m in thickness. In some places, they are also associated with calc-alkaline andesitic-to-dacitic tuffs, ignimbrites and lava flows (Yanev, 1981). Generally, this younger volcanic activity, which is clearly represented in the Belogradcik, Berkovica and central Balkan areas, began during Latest Carboniferous times, but mainly developed during the Earliest Permian.

Normally, the Stephanian deposits unconformably overlie a folded and metamorphic basement, presumably affected by the Caledonian orogeny (Fig.3). On top, in some basins, they pass gradually to Lower Permian.

To the east, in the Srednogorie region, the post-Variscan succession of Mount St. Iliya is also characterized by basal conglomerates, which have been doubtfully related to Late Carboniferous-Early Permian times (Catalov, 1985) (Fig.3).

In Kraishte, i.e. in southwestern Bulgaria, a presumed Carboniferous cover is only recorded in the Vukovo area, where some "Stephanian"-Lower Permian slightly metamorphosed gray and red clastic beds unconformably lie on a Lower Palaeozoic, or older metamorphic basement (Yanev, 1982).

-Permian

Throughout the Permian, a general Rotliegend-type detrital sedimentation spread progressively over vast Bulgarian regions, and was locally accompanied by marked igneous activity (Figs. 2 and 3). However, this magmatic scenario, which was generally characterized by volcanic eruptions of prevalently acidic composition, only occurred during the Early Permian. Moreover, extensive unconformities represent an important key for inter-regional correlation.

Within the geological limits of Moesia, Permian rocks, like Carboniferous, have so far been displayed only by drillings. Some Permian sections in the eastern sector (Kaliakra, Targovishte and other places) can be clearly divided into two sedimentary cycles. The first Permian cycle (North Bulgarian Lower Group of Yanev, 1992) of the former locality, in coastal Dobrudgea, begins with the Nanevo Fm., which is also sig-

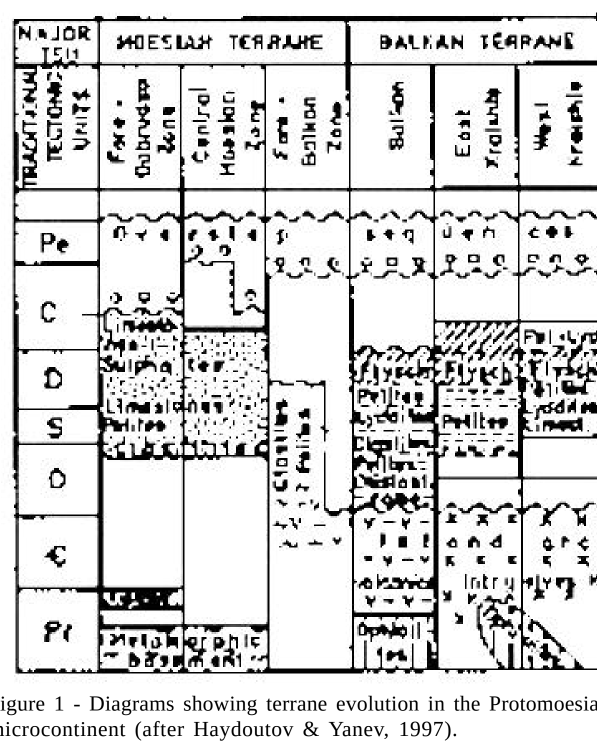

Figure 1 - Diagrams showing terrane evolution in the Protomoesian microcontinent (after Haydoutov & Yanev, 1997).

nalled in southern Dobrudgea and around the Permian "paleo-horst" of the northeastern part of Bulgaria. The unit is generally characterized by Rotliegend-type varicolored clastic beds, and by calc-alkaline andesitic-to-dacitic volcanics (Tchounev & Bonev, 1975). Towards southern Moesia, these volcanics, which are associated with massive terrigenous rocks, also occur in Targovishte, west of Sumen.

During the Permian, in the Varna area, in North Bulgaria structural high and along the Dobrudgea slope, the Nanevo Fm. was overlain by the coarse-grained detrital deposits of the Severci Fm., which lacks volcanic products, and can again be correlated with the Rotliegend facies. Generally, the fanglomerates of these two units bear Lower Palaeozoic metamorphic and Devonian-Lower Carboniferous carbonate rock-fragments, deriving from the same Moesia plate.

According to Yanev (1992), from a stratigraphic point of view, only this lower succession is defined as typical Rotliegend, which in turn is subdivided into two parts, respectively indicated as P11 (Lower Rotliegend) and P12 (Upper Rotliegend), both generally related to the Lower Permian.

Locally, in the Bulgarian "Dobrudgea Coal Basin", the Lower Permian deposits also appear to be confined between two main unconformities, respectively with the Devonian carbonate basement and with the overlying Lower Triassic, or Jurassic sediments.

In central and western Moesia (Fig.3), the Lower Permian products are grouped under the name of Bdin Fm. More specifically, this unit spread throughout the northwestern part of the present Bulgaria, approximately from Vidin to Pleven, where it unconformably overlies Lower Carboniferous (Visean) deposits. On the top, near the village of Rasovo, this Bdin Fm. comes directly, again through an unconformity, into contact with Lower Triassic clastics.

Along the southern margin of the Moesia plate, the Lower Permian consists of fanglomerates, breccias and finer-graded clastics. These last deposits, known as Dolna Zlatitsa Fm., are particularly prominent to the south of the "Tarnovo depression" and a little to the west. In contrast, in the eastern Vetrino area, they pass laterally to coarse-grained detritic sediments (Komunare Fm.), which also occur in the Varna area.

In the Balkan region, the Lower Permian is made up again of continental Rotliegend-type sediments and volcanics (Figs. 2 and 3). The former, which generally consist of polygenic conglomerates, breccias, sandstones, siltstones and finer deposits, infilled a number of fault-bounded subsiding basins, and locally onlapped outside. The rock-fragments are mostly formed of metamorphics, Variscan and perhaps older intrusives, as well as of Permian volcanics. These volcanic rocks, which crop out in the pre-Balkan (Belogradcik, Teteven) and western-central Balkan (Berkovica, Levskj peak) areas, generally display a calc-alkaline acidic composition, are irregularly distributed in the field, and can reach about 1000 m in thickness; farther east, near Sliven, these igneous, extrusive rocks are also associated with sub-volcanic bodies, and are generally characterized by rhyolites, pyroclastics, ignimbrites, granophyres and microgranites (Zhukov et al., 1976).

The disappearance of this younger magmatic activity was often followed by the inception of an unconformity, which would fix, not only in the Balkan region but also in other parts of Bulgaria, the boundary between the Lower and Upper Rotliegend.

In some places, however, the Lower Rotliegend succession comes directly, again through an unconformity, into contact with the Lower Triassic Buntsandstein (Petrohan Group). In the Svoge area, the Permian was probably never deposited.

In Srednogorie too, above a Lower Palaeozoic and older basement, the Lower (?) Rotliegend of Mount St. Iliya consists both of fanglomerates, sandstones and finer-graded slightly metamorphic sediments, and, on the top, of volcaniclastic products linked to important faults; this presumed Lower Rotliegend is itself unconformably capped by the redbeds of the Upper Rotliegend and, locally, by the so-called Petrohan Group (Figs. 2 and 3).

The Permian of southeastern Bulgaria is still the object of controversy (Figs. 2 and 3). In the Strandzha Mts., near the Black Sea, above a Lower-Middle Palaeozoic slightly metamorphic basement, the Kondolovo area displays some carbonate and terrigenous rocks (60-70 m thick) which, for the recognition in the former sediments of numerous algae, have been related to Early Permian times (Malyakov & Bakalova, 1978). *Epimastopora piae*, *E. alpina* and *Mizzia velebitiana* are among the most representative forms (Bakalova, 1988).

In the southwestern Kraishte region (Yanev, 1979; Ellenberg *et al.*, 1980), Permian deposits are generally affected by stratigraphic and geometric changes. As already stated, within a narrow fault-bounded basin of the Vukovo area, there are some gray and red slightly metamorphic clastic beds of presumed Latest Carboniferous-Early Permian age, which unconformably overlie a Lower Palaeozoic, or older, folded and low-metamorphic basement. Moreover, near Boboshevo, this basement is intruded by a granite body, which is probably linked to Variscan diastrophism.

In north Bulgaria, along the Moesia region, the second Permian cycle (Lower Danube Upper Group of Yanev, 1993a) is generally made up of alluvial, partly deltaic massive clastic redbeds, known as the Targovishte Fm. This unit reaches a maximum of more than 1000 m in thickness, and lies unconformably on the Lower Permian or older rocks (Figs.2 and 3). Coeval influence of lagoonal and/or marine environments in southeastern Moesia is attested by conspicuous intercalations, specifically in the Provadija synclinal, of evaporite and carbonate fossiliferous bodies (Vetrino Fm.) (Figs.2 and 3), which seem consistent with marine conditions towards the east, in the position of what is now the Black Sea.

On the basis of palynological data and regional correlation (Schirmer & Kurze, 1960; Pozemova et al., 1972, unpublished, in Yanev, 1993a), this second cycle is attributable to Late Permian. The discovery of *Lueckisporites virrkiae, L. platysaccoides, Klausipollenites schlaubergeri, Falcisporites zapfei*, as well as of other forms, which have been extracted by a basal prevalent pelitic dark unit (Pozemova et al., 1972, unpubl., in Yanev, 1993a), agrees with this time assessment.

As already observed, in some Bulgarian continental areas, the Upper Permian deposits lack evidence (Figs. 2 and 3). However, the respective products, which are again characterized by fluvial and locally deltaic redbeds, generally assume a more widespread distribution than do those of the Lower Permian cycle. The products therefore give rise to a marked and expressive unconformity with the previous differing units, until they step down onto the pre-Upper Carboniferous basement (Fig.3).

Their development was also signed by the complete disappearance of any volcanic episode.

In a large part of Moesia, these younger redbeds of the Targovishte Fm. pass upwards, locally through a possible discontinuity, to the Totleben Fm. This unit, again on the exclusive basis of drilling data, is characterized by a well-bedded varicolored alternance of mature clayey-silty-sandy sediments, which yielded palynomorphs (Pozemova *et al.*, 1972, in Yanev, 1993a) related to Latest Permian times (= Upper Tatarian of the Russian Platf.). On top, the unit is unconformably followed by the Lower Triassic red clastic deposits of the already mentioned Petrohan Group, which spread all over the country's rocks.

However, as already stated, the Permian continental domains were affected to the east, in particular in proximity with the Black Sea, by transitional and marine conditions (Figs.2 and 3). For instance, in the eastern part of the Rhodope massif, near the Bulgaria-Greece border (Fig.2), silicified carbonate rock-fragments, which are reworked into an Upper Jurassic-Lower Cretaceous terrigenous olistostrome cropping out to the North of Dolno Lukovo, uncovered Upper Permian foraminifers (Trifonova & Boyanov, 1986). These forms include *Agathammina pusilla, Bradyina novizkiana, Neoendothyra parva* and *Colaniella* sp. The already cited Kondolovo area, in Strandzha, also seems to display a similar, although slightly older, marine influence. These examples are generally interpreted as a result of tectonic transport from southern sectors, and specifically the latter still promotes controversy. However, a general stratigraphic and palaeogeographic restoration of the Black Sea and adjoining areas supports the hypothesis of Permian, transitional and marine incursions in the present easternmost part of Bulgaria (Figs. 2 and 3).

Conclusions

Briefly, on the basis of the data given above, the Bulgarian rock-basement consists of very contrasting litho-stratigraphical associations which are consistent with an original subdivision of the same complex into a number of major and minor crustal fragments deriving from different areas, specifically, for the Moesia and Balkan terranes, from peri-Gondwanan lands. The collage of these megablocks was not necessarily simultaneous, but must have been connected with the Variscan collisional framework. At the end of this orogeny (Sudetian phase?), all or a large part of the present Bulgarian basement was joined to the Palaeo-Europa, and shared the same history.

Subsequently, from Late Carboniferous to Permian times, the thus formed Bulgarian territory was affected by a series of geological events, which can be summarized as follows.

Depositional events

Southern Dobrudgea and the Balkan mountains are the only Bulgarian areas where the Upper Carboniferous appears widespread and well-developed, owing to the presence of deposits

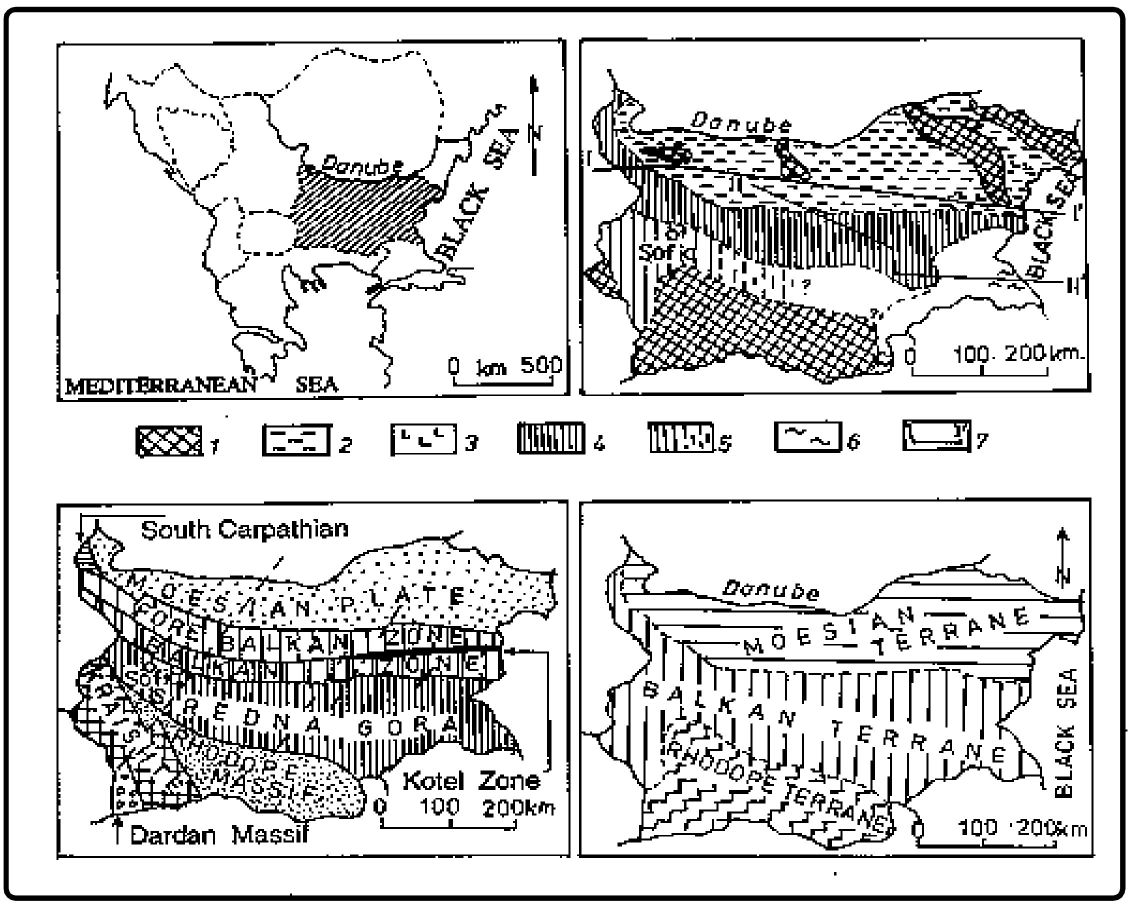

Figure 2. A: Bulgaria in the Balkan geographic context. B: Schematic distribution map of Permian deposits. 1: areas lacking in Permian rocks; 2: relatively stable region with local Lower Permian clastic deposits, and more widespread Upper Permian, also detritic sediments ("continental basin" Auct.); 3: Upper Permian lagoon ("sabkha") and well-bedded carbonate sediments; 4: Variscan mountain system locally infilled, within fault-bounded basins, mainly by coarse-grained clastic deposits; 5: Upper Permian clastics, with distribution: a- certain, or b- presumed (locally, in some basins, along with Lower Permian coarse-grained deposits); 6: presumed Permian marine deposits; 7: Traces of the pre-Triassic palaeogeographic sections restored in Fig.3. C: Morphotectonic subdivision of Bulgaria, according to Bonchev (1986). D: Pre-Late Carboniferous terranes of the Bulgarian basement (after Yanev, 1990).

that are generally related to a "Namurian-Stephanian" interval. They infilled a large number of fault-bounded and intramountainous narrow and subsiding basins, which were mainly concentrated along and near the most mobilized marginal areas of the Moesia and Balkan terranes.

On the basis of the vertical and lateral distribution of these early Late Palaeozoic products, we are led to recognize that deposition was possibly cyclical.

The first, or older Upper Carboniferous cycle encompasses the "Namurian-Westphalian" sediments, from the boundary with the Variscan substratum up to about the top of the Series. Thus, this cycle appears to be confined between two unconformities, which presumably coincide with the widely reported "Sudetian" and "Asturian" tectonic phases.

The second, or younger Carboniferous cycle begins with "Stephanian" sediments, and ends during the Lower Permian. Specifically, this cycle's presence is suggested by a general switching of the depositional areas, which generated new basins and extensively abandoned other areas. It is highly probable, in this case too, that the Uppermost Carboniferous-Lowermost Permian cycle developed between two unconformities, which more or less coincide, respectively, with the younger one of the previous cycle and another located inside the overlying Rotliegend units. In Bulgaria, according to Yanev (1981), the latter unconformity marks the boundary between the Lower and Upper Rotliegend, and is followed both by a progressive or abrupt disappearance of the igneous, intrusive and extrusive deposits, and by the onset of differing sedimentary and structural features. In a Permian excursus, this unconformity could be reasonably correlated with the main "Saalian" tectonic phase proposed by German authors.

The subsequent third cycle, which includes the Upper Rotliegend sediments, probably extended from undefined Early Permian times to the beginning of Late Permian. It is delimited by the second of the aforementioned unconformities and by another one, which expresses itself markedly and extensively in the present Bulgaria and abroad. This younger unconformity is generally related to a plate structural reorganization of vast European regions, which was probably caused by a major extensional activity. In other European regions, this discontinuity has variously been identified with the "Palatine" tectonic phase (*e.g.*, Kozur, 1980), and with the "post-Saalian" or the "Altmark" phases (*e.g.*, Hoffmann *et al.*, 1989).

As a consequence, the overlying Upper Per-

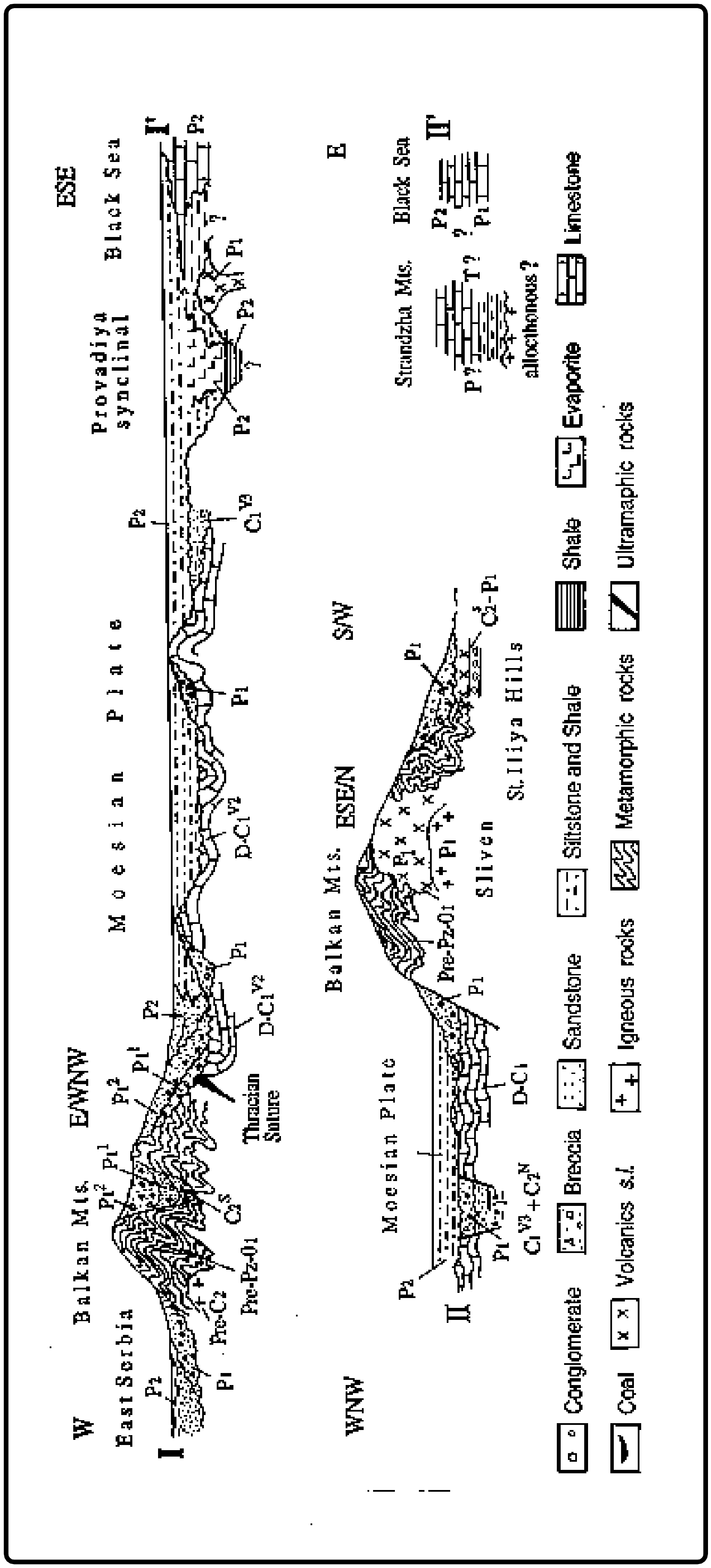

Figure 3. Schematic, non-palinspastic sections through the Permian of Bulgaria, before deposition of Lower Triassic clastic redbeds. Section traces in Fig.2B; lateral and vertical distances not in scale. Symbols: Pz = Palaeozoic; O1 = Lower Ordovician; D = Devonian; C1 = Lower Carboniferous; C1V2 and C1V3 = Lower Carboniferous - Visean; C2 = Upper Carboniferous; C2N = Upper Carboniferous - Namurian; C2S = Upper Carboniferous - Stephanian; P1 = Lower Permian; P11 = Lower Rotliegend; P12 = Upper Rotliegend; P2 = Upper Permian; T = Triassic.

mian cycle, which is again represented by Rotliegend-type redbeds, clearly shows a more widespread distribution than do the older, Upper Palaeozoic cycles. However, towards the Black Sea, this cycle also appears to be affected by some intercalations of transitional-marine fossiliferous sediments.

On top, the sharp contact with the Lower Triassic Buntsandstein (Petrohan Group), or with other equivalent red clastics, marks the onset of a new cycle. The transgressive trend of these younger units all over the previous deposits, as far as the Variscan complex, certainly gave rise to the most significant unconformity of the investigated territory. Presumably, this regional discontinuity marks the presence of a gap of still undefined duration. According to some authors (*e.g.*, Yanev, 1981), it could more or less be placed in correspondence with the Permian-Triassic boundary.

Finally, in the light of the foregoing, we should emphasize the progressive widening of the Late Paleozoic depositional processes in Bulgaria. This development was probably connected with changes in tectonic regime, which we will later tentatively interpret. Therefore, the above-mentioned Upper Carboniferous-Permian cycles seem essentially to coincide with tectono-sedimentary cycles.

Igneous events

The Upper Palaeozoic igneous, intrusive and extrusive products of the present Bulgaria have not yet been well-studied. Thus, further investigations are needed.

According to some authors (*e.g*., Tchounev & Bonev, 1975; Zhukov *et al*., 1976), the aforementioned igneous activity consisted in a number of events.

The first event probably took place during the Variscan orogeny, perhaps at the end of the Early Carboniferous, when some granitoid bodies intruded into the basement.

The second event is attributable to ”Westphalian B”, and presumably to slightly younger times. It is mainly characterized by calc-alkaline andesitic products. The basic volcanics of some research (e.g., Tchounev & Bonev, 1975) still require careful investigation.

The third event encompasses the Latest Carboniferous and the Earliest Permian times. Calc-alkaline andesitic-to-dacitic deposits occurred.

The fourth, and youngest igneous event took place again in the Early Permian, and probably within the Lower Rotliegend. It probably represented the most conspicuous example from the Balkan areas, in particular near Sliven, where the event is characterized by volcanic, subvolcanic and plutonic rocks. Generally, the volcanics consist of calc-alkaline dacitic-to-rhyolitic products, whereas the other bodies are made up of granophyres, microgranites and granodiorites.

Subsequently, until the end of the Permian, no volcanic and intrusive manifestation is recorded in Bulgaria.

Finally, from a general point of view, we also draw attention to the good temporal and compositional affinity between the above Late Palaeozoic volcanic scenario and that of many other parts of Europe.

Tectonic events

At the end of the Variscan collision, the assembled and varied block-fragments of the Bulgarian basement generally shared the same Late Palaeozoic evolution. A fault-bounded swell-and-basin framework developed locally, as from the early Late Carboniferous, and spread progressively throughout the territory.

Specifically, the Moesian and Balkan “Namurian-Westphalian” sedimentary basins, which are located along, or in proximity with, the boundaries of the older respective terranes, could be interpreted as due to crustal weakness. Thus, as in other parts of Europe, the opening and development of the Late Carboniferous basins in question seem to be connected with a tensile tectonics, apparently lacking in marked compressional effects.

The Latest Carboniferous up to the Early Permian basins, which were infilled by the products of the above-mentioned 2nd and 3rd cycles, show sedimentary and structural features which are consistent with an extensional regime. These basins evolve from narrow places into wider depositional areas. Presumably, transtensional movements determined the onset and development of this tectonic scenario.

The Late Permian epoch points to more general, but more influential features, which were characterized by the progressive, widespread red sedimentation of the 4th cycle. Owing to correlation with other parts of Europe, this new cycle was probably connected with a marked and substantial plate reorganization. Certainly, the switching and the lateral continuity of the depositional area (“continental basin” *auct.*), as well as the marine incursions in the easternmost areas of Bulgaria, add weight to the hypothesis of a more extensional regime than that of the previous Late Palaeozoic times. Variscan crustal attenuation was clearly responsible for the sharp increase in this geodynamic activity. Furthermore, in our opinion, the Early-to-Late Permian stratigraphic and palaeogeographic turnpoint could also represent the onset of a rift system.

In conclusion, the Late Palaeozoic structural evolution of Bulgaria could be interpreted as the result of two main tectonic stages. The first, beginning from undefined Carboniferous times, essentially expressed itself as (trans)tensional movements, while the second one, which developed from Late Permian, emphasized the influence of an extensional regime.

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Discussion on Permian-Triassic Conodont Study

by Lai Xulong

Introduction

Since Yin et al.(1988) proposed the first appearance of *Hindeodus parvus* as a marker of basal Triassic, the study of the conodont faunas across the P/T boundary becomes more and more important. In recent three years, successive presentations about conodont diagnosis, zonation, clines and biofacies near the P/T transitional period have been published. Besides some agreements, there are still some disagreements on P/T conodont study. This paper mainly deals with some problems of conodont nomination, lineage and biofacies . We hope that conodontists can reach agreement after further study on these problems. It is very important for understanding P/T boundary and establishing the Global Stratotye Section and Point (GSSP) of the Permian-Triassic Boundary (PTB).

1. Regulation of establishing a new conodont species or subspecies

Sometimes we can hear complaints from non-conodontist, palaeontologists and even conodontists not specialized on Permian-Triassic that there are too many species and subspecies in P/T conodonts. Actually, it is a natural result of intensive study on conodonts for this interval. However, it is very important for the P/T conodontists how to appropriately distinguish the interspecific and intraspecific variations of different conodont specimens. Otherwise, too many new conodont species and subspecies will bring us more problems than it resolves. It needs some common accepted regulations for establishing a new conodont species near the P/T boundary. Besides stable minor morphological changes, clear distribution range, enough materials and regional or worldwide correlatable of a newly established species or subspecies should be emphasised. Morphologically, for example, *Isarcicella isarcica* (Huckeride,1958) has following morphotypes based on its denticle number and denticle distribution: a. one denticle on one side; b. two denticles on one side; c. three denticles on one side; d. more than three denticles on one side; e. one denticle on each side; f. one denticle on one side and two denticles on the other side; g. one denticle on one side and three denticles on the other side; h.one denticle on one side and a denticle series with more than three denticles on the other side; i. two denticles on each side; j. two denticles on one side, three denticles on the other side etc.. If we only consider the minor morphological changes of the conodont specimens, there would be more than 10 species of genus *Isarcicella*. Moreover, if these so-called new species are without definite distribution, enough materials and correlatable characters, it may evoke confusion on the P/T boundary study.

Mei(1996), Zhu(1996) and Kozur (1996) have proposed many new species or subspecies of *Clarkina (Neogondolella)* and *Hindeodus (Isarcicella)*. Some of these new species or subspecies need to be re-assessed based on the above mentioned regulations.

2.*Isarcicella staeschei* is it a valid species?

The holotype of *Isarcicella isarcica* has one denticle on each side of the carina (Huckriede, 1958). According to Staesche (1964), *Spathognathodus isarcicus (Isarcicella isarcica)* included three morphotypes. Morphotype 1(M1) is the laterally adenticulate element which was later ascribed to the new species *Anchignathodus parvus (Hindeodus parvus)* by Kozur and Pjatakova (1976). Morphotype 2 (M2)is the element with one denticle or a denticle series on one side of the carina. Morphotype 3 (M3) is the element with one denticle or a denticle series on both sides. Dai and Zhang established a new species *Isarcicella staeschei* for M2 (in Li et al., 1989), which received few response from the conodont specialists. Perri (1991, including M2 and M3), Tian (1993a,b, both M2 and M3), Orchard et al. (1994, only M2), Lai et al. (1995,only M2), Zhang et al. (1995, only M2) still use the *Isarcicella isarcica* for the Morphotype 2 element.

Wang (1996) listed several reasons (a-h) to verify that *Isarcicella staeschei* (M2) (the species name was wrongly spelled as staescheri in Wang's paper) appears much earlier than *Isarcicella isarcica* (M3) and *Isarcicella staeschei* is valid.

At Heping section, Luodian County (Wang,1996),Selong section (Orchard et al., 1994) and Guryul Ravine section (Matsuda, 1981), so far only M2 elements were reported. The M2 element does not associate with M3 element. It is impossible to determine which morphotype appears earlier in these sections.

Perri(1991) presented plenty of *Isarcicella* specimens from Werfen Formation, southern Alps, Italy. These *Isarcicella isarcica* specimen were collected from two sections Bulla section and Tesero section. At Bulla section , M2 and M3 only co-occur at the same horizon- Bed BU27. The M2 and M3 elements have been found at the same horizon - Bed 33 at Shangsi section (Li et al. 1989,P.11). At Yangou section of Leping County, the M2 and M3 element also occur at the same bed (bed 15) (Wang,1996). It is difficult to deternine which *Isarcicella isarcica* morphotype appears earlier in these section. The sequence of *I. staeschei- I. isarcica* (Wang ,1996) does not exist at Shangsi section.

On the other hand, some data suggest M2 occurs earlier than M3 element. The materials from Tesero section, Italy show that the M2 appears earlier than M3 element (Perri,1991). M2 element first occurs at bed TS19(1) and TS25 (3), and co-occur with M3 late at bed TS26. At Xiaoba section, Anxian County, Sichuan Province, China, M2 element appears much earlier than M3 element (Li et al., 1989). M2 element personally occurs at Bed 21 and 22, co-occur with M3 at bed26, while M3 independently extends to bed 27. At Meishan section, one M2 specimen has been reported at Bed 28, section A (Lai et al., 1995; Zhang et al., 1995), and one M3 specimen has been recently found at Bed 29, Section D (Yang, 1997).

So far, there is no evidence proposing that M3 element appears earlier than M2 element of *Isarcicella isarcica*. Nevertheless, these two morphotypes separately preserved at many intensively studied P/T boundary sections such as Xishan section of Selong, Guryul Ravine section of Kashmir, Heping section of Ludian. It is difficult to recongnize the relationship between *I.isarcica*(M3) and *I. staeschei*(M2) at above sections. Hence, we prefer that *Isarcicella staeschei* is a synonym of *Isarcicella isarcica* until more fossil record are presented, and the minor morphological differences between them can be considered as intraspecific variability.

3.The *Hindeodus Isarcicella* cline

Kozur (1989,p.390) first proposed the phylomorphogenetic line of *Hindeodus typicalis - H. latidentadus - H. turgidus- Isarcicella* *isarcica*. Ding et al. (1996) established the same lineage of *H.latidentadus - H.parvus - Isarcicella turgida (H. turgidus) - I. isarcica* at Meishan . Wang (1996) mistook this lineage as proposed by Lai et al.(1995) and Zhang et al.(1995). Actually, there is no paragraph or sentence dealing with this lineage in those two papers.

In recent two years, different opinions on this lineage have been published (Mei, 1996; Baud, 1996; Wang, 1996). Wang (1996) suggested *H. latidentatus- H. parvus M1- I. staeschei- I. isarcica* lineage instead of *latidentatus- parvus- turgida- isarcica*. To support his viewpoint, he emphasized that Lai et al.(1995) and Zhang et al.(1995) (actually Ding et al.(1996)) have not documented *Isarcicella turgida* between the *parvus* zone and *isarcica* zone at Meishan sections. However, Ding et al.(1996) based *I. turgida* on Wang's data, because Wang has reported *Hindeodus turgidus* (*Isarcicella* turgida) at Bed 882-3 (sesus Bed 27c) at Meishan section (Wang, 1994, Plate 1, fig.6-8). In the illustration of Ding et al. (1996), they have exactly cited that their *I. turgida* data in Meishan is after Wang (1994). Later, Wang (1996) gave a different data stating that " according to the identification of Wang (1994, 1995), and Kozur et Wang (1995), *Hindeodus turgidus (I. turgida)* first occurs in bed 29". As the statement differs between Wang (1994) and Wang (1996), the exact bed of the first occurence of *Isarcicella turgida* at Meishan need to be settled.

Baud (1996) strongly expresses his opposition to the *latidentatus - isarcica* lineage of Ding et al. (1996). He cited both Orchard (in Krystyn & Orchard, 1996) and Mei (1996d) do not agree with the supposed cline from *H. latidentatus* to *I. isarcica* (p.7)". However, except that Mei (1996) disagreed that *Hindedus latidentatus- Hindeodus parvus* cline, Krystyn & Orchard (1996) did not deal with this lineage in fact.

Tian (1993a) and Mei (1996) considered that *H. parvus* evolved from *H. typicalis*. Kozur (1989, 1995), Ding et al. (1996) and Wang (1996) prefered that *H. parvus* evolved from *H. latidentatus*. Morphologically, *latidentatus* is more closer to *parvus* than to *typicalis*. Stratigraphically, the first appearance of *latidentatus* is lower than *parvus*, and these two species can co-occur at the basal Triassic *parvus* zone. In Meishan, *latidentatus* occurs at bed 25 (white clay) near the top of the Upper Permian (section B, Lai et al.(1995), Zhang et al. (1995)), and co-occurs with *parvus* at bed 27c (Wang,1995). In NW Iran (Kozur et al., 1975), Dorasham (Kozur, 1980), Armenia (Kotlyar et al., 1993), Austria (Schonlaub, 1991), the same conclusion can be reached. Orchard (1996) suggested that the *H. latidentatus* from bed 25 at Meishan in Zhang et al.(1995) showed closer affinity to *Isarcicella parva (H. parvus)* than to *H. latidentatus*. Mei (1996) also considered it much more similar to *Hindeodus parvus*. Ding et al. (1997, in press) insist on the specimen close to *H. latidentatus* with some explanation. Kozur (1996, p.92) also considered this specimen is a *H. latidentatus* sensu stricto. Apart from this disagreement, we should admit that first occurrence of *latidentatus* is lower than that of *parvus* by worldwide data. Baud (1996) claimed that " Orchard (in Krystyn & Orchard, 1996) found *H. latidentatus* emend above the *I. parva* FAD and co-occuring with this species in the Spiti area" for supporting his opposition to the cline *latidentatus - parvus* of Ding et al.(1996). The ground of argument is not sufficient. That *Hindeodus latidentatus* co-occurs with *H. parvus* is a common phenomenon, but it does not influence the cline *latidentatus - parvus* which is based on the fact that *latidentatus* appears earlier than *parvus*. Actually, in fig. 5.3 of Ding et al. (1996), the authors clearly show that *latidentatus* distribution ranges much higher than the FAD of *H. parvus*.

That *Isarcicella isarcica* evolved from *I. parva (H. parvus)* becomes a common idea (Kozur, 1989, 1995; Tian, 1993a; Wang et Cao,1993; Wang, 1996; Ding et al., 1996). The main discrepancy is whether there existed a transitional form between *parvus* and *isarcica*, and what is the intermediate form.

Tian (1993a) and Wang et al. (1993) consider that *isarcica* directly evolved from *parvus*. Kozur (1989, 1995) and Ding et al.(1996) suppose that *Isarcicella turgida (H. turgidus)* is the transitional form between *parvus* and *isarcica*. Morphologically, *I. turgida* has a transverse ridge on the sides of its upper surface, so it is acceptable that it evolved to laterally denticulate *isarcica* . Stratigraphically, *I. turgida* occurs earlier than *parvus* in Hambast C, Abadeh (Iranian- Japanese research group, 1981), NW Iran (Kozur et al., 1975) and Gartnerkofel (Holser et al, 1991). These data support that *I.turgida* evolved from *H. parvus*.

On other hand, *turgida* occurs earlier than *parvus* in Shangsi (Li et al., 1989, Lai et al.,1996). Even in Meishan, the first appearance of *H. parvus* (Zhang , 1987; Wang ,1994,1995; Yang, 1997) and that of *I. turgida* (Wang, 1994) located at the same horizon bed 27c (sesus 882-3). It is difficult to confirm *I. turgida* evolved from *H. parvus* in Shangsi and Meishan. Therefore, the main problem of cline *parvus - turgida- isarcica* is the relative stratigraphical range between *parvus* and *turgida*.

Wang (1996) proposes *I. staeschei* instead of *I. turgida* as the intermediate form between *parvus* and *isarcica*. In fact, Tian (1993a) displayed the same cline of p*arvus- staeschei- isarcica* in his evolution figure (p.184, fig.9), but he attributed the specimen of *Isarcicella* (M2) with two denticulates on one side to *I. isarcica*. Morphologically,that *I.staeschei* (*I.isarcica* M2) evolved to *I.isarcica* (*I.isarcica* M3) can be accepted. Stratigraphically, the data from Tesero (Perri, 1991), Xiaoba of Anxian (Li et al., 1989) and Meishan (Lai et al. 1995; Yang 1997) also support this lineage. As mentioned above, the main problem of this cline is that we need more intensively studied P/T sections with these two species coexisting.

4. The Permian-Triassic conodont biofacies

Tian (1993b) considered that gondolellid elements (*Neogondolella* or *Clarkina*) near the P/T boundary were planktonic - free swimming types and occurred at deep water, and hindeodid elements (*Hindeodus* and *Isarcicella*) were benthonic swimming types and occurred at shallower water. Orchard (1996) concluded that " throughout the Permian and beyond, Neogondolella is more common in offshore, deeper , and /or cooler water marine environment, whereas *Hindeodus* and its antecedents flourished in the near shore, shallower, and/or warmer regions. Wang (1996) supposed that the gondolellid conodont was of pelagic facies and hindeodid conodont was of shallow water facies. Furthermore, he gave two different conodont zonations for these two different facies. Baud (1996) also believed the *I. parva (H. parvus)* is a shallow-water species.

However, many geological data do not support above conclusion. Clark et al. (1983), Halteberg et al. (1984) concluded the Griesbachian hindeodid conodont *Isarcicella* and *Hindeodus typicalis* from western USA belong to basinal to outershelf biofacies. Based on systematic study of the Lower Triassic conodonts from eastern Yuannan, western Guizhou and northern Guangxi, southwest China, Wang Z H et al. (1990) divided the conodont biofacies into basinal and platform facies. In platform facies area, *Hindeodus minutus* zone and *Hindeodus parvus* zone are outlined. In basinal facies area, *Hindeodus minutus*, *H. parvus* and *Isarcicella isarcica* zones also can be recognized. Kozur et al.(1994/1995) pointed out that the first appearance of *H. parvus* is not facies related and can be discovered both in ammonoid- free shallow water deposits and in ammonoid - bearing pelagic deposits. Kozur (1996) also vividly expressed his opposition to Orchard's conclusion in more than two pages. The evidence presented in his paper need us to pay more attention.

Therefore, the assumption that *parvus* is a shallow water conodont should be re-assessed. Intensive sedimentological and palaeoecological analysis in conodont biofacies study are required before we reach a reliable conclusion on the ecology of hindeodids and gondolellids.

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COMMENTS

Permian Chronostratigraphic Subdivisions

by Brian F. Glenister and Bruce R. Wardlaw

The following E-mail message of December 18, 1997, from Lucia Angiolini was addressed jointly to Jin Yugan, B. R. Wardlaw, B. F. Glenister, and G. V. Kotlyar. We judge it to be sufficiently insightful and provocative that it and our response will be if interest to readers: both follow.

"Permian chronostratigraphic subdivisions: a question from an ordinary Permian (Tethyan) worker

It is a great achievement that the names and boundary levels for series and stages of the Permian System have been approved by the Subcommission on Permian Stratigraphy of ICS. The final selection is a good compromise among tradition, deposition continuity, accessibility of sections, and global correlations. Nevertheless, some problems arise when dealing with the correlation to other scales. For example, the correlation between Wordian and Murgabian is not exact, the latter ranging higher if the entire *N. margaritae* Zone is included. In any case, the Murgabian correlation was not satisfactorily performed by any of the already proposed chronostratigraphic scales, (i.e., Waterhouse, 1982; Dickins et al., 1989: Jin Yugan, 1996, Permophiles 28; etc.), and the problem probably lies in its original definition.

Despite the fact that correlation of the existing chronostratigraphic units requires further investigation and discussions (Archbold & Dickins, Permophiles 30), the selected Permian scale offers a great tool for all Permian workers. For example, working on the Permian brachiopods from Central Oman I had no problem to use the Wordian, the brachiopods and conodonts of the Khuff Fm. being mostly similar to those of the Amb Fm., dated as Wordian by Wardlaw and Pogue (1995).

However, going through the paper by Jin Yugan et al. (1997), a need of clarity is required concerning the **position of the Illawarra Reversal (IR).** According to Menning (1995), the estimated maximum age for the Illawarra Reversal is 265Ma. In the designation of the Permian chronostratigraphic subdivisions, Jin Yugan et al. (1997) placed the IR in two different stratigraphical levels:

- in Fig. 2, the IR is located in the late Wordian;
- at p. 13 bottom left column, the IR is recognized at the base of the Capitanian;
- at p. 13 top right column, the IR is located in the *Jinogondolella*

aserrata Zone (which is Wordian). According to Menning (1995) the IR was found within the Tatarian rocks of Russia (Khramov, 1963). The lower/middle part of the Tatarian being correlated to the Capitanian in the correlation chart of Jin Yugan et al. (1997). Since the IR represents a critical marker in the mid-Permian global correlations, its position must be clear: Wordian or Capitanian?
Waiting for an answer.

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Waterhouse J. B., 1982. An early Djulfian (Permian) brachiopod faunule from Upper Shyok Valley, Karakorum range, and the implications for dating of allied fauna from Iran and Pakistan. Contr. Himalayan Geology, 2:188-233."

Response

"First we want to thank you for your communication of December 18, which demonstrates clearly that Lucia is far from an "ordinary" Permian worker. Personally, we regard your conclusions as displaying extra-ordinary insight and laudable judgement in evaluating the complexities of decisions on Permian chronostratigraphic subdivisions. We regret that you have not received a consensus response from the four of us. However, we are widely separated geographically, and differing individual commitments make communication anything but simple.

It is too much to expect that boundaries of different regional scales will correspond precisely. Our objective has been to find the best successions to serve as international standards and name-bearers. Only in this manner can we hope to develop a single international language for subdivisions of geological time. In the instance you cited, our hope and expectation are that Wordian will become the standard, and Murgabian will progressively become less useful, and finally cease to serve. The advent of an international language for geologic time will be welcome!

Your second point is a very interesting one, and we agree that progressively the position of the Illawarra Reversal will become one of the most critically important instants in the geologic time scale. Conodonts oblige us by evolving rapidly, commonly displaying morphoclines (evolutionary continua) within which zonal and species boundaries must be chosen arbitrarily. This choice has already been made for *J. nankingensis* and the base of the Roadian: the result is that the Roadian begins in the type section of the Road Canyon Formation slightly above the base of the lithic unit. Comparable decisions have not yet been finalized for stage and species boundaries of the Wordian and Capitanian. Page 13 bottom left column of our paper recognizes the IR "near" the base (not "at the base", as you stated) of the Capitanian. However, as with the Roadian, definition of Wordian/Capitanian time boundary will depend on future arbitrary selection of a point in an evolutionary continuum. The suggested point in conodont evolution is the first occurrence of *J. postserrata* which developed through a transitional morphocline from *J. aserrata*. This occurs in the upper part of the Pinery Limestone Member of the Bell Canyon Formation (the basinal equivalent of the Capitan Limestone). The Illawarra Reversal occurs within the Bell Canyon Formation between the Hegler and superjacent Pinery Limestones Member. Therefore, if the first occurrence of *J. postserrata* is formally accepted as the base of the Capitanian, the Illawarra would be just below the base of the Capitanian."

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Permian Ammonoid *Perrinites* Fauna Associated with Fusulinids *Misellina* in Thailand

by Zuren Zhou and Malai Liengjarern

Glenister and others (1990) reported the first known occurrence of the Permian ammonoid *Perrinites* fauna discovered in Changwat Nakhon Ratchasima (i.e., Khao Nong Hoi, Amphoe Pak Chong), approximately 150 km northeast of Bangkok. Four species, including *Miklukhoceras* cf. *M. pamiricum* Pavlov, *Agathiceras mediterraneum* Toumanskaya, *Perrinites* cf. *P. hilli* (Smith) and *Prostacheoceras* cf. *P. oshense* (Toumankaya) were identified. The age was assigned as part of the Leonard/Road Canyon sequence of the American southwest, the Artinskian/ "Kungurian" Kochusuy Suite of southeastern Pamir.

A cooperative investigation, with support from NSF of China and NRC of Thailand, was conducted at the ammonoid localities by the authors in late February, 1997. A new locality for *Perrinites* was discovered in a quarry near Amphoe Phra Phuttabat, about 42.5km to the west of the original site, Khao Nong Hoi, Amphoe Pak Chong.

The field collection indicates that the *Perrinites* ammonoid fauna has rather wide geographic distribution in south central Thailand, and occurs at more than one horizon. Within a twenty-meter interval at the Khao Nong Hoi site, there are at least three limestone beds containing ammonoids.

The most interesting aspect is that all the *Perrinites* ammonoids are directly associated with an advanced *Misellina* fusulinid fauna. The occurrences of the *Perrinites* fauna in Thailand is quite different from those of the Pamirs and Darvaz, where the horizons are lower or much lower than the horizon of *Misellina* with advanced features. However Chinese authors had found more primitive perrinitids - genus *Metaperrinites* in association with *Misellina claudiae* in southwest Guizhou of South China. All these occurrences of fossils suggest that the fusulinid genus *Misellina* may have a longer geological range than previously considered.

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COMMITTEE REPORTS

IGCP Project Annual Report Project no. 359

IGCP Project Short Title: Correlation of Tethyan, Circum-Pacific and marginal Gondwanan Permo-Triassic

Duration and Status:(1993-1997)

Project Leaders:Yin Hongfu, J.M.Dickins, A. Baud, Yang Zunyi

1. Summary of Major Past Achievements of the Project

The project embraces 185 members from 25 countries and develops relations with IGCP projects 306, 321, 335, 343, 369, 383, as well as the Shallow Tethys Symposium and GSSP project (Pangea). During 1993-1995 noteworthy progress has been achieved on two main tasks of this project: the intersystem and intrasystem boundaries of Permian and Triassic, and compilation of the regional stratigraphic charts. In the past four years 28 books and about 250 papers have been published. We have aided more than 40 persons to participate in 14 workshops and meetings conducted or co-organized by the project.

2. Achievements of the Project This Year

2.1. General Scientific Achievements

Results of the proceedings of IGCP Project 272 have been published in Dickins et al. (1997), which contains 25 papers dealing with Permo-Triassic biota, stratigraphy, paleogeography, climatology and tectonics. Summaries of these results are included in Dickins,Yang and Yin (1997) and will not be repeated here.

The international conference on stratigraphy and tectonic evolution of southeast Asia and the South Pacific, and the associated meetings of IGCP 359 and IGCP 383 (19-24 August 1997, Bangkok, Thailand), summarized recent achievements in the stratigraphic and tectonic framework as well as related energy and mineral resources of Thailand, Laos, Malaysia and adjacent regions, as shown in some key papers read in that meeting. Map series of Thailand were displayed. Tectonic subdivisions and stratigraphic correlations of the whole Indochina Peninsula plus southwest China, Australia and other adjacent regions were vigorously discussed and showed considerable advances compared to those of the late 80's. A two-volume proceedings of this meeting was distributed to attendants during the meeting, including all papers and abstracts submitted, altogether 769 pages (Phisit Dheeradirok et al., 1997). Member of Project 359 submitted more than ten papers.

Kotlyar(1997) proposed a new scheme for correlation of the Permian, concentrating on the Kungurian as a stage of international status. Zakharov et al. (1997) in a series of papers investigated the $*^{13}$C and $*^{18}$O of Carboniferous to Jurassic rocks and ammonoid shells, and reached some interesting results. For other contributions of the Russian group please refer to the Annual report (1997, proposed to be published in the present issue). Triassic stratigraphy and paleogeography of South China and Bayan Har-Hoh Xil have been published by Feng et al. (1997) and Zhang (1997). Other Chinese contributions include those on conodonts (Wang, 1996), radiolarians (Du et al., 1997) and ammonoids (Xu and Wang, 1997). Tazawa (1997) and his colleagues made a serial research of Permo-Triassic paleobiogeography of Japan, NE China and Russian Far East based on brachiopods, corals and forams. Waterhouse (1996, 1997) contributed on systematic description of Triassic ammonoids in Nepal.

The Permo-Triassic boundary: A joint paper to propose *Hindeodus parvus* as the boundary marker and Meishan as the type locality has been published by Yin et al. (1997), and may serve as the draft of a formal submission for ballot of the PTBWG. Nevertheless, the P/T boundary has been under discussion by Baud (1996), Bai & Yang (1996), Kozur (1996), Wang (1996), Yin (1996) and others, focusing on these two topics raised by Yin et al. Despite these discussions there is as yet no submission of the above proposal. Research on other criteria like ammonoids and carbon isotopes and other localities like Arctic Canada and Himalaya are still far behind the standard required by the ICS Guidelines.

Other boundaries: Zakharov (1996) suggested the ravine near Tree Kamnya Cape in South Primorye as a candidate of GSSP for Induan-Olenekian boundary. Triassic-Jurassic boundary (Gonzalez et al., 1996) was also discussed.

2.2. List of Meetings with Approximate Attendance and Number of Countries

(1). International Field Excursion on Permian-Triassic sections on the North Caucasus, 7-17, July, 1997, Psebai, Russia. Organizers: IGCP Projects 359, 343 and North Caucasus Organizing Committee. Subjects: field trips in the basins of the Laba and Belaya Rivers to demonstrate the Upper Permian (Dorashamian) sections in various facies, the Lower Permian red-color continental deposits and the Triassic deposits. 8 attendants include Russian and USA specialists. Among other results, Triassic deposits of NE Caucasus were for the first time subdivided into ten ammonoid beds.

(2). GEOTHAI'97—International Conference on Stratigraphy and Tectonic Evolution of Southeast Asia and the South Pacific, 19-24 August, 1997, Bangkok, Thailand. Organizers: The Department of Mineral Resources, Thailand, jointly sponsored by IGCP nos. 359 and 383. Subjects: scientific program from 19-21 August, followed by 3 excursion routes on 22-24 August to observe stratigraphy and tectonic evolution of eastern, western and northeastern Thailand respectively. About 400 attendants, nearly half of them foreigners from 22 countries, including about twenty IGCP nos.359 members. The meeting consisted of 5 oral sessions: stratigraphy & paleontology, tectonics, economic & applied geology, fossil fuels, and special topics, plus postal sessions and an exhibition. More than 100 presentations, oral and poster, were given. Workshop of IGCP 359 was also held.

(3). International Conference on the Permian of eastern Tethys: Biostratigaphy, Palaeogeography & Resources, jointly sponsored by IGCP 359 and Deakin University, 30 November-3 December, 1997, Deakin University, Rusden Campus, Melbourne, Australia. Subjects: Permian stratigraphy, sedimentology and palaeontology of peri-Gondwana and eastern Asian terranes; Non-tropical distribution of Permian biota; Permian palaeogeography and climate of Eastern Tethys; Permian migration pathways of biotas in Eastern Tethys; Correlation of Permian sequences between Gondwanan, Tethyan and Boreal Realms; Distribution of Permian coal deposits; Geochronology and boundaries of the Permian Period. During- and post-conference field excursions. A full report, by Guan R. Shi appears elsewhere in Permophiles.

2.3. Number of Publications: List of Major or Most Important Publications

5 books and more than 60 papers have been published. Statistics are based on books and reprints sent to the project leader by the members.

Books:

Zhang Yifu, 1997, Formation and evolution of the Hoh Xil-Bayan Har Triassic sedimentary basin. Qinghai People's Press, Xining, China.136p.

Feng Zhengzao, Bao Zidong and Li Shangwu, 1997, Lithofacies and paleogeography of Early and Middle Triassic of South China. The Petroleum Press, Beijing, 222p.

Phisit Dheeradilok, C. Hinthong, P. Chaodumrong et al.(eds.), 1997, Stratigraphy and tectonic evolution of Southeast Asia and the South Pacific. Proceedings Intern. Conference on Stratigr. Tectonic Evolution SE Asia and S Pacific. Pt. 1(p.1-464) & Pt. 2 (p. 465-767).

Dickins, J.M., Yang Zunyi, Yin Hongfu, S.G. Lucus and S.K. Acharyya (eds.), Late Palaeozoic and Early Mesozoic Circum-Pacific Events and their Global Correlation. Cambridge University Press, 245p.

Selected papers:

Du Yuansheng Feng Qinglai, Yin Hongfu, Zhang Zongheng and Zeng Xianyou, 1996, New evidence for eastward extension of late Hercynian-early Indosinian Qinling Sea. Journal of China University of Geosciences, 7(2):141-146.

Gonzalez-Leon, C.M., D.G. Taylor and G. D. Stanley, 1996, The Antimonio Formation in Sonora, Mexico, and the Triassic-Jurassic boundary. Can. J. Earth Sci., 33:418-428.

Kotlyar, G.V., 1997, The basic correlative levels of the Permian System. Stratigr. Geol. Correl., 5(2): 35-50 (in Russian).

Kozur, H., 1996, The conodonts *Hindeodus, Isarcicella* and *Sweetohindeodus* in the Uppermost Permian and Lowermost Triassic. Geol. Croat., 49(1): 81-115.

Tazawa, Jun-ichi and Shen Shuzhong, 1997, Middle Permian brachiopods from Hiyomo, Mino Belt, central Japan: Their provincial relationships with North America. Sci. Rep., Niigata Univ., Ser. E (Geology), No. 12, 1-17.

Tong Jinnan, 1997, A study on the Griesbachian cyclostratigraphy of Meishan section, Changxing, Zhejiang Province. Proceedings Intern. Conference Stratigr. Tectonic Evolution SE Asia and S Pacific, 158-163.

Wang Chengyuan, 1996, Conodont evolutionary lineage and zonation for the Latest Permian and the Earliest Triassic. Permophiles, 29:30-37.

Xu Guanghong and Wang Chuanshang, 1997. Extinct summit of ammonoids near the boundary between Guadalupian and Lopingian of Permian. Geology and Mineral Resource of South China, 16:11-22.

Yin Hongfu, Sweet W.C., Glenister B.F., Kotlyar G., Kozur H., Newell N.D., Sheng J., Yang Z. and Zakharov Y.D., 1996, Recommendation of the Meishan section as Global Stratotype Section and Point for basal boundary of Triassic System. Newsl. Stratigr., 34(2): 81-108.

Zakharov, Yu. D., 1996, The Induan-Olenekian Boundary in the Tethys and Boreal Realm. Ann. Mus. Civ. Rovereto, Sez.: Arch., St., Sc. Nat., Suppl. 11(1995): 133-136.

Zakharov, Yu.D., N.G. Ukhaneva, A.V. Ignatyev, T.B. Afanasyeva, M.N. Vavilov, G.V. Kotlyar, A.V. Popov, A.M. Popov, 1997, Isotope composition of carbon and oxygen in Upper Paleozoic and Mesozoic organogenic carbonates of Eurasia. Geology of the Pacific Ocean, 16(1):45-58 (In Russian).

2.4. List of Countries Involved in Project(*indicate the countries active this year)

Australia*, Austria*, Canada, China*, France, Germany, Hungary*, India, Iran, Italy*, Israel, Japan*, Jordan, New Zealand*, Poland, Russia*, Slovakia, Slovenia, Spain, Switzerland*, Thailand*, Turkey, United Kingdom, USA, Vietnam, Yugoslavia.

2.5. Activities Involving Other IGCP Projects, IUGS, or Major Participation of Scientists from Developing Countries

A joint conference with IGCP Projects 383 was held in Thailand, August 1997, with major participation from developing countries. Joint research with CCOP involving SE Asian developing countries is under discussion. Cooperations with IGCP Projects 335, 343 and 369 are going on in form of member participation and exchange of newsletters. Thailand is the developing country contributing a lot in organizing GEOTHAI'97 meeting.

3. Proposed Activities of the Project for the Year Ahead

Because the project will close by the end of this year, no new activities have been proposed. The Chinese members are drafting the first circular of a Permo-Triassic meeting to be held in the spring of 1999. If a successive project is established, that meeting will naturally become a part of the new project. The meeting of Shallow Tethys 5, in close connection with our project, will be held in Chiang Mai, Thailand, 1-5 February, 1999 (correspondence: Dept. Geol. Sci., Faculty Science, Chiang Mai Univ., Chiang Mai, Thailand).

4. Intention to Propose Successor Project.

In 1996 Dr. Trinh Dzanh, director of the Geological Museum of Vietnam, and Dr. Phan Cu Tien, director of Geological Research Institute of Vietnam, have suggested a project on the geological development and mineral resourcesof SE Asia emphasizing Late Palaeozoic and Early Mesozoic. In the workshop meeting held during the GEOTHAI'97 meeting, Dr. John Rigby was chosen to contact the Vietnamese specialists and to raise a proposal of the successor project.

5. Summary

A number of regional stratigraphic charts covering large parts of Tethys, Circum-Pacific and marginal Gondwana have been submitted and discussed and other are being compiled. Major progress has been achieved in the research on intersystem and intrasystem boundaries of Permian and Triassic. This project has been recognized as a dynamic working group toward a comprehensive correlation of Permian and Triassic and compilation of researches on the global changes that occurred during this important geological period for a better understanding of the past, present and future of the world.

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Upper Carboniferous and Lower Permian Stratigraphic Studies: Southern Ural Mountains, Russia and Kazakstan. Summary of the 1997 Field Season: Permian Research Institute, Boise, Idaho, USA and VSEGEI, St. Petersburg, Russia.

by Dale A. Kerner, Vladimir I. Davydov and Kyle Graff

Upper Carboniferous and Lower Permian strata of the Urals have historically been of great importance to the establishment of Permian chronostratigraphic divisions. The Permian Research Institute (PRI) of Boise State University jointly with VSEGEI and the Paleontological Institute of the RAN have been conducting field studies in the southern Ural mountains of Russia and Kazakstan since 1991. Strata of the Pre-Uralian foredeep provide the body and boundary stratotypes for most of Cisuralian (Lower Permian) Series, consisting of the Asselian, Sakmarian, Artinskian, and Kungurian stages. The Kungurian represented the original base of the Permian System (Murchison, 1841), and SPS has determined to preserve the name for the uppermost stage of the Cisuralian; however, the Kungurian stratotype will be elsewhere. Numerous sites in the region also exhibit well exposed Upper Carboniferous strata. The Carboniferous-Permian boundary Global Stratotype Section and Point (GSSP) has recently been established at Aidaralash Creek.

Current focus of the studies in the region by PRI and others is the ultimate establishment of stratotypes and precise chronostratigraphic stage and substage boundaries for all Cisuralian stages and substages, based on biostratigraphic and sequence stratigraphic data. Both serve as powerful tools for correlating Cisuralian stages worldwide through recognition of widely distributed faunal and eustatic sequence boundaries. To accomplish this, paleogeographic reconstructions are required in order to understand the nature of sequence boundaries in the region, and to determine whether they are predominantly eustatically or tectonically controlled.

During the 1997 field season in the southern Urals, thirteen stratigraphic sections were visited and sampled; four were measured and described in detail. Figure1 shows the location of some of the stratigraphic sections studied in 1997, and those measured and described during PRI's prior field seasons. A primary goal of the 1997 field season was detailed resampling for conodonts, fusulinids, ammonoids and palynomorphs of several previously measured sections. Ash beds were also sampled for absolute dating of key intervals of critical sections. In addition, several sections were measured, described, and sampled by PRI for the first time.

The ultimate goal of our current research in the Ural Mountains is the establishment of globally accepted Cisuralian stage and substage boundaries and body stratotypes. Recent ratification of the section at Aidaralash Creek as the Lower Permian GSSP is one step towards this goal. To achieve globally accepted stage and substage boundaries, candidate stratigraphic sections must be well studied and documented to conform with guidelines set forth by the International Commission on Stratigraphy.

The primary management vehicle for such extensive sampling and detailed measurement and description of sections is a biostratigraphic and lithostratigraphic database that we are developing for the southern Ural Mountains, which will also include sequence stratigraphic data.

Preliminary sequence stratigraphic correlations attempted for sections in the southern Urals compared with the global sea level curves of Ross and Ross (1988) suggest that depositional rates in the pre-Ural foredeep were not uniform along the entire foreland basin. What remains poorly understood is to what relative extent tectonics and eustacy have played in the formation of the observed sequences. These problems need to be resolved before worldwide correlation can be achieved. Numerical dates fully integrated with biostratrigraphy for Cisuralian type sections will provide important data points.

Special thanks are extended to Academician A. D. Shcheglev, Director of VSEGEI, and to Dr. Bruce R. Wardlaw for cooperative support of our field efforts.

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Report on the Activities and State of Art of "Working Group 5" of the SPS

by V. R. Lozovsky and J.W. Schneider

The Continental Marine Correlation Working Group - **"Working group 5"** (leader V. Lozovsky, co-leader J. W. Schneider) was established during a workshop of the XIII International Congress on Carboniferous-Permian. Thus Excursion A5, "Stratigraphy of the Middle European Continental Carboniferous and Permian" was the first workshop of the working group and the second, entitled "Stratigraphy, Sedimentation and Basinal Development during the Carboniferous and Permian" was organized by J. W. Schneider, 0. Elicki and V. Lozovsky, June 18th - 21th 1997 in Freiberg, Germany. It was linked to the yearly congress of the Technical University Freiberg Mining Academy. Attending members of the working group: V. Lozovsky, Russia; S. Oplustil, J. Zajic, Czech Republic; T. Peryt, Poland; H. Kozur, Hungry; M. Menning, C. Breitkreuz, R. Gaupp, B.G. Gaitzsch, J. Goretzki, R. Roessler, H. Walter, J.W. Schneider, Germany.

A very important element for the consultation and work of this group is the cooperation of geologists from Germany, Czech Republic, Italy and Spain with the highly active French Association des Géologues du Permien (AGP). Activities in cooperation with the AGP include:

1996, 12-17th July, AGP excursion, "Permian of the French Alps", organized by G. Gand, J. P. Deroin and F. Guillot

1996/97 start of the investigation of the higher Permian continental red beds of the South-French basins (Gand/Schneider/Walter) by a yearly one to two weeks of fieldwork., Rich collections of insects, conchostracans, tetrapod and arthropod ichnia are available for study, and are very important for the correlation with the continental-marine higher Permian of the Volga-Urals Region of Eastern Europe and North America.

1997 start of the biostratigraphical investigation of the classical "Autunian" in the French Massif Central with a case study of the Aumance Basin, the mine Buxiere-les-Mines, J. M. Poullion, G. Gand, J. Broutin, P. Freytet, C. Poplin, J. S. Steyer, A. Nel; the Association Rhinopolis, from France, J.W. Schneider, R. Werneburg, H. P. Schultze, H. Walter, and B.G. Gaitzsch from Germany, and St. Stamberg from Czech Republic.

1996 and 1997 fieldwork in the Appalachian and Illinois basin, U. Gebhardt and T. Merkel, Germany, J. Copp and D. R. Chestnut, Kentucky Geological Survey. "Biostratigraphy and microfacies analysis of Upper Carboniferous/Lower Permian non-marine limestones".

1997, October, start of the project, "Revision of the NOVOJILOV-collection of Carboniferous and Permian conchostracans", M.Sc. thesis and following Ph.D. thesis of J. Goretzki, supervisor J.W. Schneider/V. Lozovski. 1997 V. Lozovski (ed.) completed the 200 p. manuscript "The Permian/Triassic boundary in the continental series of Eastern Europe" for publication.

Working Group 5 benefits from cooperation with some members of the IGCP 328, "Paleozoic microvertebrate biochronology and global marine - non-marine correlation". Contributions to the final report of this project, were delivered in 1997, e.g., by J. W. Schneider, 0. Hampe, R. Soler-Gijon, S. Zajec, 0. Lebedev, M. Ginter. The new IGCP 406, "Circum-Atlantic Paleozoic Vertebrates" (Carboniferous - 0. Lebedev; Permian - J.W. Schneider) will contribute to targets of Working Group 5."

Planned activities in 1998

- A workshop of "Working Group 5" is linked to the International Symposium, "Upper Permian Stratotypes of the Volga Region", 28 July - 2 August 1998, Kazan, Russia;
- A workshop of "Working Group 5" is linked to the AGP-excursion "Permian Basins in Czech", July 1998, Hradec Králové, Czech Republic.

To make the work more effective, to bring together people who are interested in cooperation in the "Working Group 5", we should communicate via the internet. For that, please, send your E-mail or FAX adress to J. W. Schneider (see below); he is in direct contact with the chair of the group, V. Lozovsky, Moscow. At the start of 1998 we will try to create a www page for the working group. The main objectives should be the compilation of regional to global correlation charts by holostratigraphical synthesis of the local profiles of single basins or subbasins with all stratigraphic information - biostratigraphy, isotopic ages, magnetostratigraphy, tectonostratigraphy, tephrostratigraphy etc.

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Report from the International Fish Microvertebrate Group

by Susan Turner

UNESCO/I.U.G.S. IGCP 328: Palaeozoic Microvertebrates finished its year on extended term in 1996 and now co-leaders Dr. Alain Blieck (Lille) and Sue Turner (Brisbane) are editing a Final Report volume for Courier Forschungsinstitut Senckenberg. Plans are being developed to extend our work across the P/T boundary and into the Mesozoic.

1997 - List of publications relevant to the Permian System

Volumes

Turner S. & Blieck A. eds (1996).- Gross Symposium, Volume I.- Modern Geology, Special Issue, 20 (3-4).

Turner S. & Blieck A. eds (1997).- Gross Symposium, Volume II.- Modern Geology, Special Issue, 21 (1-2).

Refereed Papers

Blieck A., Conti M. A., Dalla Vecchia F. M., Flogel H. W., Gand G., Hubmann B., Lelièvre H., Mariotti N., Nicosia U., Poplin C., Schneider J. W. & Werneburg R. (1997).- Palaeozoic vertebrates of the Alps: a review.-Bull. Soc. Géol. France, 168 (3): 343-350.

Esin, D. N. 1997. Peculiarities of trophic orientation changes in paleoniscoid assemblages from the Upper Permian of the European part of Russia. Modern Geology 21, 1/2, 185-195.

Hampe, O. 1997 Dental growth anomalies and morphological changes in the teeth of the Xenacanthida (Lower Permian; Saar-Nahe Basin, SW Germany). Modern Geology 21 (1/2), 121-135.

Richter, M. & Breitkreuz, C. 1997. Permian fish-remains from the Peine Formation of northem Chile. Modern Geology 21 (1/2), 171-184.

Abstracts/Reports

Albright, G.M. 1997. A survey of the Late Paleozoic fish fauna of Utah. Abstracts SVP Chicago, Jour. Vert. Paleo. Supplement to vol.

Bender, P. 1997. Upper Permian fish from the South African Karoo Basin. In Conference on Australasian Vertebrate Evolution, Palaeontology and Systematics, July 7th-11th, 1997, Programme and Abstracts, p. 14-15.

Evans, F. & Bender, P. 1997. Whitehill Formation (Ecca Group) palaeoniscoids from the Permian of South Africa. In Conference on Australasian Vertebrate Evolution, Palaeontology and Systematics, July 7th-11th, 1997, Programme and Abstracts, p. 23-24.

Doneland, C. & Johnson, G. D. 1997. *Orthacanthus platypternus* (Chondrichthyes: Xenacanthida) occipital spines from the Lower Permian Craddock Bonebed, Baylor County, Texas. Abstracts SVP Chicago, Jour. Vert. Paleo. Supplement to vol.

Turner S. & Blieck A. (1997).- The final flings of IGCP 328: Palaeozoic microvertebrate biochronology and global marine/non-marine correlation. Episodes, 20 (1): 48-52.

Turner, S. & Long, J.A. 1997. Palaeozoic sharks of Western Australia. In Conference on Australasian Vertebrate Evolution, Palaeontology and Systematics, July 7th-11th, 1997, Programme and Abstracts, p. 60-6 1.

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ANNOUNCEMENT OF FIELD CONFERENCES

International Field Conference on: The continental Permian of the Southern Alps and Sardinia (Italy). Regional reports and general correlations.

Date: 16-25 September, 1999

Venue

Brescia Museum of Natural Sciences, Italy, and excursions in Sardinia and in the Southern Alps.

Organizer

A team of Italian geologists already involved in the IGCP projects n. 203, 272, 343, 359, jointly sponsored by the Italian Geological Society (SGI), the National Research Council (CNR), and other scientific organizations. Foreign geologists have also collaborated for this meeting.

Subjects

The proposed aim of the Conference is not only to present the results of research carried out over recent years in the aforementioned Italian areas, but above all, to establish possible correlations between these regions and other Permian continental domains of the world. Two field trips are planned. The first pre-Conference excursion will be held, from 16 to 18 September, in Sardinia, specifically both in the central-eastern continental basins of Escalaplano, Perdasdefogu, Seui, and in the northwestern Nurra. Afterwards, the participants can reach Brescia by ferry-boat and bus. The Conference, which will take place in Brescia from 20 to 22 September, is designed to improve our current understanding of the continental Permian; as well as the presentation of papers and posters, there will be restricted meetings on specific research topics. The focus will be on stratigraphic, palaeontologic, magmatic and tectonic separate sections. An additional section on the Permian-Triassic boundary in the continental, or on the continental-marine transition domains, is being planned. A further three-day excursion, from 23 to 25 September, will be dedicated to the Permian of the central-eastern Southern Alps. The Collio and Tregiovo continental basins, the Bolzano volcanics, and the Val Gardena Sandstone-Bellerophon Formation of the well-known Butterloch-Bletterbach section in the western Dolomites, will all be visited. The trip will also take in the famous P/T type-section of Tesero, near Cavalese (Fiemme Valley).

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International Conference on Pangea And The Paleozoic-Mesozoic Transition (First Circular)

Organizer

Professor Yin Hongfu, Member of Academia Sinica, President of China University of Geosciences (Wuhan)

Objective

The conference is designed to provide a forum to all kinds of scientists who are interested in the special interval of Pangea for discussing Pangea formation and dispersion; global changes related to Pangea integration and break-up; biotic crisis, extinction, recovery and evolution at the Paleozoic-Mesozoic transition; and Tethys evolution during Pangea interval.

Date

Pre-Conference Field Excursion: 7-8 March, 1999
Conference: 9-11 March, 1999
Post-Conference Field Excursion**:** 12-16 March, 1999

Place

China University of Geoscience (Wuhan)

Language

English will be the official language for all presentations.

Important Dates

1 April 1998: Deadline for submission of response to first circular
1 October 1998: Deadline for submission of abstracts
1 February 1999: Deadline for submission of pre-registration

Themes

1. Tectonics and dynamics of Gondwana break-up, Pangea integration and Tethys evolution;
2. Paleogeography, paleoclimatology and paleoecology during Pangea interval;
3. Stratigraphy, sea level changes, high-resolution events and boundary;
4. Biotic crisis, mass extinction, recovery and evolution at the Paleozoic-Mesozoic transition.

Field Excursion

Pre-conference Field Excursion-Huangsi, Southeast Hubei Province (7-8 March, 1999). This two day field excursion will visit some typical marine Carboniferous-Lower Triassic and terrestrial Middle Triassic sections in Huangsi, southeastern Hubei Province. Some key boundaries will be examined there as well.

Post-conference Field Excursion-the Yangtze Gorges (12-16 March, 1999). The Yangtze Gorges areas are not only famous for the attractive scenery and the Dam construction, but also for the well-exposed Pre-Cambrian-Triassic stratigraphic sequences and their special geological significance. The excursion is planned mainly to examine the stratigraphic sequence and it's related geological aspects. As the Yangtze Gorges Dam cut off the river at the end of 1997, a search for new exposures may be necessary.

Publications

We anticipate that refereed and accepted papers will be published either as a book or as a special issue of an international journal series. Papers must be presented (either orally or in poster) before being considered for publication.

Registration and excursion

Registration should be made on the registration form attached to the second circular, which will be sent to all who respond to the first circular. Registration fee for the Conference (including the proceedings, morning and afternoon teas and three lunches) will be $150 US Dollars. Pre-conference field excursion fee (including transportation, accommodation, field guidebook and meals) will be $120 US Dollars. As the Yangtze Gorges Dam is under construction and began daming the river late in 1997, the post-conference field excursion fee is presently uncertain but is estimated at about $500 US Dollars (refer to second circular for details).

Transportation

Wuhan is the capital of Hubei Province, situated in the center of China. The international airport has daily flights from Hong Kong, Beijing, Shanghai, Guangzhou and other major cities in China. Wuhan is on the mid-way of Beijing-Guangzhou Railway with more than 20 express and rapid trains daily from Beijing and Guangzhou. Meanwhile, Wuhan is situated in the middle part of Yangtze River with more than 10 scheduled boats from Shanghai and Chongqing every day.

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International Symposium
Upper Permian Stratotypes of the Volga Region

(see lower figure, page 43)

Kazan State University and Tatar Republican Mineral Resources Commission at the Ministers Cabinet of the Republic of Tatarstan, Kazan, Russia, 28 July, 1998 - 3 August, 1998

Dates to Remember

1 March 1998 - deadline for submission of abstracts;
25 June 1998 - deadline for submission of registration forms;
30 July 1998 - deadline for submission of Conference papers.

Since release of the First Circular, the Organizing Committee has received some 140 pre-registrations for the Symposium from Russia, Europe, Asia, North America and Australia.

Symposium Objectives

The main objectives of the Symposium are to show to participants the stratotypes of the Ufimian, Kazanian and Tatarian; to provide the opportunity to collect samples for different kinds of analyses; to discuss the new data on the Upper Permian sections in the Volga region as well as in other areas; and to identify the prospects for future investigations.

Papers and Publications

The Organizing Committee now calls for titles, abstracts and papers from intending participants. The abstract volume will be published as a special issue of Kazan State University. Abstracts may be up to two A4 pages in length (both reference and illustrations inclusive). Posters are also welcome. Abstracts to be included in the abstract volume will be required as photo-ready copy and disk in any word processing program by 1st March 1998. They should contain: a brief title, the name, address, and European titles of the author(s). Illustrations may be no more than 60mm x 120mm.

Symposium Schedule

Post-Conference field excursion group photo taken at Oxford Point near Wollongong. Background shows Permo-Triassic sequence. (Submitted by Guan R. Shi, G. R. Strzelecki International Symposium on the Permian of Eastern Tehys: Biostratigraphy, Palaeogeoraphy and Resources, Deakin University, Melbourne, Australia; 30 November - 3 December 1997.)

Member B ("Lamellar Stone") of Upper Kazanian stratotype near the village of Pechischi, right bank of the Volga River, near the city of Kazan (from "Stratotypes and Reference Sections of Povolzhie and Prikamie", Kazan', 1996, p. 85)

Arrive in Kazan - 27 July 1998
Departure from Kazan - 4 August 1998
Opening ceremony - 28 July at 2.00 p.m. in the Hall of Culture Centre "Kazan".
Oral presentations and posters will be presented from 29 July to 3 August aboard the special ship; the field excursions will take place during the same dates. This scientific trip is planned to examine the main sections of the Ufimian, Kazanian and Tatarian stages in basins of the Volga, Kama, Sheshma, and Sok rivers.
Closing ceremony - 3 August 1998.

Weather

The Kazanian region in late July and early August enjoys a warm and sunny summer: temperatures usually range between +18 and +27. However, rain and cool conditions can also occur.

Travel to Kazan

For foreign participants, the most convenient way is by direct flight from Frankfurt (Lufthansa) on Mondays and Thursdays, and return flight on Tuesdays and Fridays. Also it is possible to travel to Kazan through Moscow by plane (domestic airline) or by train. There will be a special vehicle to meet participants at the Kazanian airport and railway station. It will transport participants to the site of registration and accommodation. Please inform the Organizing Committee about details of your flight or train before 25 July. If you wish to arrive earlier than 27 July or if you wish to depart after 4 August, please inform the Organizing Committee before 1 July to provide your accommodation hotel.

Registration

Accommodations for participants are planned in first and second class cabins aboard a special ship. Registration fee for the Symposium will be $100, and $50 for students, post-graduates and accompanying members (dollars USA). Accommodation (ship cabins and meals) will be $40 or $60 per day. Payment can be made during registration, after arriving to Kazan, or through the banks:
UNION BANK OF SWITZERLAND, ZURICH
for corr.acc. 89 023 79 W of TATSOTBANK in favor of acc. 142070084 of the Tatar Republic Commission of Reserves of Deposits
or CITI BANK N.A New York for corr.acc. 36111247 of TATSOTBANK in favor of acc. 142070084 of the Tatar Republic Commission of Reserves of Deposits.

All information:

The Organizing Committee of International Symposium
Dept. of Geology
Kazan State University
Kremliovskaya, 4/5, Kazan, P.b. 73, 420111, Russia
tel./fax (7-843) 232 15 77
E-mail:symp@reggeo.ksu.ru or geod@pmkgu.kcn.ru

MEETING REPORTS

The Strzelecki International Symposium on the Permian of Eastern Tehys: Biostratigraphy, Palaeogeography and Resources, Recently Held at Deakin University, Melbourne, Australia; 30 November 1997. (see upper photo, page 43)

by G. R. Shi

A Summary Report

We are pleased to provide this summary report on the Permian Conference particularly in the interest of those who were unable to attend.

The Permian Conference was dedicated to the 200th Anniversary of the birth of Sir Paul Edmund Strzelecki (1797-1873), an explorer of the Americas, Hawaii and the British Colonies of New South Wales and Van Diemen's Land (now New SouthWales, Victoria and Tasmania of Australia). During the course of his extensive SE Australian explorations, Strzelecki studied the Permian sequences of the Sydney and Tasmania Basins and collected the first comprehensive suites of fossils from these basins.

Attendance at the Permian Conference was particularly pleasing, with some 64 paid registrants representing 16 countries. A total of 82 abstracts were received, 48 of which were presented as posters. The spread of the papers received is also of interest; they covered 7 major themes with "Biostratigraphy" dominating the conference.

Two excursions were organized: one (mid-conference excursion) to Bacchus Marsh area, about 50 km NW of Melbourne; the other (post-conference excursion) to the southern Sydney Basin some 750 km NE of Melbourne. The post-conference excursion was conducted in a manner simular to a field geology conference; it involved active group discussions in the field following individual's observations. Of course, running kangaroos and sleepy koalas have not escaped participants' eyes either.

In conclusion, we would like to thank all of the participants for your active participation in and contribution to the conference. We trust that you all have had an enjoyable and fruitful trip to Australia.

Announcements:

The abstracts volume (see reference below) of the Permian Conference is available at a small cost (AUST$30 per copy including postage). If interested, please write to us with a cheque made payable in Australian dollars to:

Deakin University
Rusden Campus
662 Blackburn Road
Clayton, Victoria 3168, Australia

Shi, G. R. (ed.). 1997. Abstracts of the Strzelecki International Symposium on the Permian of Eastern Tethys: Biostratigraphy, Palaeography and Resources, Deakin University, Melbourne, Australia, 30 November - 3 December 1997. Deakin University , School of Aquatic Science and Natural Resources Management Technical Paper 1997/3, iv + 161p.

PaleoForams '97 Conference Report

by Charles A. Ross and June R. P. Ross

PaleoForams'97 Conference was held at Western Washington University, Bellingham, Washington, August 17 through 21, 1997. Below is a brief summary of some of the accomplishments of the meeting.

Thirty-eight very enthusiastic and dedicated Paleozoic foraminiferal workers from twelve countries assembled for the PaleoForams '97 Conference held at Western Washington University, Bellingham, Washington, in late August. With funding from outside sources, six scientists from different institutions in Russia and one from Kyrgystan were supported to present papers and posters at the conference. The international group of professional scientists included: two each from Australia and Canada; four from Japan; and one each from Austria, Belgium, The Netherlands, Spain, and Turkey, and a student from Thailand who is completing her Ph.D. in Japan. There were also fifteen scientists from the U.S.A.

Because of the widespread use of Paleozoic foraminifers in biostratigraphy, particularly in correlations and interpretation of depositional environments, the participants represented an excellent mix from universities and other academic institutions, geological surveys, and the petroleum industry. Everyone actively participated and the presentations and poster sessions went very well. Speakers gave 30 minute presentations followed by 15 minutes for discussion. Particpants were able to cover their topics fully and the discussion permitted exploration of ideas and also lead to further fruitful expansion of the topics. Several participants used the opportunity to clarify a speaker's stand on concepts and many discovered ideas of which they had not been aware because of literature and language bottlenecks. Many participants had not previously met, although many had corresponded with each other. They found this a long awaited opportunity to discuss details of taxonomy and biostratigraphy. Many brought prepared thin sections of specimens. Microscopes were used extensively at all times of the day and night. Some participants also presented elaborate posters.

The conference volume, published for distribution at the meeting, is in an extended abstract format in the Cushman Foundation for Foraminiferal Research Special Publication 36 (170 p.) with a postconference guidebook supplement (63 p.), which documents the important and newly approved International Carboniferous type section defining the Mid-Carboniferous boundary at Arrow Canyon, near Las Vegas, Nevada. This widely distributed international publication will make this summary of our current understanding of Paleozoic Foraminifera available to a much wider audience.

The PaleoForams'97 preconference field trip examined the Paleozoic stratigraphy of accreted terranes in northwestern Washington and south-central British Columbia and the postconference field trip studied the Mid-Carboniferous boundary in Arrow Canyon, Nevada.

Participants have corresponded that they were very pleased with the conference and the field trips. They expressed pleasure at the opportunity to discuss foraminifers and biostratigraphy, to interact with their colleagues, and to broaden their knowledge at this theme conference.

Organizers

Conference: August 17-21,1997,

Charles A. Ross, Department of Geology, Western Washington University;

June R. P. Ross, Department of Biology, Western Washington University; and

Paul Brenckle, Westport, MA.

Pre-conference Field Trip

August 14-16, 1997, Devonian through Permian strata of accreted terranes in western Washington and Southwestern British Columbia (Canada), led by W. R. (Ted) Danner, University of British Columbia.

Post-conference Field Trip: August 22-24, 1997, Carboniferous of Arrow Canyon and the Mid-Carboniferous boundary, southern Nevada, (USA), led by Paul Brenckle and W. R. (Ric) Page (U.S. Geological Survey).

Contents of Cushman Foundation for Foraminiferal Research Special Publication 36 and supplement

Demir Altiner, Origin, morphologic variation and evolution of Dagmaritin-type biseriamminid stock in the Late Permian;

Paul L. Brenckle, Late Tournaisian (Lower Carboniferous) foraminifers from the Middle Urals and their use in Russian Horizon definition;

Paul L. Brenckle, What is *Urbanella?*

Titima Charoentitirat and Katsumi Ueno, Late Carboniferous-Early Permian fusulinacean fauna of Loei, northeast Thailand: A preliminary report;

Wilbert R. Danner, Fusulinds and other Paleozoic Foraminifera of accreted terranes, southwestern British Columbia and northwestern Washington;

Vladimir I. Davydov, Walter S. Snyder and Claude Spinosa, Fusulinacean biostratigraphy of the Upper Paleozoic of the southern Urals;

Vladimir I. Davydov, Walter S. Snyder and Claude Spinosa, Permian foraminferal biostratigraphy and sequence stratigraphy of Nevada;

Anna V. Durkina, Stages in evolution of Foraminifera as a basis for biostratigraphic subdivision of Carboniferous deposits in the northeastern portion of European Russia and their corrrelation with those in Western Europe;

Alexandra Dzhenchuraeva, Biostratigraphy of Middle and Upper Carboniferous deposits of the Tien-Shan;

Stephen J. Gallagher, The use of multivariate statistics to detemiine the paleoenvironmental distribution of Lower Carboniferous Foraminifera from Ireland;

Nilyufer B. Gibshman, Foraminiferal zonation and paleogeography of Early Carboniferous PreCaspian depression (West Kazakhstan);

John R. Groves, Repetitive patterns of evolution in late Paleozoic foraminifers;

John R. Groves and Paul L. Brenckle, Graphic correlation of upper Paleozoic outcrop sections in the Western Tarim Basin, China;

Luc Hance, *Eoparastaffella*, its evolutionary pattern and biostratigraphic potential;

Johann Hohenegger, Morphological niches as tools for phylogenetic analysis: Permian and Triassic Lagenina as a case study;

Rimma M. Ivanov, Middle Carboniferous fusulinid zones of the

Ural Mountains;

Fumio Kobayashi, Middle Permian biogeography based on fusulinacean faunas;

Fumio Kobayashi, Middle Permian fusulinacean faunas and paleogeography of exotic terranes in the Circum-Pacific;

Maria Konovalova, Lower Permian (Kungurian) Foraminifera and stratigraphy in the Timan-Pechora Basin;

Elena I. Kulagina and Zinaida A. Sinitsyna, Foraminiferal zonation of the Lower Bashkirian in the Askyn Section, South Urals, Russia;

Jerry L. Liszak and Charles A. Ross, Foraminifera and associated faunas, Lower Carboniferous-Lower Permian Chilliwack Group, Black Mountain,Washington;

Bernard L. Mamet, On a Late Devonian *Quasiendothyra* (Foraminifera) fauna, Arctic Alaska;

Z. P. Mikhailova and V. A. Chermnykh, Fusulinoida zones of the Upper Carboniferous and lowest Permian in the Northern Urals;

Merlynd K. Nestell and Galina P. Pronina - The distribution and age of *Hemigordiopsis;*

Galina P. Pronina and Merlynd K. Nestell, Middle and Late Permian Foraminifera from exotic blocks of the Alma River Basin, Crimea;

Svetlana T. Remizova, Fusulinid correlation of the Middle-Late Carboniferous boundary beds of North Timan, Russia, with the North Euramerican Province;

Charles A. Ross and June R. P. Ross, Hessian (Leonardian, middle Lower Permian) depositional sequences and their fusulinid zonations, West Texas;

June R. P. Ross and Charles A. Ross, Nealian and Lenoxian (Wolfcampian, Lower Permian) depositional sequences and fusulinid facies and biostratigraphy, Glass Mountains, West Texas;

Oleg A. Shcherbakov, Biostratigraphy of the Carboniferous System of the Urals;

Janina Sobon-Podgorska and Anna Tomas; Foraminifers of the Polish Carboniferous;

Patrick K. Spencer and Charles A. Ross, Black Prince Limestone and its foraminifers, Upper Mississippian-Lower Pennsylvanian, S.E. Arizona and S.W. New Mexico;

Calvin H. Stevens, Affinities of Early Permian fusulinid faunas in the Golconda allochthon, central Nevada, and northern Sierra Nevada;

Katsumi Ueno, Daisuke Watanabe, Hisaharu Igo, Yoshitaka Kakuwa, and Ryo Matsumoto, Early Carboniferous foraminifers from the Mobarak Formation of Shahmirzad, northeastern Alborz Mountains, northern Iran;

Maya V. Vdovenko, Taxonomic position of *"Ammodiscus" buskensis* Brazhnikova, 1956;

Elisa Villa and Adriaan C. van Ginkel, Early schwagerinids and accompanying fusulind genera from the Kasimovian of the Cantabrian Mountains (Spain);

Valery Ja. Vuks, Triassic foraminifers of Russia and adjacent countries (Caucasus, Mangyshlak, Pamirs);

Gregory P. Wahlman, G. J. Verville and G. A. Sanderson, Biostratigraphic significance of the fusulinacean *Protriticites* in the Desmoinesian (Pennsylvanian) of the Rocky Mountains, western U. S. A.;

Valentia Ya. Zhaimina, V. G. Zhemchuzhnikov, H. E. Cook, V.M.Buvtyshkin, L.Ya. M. Golub, W.G. Zempolich, E. A. Kotova, M. Viaggi, P. **J.** Lehmann, A. Giovannelli, P. Lapointe, and M. Bowman, Biostratigraphic succession of a 4,500 meter thick Upper Paleozoic carbonate platform: Bolshoi Karatau Mountains, southern Kazakstan.

Special Publication 36 Supplement

GUIDEBOOK TO MID-CARBONIFEROUS BOUNDARY STRATIGRAPHY OF ARROW CANYON, NEVADA.

Location map for field trip

Stratigraphic nomenclature

DAY 1

Photograph of the type section of the Mid-Carboniferous stratotype

William R. Page, and Gary L. Dixon, Geologic Framework of the Arrow Canyon Area, Clark County, Nevada.

P.L. Brenckle, J. F. Baeseman, H. R. Lane, R. R. West, G. D. Webster, R. L. Langenheim, U. Brand, B. C. Richards,

Arrow Canyon, the Mid-Carboniferous boundary stratotype.

Appendix 1, Arrow Canyon measured section across the Mid-Carboniferous boundary.

Appendix 2, List of fossil occurrences by sample.

Charles A. Ross, Pennsylvanian and Lower Permian stratigraphy and fusulinids, Arrow Canyon, Nevada.

Paul L. Brenckle - Battleship Wash Section.

DAY 2

Photograph of the Upper Devonian and the Lower Mississippian succession.

Paul L. Brenckle - Hidden Valley Locality.

Extended Abstracts

The extended abstracts for the PaleoForams '97 Conference and the post-conference field trip guidebook are available from the Cushman Foundation for Foraminiferal Research, Museum of Comparative Zoology, Harvard University, 26 Oxford Street, Cambridge, Massachusetts, 02138, U.S.A., for US$40.00. The reference is C. A. Ross, J. R. P. Ross, and P. L. Brenckle, editors, 1997, Late Paleozoic Foraminifera, their biostratigraphy, evolution and paleoecology and the Mid-Carboniferous boundary, Cushman Foundation for Foraminiferal Research Special Publication 36, 170 p. and its supplement is P. L. Brenckle and W. R. Page, leaders, 1997, Post-conference field trip to the Arrow Canyon Range, Southern Nevada, U.S.A., 63 p.

Special Publication 36 includes the extended abstracts of the talks and posters presented at the meeting, as well as a few papers submitted by several authors who were unable to attend. The supplement is a field guidebook to the Carboniferous succession, in the Arrow Canyon Range, Nevada, and includes commentary on the newly approved Mid-Carboniferous boundary section.

Also, a few copies of the guidebook for the Preconference 'Field trip to Black Mountain-Red Mountain, U.S.A., Harper Ranch, Kamloops, British Columbia and Marble Canyon, British Columbia, Canada', 91 p., which examined a number of late Palezoic outcrops in accreted terranes of western Washington and southern British Columbia, may be available from the field trip leader, W. R. Danner, Dept. of Earth and Ocean Sciences, University of British Columbia, Vancouver, B. C., V6T IZ4, Canada.

NOTES

Permian Research

by Calvin H. Stevens

My colleagues and I would like to alert Permophiles to some projects completed or in progress that deal with the Permian. These include:

(1)Stevens, C.H., Stone, Paul, Dunne, George, and others, in press, Paleozoic and Mesozoic evolution of east-central California: International Geology Review (to be published with other Hall Symposium papers). A substantial portion of this paper deals with Permian structural development.

(2)Stone, Paul, and Stevens, C.H., Stratigraphy and contact relations of rocks near the Permian-Triassic boundary, southern Inyo Mountains, California: New data and interpretations. Essentially completed, but not yet submitted.

(3)Revision of the classification of Permian colonial corals in the Boreal realm by J. Fedorowski, W. Bamber, and C. Stevens. Work still in progress.

(4) A new look at the Permian paleobiogeographic affinity of the Wrangellian terrane by P. Belasky, R. Hanger, and C. Stevens. This work is well underway.

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