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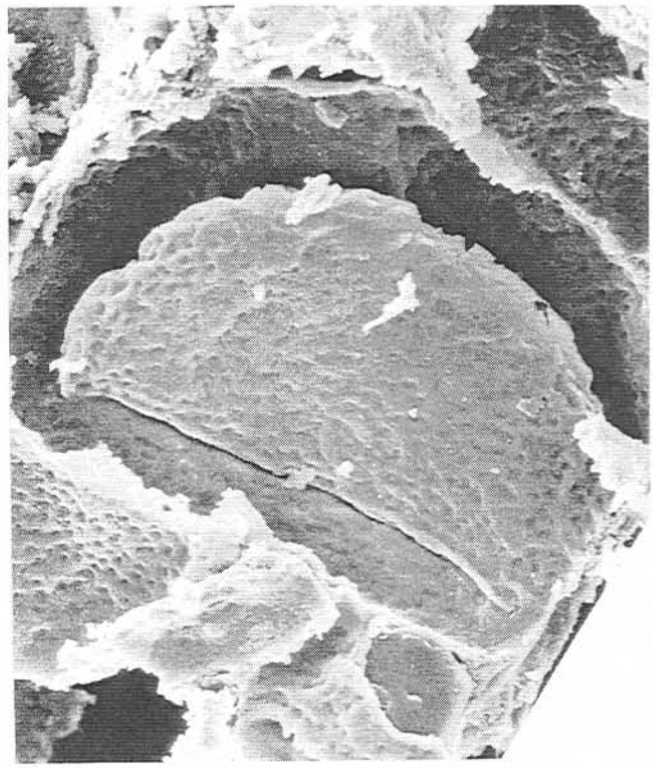

SUBCOMMISSION ON PERMIAN STRATIGRAPHY

INTERNATIONAL COMMISSION ON STRATIGRAPHY

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES (IUGS)

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Monolaesurate spores of *Qasimia schyfsmae* (Lemoigne) Hill, Wagner and El-Khayal 1985, an early *Marattia*-like fern from the Permian of Saudi Arabia.

Left: SEM photo of spores in synangia (magnification X 1000)

Right: SEM photo of single spore showing ornament of exine (magnification X 3500).

Photographs provided by R.H. Wagner

1. SECRETARY'S NOTE

I should like to thank all those who contributed to the issue of "Permophiles". The next issue will be in November 1995; please submit contributions by October 1.

Contributors may send in reports by mail, FAX or E-mail. "Permophiles" is prepared using WordPerfect 5.1 for those wishing to send in 5¼" or 3½" IBM computer discs (please also send printed hard copy). Files can also be sent in their native format with an ASCII version.

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

2. THE PERMIAN IN THE BRITISH ISLES — AN UPDATE

There has been a substantial increase in knowledge of the Permian stratigraphy, sedimentology and palaeogeography in and around the British Isles since my last report. Much of this increase results from the release and analysis of data from hydrocarbon exploration that had previously been confidential, but much also stems from new research on land and on the completion of several long-term projects on land and sea. As before, the advances have been mainly directed to the resolution of problems posed by the British Permian strata, and throw little light on the major outstanding problems of the world Permian.

The data released from hydrocarbon exploration programmes is mainly from isolated and interconnected basins that are unevenly distributed in seas around the British Isles, including some that were previously unknown and others in which the presence of Permian strata had been known but few details had been available. Most of the new information, however, has come from the later boreholes in established fields, especially in the North Sea where only relatively minor changes to existing interpretations have been necessitated, and the Irish Sea where new data have led to significant advances in knowledge of the regional Permian stratigraphy and palaeogeography. In this latter area, also, publication is eagerly awaited of the papers presented at the symposium on the geology of the Irish Sea that was held in February at the Geological Society headquarters in London. Summaries and reassessments (where necessary) of Permian strata in most of the basins in and around the British Isles have been published in an attractive range of booklets, though rumour has it that some of these may already be in need of further updating.

New research on Permian land areas of the British Isles has been concerned mainly with local and regional investigations of individual formations, providing infill to the broad framework but requiring no major changes in existing interpretations. For the southern North Sea Basin, the stratigraphical framework and sedimentology of late Permian strata near the western margin of the English Zechstein has been published recently in a synthesis of the geology of the Sunderland district (the type area of the marine Zechstein in England) and the detailed geology of twenty-eight key surface exposures of English marine Permian strata was published early this year. Long-term projects completed include a palaeogeographic atlas of the British Isles, which contains a full range of palaeogeographical maps of continental and marine strata throughout the British Isles.

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Denys B. Smith, GEOPERM
79 Kenton Road
Newcastle upon Tyne
United Kingdom NE3 4Nl

3. PROPOSAL OF AIDARALASH AS GSSP FOR THE BASE OF THE PERMIAN SYSTEM

Introduction

Since the original proposal of the Permian (Murchison, 1841), the base of the System has been subject to frequent regional redefinitions. Even in the type areas of the Ural Mountains, it has been lowered repeatedly following recognition of post-Carboniferous affinities of fossils from beneath the original (Kungurian) base of the System. As considered further herein, the Artinskian, Sakmarian, and Asselian were added in sequence beneath the Kungurian. Elsewhere, separate and largely independent chronostratigraphic standards evolved. As an example, problems in recognition of the Carboniferous/Permian boundary in Australia resulted in proposal of the "Kamilaroi" to embrace both systems (David, 1950), and sequences of local letter-designated stages for the Permian are still being utilized (e.g., Archbold et al., 1993) despite the fact that the Urals international standard has served effectively as a Western Australian reference for over one-half century (e.g., Miller, 1932). Similarly, in China the base of the Permian became stabilized at the unconformity beneath the Chihsian, the approximate correlative of the Kungurian, without appropriate consideration of successive lowering of the base in the Urals. Such practices are counterproductive. While stratigraphers are content to utilize local references, there is no incentive to develop a common international language for geological time.

The present statement contends that there is now sufficient detailed information on Carboniferous/Permian boundary sequences, world-wide, that selection of the Global Stratotype Section and Point (GSSP) for the base of the Permian is fully justifiable and timely. We recommend a definition (Chernykh and Ritter, 1994) based on a conodont chronomorphocline extending through Bed 19 of the Aidaralash section of northern Kazakhstan (Fig. 1). Fundamental principles involved in selection and definition of a GSSP were explored fully in the pioneering investigations of the Silurian-Devonian Boundary Committee (McLaren, 1977), and are expressed clearly in the Guidelines and Statutes of the ICS (Cowie et al., 1986). In seeking the GSSP for the Permian, we have been mindful of these principles and of the prerequisites summarized below:

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

History of Carboniferous/Permian boundary definition in Urals

Dunbar (1940) has provided a summary statement on the progressive early downward extension in definition of the base of the Russian Permian. In its original sense (Murchison, 1841), this base coincided with the initiation of evaporite deposition that is now referred to the Kungurian regional stage. Karpinsky (1874) identified clastic sequences that Murchison had included in the British Millstone Grit as being younger, transitional between Carboniferous and Permian, and termed them the Artinskian series. His subsequent classic study of the abundant ammonoid fauna (Karpinsky, 1889) led him to add the interval to the Permian. Further study, especially of ammonoids, permitted Ruzhencev (1936) to recognize the Sakmarian as an independent lower subdivision of the Artinskian. In turn, he subdivided the Sakmarian, and referred the lower interval to the independent Asselian Stage (Ruzhencev, 1954). The base of the Asselian and the coincident Permian System was designated, thereby, on the appearance of the ammonoid families Paragastrioceratidae, Metalegoceratidae, and Popanoceratidae, concurrent with the first inflated fusulinaceans referable to "*Schwagerina*" (i.e., *Sphaeroschwagerina*).

The base of the Asselian Stage, defined by reference to both ammonoids and fusulinaceans received progressively greater recognition and eventually Russian official status (Resolutions of the Interdepartmental Stratigraphic Committee of Russia and its Permanent Commissions - Resolution on Carboniferous/Permian boundary. St. Petersburg, 1992, p. 52-56) following Ruzhencev's original proposal. The ammonoid boundary divided the *Shumardites—Vidrioceras* Genozone below and the *Juresanites—Svetlanoceras* Genozone above, the latter reflecting first appearances of the characteristically Permian families Metalegoceratidae, Paragastrioceratidae and Popanoceratidae. The boundary favored by fusulinacean workers is almost coincident, separating the *Daixina postgallowayi* Zone below from the *Sphaeroschwagerina vulgaris aktjubensis—S. fusiformis* Zone above, the latter characterized by the earliest inflated forms. More recently, a chronomorphocline of streptognathodid conodonts has offered a basis for an even more precise and widely recognizable boundary definition, marked by the appearance of the "isolated nodular" morphotype of *Streptognathodus*. These three boundary definitions are not competitively destructive, since for practical purposes they are coincident. As an example, at the Aidaralash section favored as GSSP (Fig. 2), the conodont boundary lies 27 m above the base of Bed 19, the fusulinacean boundary a mere 6 m higher at 33 m, and the ammonoid boundary that originally defined the base of the Asselian lies 54 m above the base of Bed 19 at the 19/20 Bed boundary.

Aidaralash as GSSP

Introduction

Many Carboniferous/Permian boundary sections in the Southern Ural Mountains of Russia and Kazakhstan have been studied in detail, and can be correlated confidently with the proposed boundary stratotype along Aidaralash Creek. However, each of these other sections has attributes that detract from its scientific merit. For example, the classic condensed section along the Usolka River, deposited along the margin of the Pre-Uralian Foredeep trough (Fig. 1), is exceptionally rich in conodonts; these afford precise correlation with Aidaralash (Chuvashov et al., 1993), but other critical fossil groups are only rarely associated. The Aidaralash Creek section is located in the Aktyubinsk (currently Aqtöbe) region of the Southern Ural Mountains of northern Kazakhstan, approximately 50 km east of the city of Aqtöbe (Fig. 1). The stratigraphic section there is readily accessible, and is characterized by an uninterrupted succession of strata across the Carboniferous/Permian boundary that contain abundant and well-preserved conodont, ammonoid, and fusulinacean faunas. Associated microfossils, such as radiolarians, small foraminiferans, and palynomorphs should provide additional important bases for correlation, and paleomagnetics have been investigated (Khramov and Davydov, 1984).

Current consensus on the position of the Carboniferous/Permian boundary has evolved, in large part, from studies of ammonoids (Ruzhencev, 1936, 1945, 1950, 1951, 1952, 1954) and fusulinaceans (Rauser-Chernousova, 1940) from the Urals. Ruzhencev investigated many sections, but principal among them, and the focus of the present statement, was Aidaralash Creek. Resulting publications (Ruzhencev, 1950, 1951, 1952) contain detailed documentation of the succession of ammonoids and fusulinaceans, and together with the sedimentologic data of Khvorova (1961) provide the framework for the modern understanding of regional Late Paleozoic stratigraphy. A series of recent investigations addressed placement of the Carboniferous/Permian boundary (e.g., Pnev, Polozova, Pavlov and Popov, 1978; Davydov and Popov, 1986; Bogoslovskaya, Leonova and Shkolin, 1995), as have numerous reports from recent issues of Permophiles (e.g., No. 19, November 1991; Utting, p. 2-5: No. 21, November 1992; Jin, p. 3-4; Wardlaw, p. 5-7; Nassichuk and Rui Lin, p. 11-15; Henderson, p. 15-16: No. 22, June 1993; Glenister, p. 2-5; Chuvashov, Chernykh and Mizens, p. 11-16: No. 23, November 1993; Utting, p. 1-4; Davydov, p. 5-8; Spinosa et al., p. 9-11: No. 24, June 1994; Ross and Ross, p. 3-6: No. 25, November, 1994; Glenister and Wardlaw, p. 2-3; Chernykh and Ritter, p. 4-6).

A combined meeting of the Subcommission on Permian Stratigraphy and the two boundary working groups convened in connection with the International Congress on the Permian System of the World, Perm, Russia, August 5-10, 1991. There the proposal was made (Permophiles No. 19, November 1991, p. 2-5) that the Chair invite the Carboniferous/Permian Boundary Working Group:

"To formally propose that the boundary stratotype for the Carboniferous/Permian boundary be defined at the base of the *Sphaeroschwagerina vulgaris—fusiformis* Zone between beds 19 and 20 of the Aidaralash section, with a parastratotype at Usolka River. This proposal should be provisional until:

a. Additional conodont studies especially of the shales are carried out.

b. The site is formally designated for permanent free access.

c. The exposures are improved.

"Following discussion, the proposal was informally approved 26 for, 3 opposed, 9 abstentions. In response to the perceived need for additional information on the Aidaralash section, especially relating to sedimentology, sequence stratigraphy, and conodont biostratigraphy, a Russian-American team led by Vladimir Davydov and Claude Spinosa initiated a research program that continues actively to the present. Free convenient access has facilitated repeated improvement of exposures, using heavy mechanical equipment (bulldozers), and a wide variety of investigations have been initiated. Summary statements on these investigations follow, and were reviewed in connection with the International Symposium on Permian Stratigraphy, Environments and Resources, Guiyang, China, August 28-31, 1994. The meeting posed the question:

"Is this the correct time for the Subcommission on Permian Stratigraphy to formalize a proposal on the Carboniferous/Permian Boundary?"

Results of the informal vote were 21 for, 0 opposed, 2 abstentions.

These deliberations support the consensus of the Carboniferous/Permian Boundary Working Group (BWG) that formalization of the Carboniferous/Permian GSSP is both appropriate and timely, and the present proposal will be distributed to Voting Members of the BWG concurrent with submittal of the manuscript. If approved, it will be forwarded to the International Commission on Stratigraphy Full Commission for approval and ultimate submittal for final ratification by the International Union of Geological Sciences Executive Committee and subsequently the International Geological Congress, Beijing, August 1996.

Sedimentology and Stratigraphy

The Gzhelian to Sakmarian succession, Beds 1 through 39 of the Aidaralash Creek section, represents strata deposited on a shallow marine shelf in a distal prodelta slope or sloping outer shelf. There in the southeastern region of the Aqtöbe sub-basin of the Pre-Uralian Foredeep (Fig. 1; Snyder et al., 1994), a large and persistent delta complex appears to have been located to the northeast of the Aidaralash Creek site. Mass gravity-flow deposits were transported southwestward to the Aidaralash area, paleocurrent analysis suggesting a S55W direction. The strata of Beds 1-39 consist of hemipelagic silt and clay, with occasional sand and very coarse sand lenses (Fig. 2).

Published sea level curves (e.g., Ross and Ross, 1987) indicate distribution of sequence boundaries, and suggest a probable unconformity at the Carboniferous/ Permian level. Were this correct for the proposed Aidaralash boundary, a biotic discontinuity should occur there, corresponding with a disconformity. However, the conodont succession across the boundary comprises a chronocline that necessitates definition of the boundary at an arbitrarily-chosen level within the continuum. Thus, detailed biotic as well as sedimentologic analyses suggest that sedimentation was continuous through Beds 19, 20, and 21, without recognizable breaks. This continuity permits a high level of confidence that the proposed boundary does not correspond to a hiatus.

Ammonoid biostratigraphy

Ruzhencev (1950, 1952) placed the boundary between the Orenburgian and Asselian stages at the contact between Beds 19 and 20 in the Aidaralash Creek section (Fig. 2), and subsequently this became generally accepted as the Carboniferous/Permian boundary. In a recent reexamination of the ammonoid biostratigraphy of this section, Bogoslovskaya et al. (1995) supported Ruzhencev's choice, and documented a greater level of ammonoid diversity there than known previously. They recognized 9 species from Bed 19 (19.2a and 19.3a, Fig. 2) and 13 from Bed 20 (20a, Fig. 2). A consequential turnover at that level was suggested, including termination of the *Prouddenites—Uddenites* lineage at the top of Bed 19, and introduction of two important Permian species, *Svetlanoceras primore* and *Prostacheoceras principale* in Bed 20.

Several ammonoid lineages can be identified as crossing the Carboniferous/ Permian boundary (Bogoslovskaya et al., 1995). The ancestral species of *Prostacheoceras, P. principale* from Bed 20, appears to be closely related to the Carboniferous *Vidrioceras*, but is a more advanced representative of the group. *Artinskia irinae* from Bed 19 and *Artinskia kazakhstanica* from Bed 20 constitute a possible chronocline that crosses the Carboniferous/Permian boundary. Above Bed 19 several Carboniferous genera are represented by new Permian species, including *Daixites antipovi, Prothalassoceras serratum, Glaphyrites angustilobatus*, and *G. rarus*, and this boundary corresponds to that between the *Shumardites—Vidrioceras* Genozone below and the *Svetlanoceras-Juresanites* Genozone above (Bogoslovskaya et al., 1995). These ammonoid changes at the boundary of Beds 19 and 20 therefore offer advantages for serving in definition of the GSSP, notably that the new appearances seem to usher in distinctive ammonoids with good correlation potential. There are serious problems, however:

1) ammonoids of critical stratigraphic significance are rare; those that represent the only plausible chronocline, Artinskia irinae and Artinskia kazakhstanica, are scarce indeed;
2) there exists an interval of 26.8 m (Fig. 2) between the last documented Carboniferous ammonoid occurrence (Bed 19/3) and the first Permian occurrence in Bed 20 (both Bogoslovskaya et al., 1995);
3) ammonoid genera from the Urals may occur elsewhere, but most species appear to be endemic.

Fusulinacean biostratigraphy

Fusulinacean distributions were documented by Ruzhencev (1950, 1952) in connection with definition of the Orenburgian/Asselian boundary. He noted the first occurrence of inflated "*Schwagerina*" (=*Sphaeroschwagerina*) at the base of Bed 20 at Aidaralash, coincident with the appearance of the distinctive new Permian ammonoid families. Subsequently, Pnev et al. (1975) reported *Sphaeroschwagerina* from Bed 17, and for a time the Carboniferous/Permian boundary was lowered to the base of Bed 10 (base of the *Ultradaixina bosbytauensis—Schwagerina robusta* fusulinacean Zone). However, restudy of the "*Sphaeroschwagerina*" from Bed 17 by a colloquium of specialists resulted in reassignment to *Licharevites*, a genus that occurs in Beds 14 through 26 at Aidaralash and is widespread from Spitsbergen to China.

Recent studies of fusulinaceans from Aidaralash have revealed that changes in the dominant lineages across the boundary interval are gradual (Davydov et al., 1992). However, the base of the *Sphaeroschwagerina vulgaris—S. fusiformis* Zone can be identified precisely and correlated confidently from Spitsbergen (Nilsson and Davydov, 1993) through the Russian Platform, the Urals, China and Japan (Davydov et al., 1992). For practical purposes it corresponds to the boundary between the Orenburgian and Asselian as defined by Ruzhencev. At Aidaralash, it coincides with the contact between Beds 19/5 and 19/6, 6.3 m above the conodont boundary and 20 m below the original ammonoid boundary (Fig. 2). There, *Ultradaixina* practically disappears, *Schellwienia* becomes scarce, and species of *Sphaeroschwagerina* first appear. Other fusulinacean lineages also intersect this boundary as well. Additional data from approximately 10,000 oriented thin sections from Aidaralash may eventually provide important morphometric bases for refined correlation. Despite their

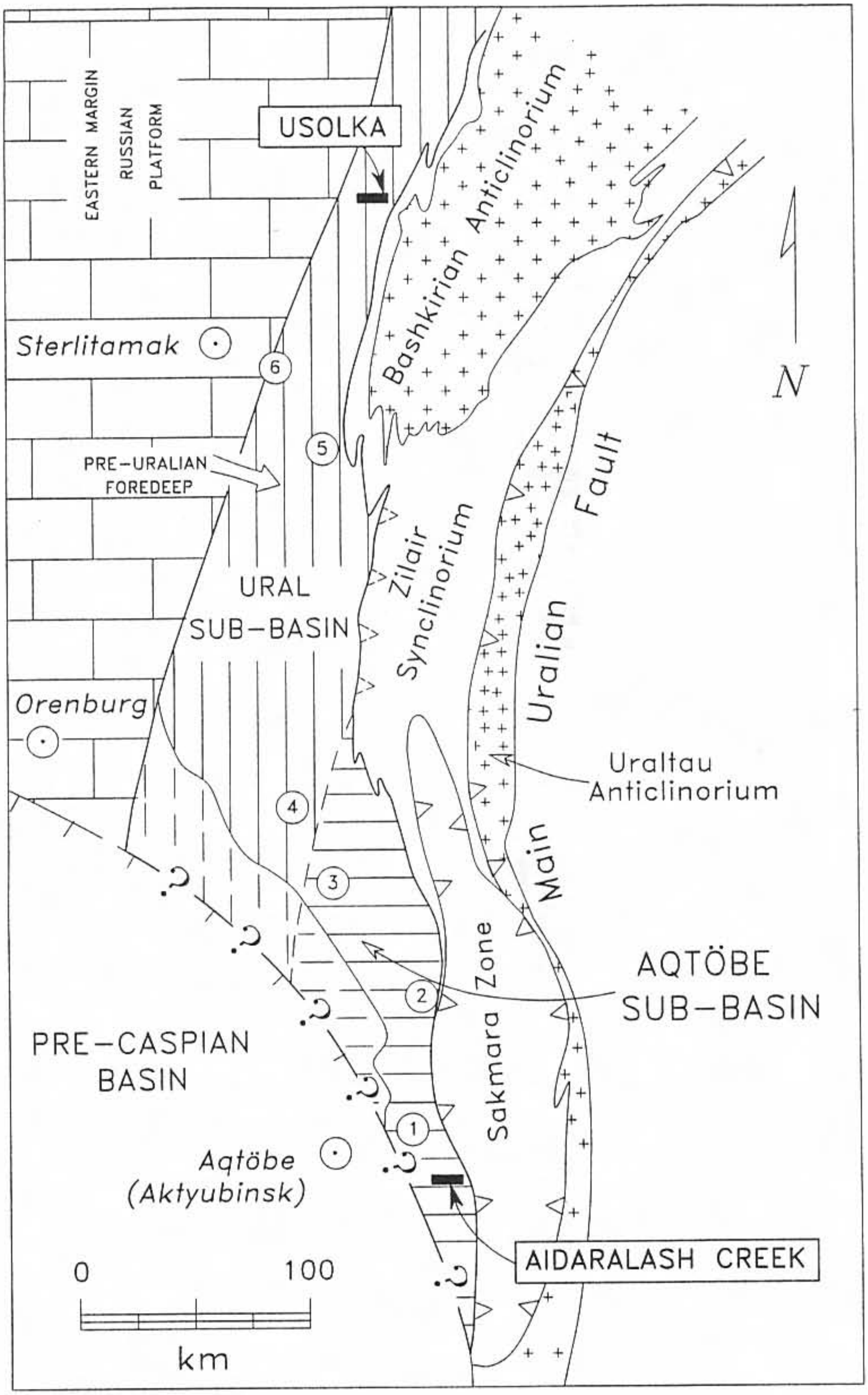

Figure 1. Upper Paleozoic tectonostratigraphic map of the southern Ural Mountains. Limestone pattern depict the eastern margin of the Russian Platform. The vertical- and horizontal-striped areas represent the Ural sub-basin and the Aqtöbe sub-basin, respectively. Together they comprise the Belsk depression (not labeled) of the Pre-Uralian Foredeep. The two main stratigraphic sections considered for GSSP, Aidaralash and Usolka, are identified. Other important Permo-Carboniferous section of the region are indicated by numbers: 1. Aktasty Hills, 2. Alimbet, 3. Nikolsky, 4. Kondurovska, 5. Belaya River, 6. Shikans.

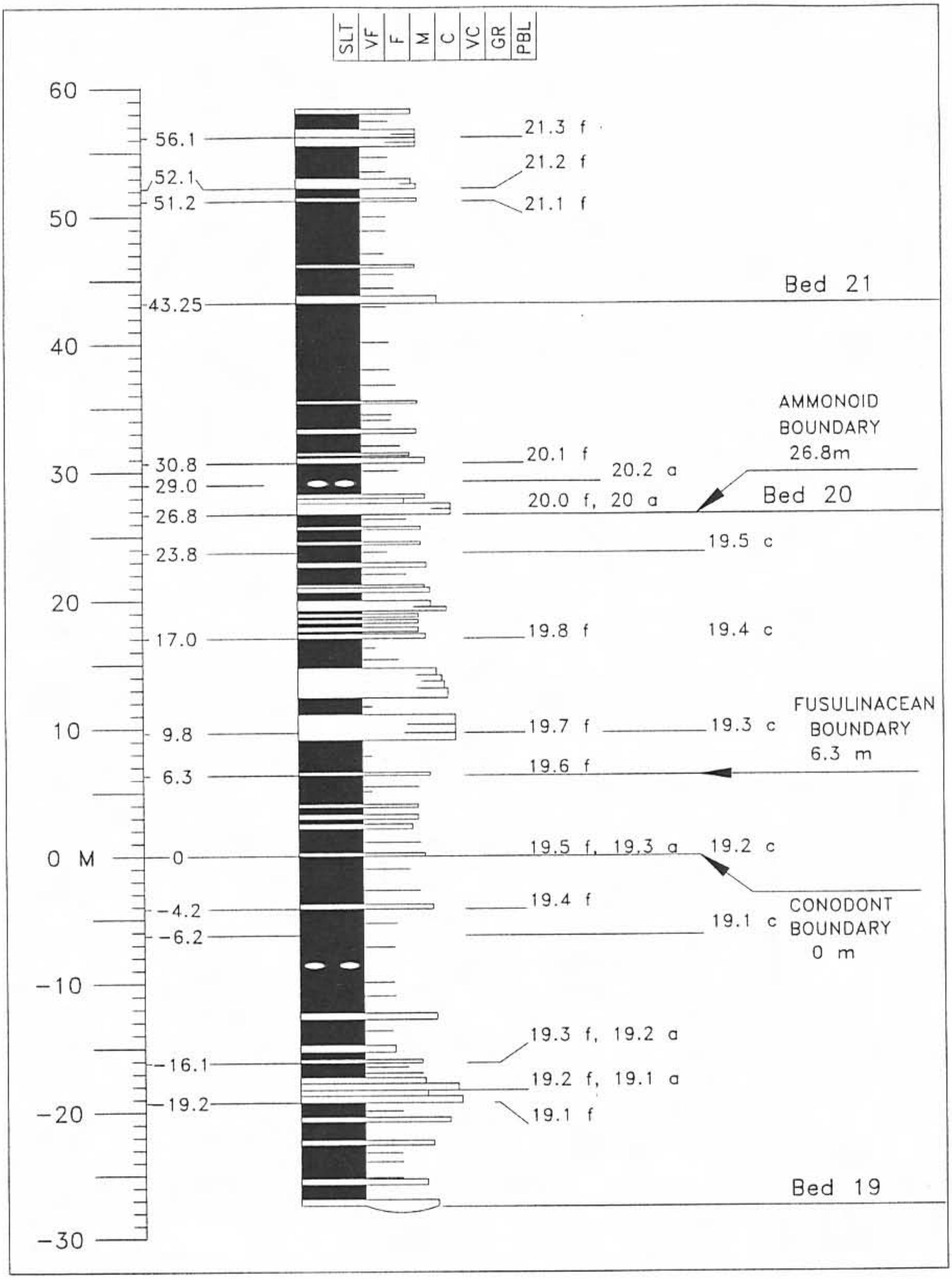

Figure 2. Stratigraphic column of beds 19 and 20 at Aidaralash Creek. Indicated are contacts of beds 19-20, 20-21; and positions of the proposed Carboniferous/Permian boundaries based on conodonts, fusulinaceans and ammonoids. Bed numbers (e.g, 19) and subdivisions (e.g., 19.5 f) represent designations widely used in recent Soviet/Russian literature e.g., Chuvashov et al. (1993), Bogoslovkaya et al. (1995) and in the Guidebook for the excursion to the southern Ural Mountains, (Permian Congress, Perm, 1991); "a", "f", "c", indicate ammonoid, fusulinid, and conodont occurrences, respectively. The zero meter mark is arbitrarily placed at the horizon marking the first appearance of the "isolated-nodular" morphotype, which developed from an advanced "non-isolated nodular" morphotype in the S. "wabaunsensis" chronocline.

undoubted value in correlation, there would be significant problems in defining the Carboniferous/Permian boundary on fusulinaceans:

1) fusulinaceans were benthic organisms, and their distribution is somewhat provincial;
2) most were confined to shallow water carbonate facies, but they may have been redeposited in deeper turbidite facies; reworking from older deposits, although not documented for Aidaralash, cannot be excluded;
3) taxonomy is in a state of flux, and regional interpretations differ substantially.

Conodont biostratigraphy

A number of Russian specialists have examined conodont successions from Aidaralash as well as the basinal shales at Usolka, and a summary analysis was provided by Davydov et al. (1992). More detailed investigations have followed, including refined sampling of the Carboniferous/Permian boundary interval (Chernykh and Ritter, 1994). These latter authors collected a total of 53 samples from all suitable horizons within Beds 3 through 37 of the Aidaralash section, and reported many horizons yielding well preserved conodont elements with abundances ranging from 5 to over 100 specimens per kilogram. Small numbers of reworked Late Devonian and Moscovian conodont elements were noted in some faunas, generally recognizable on preservation as well as identity. Conodont Alteration Index is 2 or less.

Conodont faunas throughout the sampled interval at Aidaralash, Beds 3 through 37, are dominated by Pa elements of *Streptognathodus*. The Carboniferous/Permian boundary is defined (Chernykh and Ritter, 1994) by the first appearance of the "isolated nodular" morphotype, which developed from "non-isolated" nodular *S. wabaunsensis*. This arbitrarily chosen point in the evolutionary continuum of ornamented streptognathodids (*S. wabaunsensis* chronocline) lies 27 m above the base of Bed 19 at Aidaralash, and can be recognized readily elsewhere. In the basinal shales and carbonates at Usolka, it occurs in the lower part of Bed 16 (Chuvashov et al., 1990). In the cyclic succession of the American Midcontinent it first occurs in the Glenrock Limestone Member of the Red Eagle Limestone (Chernykh and Ritter, 1994; Ritter, in press; Wardlaw, Boardman, and Nestell, in press). Some nomenclatorial problems have yet to be resolved, but it appears that specific names proposed in the two cited papers now in press will clarify the taxonomy. Although not recognized at Aidaralash, the first occurrence of *S. nodulinearis* in Kansas and Usolka nearly coincides with the first occurrence of the "isolated-nodular" morphotype, making it useful as an accessory indicator of the boundary. It should be emphasized that although an arbitrarily selected point within a single conodont chronocline is being chosen for definition of the boundary, every other line of evidence (biological, sedimentological, geochemical, geophysical) should and actually is being utilized to effect correlation to that point.

Summary and formal proposal

In summary, Aidaralash Creek fulfills, better than any other known section, all of the basic requirements for effective service as GSSP for the base of the Permian System. It enjoys historic priority and excels in overall scientific merit; exposures and accessibility are adequate, and state of knowledge for relevant geologic characteristics is advanced. Evidence from sedimentology and analysis of the conodont chronomorphocline confirm that there is no significant hiatus in sedimentation across the boundary interval. Redistribution in space of fusulinaceans is probable, and advantageous, but with the exception of a small percentage of conodont specimens, there is no evidence of reworking in time. Conodonts provide a chronomorphocline across the boundary that serves for definition, and similar clines probably occur in the fusulinaceans. For practical purposes, historic boundaries for ammonoids and fusulinaceans are coincident with that proposed in the conodont definition of the Carboniferous/Permian boundary.

For the reasons cited, the first occurrence of the "isolated-nodular"morphotype of the *Streptognathodus "wabaunsensis"* conodont chronocline, 27 m above the base of Bed 19, Aidaralash Creek, northern Kazakhstan, is hereby proposed as GSSP for the base of the Permian System. Concurrent with submittal of the present manuscript, Voting Members of the Carboniferous-Permian Boundary Working Group will be invited to "Approve" or "Disapprove" the proposal. If the required 60% of those voting approve, the proposal will be forwarded through appropriate International Commission on Stratigraphy channels to the International Union of Geological Sciences and eventual ratification at the 1996 International Geological Congress. Sections adjacent to Aidaralash in the south Urals, such as Usolka, will serve as subsidiary references. However, ICS Guidelines (Cowie et al., 1986) discourage formal proposal of parastratotypes.

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Vladimir I. Davydov
All Russian Geological Institute (VSEGEI)
Sredny pr. 74, 199026
St. Petersburg, Russia

Brian F. Glenister
Department of Geology
The University of Iowa
Iowa City, Iowa 52242, USA

Claude Spinosa
Department of Geosciences
Boise State University
Boise, Idaho 83725, USA

Scott M. Ritter
Department of Geology
Brigham Young University
Provo, Utah 84602, USA

V.V. Chernykh
Uralian Branch Russian Academy of Science
Pochtovyi, Per. 7, 620219
Ekaterinburg, Russia

B. R. Wardlaw
U.S. Geological Survey
MS 970 National Center
Reston, VA 22092, USA

W. S. Snyder
Department of Geosciences
Boise State University
Boise, Idaho 83725, USA

4. THE CARBONIFEROUS/PERMIAN BOUNDARY IN SOUTH CHINA (BASED ON MATERIAL COLLECTED DURING THE FIELD EXCURSION OF THE INTERNATIONAL SYMPOSIUM ON PERMIAN STRATIGRAPHY, ENVIRONMENTS AND RESOURCES, GUIYANG, CHINA, AUGUST, 1994)

During the summer of 1994, along with the other participants of the symposium, I took part in the excursion to the key-sections of S. China, which are deservedly placed among the best Carboniferous and Permian sections of the world. We managed to visit and collect samples from a number of excellent sections. This report contains the first results of studying the samples from the Houchang section.

We are interested in the Chinese sections because they are of high quality and because of comments made in 1985 within the program "Permian scale of the Tethys". Because of financial difficulties this program has not been completed, but nevertheless we are glad to use any possibility to develop the program. I hope, in the future we will be able to inform you of the results of the study of all the material collected by us.

The problem of the Carboniferous/Permian boundary in South China has a long history and is based on a number of quite different factors. Traditionally from the end of the last century the Carboniferous/Permian boundary was related to the transgressive and angular unconformity at the base of Chihsia series. R.I. Murchisson established the Carboniferous/Permian boundary in the Urals approximately at the same level (the base of the Kungurian). But whereas the boundary in China was stable, the boundary in the Urals was gradually lowered to the base of the Asselian, where it was officially fixed in the 1950's and is drawn at this level now. Great efforts have been exerted in China in the last decades to bring together our points of view concerning the location of the boundary. A lot of informative papers with the detailed descriptions of the sections and fauna, including fusulinids, were published. However, our points of view on the problem still differ, mainly due to different understanding of the fusulinid taxonomy and systematics. In my view, even in different sections of China the Carboniferous/Permian boundary is drawn at different levels.

The criteria for drawing the boundary at the first occurrence of subspherical schwagerin-like fusulinids are practically worked out; the possibility of homeomorphic origin of such forms at different time being not taken into consideration. Thus, schwagerin-like forms originally considered exclusively Permian, are now known to occur in the Upper Kasimovian of Spitsbergen (Nilsson, Davydov, 1993), Lower Gzhelian of Donets Basin (Davydov, 1990), Japan (Watanabe, 1991), Darvas (Leven, Scherbovisch, 1978, Davydov, 1984) and Upper Gzhelian (everywhere in *Ultradaixina bosbytauensis-Schwagerina robusta* Zone). Placing the Carboniferous/Permian boundary by first occurrence of schwagerin-like forms will cause (and causes now) its being asynchronous in different sections. The studied material from the Houchang section shows this to a certain degree.

The Carboniferous/Permian boundary in the Houchan section can be drawn by fusulinids in accordance with the criteria worked out in the stratotype area. I hope that the results given below will serve to provide a better understanding between Russian and Chinese specialists.

The Houchang section has already been the subject of our study (Davydov et al., 1994), when in 1987 Dr. Leven was kindly given the opportunity by Madame Dong to look through the thin-sections from this section. The present study of the samples from the Houchang section enable us to clarify and develop the previously made conclusions.

Due to lack of time we did not manage to sample the boundary beds thoroughly enough. Six samples were collected from the boundary beds: 7, 13, 14, base of bed 16 (16-0), 4.5 m from base of bed 16 (16-4), 8.5 m from base of bed 16 (16-8).

The bed numbers correspond to those from the description of the section in the excursion's guide-book (1994) and Xiao's et al. monograph (1986 p. 14-22). The following species are recorded in the stratigraphic succession from bottom to top:

bed 7 - *Schubertella pseudogiraudi* Sheng, *Sch. subkingi* Putrja, *Quasifusulina compacta* Lee, *Triticites longissima* Lin, Xiao et Dong, *Rauserites* aff. *variabilis* Rosovskaya, *R. shikhanensis* Rosovskaya, *Rugosofusulina* sp. nov.

bed 13 - *Quasifusulina* cf. *longissima* (Moeller), *Q.*

elongata Shlykova, *Rauserites paraturgidus* Xia, *R. praemontiparus* (Zhou, Sheng et Wang), *R. monhonensis* Zheng et Bao, *Schellwienia huanglienhsiaensis* (Chen).

bed 14 - *Schwagerina parakrotowi* (Xia), *Schw. copiosa* (Xia), *Schw.* aff. *pseudokrotowi* (Sjomina), *Zigarella* ex gr. *elegans* (Bensh).

16-0 - *Boultonia cheni* Ho, *Rugosochusenella qunlingensis* Xia, *R. pseudogregaria* (Bensh), *Ultradaixina cheni* (Kahler et Kahler), *Schwagerina* aff. *crassa* (Rauser), *Schw. quasichenxiensis* (Xia), *Zigarella pseudoanderssoni* (Sjomina), *Z.* aff. *asherinensis* (Sjomina).

16-4 - *Quasifusulina cayeuxi* (Deprat), *Rugosofusulina maturusa* Chen et Zhang, *Ultradaixina* ex gr. *cheni* (Kahler et Kahler), *U.* sp. nov., *Likharevites paranitidus auritus* Davydov, *L.* aff. *tinvenkiangi* (Lee), *L. bianpingensis* (Zhang et Dong), *Zigarella huangshigonensis* (Zhang et Xia), Z. aff. *anderssoni* (Schellwien), *Schwagerina* aff. *subnathorsthy* (Lee), *Schw. taitouensis* (Zhang et Xia), *Rugosochusenella paragregaria* (Rauser), *R. hutiensis* (Chen), *R. bicornis* (Chang), *R. shagoniensis* (Davydov).

16-8 - *Sphaeroschwagerina kolvica* (Scherbovich), *S.* ex gr. *fusiformis* (Krotow sensu Scherbovich), *S.* ex gr. *sphaerica* (sp. nov.), *Schwagerina* ex gr. *robusta* (Rauser), *Schw. machalensis* (Zhang), *Schw.* aff. *robustissima* (Sjomina), *Schw.* ex gr. *subnathorsthy* (Lee), *Ocelli* (Chen), *O.* aff. *hutiensis* Davydov, *O.* aff. *constans* (Han et Zhao), *Rugosochusenella* aff. *qinlingensis* Xia, *R.* aff. *simplex* (Z. Mikhailova).

Fusulinid assemblages in the boundary deposits in the Houchang section are characterized by considerable endemism, hampering correlation. Nevertheless among fusulinids there are species widespread in the stratotype area.

Bed 7 can with certainty be correlated with the lower part of the Gzhelian thanks to the presence of *Rauserites variabilis* Ros., *R. shikhanensis* Ros., and rather primitive *Rugosofusulina*. Analogues of the fusulinid *Jigulites jigulensis* Zone lying between beds 7 and 13 were not sampled.

All the rest of the sampled beds of the Houchang section can be fairly precisely correlated with the beds of the Aidaralash section, proposed as the Carboniferous/Permian Global Boundary Stratotype Section and Point GSSP. Owing to the unique location of the Aidaralash section at the junction of the stratotype and Tethyan areas, Gzhelian and Asselian fusulinid assemblages contain not only East European taxa (the Urals, Russian Platform) but ones characteristic of Tethian sections (*Dutkevitchia, Likharevites, Ultradaixina*, etc.).

Fusulinids from bed 13 are difficult to define. Chinese species are dominant. The occurrence of *Schellwienia huanglienhsiaensis* enables one to correlate bed 13 of the Houchang section and beds 1-6 of the Aidaralash section, because *Schellwienia* in both localities is of the same level of evolution. However, there is a slight possibility that bed 13 of the Houchang section is slightly older than beds 1-6 of the Aidaralash section.

Bed 14 of the Houchang section according to the occurrence of *Schwagerina* aff. *pseudokrotowi* and Z. ex gr. *elegans*, and also other *Schwagerina* species similar to *Schw. robusta*, can be approximately correlated with beds 10-13 of the Aidaralash section (Davydov et al., 1992), characterized by the first occurrence of *Schwagerina* ex gr. *robusta*.

Bed 16-0 is precisely correlated with beds 14-17 of the Aidaralash section. this is demonstrated by the occurrence of *Ultradaixina cheni* similar to *U. bosbytauensis*, occurring in beds 14-16 of the Aidaralash section. At this very level in both sections is the earliest occurrence of *Rugosochusenella*, which is widespread in underlying beds. The first occurrence of *Boultonia cheni*, recorded in the *Ultradaixina bosbytauensis-Schwagerina robusta* Zone in the Donets Basin and Carnic Alps should be noted.

In bed 16-4 together with *Ultradaixina*, apparently represented by new species, *Likharevites paranitidus auritus* first occurs. This in South Fergana characterizes beds directly underlying the Asselian (Popov, Davydov, Kossovaya, 1989), nominative subspecies (*L. paranitidus paranitidus*), which occurs in beds 18-19 of the Aidaralash section. The epibole of *Likharevites* lies in beds 18-19/5 in the Aidaralash section.

In bed 16-8 in the Houchang section *Sphaeroschwagerina*, such as *S. kolvica*, *S.* ex gr. *fusuformis*, *S.* ex gr. *sphaerica* first occur. These forms are most similar to the corresponding fusulinids from beds 20-21 in the Aidaralash section, i.e., from the very base of *Sphaeroschwagerina vulgaris aktjybensis-S. fusuformis* Zone. It is remarkable that in both sections at this level *S.* ex. gr. *sphaerica* occurs. It is known that typical representatives of *S. spaherica* characterize the upper and to a lesser degree the middle part of the Asselian. Form *S.* ex gr. *sphaerica* is attributed to this species only because of external resemblance of the shape of the shell, however they are much more primitive than typical *S. sphaerica*: the shell is 2 to 3 times less in size, has smaller number of volutions, and septa are fluted throughout shell. Typical *S. sphaerica* first occurs in the Aidaralash section in bed 29.

The results summarized above enable one to suppose that the Carboniferous/Permian boundary in the Houchang section should be placed between beds 16-4 and 16-8. More detailed study of morphology and taxonomy of fusulinids in boundary beds is needed to work out the criteria of drawing the boundary by the local fusulinid species.

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V. Davydov
VSEGI, St. Petersburg, Russia

5. LOWER PERMIAN OF THE CARNIC ALPS (AUSTRIA): STATE OF THE ART AND CURRENT RESEARCH

Upper Carboniferous and Lower Permian deposits of the Carnic Alps (Austria/Italy), represented by the *Auernig Group*, the *Rattendorf Group* and the *Trogkofel Group*, have been intensively studied with respect to facies, stratigraphy and various paleontological criteria:

- Biostratigraphy and systematics of fusulinids (F. Kahler)
- Biostratigraphy and systematics of plants (A. Fritz)
- Calcareous algae, paleoecology and reef evolution (W. Homann, E. Flügel)
- Microfacies and depositional patterns (E. Flügel, K. Krainer, C. Venturini)

The results of these studies are of major importance for understanding cyclothem development, reef evolution, fusulinid-based interregional correlations, Carboniferous/Permian boundary problems and Upper Paleozoic biozonation patterns.

Current studies of the 'Erlangen Pangaea Group' concern

- Types and controls on cyclic depositional patterns (cf. paper by E. Samankassou)
- Origin and development of reef mound structures (cf. paper by W. Kraft)
- Biodiversity and stratigraphical importance of Late Paleozoic ostracods (cf. paper by B. Fohrer)
- Biostratigraphy and correlation patterns based on the combined use of fusulinids and conodonts (cf. paper by H. Forke).

These studies are part of the ''Pangaea Project' of the Global Sedimentary Geology Program.

Erik Flügel and Franz Kahler
Institute of Paleontology,
University Erlangen-Nürnberg
Loewenichstrabe 28, D-91054
Erlangen, Germany

6. CYCLIC SEDIMENTATION PATTERNS OF THE LOWER PSEUDOSCHWAGERINA LIMESTONE (LATEST CARBONIFEROUS, CARNIC ALPS)

The existence of Late Paleozoic depositional in the Auernig Group in the Naßfeld area ("Auernig Cycles" of F. Kahler) was recognized as early as early as the 19th century. Later studies by Homann (1969) found sedimentological and paleontological evidence for cycles in the Lower Pseudoschwagerine Limestone (LPL). Reference has been made to these cycles in various studies but their patterns and controls have never been the main topic of discussion. This paper is the first one devoted specifically to this topic and provides the he first detailed description cyclothems in the LPL.

Each cyclothem is composed of the following sequence stratigraphic units in terms of glacioeustatic scheme:

- Lowstand System (LST 1, few m), composed of fine-grained sandstones with ooids and coated grains;
- Transgressive System 1 (TST 1, 0.4-1 m) with shales and bioclastic limestones (fusulinid and smaller foraminifera as predominant components). The TST 1 represents the base for the algal growth in TST 2;
- Transgressive System 2 (TST 2) characterized by abundant growth of algae, contributing to the buildup of massive reef mounds with a thickness of up to 20 m. The biota is almost monospecific and consists of *Anthracoporella* in growth position. The intermound facies is more diverse, with *Epimastopora*, Fusulinids, smaller foraminifera, *Tubiphytes* and fragments of *Anthracoporella*.

- Maximum Flooding Surface (MFS)/Highstand System (HS) is marked by the end of algal growth and the drowning of reef mounds. The HS is characterized by dark deeper water even- bedded cherty limestones, containing sponge spicules, brachiopods, cephalopods as well as fragments of shallow-water phylloid algae resulting from highstand shedding.
- Regressive System Tract (RST) composed of bioclastic limestones (mainly reworked material from the HST), shales, siltstones and fine-grained sandstones.

This cyclothem model differs from the classical Midcontinent cyclothems by the facies succession and by the absence of subaerial exposure.

The rhythmic repetition of these cyclothems and the rapid facies changes infer high-frequency sea-level fluctuations. The occurrence of cyclothems at this time coincides with the glaciation of Gondwana; the duration of one cyclothem lies within the Milankovitch eccentricity band. The wide distribution of the cyclothems at this time (Carnic Alps, Karawanken Mountains, Cantabrian Mountains, US Midcontinent) cannot be explained by autogenic processes alone. We favour a glacioeustatic control.

Elias Samankassou
Institute of Paleontology
Univeristy Erlangen-Nürnberg
Loewenichstrabe 28, D-91054
Erlangen, Germany

7. UPPERMOST CARBONIFEROUS MOUNDS IN THE CARNIC ALPS (AUSTRIA)

Mounds of different composition are common in the Lower Pseudoschwagerina Limestone (LPL) of the Rattendorf Alm area within different stratigraphical levels. Mounds in the lowermost parts correspond to mud mounds. Most mounds, however are reef mounds characterized by a monospecific dasyclad algal association. Previous studies were focused on the role of the dasyclad alga *Anthracoporella* (= *An.*) as sediment baffler as well as on microfacies. Current studies reveal strong microbial controls on mound development. Several mound types can be distinguished:

(1) The *An.* mounds exhibit a vertical succession of basal bioturbated wackestones overlain by *An.* boundstones of the mound core. The algal thalli are either connected by bridge-like thrombolitic structures or embedded in milky porcellaneous micrite (interpreted as thrombolite as well). Voids within this algal-thrombolitic framework are basally filled with fine-grained peloidal or bioclastic sediment. The mound core is overlain by bioclastic *An.* wacke- and packstones. Mounds of the lower part of the LPL are of variable composition and considerably smaller than the mounds of the upper part of the LPL.

(2) Dominating biogenic constituents are thrombolites, agglutinated worm tubes and *Tubiphtyes*, together with varying amounts of phylloid or dasyclad algae, bryozoans and 'calcisponges'. A well-exposed section exhibits three vertically zoned, small and stacked mounds, separated and interfingering with bedded crinoidal packstones of a high-energy channel environment. Basal bioturbated bioclastic wackestones are overlain by mud-dominated bindstones of the mound core with whole specimens of *Epimastopora kansaensis* and fenestellid bryozoans. Thrombolites and agglutinated worm tubes form a network between these biogenic constituents. The upper part of the mounds consists of thrombolite/worm bindstones with large brecciation voids, partly filled with peloidal sediment. Skeletal mound-building organisms are absent. Mound development was terminated by the deposition of echinoderm packstones.

(3) Lenticular mounds (with a height up to 0.5 m), formed predominantly by a network of *Tubiphytes* associated with *Vermiporella*, *Archaeolithophyllum lamellosum* and agglutinated worm tubes, occur within fine-grained siliciclastics and echinoderm packstones.

Wolfram Kraft
Institute of Paleontology
University Erlangen-Nürnberg
Loewenichstrabe 28, D-91054
Erlangen, Germany

8. UPPER CARBONIFEROUS AND LOWER PERMIAN OSTRACODS OF THE CARNIC ALPS (AUSTRIA): SYSTEMATICS, BIOSTRATIGRAPHY AND PALEOECOLOGY

Nine ostracod faunas from Upper Carboniferous and Lower Permian strata of the Carnic Alps (Austria/Italy) were investigated. The silicified material (about 12500 individuals) was dissolved by formic acid from limestones of the Auernig Group and Rattendorf Group. The ostracods belong to 81 species of the orders Podocopida, Palaeocopida and Myodocopida.

Microfacies analysis and the examination of ostracod assemblages indicate distinct shallow water environments. One of the two main types of the Auernig Group microfacies is algal wackestone consisting of the dasycladacean *Anthracoporella spectabilis*. Red algae (*Archaeolithophyllum*) and phylloid algae are also common. The associated fauna exhibits a low diversity, only some encrusting organisms such as *Tubiphytes* or bryozoans, foraminifera and a few ostracods. The other main type is bioclastic wacke- or packstone with a very highly diverse fauna composed of algae, bryozoans, brachiopods, smaller foraminifera, fusulinids, gastropods and ostracods. There are additional facies types in the Lower Pseudoschwagerina Formation and the Grenzland Formation. For example, a facies type dominated by a highly diverse crust and gastropod fauna or the *Ramovsia* facies composed of many fragments of *Ramovsia*, a problematic encrusting organism, smaller foraminifera and fusulinds.

The biostratigraphic value of the faunas is quite different.

It is of great value when it is possible to compare similar environments, but of little value, for example, in the crusts/gastropod milieu with its highly specialized ostracod fauna. So we have to differentiate between ecological and biostratigraphical aspects.

The most important group of ostracods for biostratigraphical purposes are the members of the familiy Hollinellidae. A widespread species in the upper part of the Auernig Group is *Hollinella (Hollinella) ulrichi*, which is absent in the Rattendorf Group. In the lower part of the Auernig Group this species is replaced by *Hollinella (Keslingella)* aff. *radiata*. A long ranging species is *Gortanella regina*, missing only in the Lower Pseudoschwagerina Formation because of this special gastropod/crust milieu. *Hollinella (Hollinella)* aff. *cristinae* is limited to the Rattendorf Group.

Beate Fohrer
Institute of Paleontology,
University Erlangen—Nürnberg
Loewenichstrabe 28, D-91054
Erlangen, Germany

9. THE CARBONIFEROUS/PERMIAN BOUNDARY IN THE CARNIC ALPS (AUSTRIA): ADDITIONAL OBSERVATIONS ON CORRELATING FUSULINID ZONES IN THE STRATOTYPE SECTIONS OF THE SOUTHERN URALS AND THE DARVAZ REGION WITH THE SCHULTERKOFEL SECTION.

Sedimentological and paleontological data about the Schulterkofel Section (Lower *Pseudoschwagerina* Limestone) were provided by Kahler and Krainer (1993a, b). This paper more closely examines the correlation of the fusulinid zones in the stratotype sections of the Southern Urals and the Darvaz region with the occurrence of fusulinids in the Schulterkofel Section (Table 1).

A detailed description of the fusulinid fauna and the sedimentology of the Schulterkofel Section is in preparation together with Prof. Kahler and Dr. Krainer (sedimentology).

The history of the Carboniferous/Permian boundary in Russia

A historical overview of the development of the Carboniferous/Permian boundary in Russia has often been given (e.g., Davydov, 1993). Only a few aspects, which are important in the following discussion, will be focussed on.

When Ruzhenzev (1954) established the Asselian stage (stratotype: Aidaralasch creek), he placed the lower boundary where a change in ammonoid fauna takes place and the first *Schwagerina* (in the Russian sense) occur. While studying fusulinids in the type section of the Orenburgian stage (near the village of Nikolskoe), Pnev et al. (1975) extended the Zone of *Schwagerina vulgaris - Schw. fusiformis* down to the beds of the Orenburgian. Other authors placed their boundary between the fusulinid zones of *Schwagerina vulgaris - Schw. fusiformis* and the underlying *Daixina sokensis* zone at different horizons in the stratotype sections (Davidov and Popov, 1986; Isakova, 1986). It was widely accepted at this time that the upper part of the Orenburgian type section had the same age as the lower part of the Asselian type section. DAVIDOV & POPOV (1986) restudied the stratotype sections of the Orenburgian and Asselian to clarify the correlations of ammonoid and fusulinid zones. They rehabilitated the opinion of Ruzhenzev and established the *Daixina bosbytauensis - D. robusta* zone, which corresponds to the bottom part of the *Schwagerina vulgaris - Schw. fusiformis* zone sensu Pnev (1975), or the upper part of the Orenburgian stage of Ruzhenzev.

The creation of this middle zone presents two possibilities of drawing the Carboniferous/Permian boundary (base of the *Daixina bosbytauensis - D. robusta* zone, or base of the *Schwagerina vulgaris - Schw. fusiformis* zone). Therefore, Leven (1986) discussed the following:

1. The faunal change of the fusulinids at the base of the *Daixina bosbytauensis - D. robusta* zone is more distinct than at the base of the *Schwagerina vulgaris - Schw. fusiformis* zone. The species of the *Daixina bosbytauensis - D. robusta* zone have more affinities to the species occurring in the Asselian.
2. The majority of species of the *Daixina bosbytauensis - D. robusta* zone extend into the *Schwagerina vulgaris - Schw. fusiformis* zone.
3. The genus *Schwagerina* is not a suitable marker for the Carboniferous/Permian boundary, because it rarely appeared in the *Schwagerina vulgaris - Schw. fusiformis* zone and often at different stratigraphic horizons. Chuvashov et al. (1993) emphasized that the index fossils of the *Schwagerina vulgaris - Schw. fusiformis* zone strongly depends on facies and are therefore sometimes absent.
4. On the other hand the Carboniferous/Permian boundary has been connected with the base of the *Schwagerina vulgaris - Schw. fusiformis* zone since Ruzhenzev established the Asselian.
5. The base of the *Schwagerina vulgaris - Schw. fusiformis* coincides approximately with the Pennsylvanian/Permian boundary of the American stratigraphy.
6. The major change in the ammonoid fauna took place between the genozones of *Shumardites-Vidrioceras* and *Svetlanoceras-Juresanites*. But there are some uncertainties about the correlation with the fusulinid zones amongst the Russian researchers. In the view of CHUVASHOV et al. (1993) the base of the latter correlates with the base of the *Schwagerina moelleri - Pseudofusulina fecunda* zone, whereas Davydov (1993) is of the opinion that it correlates with the *Schwagerina vulgaris - Schw. fusiformis* zone.

Schulterkofel Section	Carnic Alps	Darvaz (LEVEN & DAVYDOV, 1986)		Southern - Urals (DAVYDOV & POPOV, 1986)	
Grenzland Formation	"*Pseudoschwagerina*" *confinii* - *Pschw. extensa*	*Schwagerina moelleri*-*Pseudofus. fecunda*		*Schwagerina moelleri*-*Pseudofus. fecunda*	
Grenzland Formation		*Schwagerina vulgaris*-*Schw. fusiformis*		*Schwagerina vulgaris*-*Schw. fusiformis*	
gap	?				
Lower *Pseudoschwagerina* Lm.	"*Occidentoschwagerina alpina*" (megalospheric form) *Rugosofusulina* - (*Rugosochusenella*?)	*Daixina bosbytauensis*-*D. robusta*		*Daixina bosbytauensis*-*D. robusta*	
Lower *Pseudoschwagerina* Lm.		*Daixina sokensis*	*Pseudofusulina elegans*	*Daixina sokensis*	*Daixina vasylkovskyi*
Lower *Pseudoschwagerina* Lm.	*Ruzhenzevites parasolidus* - *Quasifusulina* - *Triticites*	*Daixina sokensis*	*Ruzhenzevites ferganensis*-*Pseudofusulina malkovskyi*	*Daixina sokensis*	*Daixina vasylkovskyi* / *Daixina enormis*
gap / Auernig - Group		*Daixina sokensis*	*Dutkevitchia dastarensis*	*Daixina sokensis*	*Daixina enormis*
Auernig - Group		*Schagonella implexa*		*Jigulites jigulensis*	*Daixina ruzhenzevi*

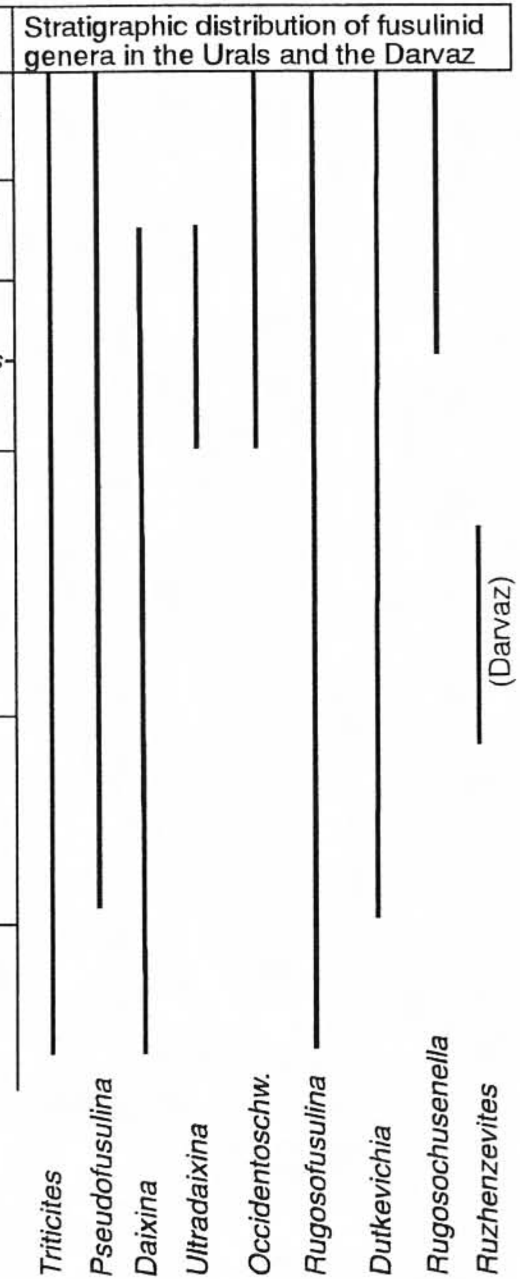

Table 1: Correlation of the standard fusulinid zones of the Southern Urals and the Darvaz sections with the distribution of fusulinids in the Schulterkofel Section (Carnic Alps).

At the present time the boundary in Russia is drawn in the Aidaralash type section in bed 19 at the base of the *Schwagerina vulgaris - Schw. fusiformis* zone. This approximately corresponds to the *Svetlanoceras-Juresanites* ammonoid genozone, or the first appearance of " isolated nodular streptognathodids" (Chernykh and Ritter, 1994).

Occidentoschwagerina alpina **Kahler and Kahler, 1941**
Occidentoschwagerina alpina was first described as *Pseudoschwagerina alpina* by Kahler and Kahler in 1941. Amongst the abundant megalospheric forms they also found one specimen, which in their opinion represents the microspheric form of the same species. As was usual, they designated the microspheric form as the holotype (Kahler and Kahler, 1941, pl. 10, fig. 1).

In 1959 Miklucho, Maklay established the genus *Occidentoschwagerina* (Type-species *Schwagerina fusulinoides* Schellwien, 1898) but without giving details, which species should be included in the genus.

Rauzer, Chernoussova (1960) tried to revise the genus *Schwagerina* and allied genera in establishing "form-groups". In the assembly of the genus *Occidentoschwagerina* she mentioned *Pseudoschwagerina alpina* Kahler and Kahler, 1941, but with the remark that only the B-form (holotype) should be assigned to this genus.

When Davydov (1982) erected the subgenus *Ultradaixina* (type-species: *Daixina galloway bosbytauensis* Bensh, 1962), he included the following species (cf. Davydov, 1986):

Schwagerina fusulinoides Schellwien, 1898 - but this is the type-species of the genus *Occidentoschwagerina*!
Pseudoschwagerina alpina Kahler and Kahler, 1941 (pars) - presumably the megalospheric forms.
Bosbytauella Isakova, 1982

and the newly described species as well:

Daixina (*Ultradaixina*) *postsokensis* Davydov, 1986
Daixina (*Ultradaixina*) *dashtidzhumica* Davydov, 1986

The subgenus *Bosbytauella* Isakova, 1982, which had the same type-species as *Ultradaixina* is included in the work of Davydov (1986) as a junior synonym. *Bosbytauella* Isakova, 1982 consists of the following species:

Pseudofusulina gallowayi Chen, 1943 [= *Occidentoschwagerina gallowayi* (Chen, 1934) in Leven 1967, Tab. 7/2, 3;
Daixina postgallowayi Bensh, 1962
Occidentoschwagerina postgalloway sarykolensis Leven, 1967
Occidentoschwagerina ? *deserta* Grozdilova, 1966
Daixina vasilkovskyi Bensh, 1962

In 1988 Davydov suggested a phylogenetic theory for the genus *Daixina* with the end member *Ultradaixina*. *Occidentoschwagerina* is here related to daixina-like *Schellwienia*, whereas in the opinion of Isakova (1982) *Occidentoschwagerina* evolve from *Daixina*. It should be said that the type-species of *Occidentoschwagerina*, described by SCHELLWIEN in 1898 from "red limestones of the Uggowitz breccia" (Austria), are probably Sakmarian in age. The holotype is a highly evolved species with a fusiform shape and a relatively large proloculus (~ 250 µm). The first whorl has a subspherical shape as is characteristic in the subgenus *Ultradaixina*. But it has a weak and more regularly septal fluting limited mostly to the lower part of the septum. In the axial section, therefore, round arches appeared in the lower half of the whorls.

In spite of all the uncertainties in the relationship, the megalospheric forms of *Occidentoschwagerina alpina* Kahler and Kahler, 1941 closely resemble *Daixina* (*Ultradaixina*) *bosbytauensis* Bensh, 1962 (see also Davydov, 1986; Isakova, 1986).

Correlation of the Schulterkofel section with the type-sections of the south Urals and the Darvaz region
The first appearance of *Occidentoschwagerina alpina* (megalospheric form sensu Kahler, 1941) is in the upper part (92-93 m above the base) of the Lower *Pseudoschwagerina* Limestone in the Schulterkofel Section (Kahler and Krainer, 1993a). All the species of the subgenus *Ultradaixina* are restricted to the *Daixina bosbytauensis - D. robusta* zone, both in the Southern Urals and the Darvaz sections, but can sometimes pass into the overlying *Schwagerina vulgaris - Schw. fusiformis* zone.

In the uppermost part of the Schulterkofel Section the fusulinid fauna consists mainly of the genus *Rugosofusulina* (*Rugosofusulina stabilis* Rauzer, Chernoussova, 1937, *Rugosofusulina latioralis* Rauzer, Chernoussova, 1937, *Rugosofusulina subundulata* Sjomina, 1971), which are common in Late Gzehlian, but also in Asselian rocks of the Urals and in the Darvaz region.

According to our new investigations, the lowest part of the Schulterkofel Section yield a fusulinid fauna with *Ruzhenzevites ferganensis* (Dutkevitch, 1939), *Ruzhenzevites parasolidus* (Bensh, 1962) (see also Kahler, 1983, pl. 8, fig. 2), *Quasifusulina* sp. and *Triticites* sp.. This conspicuous fauna is also described from the Darvaz region in the *Daixina sokensis* zone, where it is restricted to the middle part (*Ruzhenzevites ferganensis-Pseudofusulina malkovskyi* subzone) (Leven and Davydov, 1986). In the type-sections of the Urals this fauna is missing.

The Carboniferous/Permian boundary, as suggested by Kahler and Krainer (1993a, b), coincide approximately with the base of the *Daixina bosbytauensis - D. robusta* zone.

The base of the *Schwagerina vulgaris - Schw. fusiformis* zone is difficult to determine in the Carnic Alps, because the overlying Grenzland Formation consists of mainly siliciclastic deposits and fusulinid rich limestones are only found in some scattered outcrops. In addition, no type-section of the Grenzland Formation exists, where the whole formation and especially the lower part is exposed, because it is always tectonically disturbed.

The Carboniferous/Permian boundary, as preferred in the type sections by russian researchers (base of the *Schwagerina vulgaris - Schw. fusiformis* zone in bed 19/6 in the Aidaralasch section Davydov, 1993) can only therefore be traced in the Grenzland Formation by the occurrence of *"Pseudoschwagerina" confinii* and *Pseudoschwagerina extensa* Kahler and Kahler, 1937, which are probably already middle Asselian in age.

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Holger C. Forke
Institute of Paleontology
University Erlangen-Nürnberg
Loewenichstr. 28, D-91054
Erlangen, Germany

10. BIOSTRATIGRAPHY OF THE LOWER PERMIAN OF THE CARNIC ALPS (AUSTRIA): FUSULINID AND CONODONT DATA

Biostratigraphic subdivisions of the Lower Permian shelf sediments of the Carnic Alps have been based predominantly on fusulinid zones (Kahler, 1986), which allowed correlations with the Russian standard fusulinid zonation (Kahler, 1984; 1992). Shallow-marine limestones east of the Naßfeld area yielded the first small (10-20 specimen/kg) but stratigraphic significant conodont fauna encountered in Lower Permian sediments of the Carnic Alps. The conodonts (6 species) occur together with fusulinids (20 species), thus providing an opportunity for the correlation of conodont-based and fusulinid-based biostratigraphic zonations as well as comparisons with Lower Permian sections in Russia and U.S.A. (Table 2).

Hindeodus minutus (Ellison, 1941) (common)
Diplognathodus expansus (Perlmutter, 1975) (common)
Mesogondolella cf. *bisselli* (Clark and Behnken, 1971) (rare)
Sweetognathus inornatus Ritter, 1986 (abundant)
Sweetognathus aff. *whitei* (Rhodes, 1963) (abundant)

Sweetognathus inornatus and *Sw. whitei* is widely distributed in the Upper Wolfcampian of the U.S.A (Ritter, 1986).

In the Russian conodont zonation (Chernikh and Chuvashov, 1991) *Sweetognathus whitei* (which is probably a younger descendant of *Sw. inornatus*) was described from the Lower Artinsk (Burchev). The Sakmarian zonation is predominantly based on species of the genus *Mesogondolella*. Isakova (1989) described one specimen of *Sweetognathus* ex gr. *whitei* from the fusulinid zone *Pseudofusulina verneuili* (Sterlitamak).

The conodonts and fusulinids occur within red bioclastic wacke- to packstones at the "base of altitude 2004 m" (after Kahler, 1985) southwest of the Rudnig Alm. Beside common fusulinids, the limestones yield crinoids, bryozoans and phylloid algae. Large cm-sized oncoids composed of *Girvanella* and *Claracrusta* are conspicuous components of the limestones. Microfacies data indicate shallow-marine, subtidal conditions throughout the studied interval. A diagenetic origin is regarded as the main reason for the striking red color of the limestones.

Kahler and Kahler (1938) and Kahler (1985) described the fusulinid fauna from these red limestones and many new, oriented thin sections were made during my investigations, to directly correlate the conodonts and fusulinids in the same sample. The stratigraphically important species are the following:

Quasifusulina nimia Kochansky - Devidè, 1959
Pseudofusulinoides pusillus (Schellwien, 1898)
Pseudofusulina moelleri (Schellwien, 1908)
Paraschwagerina inflata Chang, 1963
Robustoschwagerina geyeri (Kahler and Kahler, 1938)

Kahler (1985) attributed a Sakmarian (Sterlitamakian) age to the red limestones, which were believed to belong to the Trogkofel stage.

Field studies indicate, that the red limestones are overlain by dark oncoid limestones containing abundant *Zellia heritschi* Kahler and Kahler 1937, the index fossil of the Upper *Pseudoschwagerina* Limestone (UPL) in the type section of the Zottachkopf (Kahler and Kahler, 1937), regarded as Late Asselian. *Zellia*, however, is also common in Sakmarian deposits of the Darvaz region (Leven and Scherbovich, 1980).

A siliciclastic-carbonatic sequence is exposed in the lower part of the succession, lithologically corresponding to the rocks of the Grenzland Formation. A fusulinid packstone within this sequence yields *Sphaeroschwagerina glomerosa* (Schwager 1883), the index fossil of the Late Asselian of Middle Asia (Bensh, 1972).

It seems more likely, therefore, that the red limestones containing the conodonts and fusulinids listed above are a part of the Upper *Pseudoschwagerina* Limestone, as indicated by the stratigraphic position between the Grenzland Formation and the overlying limestones with *Zellia*. Therefore the limestones with *Zellia* can no longer be regarded as Late Asselian in age but must be attributed to the Sakmarian stage of the Russian stratigraphic subdivision (Table 1).

The comprehensive study by the author of the biostratigraphy, correlation and microfacies of the Upper *Pseudoschwagerina* Limestone has been accepted by the Jahrb. Geol. B.-A. (Vienna) and will be published soon.

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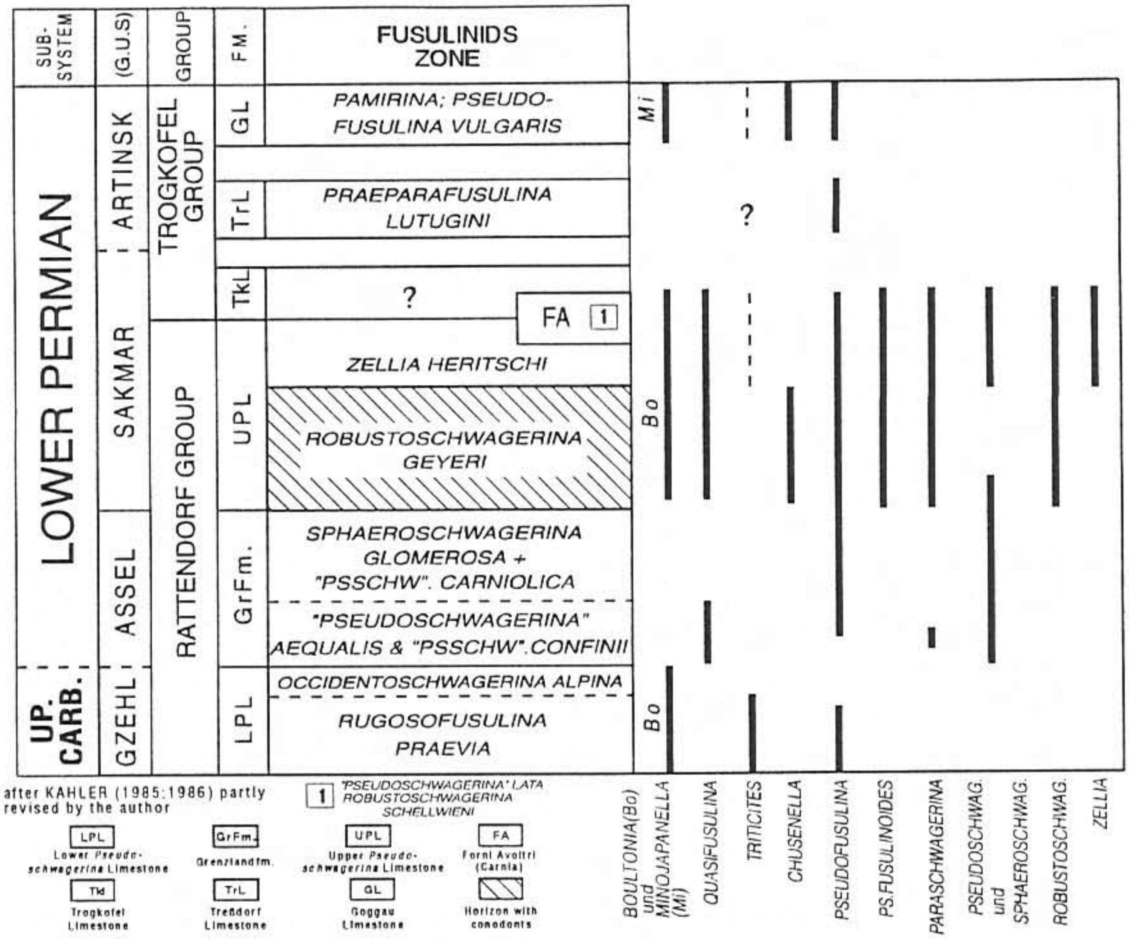

Table 1: Stratigraphic distribution of important fusulinid genera in the Early Permian of the Carnic Alps.

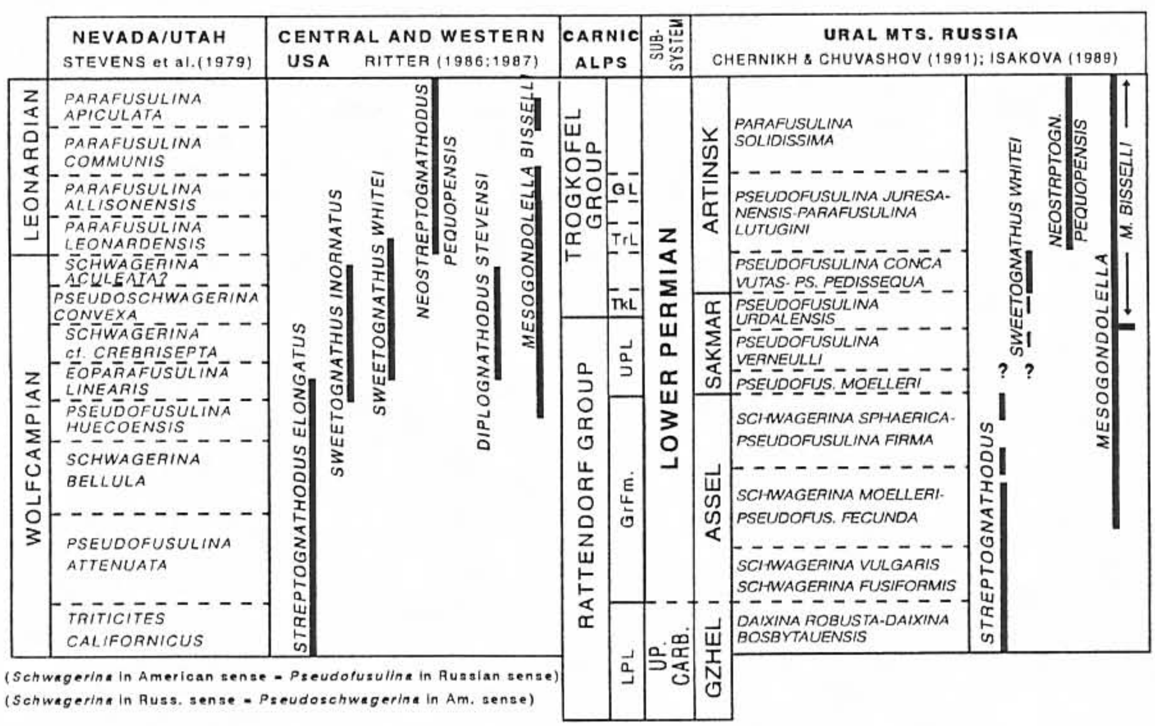

Table 2: Tentative correlation of fusulinids and conodonts in the U.S.A., the Carnic Alps and Russia (see Table 1 for Abbr.).

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Holger C. Forke
Institute of Paleontology
University Erlangen-Nürnberg
Loewenichstr. 28, D-91054 Erlangen, Germany

11. EARLY AND MIDDLE PERMIAN REGRESSION AND TRANSGRESSION IN SOUTH CHINA

The Artinskian regression, associated with a biota crisis, is one of the most prominent events in Permian history of the Tethys (Leven, 1994). The well developed Sakmarian, Artinskian and Chihsian marine deposits and faunas in South China permit us to learn more about the regression and subsequent transgression than is possible in other areas.

1. The regression began exactly in the latest Sakmarian, not in the Artinskian (Yahtashian) as Leven suggested. In Nanjing area, the Asselian and Sakmarian consist of alternations of white wackestone, packstone and dark gray wackestone, lime-mudstone. A shift from white limestone to dark gray exhibits a local regression, judging from paleo-karst developed on the upper surface of the dark gray limestone. The last change from white to dark gray, associated with the increase of argillaceous material, occurs slightly below the extinction point of *Sphaeroschwagerina* in the Chuanshan Formation.
2. The Early Artinskian is still a period of regression in South China. The regressive sequence, which is composed of dark gray wackestone, lime-mudstone interbedded with argillaceous wackestone, continues into the top part of the Chuanshan Formation above the *Sphaeroschwagerina* horizon; it ends at the unconformity surface between the Chihsia Formation and Chuanshan Formation in the middle and east part of South China. Fusulinid *Schwagerina* assemblage is characterized by *Schwagerina cushmani, S. tschernyschewi, Eoparafusulina* and *Darvasites* (Zhou, 1982; Zhang, 1983; Lin, 1985; Wu et al., 1986; Qing et al., 1992). The first occurrence of *Darvasites* in the base of *Pamirina darvasica* Zone in Yangchang section in Guizhou indicates an Artinskian age for this fusulinid assemblage. In the southern part of Hunan and Leiben of Guangxi a *Staffella* assemblage occurs between *Schwagerina* assemblage and unconformity surface, this *Staffella* assemblage is missing in the Nanjing area.
3. The sea level reaches its major low stand in the middle Artinskian, not in the earliest and latest Artinskian as Ross and Ross (1994) suggested. A shift from shoal facies to intertidal shell facies took place in middle Artinskian in the platform margin area where shell beds and blue and green algae bed developed in the middle part of *Pamirina* Zone (Xiao et al., 1986). Correspondingly, a large amount of terrigenous material was transported over the platform margin and deposited in the trough area at this level in South Guizhou and Northwest Guangxi.
4. The subsequent transgression extended for a long period from latest Artinskian to the middle Chihsian in South China. The lithofacies return to shoal grainstone and packstone facies in the upper part of the *Pamirina* Zone in the platform margin and terrigenous material decreases in this level in the trough area. This marks the beginning of the transgression. The distribution of *Chalaroschwagerina* in western Guangxi, eastern Yunnan and southern Guizhou suggests the sea was restricted in those areas. The transgression accelerates in the earliest Chihsian when eastern Guangxi, southern and central Hunan, Jiangxi, Zhejiang and Jiangsu were submerged by the sea. Two facies were recognized, one is open platform or trough limestone facies with the fusulinid *Brevaxina* assemblage in western Guangxi, southern Guizhou and eastern Yunnan, the other is restricted platform or littoral alternation of limestone and mudstone facies with the fusulinid *Staffella, Schwagerina* and *Schubertella*, bryozoan *Fenestella*, brachiopod *Athyris* and ostrocode *Bairdia*. At the *Misellina claudiae* level, the littoral mudstone and marl facies with ostracodes, brachiopods, bryozoan and nonfusulinid foraminifera shift landward to northern Guizhou, Sichuan Basin, northwestern Hunan and western Hubei. All other parts of South China become an open environment with the fusulinid *Misellina* assemblage. At the *Cancellina* level most part of South

China submerged and diverge into two environments. One is open platform with fusulinids *Cancellina*, *Armenina* and *Verbeekina* in western Guangxi, southern Guizhou and eastern Yunnan, and the other becomes a restricted sea with fusulinids *Nankinella* and *Staffella* in other parts of South China.

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Zhu Zili
Nanjing Institute of
Geology and Palaeontology
Academia SinicaChi-Ming Ssu
Nanjing 210008, China

12. UPPER PERMIAN CONODONT STANDARD ZONATION

Lopingian Series

The concept of the upper Permian is quite different. The traditional concept of Chinese geologists for the Upper Permian includes only two stages: The Wuchiapingian and Changhsingian. Jin et al. (1994a) has proposed an operational scheme of Permian choronostratigraphy at the Guiyang meeting. This scheme is very debateable, and many comments have been proposed (Leven, 1994; Bogoslavaskaya and Leonova, 1994; Davydov, 1994) in Permophiles 25. A revised operational scheme of Permian choronostratigraphy has also been proposed by Jin et al. (1994b), in which Upper Permian consists of two subseries: the Guadalupian and Lopingian. Chronostratigraphic subdivision of the Permian system will continue to be disputed among geologists. The Upper Permian, the Lopingian Series, has traditionally been subdivided into the Wuchiapingian and Changhsingian in China, and this usage is maintained in this paper, it does not imply disagreement with the revised operational scheme of Permian chronostratigraphy.

The upper limit of the Lopingian, known also as a boundary between Permian and Triassic, should have been subject to study at a highly elaborate level. The problem has been well solved based on the study of the Zhongxin Dadui section at Meishan (Wang, 1994a, b). The Permian/Triassic biostratigraphic boundary is defined at the first appearance of *Hindeodus parvus* Morphotype[1]. It falls within the boundary bed 2 (=mixed bed 2 of Sheng et al., 1984), exactly at the base of AEL882-3 (Wang, 1994a, b). Wang recommended that the Zhongxin Dadui section and its base of AEL882-3 should be GSSP of Permian/Triassic boundary (Wang, 1994a, b). Yin, H.F. concluded at the Guiyang meeting that "the Permian—Triassic boundary provides excellent combination of biostratigraphic, chemostratigraphic and eventostratigraphic criteria necessary for its delineation", he places the Permian/Triassic boundary at the base of so-called "transitional bed", i.e., between bed 25 and bed 26 at the section D of Meishan. His conclusion was not accepted at the Guiyang meeting (August, 1994). After the meeting, Yin and his colleagues have accepted the results made by Wang (1994a, June, 1994b, August). They draw the Permian/Triassic biostratigraphy boundary at the base of bed 27c at section D, exactly the same as Wang had been made at the Zhongxin Dadui section. They do not insist that "The Permian—Triassic boundary presents an excellent case for integration of biostratigraphic and eventostratigraphic criteria". They agree that eventostratigraphic boundary and biostratigraphic boundary should be strictly distinguished, and recommended that Meishan section D and its base of bed 27c should be GSSP of the Permian/Triassic boundary. Now there is no difference of opinion about the stratotype point of Permian/Triassic boundary among Chinese geologists. This boundary could be recognized not only in Zhejiang but also in Jingxi Province (Zhu et al., 1994). The stratotype section at D or Z should also be solved by Chinese colleagues.

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The study of the lower limit of the Lopingian has made great progress in recent years. Mei et al. (1994a, b, c) in same year published their three papers, and proposed three different definitions for the lower limit of the Lopingian:

a. The first appearance of *Mesogondolella altudaensis* as a good marker for the upper limit of the Guadalupian, but they concluded that there was an "Unnamed Stage" between the Guadalupian and Wuchiapingian, i.e., the Lopingian Series include three stages: "Unnamed Stage", Wuchiapingian Stage and Changhsingian Stage (Mei et al., 1994a);
b. The first appearance of *Clarkina doukoensis* as a marker for the lower limit of the Lopingian Series and of the Wuchipigian Stage (Mei et al., 1994b). They assigned the originally so-called "Unnamed Stage" into the Maokou Formation. They do not confirm the existence of the so-called "Unnamed Stage";
c. The first appearance of *Clarkina postbitteri* as a marker for the lower limit of the Lopingian (Mei et al., 1974c; Jin, 1994).

The present author agrees that the base of the *Clarkina postbitteri* would serve effectively to define the base of the Wuchiapingian or the Lopingian.

Wuchiapingian conodont zonation

Wang, Z.H. (1978) first studied the conodonts from the type locality of the Wuchiaping Formation, and named *Clarkina liangshanensis*. Wang, C.Y. and Wang, Z.H. first reported *Clarkina orientalis* from the uppermost part of the Lungtan Formation. Wang, C.Y. and Wang, Z.H. (1981b), and Wang, C.Y. (1990) summarized the conodont biostratigraphy of the Wuchiapingian into two conodont zones, namely *Clarkina liangshanensis* (lower) and *Clarkina orientalis* (upper).

Mei, S.L. et al. (1994b) established seven Wuchiapingian conodont zones. They are, in ascending order, the *Clarkina dukouensis, C. asymmetrica, C. leveni, C. guangyuanensis, C. transcaucasica, C. orientalis* and *C. inflecta.* In addition, the *C. postbitteri* Zone in the earliest Wuchiapingian was also named by them (1994c). Eight conodont zones were proposed. Among them, the former four zones are stratigraphically lower than the *C. liangshanensis* Zone that used to be regarded as earliest Wuchiapingian in age.

This Wuchiapingian conodont succession should be revised. At least, the three conodont zones, the *C. dukouensis, C. asymmetrica* and *C. inflecta* zones should be discussed.

Ding, M.H. (*in* Yang et al., 1987) described several new species of *Clarkina* that she obtained from the Changhsing Formation and Dalong Formation. But some specimens, especially those assigned to *Gondolella serrata liuchangensis* and *Gondolella liuchangensis*, according to their characteristics, should be assigned to the Wuchiapingian. We never found the specimens in the Changhsingian with such morphological characteristics. The *Clarkina dukouensis* is a synonym of *Clarkina liuchangensis* (Yang et al., 1987, Pl. 32, fig. 9). These two species have no essential different in morphology.

Mei, S.L. et al. (1994b) studied intensively the conodonts from the lower part of the Wuchiaping Formation. But unfortunately they neglected the paper written by Li, Z.H. (1991), which concerns the conodont fauna from the lower part of the Upper Permian Wuchiaping Formation in Wufeng County, Hubei Province. Li, Z.H. described a new species from the lowest Wuchiaping Formation: *Neogondolella niuzhuangensis* (Li, 1991, Pl. 1, figs. 8a-9b). This species is exactly the same as *Clarkina asymmetrica* named by Mei et Wardlaw. The latter is the synonym of *Clarkina niuzhuangensis* (Li). Li, Z.H. (1991) did not assign the holotype for his new species, recently he informed the present author that the specimen illustrated in Pl. 1, fig. 9, should be the holotype of the *C. niuzhuangensis*. Anyway, the name of the *C. asymmetrica* Zone has to change to the *C. niuzhangensis* Zone.

The ranges of some species of *Clarkina* described by Mei et al. (1994b, p. 126, Fig. 2) are very doubtful if we check the fauna from the lower part of the Wuchiaping Formation illustrated by Li, Z.H. (1991). According to the identification of the present author, at least, the following species are present in the same sample of Li's collection (Li, p. 103, W-2): *Clarkina liuchangensis* (=*C. dukouensis*, Pl. 1, fig. 3); *C. niuzhuangensis* (=*C. asymmetrical* Pl. 1, fig. 9); *C. guangyuangensis* (Pl. 1, fig. 5); *C. bizarrensis* (Pl. 2, fig. 5); *C. leveni* (Pl. 2, figs. 6, 8); and *C. longicuspidata* (Pl. 2, fig. 16). Those six species coexist in the same sample. It means that the range of those six species are not so short as Mei et al. (1994b, Fig. 2) indicated. Especially the range of *C. liuchangesis* (=*C. dukouensis*) could overlap with the ranges of *C. niuzhuangensis, C. guangyuanensis, C. bizarrensis* and even *C. longicuspidata*. It is noteworthy that the sample W-2 was collected from stratum 0.80 m in thickness. If it is a condensed section, it could represent an interval of two or three conodont zones. We do not know if sample W-2 was collected from one layer or from the whole stratum. But anyway, the present author doubts the reliability of the ranges of *Clarkina* species described by Mei et al. (1994b) based on only two or three sections. The conodont zonation from the lower Wuchiaping Formation are also doubtful. The *C. liuchangensis* Zone and *C. niuzhuangensis* Zone might represent only one conodont zone.

The *Neogondolella guangyuanensis* was named by Dai, Tian et Zhang in 1984 (Zhang, et al., 1984, p. 176) without description and holotype. This species was named again in

1987 in a text-book "Conodonts" by the same authors with description but without holotype. In the explanation of plates, the author of this species became Dai et Tian (Jiang, W. et al., 1986, p. 262). The same name species as a new species was again described in 1989 by Dai et Zhang, having description and holotype (Li, Z.S. et al., 1989, p. 228-229). This name *Clarkina guangyuanensis* (Dai et Zhang, 1989), is valid.

Dr. Kozur considers that the *C. guangyuanensis* is a synonym of *C. transcaucasica* Gullo et Kozur, 1992. But the latter may be distinguished from the former by lacking the prominent gap between the cusp and posteriormost denticle of carina. Both species are similar in morphology with nearly same ranges, it could be representing only one conodont zone, or two zones. This needs to be tested in the future.

The *Clarkina infecta* Zone was named by Mei et al. (1994b). They suggested that the upper boundary of Wuchiapingian Stage should be drawn between the *C. infecta* Zone and the *C. subcarinata* Zone. But this species, *C. infecta*, is not suitable to establish a conodont zone. Its range is very short, it could serve as a marked species indicating the middle of the *C. orientalis* Zone. There is still an interval between the *C. infecta* Zone and the *C. subcarinata* Zone that is neither *C. infecta* nor *C. subcarinata*. The upper boundary of the Wuchiapingian Stage should be drawn between the *C. orientas* Zone and *C. subcarinata* Zone as proposed by Wang, C.Y. and Wang, Z.H. (1981).

On the whole, the Wuchiapingian conodont succession cannot be subdivided into eight conodont zones, but five conodont zones are present. They are, in ascending order: *Clarkina postbitteri*, *C. liuchangensis—C. niuzhuangensis*, *C. leveni*, *C. guangyuanensis—C. transcaucasica*, and *C. orientalis* zones.

Changhsingian conodont zonation

Two conodont assemblage zones were named by Wang, C.Y. and Wang, Z.H. (1981), namely, *Clarkina subcarinata—C. elongata* (=*C. wangi*) A.Z. (lower) and *C. changxingensis—C. deflecta* A.Z. (upper). Those two conodont A.Z. were not based on the phyletic first occurrence of the zonal name-giving species. As Wang and Wang (1981) have pointed out that even in *C. subcarinata—C. wangi* A.Z. there are some *C. changxingensis*, but they are very rare. Kozur (1991, 1992) suggested that *Clarkina changxingensis* occurs already in the basal Dzhulfian, but at the same time all specimens identified by him as *Clarkina* cf. *changxingensis* (Kozur, 1992, p. 185, Figs. 9-12, 14-17) were reassigned by him in another paper to his new species *Clarkina altudaensis* (Kozur, 1992, p. 104-105, Figs. 9-12, 14-17). It is very doubtful if the *C. changxingensis* occurs so early as Dr. Kozur proposed.

Tian, S.G. (1993) subdivided the Changhsingian into three conodont A.Z., in ascending order, they are: *C. subcarinata—C. wangi*, *C. postwangi—C. changxingensis*, and *C. xianxgiensis—C. changxingensis* assemblage zones.

Kozur (1994, in press) proposed two conodont zones for shallow water facies: *Hindeodus julfensis* (lower) and *H. latidentatus* (upper) zones; and two conodont zones for pelagic facies: *Clarkina subcarinata* (lower) and *C. deflecta—C. changxingensis* (upper).

As a standard conodont zonation of the Changhsingian Stage, the present author prefers to accept Tian, S.G.'s zonation, i.e., three conodont succession: *Clarkina subcarinata—C. wangi*, *C. postwangi—C. changxingensis* and *C. xiangxiensis—C. changxingensis* assemblage zones. It should be considered as phylogenetic zone, because from the *C. wangi* via *C. postwangi* to *C. xiangxiensis* is a clearly evolutionary lineage.

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Wang Cheng-yuan
Nanjing Institute of Geology
and Palaeontology
Academia Sinica
Nanjing 210008, China

13. COMMENTS ON THE PROPOSED OPERATIONAL SCHEME OF PERMIAN CHRONOSTRATIGRAPHY

Unlike the Eastern European (General) scale, whose stages above the Artinskian are predominantly represented by lagoonal and continental deposits, the scheme proposed by Jin et al. (1994) is based entirely on marine sections. Why did the authors of this scheme feel obliged to reject the Tethyan scale, which is also based on marine sections, and in addition is in common use and is highly detailed? It is because the latter (Leven, 1980) was based exclusively on fusulinid evolution, resulting in certain errors and ambiguous interpretations of the range of stages and their zonal subdivisions, both by the author and by subsequent researchers. Problems with the Tethyan scale are particularly acute in the part of the scheme that Leven (1974) distinguished as the middle series of the Permian System. Without reiterating details presented earlier (Kotlyar, 1993), it should be remembered Bolorian deposits are commonly grouped with the Yachtashian (Leven, 1993), as noted by Jin et al. (1994).

Ranges attributed to the Tethyan Kubergandinian, Murgabian and Midian stages have changed several times, and there is no reliable basis for boundary definition of the latter. Besides, in the original version of the Tethyan scheme the Capitanian was used instead of Midian. Severe provincialism in fusulinids makes it difficult not only to trace zonal units, but also to draw stage boundaries even within the Tethyan Realm. Additionally, no fusulinids are recorded from either the Boreal or the Notal Realm.

Tethyan datings are based mainly on sporadic ammonoid occurrences, which in many cases are unfortunately not reliably correlated with fusulinid zones. Association of an individual fusulinid species with ammonoids does not afford a reliable basis for assignment to a particular fusulinid zone, since reworking of foraminifers is known, and some species have an extensive stratigraphic range.

Significant progress attained in the last decade in conodont studies has demonstrated their capacity for fine zonal resolution, and particularly for precise global correlation. Evolutionary dynamics have proved to be of the same unidirectional pattern not only in diverse geographic regions but also in different paleobiogeographic realms. Zonal units distinguished in the Lower Permian of the Urals, North America and China are practically identical. Despite rarity in the boreal Realm, the occurrence of certain conodont species, frequently accompanied by ammonoids, provides reliable bases for correlation. Boundaries of conodont zones are based on common evolutionary criteria, and are considered to be practically isochronous. These characteristics are persuasive in selection of conodonts for definition of stage and series boundaries in the international chronostratigraphic scheme for the Permian.

Proposing the operational scheme, the authors proceeded from the following methodological assumptions:

1. The scale should be bases on marine deposits from environments that are widespread geographically.
2. Boundaries of series should correspond to event boundaries and be recognizable globally.
3. Boundaries of series should reflect major biotic reconstructions.
4. Boundaries of stages and series should be defined within continuous phylomorphogenetic conodont successions, and should coincide with boundaries of zonal units. Levels so defined should also be suitable for supporting correlation by reference to the more chronologically significant associates, primarily ammonoids and fusulinids.
5. Stratigraphically continuous, adequately studied, and fully paleontologically characterized sections that can be reliably correlated with each other should be chosen as stratotypes.
6. Priority should rule in assignment of stage names, all other factors being equal.

The scheme under discussion (Jin et al., 1994), though compiled on basis of the above criteria, still has certain disadvantages, errors, and conventions. Correlation charts that normally accompany such a scheme are not notably absent. However, the most debatable issue is the relationship between the Kubergandinian and Roadian, and I cannot agree with superposition of these two references. I proposed replacement of the Chihsia Subseries with the Cathedralian, because in that way the integrity of major parts of the scheme can be sustained. In particular, this would preserve the applicability of the defining conodont chronocline, and the coeval relationship of the Roadian and Kubergandinian ammonoid assemblages that is recognized by practically all specialists. However, due to the appearance of *Mesogondolella nankingensis* (the species that defines the lower boundary of the Roadian) above the Neoschwagerina Zone in the Luodian section of China, Jin Yugan drew the lower boundaries of the Roadian and the *Neoschwagerina craticulifera* Zone at the same level. Direct acquaintance with the Luodian section during the post-Gulyang Symposium excursion, however gave rise to doubts concerning the in situ occurrence of fossils, starting with the Chishsian Subseries. Field observation gave the impression that both conodonts and fusulinids could be reworked, especially in higher parts of the section. This reflects adversely on its suitability to serve for reference purposes.

The post-Artinskian (Cathedralian) sequence in American Southwest is in objective stratigraphic succession beneath the Guadalupian. This allows definition of the lower boundary of the basal Guadalupian Roadian Stage at the first appearance of *Mesogondolella nankingensis* in the continuous phylomorphogenetic lineage from Cathedralian *M. idahoensis*. A possible alternative is to retain the Kungurian as a stage, but this would necessitate selection of a new stratotype in the normal marine sections of the North Russian Platform.

In the course of analyzing the original scheme, two possibilities for the lower boundary of the Upper Permian Lopingian Series was discussed. The first is based on the research conducted by the Chinese and American specialists (Mei et al., 1994) who accomplished a detailed subdivision of the Upper Permian deposits in China. They divided the upper part of the Maokou into 5 conodont zones, and the succeeding Wuchiapingian into 6 conodont zones. According to this version, which serves as basis for the chronostratigraphic scheme, the basal boundary of the Lopingian Wuchiapingian Stage is drawn at the first occurrence of *Clarkina* (*C. postbitteri*), and extinction of *Mesogondolella*. Most probably, this boundary corresponds to the upper part of the Khachik Formation in Transcaucasia. An alternative proposal (Kozur, 1992) suggested placing the base of the Upper Permian Dzhulfian Stage at the base of the *Mesogondolella altudaensis* Zone. This zone was distinguished initially in the upper part of the American standard reference (uppermost Guadalupian — upper Capitanian, Altuda Formation), thereby permitting direct correlation with the Tethyan sections. In the Chinese sections (Maokou Formation) three conodont zones are distinguished above the *M. altudaensis* Zone (Mei et al., 1994), and in the overlying Wuchiaping Formation another three zones are present before gradation into the *Clarkina leveni* Zone. It follows that placement of the base of the Dzhulfian coincident with the *M. altudaensis* Zone is inappropriate. At the same time, one can agree with Kozur that the base of this zone is an event boundary, traceable globally and corresponding to the boundary between the Kiama and Illawarra paleomagnetic zones. It is also a significant biostratigraphic boundary, whose rank can be agreed upon following appropriate discussion. However, the decision should not reflect adversely on the suitability of the Guadalupe Mountains section as a Permian series standard.

As to the doubts expressed by some stratigraphers concerning difficulty in recognizing international standard series or subseries in different paleogeographic provinces, it should be noted that references were chosen as the most intensely studied and best biologically characterized intervals. Preference was given to sections subdivided in detail with reference to chronologically sensitive groups such as conodonts and ammonoids. Sedimentologic continuity was taken into account, as well as the recognition of marker levels that allow reliable correlation over large areas.

At the same time, I am asking myself: can we withdraw completely from the traditional historic East European scale, which reflects Permian geological history of the world? Perhaps, taking into account the unique nature of the Permian System, it would be desirable to retain the traditional scale for supplemental use where appropriate (e.g., Cowie and Bassett, 1989).

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Galina V. Kotlyar
VSEGEI
St. Petersburg 199026, Russia

14. COMMENTS BY H. TARAZ ON THE PROPOSED OPERATIONAL SCHEME OF PERMIAN CHRONOSTRATIGRAPHY

I am not a paleontologist and I am not going to discuss fossils for you. I am a field geologist whose foot-prints can be found all over Iran, and I would be one of those who is going to use the chosen type-sections and chronostratigraphic schemes by the International Commission on Stratigraphy for geological mapping in future. My experience may help.

I discovered the Abadeh section of Central Iran in 1968. I could not correlate the Abadeh section with the Kungurian, Ufimian, Kazanian and Tatarian stages of the Russian Platform because the Abadeh section is of marine deposits and those stages are of shallow brackish water basin or continental red bed facies. Common sense tells me that a Global Stratigraphical Scheme suitable for stratigraphic correlation should be based on marine sections, and not on an environmentally controlled sections. Ruzhentsev and Sarycheva (eds.), 1965, had the same problem for correlation of the Dorasham section of Trans-Caucasus with the Russian Platform sections, and they used the Guadalupian Stage. Following their path, I did the same. Of course, Ruzhentsev had no problem with the Guadalupian Stage because Khachik Horizon of the Dorasham section consists of a limestone sequence containing fusulinids and ammonoids, and has a sharp contact (characterized by some erosion and disconformity on the Iranian side of the Julfa region) with the overlying typical Dzhulfian beds. Consequently there was no need for Ruzhentsev to search for the definition of the (top of the Guadalupian State). Unlike Ruzhentsev, I had this problem. I had a lot of difficulties in correlating the Abadeh sections with the Guadalupian Stage. The Abadeh sections starts with the Artinskian transgression and consists of Artinskian marine limestone at the base and typical Dzhulfian at the top. It is a continuous sequence of highly fossiliferous marine limestone from the Artinskian to Dzhulfian, and I needed to mark the top of the Guadalupian Stage in that section. I searched for a very long time, and frankly speaking, I did not find any clear definition for the top of the Guadalupian Stage. So, very vaguely I had to assume that the top of Guadalupian coincides with the disappearance of the large fusulinids. This loose assumption has never been confirmed for me.

After almost 25 years, I found myself close to the proposed Guadalupian standard section and decided to visit it. Permophiles No. 23, November 1993 had enough information about the (Stratotype of Guadalupian Series), and at December 1993 I did go to the Guadalupian Mountains National Park and visited the proposed type section over there. It is a reef limestone, of biologically controlled environment. The upper part is eroded and Post-

Guadalupian (supposedly any part of the Ochoan) is not present. I do not think that it is good enough as a standard stratotype section. I was expecting to see a continuous marine (not reef) formation with clear boundary with Artinskian at the base and a clear boundary with Ochoan or Post-Guadalupian Formations on top; something similar to the Abadeh section (Central Iran), units 1, 2 and 3 combined.

Moreover, I do not believe that Roadian, Wordian and Capitanian could be applied to the Middle East portion of the Tethyan Basin. They do not fit into the geological events of Tethys. I could not use them before and I can not use them now.

I believe that in international standard stratotype section for Middle Permian should be continuous from Artinskian to Tatarian and should be marine deposits without any life-controlling environmental conditions. When I compare Guadalupian section with the Abadeh section then it seems to me that the Abadeh section is more complete and probably contains more paleontological information. Units 1 through 5 of the Abadeh section are marine continuous sequence from Artinskian to Dzhulfian without facies-controlled conditions, and there is a possibility that that section may be perfect as a standard stratotype section for Middle Permian.

I believe that we have to work a little more on the Abadeh section and then decide for the Middle Permian standard stratotype section.

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Hooshang Taraz
Associated Prof. of Geology
Nicholls State University
Thibodaux, Louisiana

15. PROPOSAL FOR A COMBINED REFERENCE SECTION OF THE CENTRAL EUROPEAN CONTINENTAL CARBONIFEROUS AND PERMIAN FOR CORRELATIONS WITH MARINE STANDARD SECTIONS

Permophiles No. 18, 1991, p. 5, Schneider *in* Hoffmann et al.: "However, the Carboniferous/Permian boundary should not be defined . . . regardless of good chances for future correlations with the classic Variscan molasses." Meanwhile the correlation of the continental profiles in Central Europe has been greatly improved by use of different stratigraphic tools. Inspired by the discussions about the Carboniferous/Permian boundary in Permophiles No. 25, 1994, we will provide results of the holostratigraphic synthesis of the majority of data of continental basins in Europe available, and discuss time lines into marine sections (for detail see Schneider, Rößler and Gaitzsch, 1995). We think that our ideas should be critical improved by the different workers in this field. At first - no isotopic ages of potential Carboniferous/Permian-boundaries exist in any of the marine section that are in discussion! Numerical ages for this boundary, shown in various time scales, are simply hopeful estimations up to now. A first provisional solution of this problem could be found by the biostratigraphic correlation of isotopical dated volcanites of well investigated Central European continental profiles with marine sections as discussed below.

The proposal of a reference section consisting of the profiles of the Saar Basin, the Saale Basin and the North German Basin (NGB) is established on the following arguments:

1. The sedimentary sequences of most of the Variscan (=Hercynian) basins (see Schneider, 1989, Fig. 2 - intermittent and temporary basins) covers only short time spans interrupted by hiatuses of variable duration, although often masked as paraconformities. The higher Rotliegend part (Sakmarian - base of the Dzhulfian) of the profiles is most incomplete. The red beds of this interval only seldom contain fossiliferous layers; the diversity of the fossil associations is strongly restricted. Linked together by cross correlations the combined profile of the Saar Basin, Saale Basin and NGB provide the most complete fossil record of the continental Upper Carboniferous and Permian.

2. Besides marine ingressions during the Carboniferous up to the top of the Westphalian B (Aegirianum = Mansfield Marine Band) in the Variscan foredeep marine incursions are indicated in the higher Stephanian and in the Upper Rotliegend II (about Capitanian) below the Zechstein transgression (Schneider and Gebhardt, 1993; Gebhardt, 1994) in the NGB, delivering marine fossils, now in research, and datas for event stratigraphy.

3. Repeated intercalatons of volcanites up to Capitanian/Dzhulfian Hannover Subgroup of the NGB offer

best conditions for isotopic age determinations; important magnetostratigraphic markers have been found near the base of the Lower Rotliegend in the Saale Basin and near the base of the Upper Rotliegend II (Menning, 1989 ff.) in the NGB. That is why the biostratigraphy got a numerical timeframe.

Correlation of Saar-Nahe Basin and Saale Basin

The basal grey sediments of the Gehren Formation of the southwest Saale Basin (Thuringian Forest), the Wettin subformation of the northeast Saale Basin (East Harz and Halle/Delitzsch area), and the Breitenbach Formation of the Saar-Nahe Basin belong to the *Sysciophlebia euglyptica*-zone (Schneider, 1982; Schneider and Werneburg, 1993) and to the *Bohemiacanthus* Ugzone (Schneider, 1988; Schneider and Zajac, 1994), according to Hampe, 1994 about lower "*Triodus*" (=*Bohemiacanthus*) *lauterensis*-zone, i.e., in the upper Stephanian. The volcanites of the Gehren Formation which follow the aforementioned basal grey sediments are dated with values of around 299 +/- 1,7 Ma to 295,6 +/- 2,7 Ma. Pyroclastics of the Breitenbach Formation, upper Ottweiler subgroup, and the basal Kusel subgroup of the Saar-Nahe Basin delivered values of around 300 Ma (Lippolt and Hess, 1983 ff.; Lippolt, Hess, and Goll, 1993). In the Saar-Nahe Basin the beginning of the Donnersberg volcanism in the basal Nahe subgroup, i.e., just above the top of the Tholey subgroup (which is superimposed on the Lebach subgroup), is dated as 290 Ma. The end of the Donnersberg volcanism is dated as 286 Ma (Lippolt, Hess and Goll, 1993). Using biostratigraphic cross correlation, the volcanism during the Oberhof Formation up to the Tambach Formation in the Saale Basin seems to be of similar age. Arguments are (see Fig. 2): The upper Oberhof Formation of the Saale basin and the Humberg horizon, top of the Odernheim Formation, upper Lebach (or Glan) subgroup of the Saar Nahe Basin could be correlated by the *Discosauriscus pulcherrimus-Melanerpeton gracile* zone (Werneburg, 1989) as well as by the conchostracan *Lioestheria extuberata*, which is very common in the lower Oberhof Formation and upper Odernheim Formation (e.g., Wörsbach locality). This correlation receives strong support by the insect zonation as presented in Schneider and Werneburg, 1993 (compare Boy and Martens, 1991, Fig. 5). The Tambach Formation of the Saale Basin and the deeper Nahe subgroup (Sobernheim level, N4) belongs to the *Lioestheria andreevi*-zone of Kozur, 1993 as well as to the *Moravamylacris kukalovae*-interval of the insect-zonation. The magnetostratigraphic Illawarra Reversal is situated between the Eisenach Formation, belonging to the *Pseudestheria wilhelmsthalensis*-zone, and the "Grenzkonglomerat" of the Saale Basin.

Correlation of the North German Basin

The Rambin Formation and Süplingen Formation were dated by macrofloral remains as Stephanian, the Grüneberg Formation correlates by *Pseudestheria paupera* and *Pseudestheria palaeoniscorum* conchostracans as well as by xenacanth teeth of the *Bohemiacanthus* type Um/Om (see Schneider, 1995) to the lower Rotliegend (Manebach Formation and Goldlauter Formation of the Saale Basin), the Bebertal Formation biostratigraphically corresponds to the Goldlauter Formation of the Saale Basin by the *Bohemiacanthus* type Ugo-zone. Conchostracan associations in the Müritz subgroup, consisting of *Lioestheria extuberata, L. andreevi, Pseudestheria graciliformis, Ps. wilhelmsthalensis, Protolimnadia sulzbachensis* and *Pr. kowalczyki*, clearly indicate Upper Rotliegend I. In the basal part of the Müritz Formation of the well Parchim 1/68 the youngest pyroclastics of the Upper Volcanites of the NGB occur. This level could be correlated to the lower Eisenach Formation (Saale Basin) as well as to the Michelbach Formation (Baden-Baden Basin) by the occurrence of the conchostracan *Ps. wilhelmsthalensis*. Thus, analogous to the Donnersberg volcanism of the Saar-Nahe Basin and the Yburg volcanism in the Michelbach Formation of the Baden-Baden Basin, the end of the volcanism in the NGB can be assumed to lie around 285 Ma. The up to 3000 m thick deposits of the Upper Rotliegend II lie above the Illawarra Reversal, which is known from the basal Parchim Formation (Menning et al., 1988); biostratigraphy of conchostracans and isolated fish remains of the Dethlingen Formation and Hannover Formation is still in work (Schneider, Gebhardt and Gaitzsch, in prep.). Unfortunately up until now no satisfactory isotopic ages for basaltic volcanites in the Parchim Formation and the Hannover Formation, which are linked to initial rifting, exist.

Correlations to the Profiles of the E-European Platform/Donezk Basin (Fig. 2)

Resulting from our fieldwork experience, including macro- and micropaleontological investigations in the Donezk Basin, this basin may provide the best opportunity for correlations to Central European Stephanian and lowermost Permian, because of nearly identical facies patterns of continental deposits, containing typical Euramerian floras and faunas. The extensive interfingering of marine and continental sediments in a continuous Carboniferous - Lower Permian (Asselian) profile is a characteristic feature of this basin. Marine fauna offers the correlation to the marine standard profile of the East European platform and the Paleotethys. The Gzhelian/Asselian boundary (Jin Yu-Gan et al., 1994) in the Donezk Basin is situated at the level of the marker limestones Q_5 /Q_6, in the Kartamyskaja svita. Thus, the following indications enable a correlation of that Carboniferous/Permian boundary to the Central European profiles: In the Donezk Basin, the characteristic species *Stomochara volvenkovensis* Schaikin is known from the middle Araukaritovaja svita up to the level of the limestone P_7, shortly below the top of this formation. This same species is very common in similar or identical lithotypes in the Rothenburg Formation of the Mansfeld subgroup in the NE-Saale Basin (Gebhardt and Schneider, 1985). The nonmarine ichnocoenosis of the Donezk Basin shows paleoecological and ecostratigraphic relationships with the limnic-terrestrial ichnocoenosis of the Central European Stephanian and Rotliegend (Schneider, Schamajew and Walter, 1992). The arthropod trails of the upper Araukaritovaja svita and lowermost Kartamyskaja svita can be compared to the low-diverse *Acripes-ichnocoenois* of the Stephanian Mansfeld subgroup. In contrast, the ichnocoenosis from the upper Kartamyskaja svita with numerous different Tripodichnia, including *Permichnium*, allows the recognition of convergences with the ichnocoenosis in the higher Lower Rotliegend and the lower Upper Rotliegend of the Saale Basin. There, *Permichnium* is a characteristic element of the *Glasbachichnium*- and *Heftebergichnus*-association in the Oberhof Formation and Rotterode Formation. It is also quite typical for the diverse playa association in the Oberrotliegend I (Hornburg Formation, Eisenach Formation and Nahe Subgroup - compare Fig. 2). The ichtyolithe associations and conchostracans of the higher Gzhelian of the Donezk Basin (limestones P_5 and P_6) currently being researched, additionally demonstrate the relationship to the Stephanian (Schneider, in prep.).

These data, in combination with the temporal distribution of the *Stomochara volvenkovensis* (see above), do not yet allow any obvious correlations. However, they demonstrate that the Stephanian/Lower Rotliegend boundary could be situated between the marker horizons P_7 and Q_3 of the Donezk Basin. This is supported by paleomagnetic data. Following Chramov (1963), a short term normal subzone inside the Permocarboniferous Reversed Megazone is situated in the Medistych Peshanikov of the Donezk Basin, i.e., in the level of Q_4/Q_5 in the lower half of the Kalitvenskaja (=Kartamyskaja) svita. This level corresponds to the top of the *Daixina bosbytauensis - Daixina robusta* - fusulinid zone in the Donezk Basin as well as in the marine profile of the S-Ural (Popov and Davydov, 1987). The base of the superimposed *Sphaeroschwagerina aktjubensis - Sphaeroschwagerina fusiformis* fusulinid zone defines the Gzhelian/Asselian boundary (Davydov, 1994), i.e., the (potential) Carboniferous/Permian boundary (Jin Yu-Gan et al., 1994). According to Menning (1987), a short-term normal event can be found in the lower Manebach Formation of the Saale Basin; this normal subzone could be correlated with the aforementioned normal subzone at the Gzhelian/Asselian boundary. The fact that biostratigraphic and magnetostratigraphic data show such agreement leads to the conclusion that the Carboniferous/Permian boundary can be located in the deeper Lower Rotliegend, i.e., at the level of the lower Manebach Formation and its equivalents. This biostratigraphically well defined level is supported by isotopic ages - see above.

Correlations with Profiles in Northern America (Fig. 2)
The insect (Spiloblattinidae) zonation of Schneider, 1982; Schneider and Wernebeburg, 1993 offers certain correlation levels based on phylomorphogenetic lineages. These levels can be regarded as isochronic, based on the highly active (flight) and passive (wind drift) migration potential of this group. One of these lineages begins in the Conemaugh Formation, middle Pennsylvanian, of the Dunkard basin, with the *Spiloblattina variegata*-zone, which includes the deeper Stephanian (about Stephanian A and deeper Stephanian B) at the roof of the Ames Limestone, followed by the *Spiloblattina allegheniensis*-zone in the Duquesne shale. This, in turn, is followed by the *Spiloblattina lawrenceana*-zone in the Lawrence shale, Stranger Formation, of the Virgilian (or upper Pennsylvanian) in the Kansas profile. *Spiloblattina lawrenceana* likely appears in the Plouznice horizon, Semily Formation, of the deeper Stephanian C of the Podkrkonose Basin. The presence of the conodonts *Streptognathodus simulator* and *Streptognathodus elegantulus* in the Ames Limestone (Merril, 1974 - see Kozur, 1980) indicates lower to approximately middle Gzhelian of the marine standard scale. Next correlation level, the Cassville shale of the Washington Formation, Dunkard Group, lowest Wolfcampian of the Dunkard Basin, as well as in the Goldlauter Formation of the southwest Saale Basin (see Schneider and Werneburg, 1993), is fixed by the *Sysciophlebia balteata*-zone. Thus, the top of the Stephanian should be traceable to the middle Virgilian, and the Wolfcampian can be correlated to parts of the Lower Rotliegend and Upper Rotliegend I. The paleomagnetic normal subzone at the level of the Washington coal in the top of the Cassville shale could therefore correspond to the lower of two normal subzones in the upper Asselian, as suggested by Menning (1995, in press). The phylomorphogenetic position of Phyloblattidae and Mylacridae (Insecta, Blattodea) from the Boskovice furrow and their relation to Phyloblattidae and Mylacridae from the lower Upper Rotliegend I (*Moravamylacris kukalovae*-interval, *Lioestheria oboraensis*- to *L. andreevi*-zone) of the Saar-Nahe Basin and Saale Basin as well as to the morphogenetic younger Phyloblattidae from the Wellington shales, Leonardian, Kansas, gave reason to position the Tambach Formation of the southwest Saale Basin, the lower Nahe subgroup (Sobernheim level, N4) of the Saar-Nahe Basin, and the Obora member of the Boskovice furrow at the Wolfcampian/Leonardian transition (Schneider, 1980 ff.; Hoffmann et al., 1989). This classification was confirmed by the occurrence of the typical North American lower Wolfcampian amphibian *Seymouria* cf. *sanjuanensis* in the Tambach Formation

Figure 1. Holostratigraphic interregional correlation chart of the Upper Carboniferous and Lower Permian Sequence in European basins.

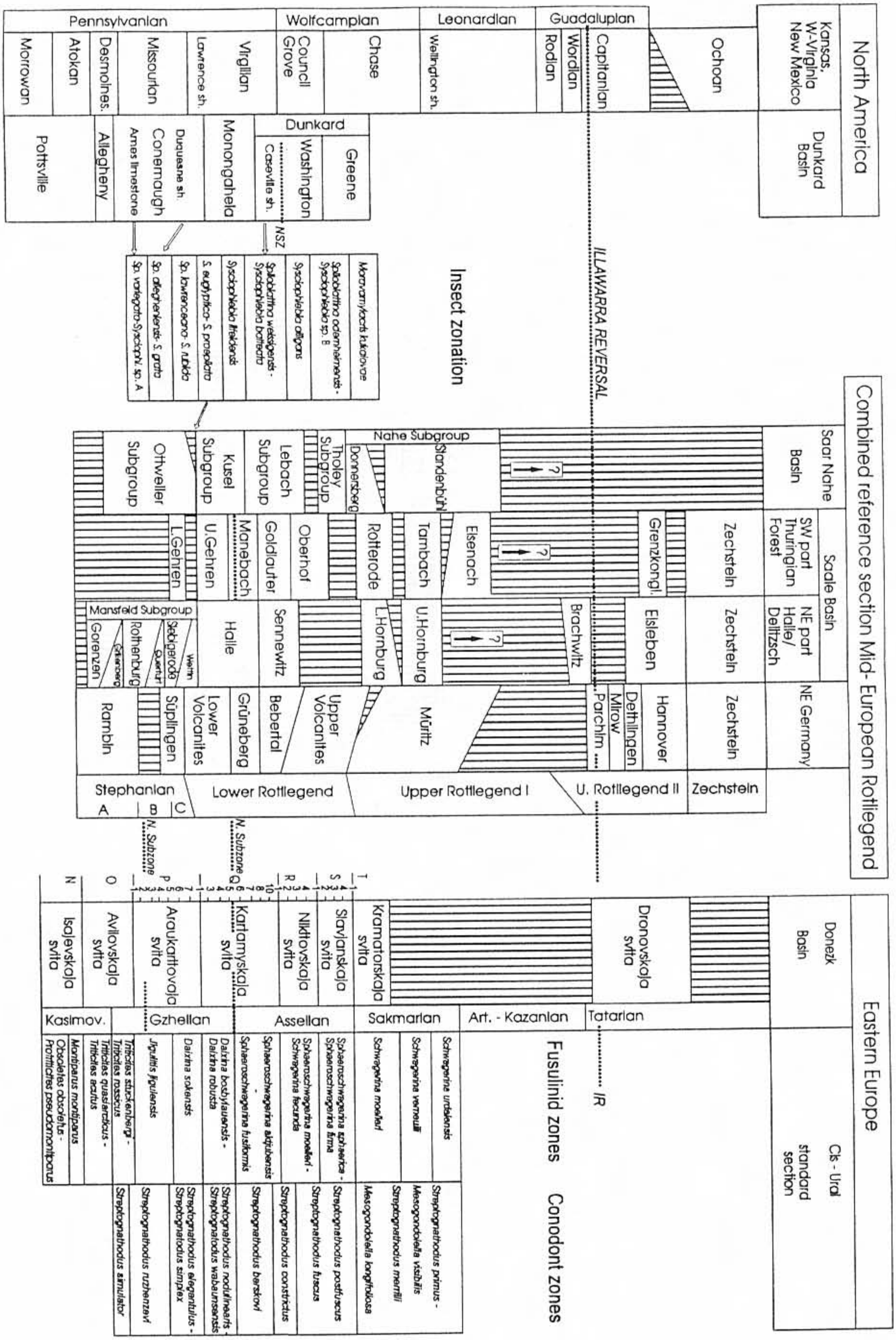

Figure 2. Correlations between the "Combined Reference Section of Mid-European Rotliegend" with marine standard sections of the European Platform/Donezk Basin and marine influenced profiles in North America.

(Berman and Martens, 1993). Consequently, the higher Upper Rotliegend I partially corresponds to the Leonardian. The next important marker level is the Illawarra Reversal in the Capitanian, near to the base of the Upper Rotliegend II (see Fig. 1).

The new defined Carboniferous/Permian boundary at the base of the *Sphaeroschwagerina vulgaris-S. fusiformis*-zone or somewhat deeper, at the first appearance of isolated nodular streptognathodids, is conspicuous well applicable for correlation with the Central European continental profiles. If our correlation is correct, this boundary will be situated in fossiliferous grey and red sediments, close above the volcano-tectonic event around the Stephanian/"Rotliegend"-boundary; additional this boundary seems to correlate with a palaeomagnetic subzone. In this way that boundary fulfils the demand of correspondence between biostratigraphic definition and geological marker events (Dickins, 1991). In our opinion, the combined profile of the Saar Basin, Saale Basin and NGB could act as an "Regional Continental Standard" in the sense of Lozovsky, 1994. Besides them our proposal should be an operational scheme for the new IGCP-project called "Paleozoic microvertebrate biochronology and global marine-nonmarine correlation", which is in preparation now.

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J.W. Schneider, R.R. Röbler
and B.G. Gaitzsch
Freiberg University of
Geological Institute
Department of Paleontology
Mining and Technology
B. v. Cotta-Str. 2
09596 Freiberg, Germany

16. RECENT PUBLICATIONS

The Permian of Northern Pangea, 1995
Volume 1: Paleogeography, Paleoclimates, Stratigraphy, 102 figures
Volume 2: Sedimentary Basins and Economic Resources, 159 figures
P. A. Scholle, T.M. Peryt, D.S. Ulmer-Scholle (eds.)

VOLUME I

Overview

Pangea and the Paleogeography of the Permian
C.R. Scotese and R.P. Langford

The End-Permian Mass Extinction
D.H. Erwin

Paleoclimates

The Climate of Pangea: A Review of Climate Model Simulations of the Permian
E.J. Barron and P.J. Fawcett

Geologic Evidence of Permian Climate
J.T. Parrish

The Ending of the Late Paleozoic Ice Age During the Permian Period
J.C. Crowell

General Stratigraphic Tools

A Numerical Time Scale for the Permian and Triassic Periods: An Integrative Time Analysis
M. Menning

Permian Sequence Stratigraphy
C.A. Ross and J.R.P. Ross
Variation in $^{87}Sr/^{86}Sr$ of Permian Seawater: An Overview
R.E. Denison and R.B. Koepnick

Carbon and Sulfur Isotope Stratigraphy of the Permian and Adjacent Intervals
P.A. Scholle

Biostratigraphic Studies

Permian Sponge Biogeography and Biostratigraphy
J.K. Rigby and B. Senowbari-Daryan

Permian Fusulinaceans
C. Ross

Permian Conodonts
B.R. Wardlaw

Permian Bryozoa
J.R.P. Ross

Permian Ammonoids in the Arctic Regions of the World
W.W. Nassichuk

The Palynology of the Permian of Northern Continents: A Review
J. Utting and S. Piasecki

VOLUME 2

Basin Studies - North America

Permian History of Arctic North America
B. Beauchamp

Permian of the Western United States
B.R. Wardlaw, W.S. Snyder, C. Spinosa and D.M. Gallegos

Permian Stratigraphy and Facies, Permian Basin (Texas-New Mexico) and Adjoining Areas in the Midcontinent United States
S.J. Mazzullo

Filling the Delaware Basin: Hydrologic and Climatic Controls on the Permian Castile Formation Varved Evaporite
R.Y. Anderson and W.E. Dean

Basin Studies - Europe

Permian History of the Barents Shelf Area
L. Stemmerik and D. Worsley

Permian History of the Norwegian-Greenland Sea Area
L. Stemmerik

Facies, Paleogeography and Sedimentary History of the Southern Permian Basin in Europe
H. Kiersnowski, J. Paul, T.M. Peryt and D.B. Smith

A General Outline of the Permian Continental Basins in Southwestern Europe
G. Cassinis, N. Toutin-Morin and C. Virgili

Permian Deposits of the Urals and Preduralye
B.I. Chuvasov

Basin Studies - Middle East/Asia

Stratigraphy and Sedimentology of the Permian in the Arabian Basin and Adjacent Areas: A Critical Review
A.S. Alsharhan and A.E.M. Nairn

The Permian of Pakistan
B.R. Wardlaw and K.R. Pogue

The Permian of China
P. Enos

Economic Resources

Oil and Gas Resources in Permian Rocks of North America
S.J. Mazzullo

Hydrocarbon Occurrences in Permian Strata of the Commonwealth of Independent States
V. Kuznetsov

Permian Phosphorites: A Paradox of Phosphogenesis
J.R. Herring

17. ANNOUNCEMENT
INTERNATIONAL FIELD EXCURSION ON PERMIAN—TRIASSIC SECTIONS OF THE NORTH CAUCASUS

July 20—28, 1996, Mineralny Vody, Russia

IGCP Projects 359, 343 and North Caucasus Organizing Committee invite you to attend the Field Excursion which will be held in the North Caucasus in July, 1996. Participants will be shown the unique Upper Permian and Triassic sections containing abundant and diverse fossils.

Geological field trips will be held in the basins of the Laba and Belaya rivers. It is planned to demonstrate: 1) the Upper Permian (Dorashamian) sections in various facies (reefogenic, carbonate and terrigenous) (Nikitin, Severnaya sections); 2) the Lower Permian red coloured continental deposits (Khamyshki section); 3) the Triassic deposits (lower—middle — Rufabgo, Sakhray sections; middle—upper — Tkhach, Maly Bombak sections).

Cost of Excursion: $600.00

This is the first announcement

If you would like to participate and receive future announcements please contact:

Dr. G.P. Pronina, Secretary General
All-Russian Geological Research Institute (VSEGEI)
Sredny pr., 74
St. Petersburg, 199026, Russia
Fax: 7 (812) 2135738
E-mail: vsg@sovam.com

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