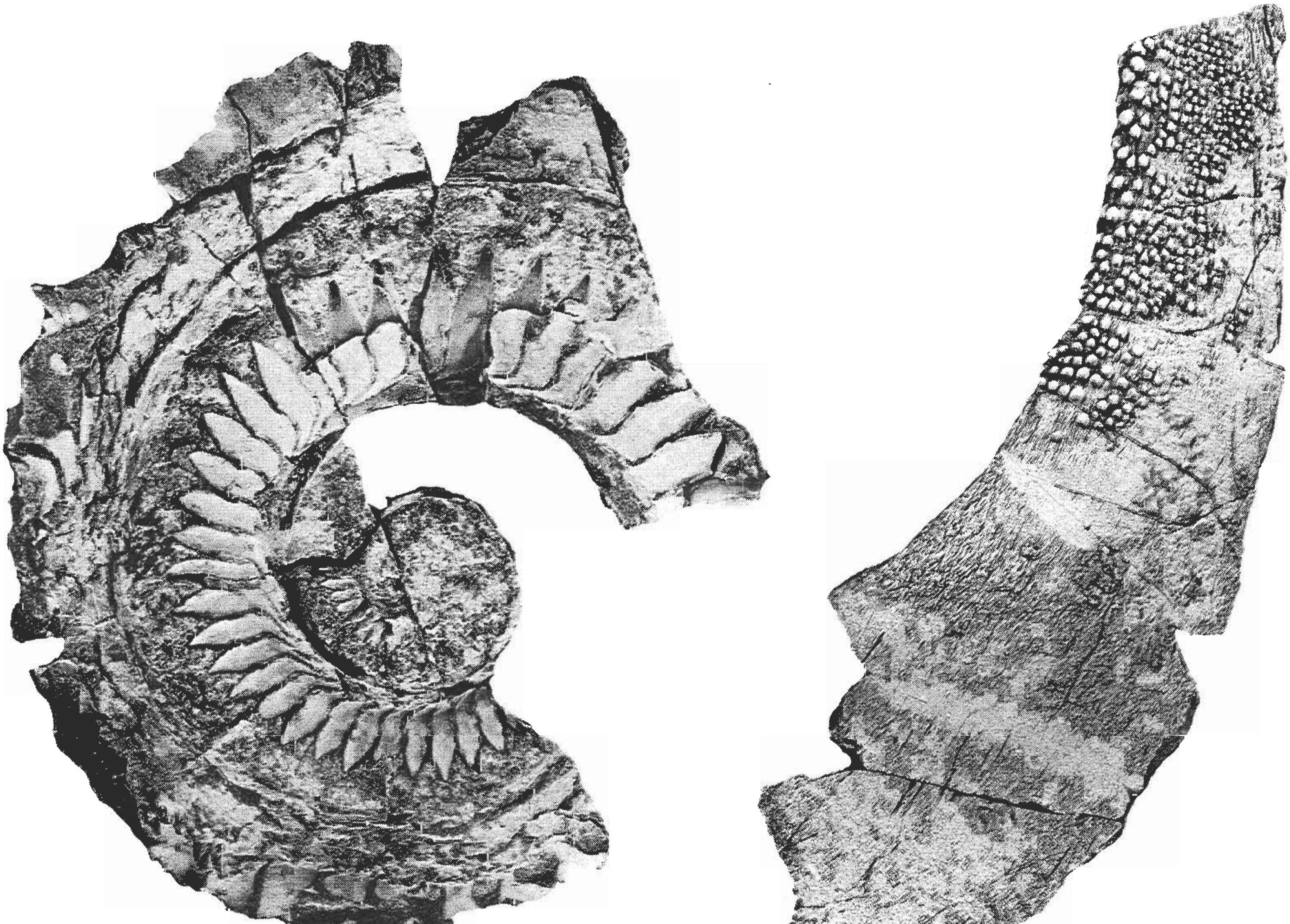
Permophiles

No. 22 June, 1993

A NEWSLETTER OF SCPS



SUBCOMMISSION ON PERMIAN STRATIGRAPHY

INTERNATIONAL COMMISSION ON STRATIGRAPHY

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES (IUGS)

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Left: Lateral view of the Permian vertebrate (Elasmobranch) *Helicoprion* sp., Assistance Formation, Roadian, Melville Island, Canadian Arctic Archipelago (x 1).

Right: Lateral view of Permian vertebrate spine (cartilaginous fish) *Physonemus* sp., Assistance Formation, Roadian, Devon Island, Canadian Arctic Archipelago (x 3).

Photographs provided by W.W. Nassichuk.

1. CHAIRMAN'S REPORT

I should like to endorse the sentiments expressed in Dr. Glenister's article "A call to action" ("Permophiles", in this issue). A tremendous amount of work has been done in recent years on the Permian and on the Carboniferous/Permian and Permian/Triassic boundaries and it is perhaps time to make some concrete decisions.

An ideal opportunity for discussing recent developments and hopefully to make some decisions will be the International Symposium "Carboniferous to Jurassic Pangea" to be held in Calgary August 15-19, 1993. A number of working groups of the subcommission have scheduled meetings during this conference.

I should like to bring to your attention a special meeting entitled the "International Symposium on Permian Stratigraphy, Environments and Resources". This will be held in Guiyang, Guizhou, China, from August 28-31, 1994, in conjunction with meetings of the Pangea Project, GSGP, IGCP Project 359 (Correlation of Tethyan, Circum-Pacific and Marginal Gondwanan Permo-Triassic) and IGCP Project 306 (Stratigraphic correlation of southeastern Asian Paleozoic-Mesozoic). There will be time allocated for subcommission working groups to meet during this conference. After the conference from September 5-20, there will be a geological excursion along the Silk Road in Xinjiang. This will be organized by the Permian Subcommission on Stratigraphy and the Phanerozoic Climatology Project. Further details are available from Wang Xiang-dong or Jin Yu-gan at the address given below.

Jin Jugan
Nanjing Institute of Geology and Palaeontology
Academia Sinica
Chi-Ming-Ssu
Nanjing, 210008
People's Republic of China

2. SECRETARY'S NOTE

I should like to thank all those who contributed to this issue of "Permophiles". The next issue will be in November 1993; please submit contributions by October 15.

Contributors may send in reports by FAX to the number given below. "Permophiles" is prepared using WordPerfect 5.1 for those wishing to send in 5¼ inch or 3½ inch IBM computer discs (please also send printed hard copy).

J. Utting
Institute of Sedimentary and Petroleum Geology
3303 - 33rd Street N.W.
Calgary, Alberta T2L 2A7
Canada
FAX (403) 292-6014

3. A CALL TO ACTION

I. Introduction

1991 was a vintage year for Permophile people. The Guadalupian Symposium (Alpine, Texas, March 13-15) served early to focus interest on prospects for a composite but single international chronostratigraphic scale for the Permian Period. Later in the year, field trips and both formal and informal sessions of the International Congress on the Permian System of the World (Perm, Russia, August 5-10) facilitated development and strengthening of international contacts amongst students of the Permian. Within one year, the first series of papers generated in connection with the Perm meeting was published as a separate number of the International Geology Review (Vol. 34, No. 9, September 1992). This includes a succinct review of the Carboniferous/Permian boundary in the southern Urals (Davydov *et al., 1992*), the formal proposal of the Guadalupian as the international standard for a Middle Permian Series (Glenister *et al., 1992*), and evaluation of suitability of component Guadalupian stages as international standards (Kozur).

Despite obvious recent progress in understanding Permian correlations, not a single proposal for international acceptance of the boundaries of a stage, series, or of the System itself has yet been distributed for formal postal vote of the membership. Some specialists continue to focus on counterproductive use and enhancement of local or provincial stage terminology, content with local rather than mondial correlations.

The purpose of the present statement is to urge that the current local "housekeeping" phase of Permian studies be de-emphasized, thereby permitting concentration upon "scientific" international initiatives. We will always welcome and need new data of diverse kinds, but the strong case can be made that the present database is more than adequate for informed international decision on several Permian chronostratigraphic boundaries. Principles involved have been recognized progressively (McLaren, 1977) and generally accepted, and desirable attributes of boundary stratotypes are well understood (Cowie *et al.*, 1986).

One philosophical caution in selection of boundary levels is perhaps appropriate. Traditionally, stratigraphers have sought "natural" boundaries dividing "real" chapters in earth history (e.g. notables ranging from Adam Sedgwick to my good friends Norman D. Newell and Ernst Ya. Leven). In a crude sense this is appropriate, as with the three Phanerozoic eras. However, to extend this to the stage level is to invite future problems. Concurrent extinctions followed by simultaneous appearances, such as those that occur at many sequence boundaries, almost invariably signal an unconformity surface with a significant gap in the record. Definitions should be devised arbitrarily but for convenient, practicable recognition within a single evolutionary continuum, preferably at a level that can be related precisely to continua in other directly associated lineages. "Natural" boundaries afford the least prospect for precise correlation, in most cases, despite the established utility of some geochemical anomalies whose identity can be verified through related paleontological data.

II. Prospects

Three major Permian boundaries appear prime for early international agreement, and will be reviewed (A-C) briefly below. Consideration of these boundaries raises the desirability of attention to related opportunities (D-F), also considered below.

A. Carboniferous/Permian Boundary. The base of the Permian in the type area of the southern Urals was proposed by Ruzhencev (1936), with special attention to ammonoid successions but supported by detailed distribution data on associated fusulinaceans. The type locality originally selected by Ruzhencev is on Aidaralash Creek in the Aktöbe (Aktyubinsk) region of Kazakhstan. Colleagues from the former Soviet Union have repeatedly considered alternatives, but have also provided detailed new data for Aidaralash and adjacent sections (Davydov *et al.*, 1992; Bogoslovskaya *et al.*, in press). Their strong current consensus is that the Global Stratotype Section and Point (GSSP) for the C/P boundary should be recognized near the top of Bed 19 at Aidaralash (Davydov *et al.*, 1992). Ammonoids, fusulinaceans and conodonts are abundant there, and essentially all desirable attributes for the stratotype are met by this section. Conodont data still need amplification, but are a major focus of detailed field investigations by a Russian/American team (V.I. Davydov, T.B. Leonova, C. Spinosa, W.S. Snyder, S.M. Ritter) during the current summer. Overall, the data are adequate and warrant early proposal and approval of this stratotype. V.I. Davydov is Chair of the Working Group charged by the joint ICS meeting in Perm, August 9, 1991, to formally propose this boundary stratotype (Permophiles No. 19, p. 3).

B. Guadalupian Series. The Guadalupian was proposed by Girty (1902) as a chronostratigraphic unit of series rank. Since that time, lithofacies and biofacies relationships in the type area of West Texas have been studied intensively to the extent that this is one of the best understood of all complex sedimentary successions. Participants in the Guadalupian Symposium endorsed the proposal to proceed with formal designation of the Guadalupian as the international standard for the Middle Permian Series (Permophiles No. 18, p. 10-11). Later, the joint ICS meeting in Perm, August 9, 1991 instructed a Working Group (B.F. Glenister, Chair) to provide basic data concerning the suitability of the Guadalupian as a candidate stratotype; reservations were expressed to designation as "Middle" Permian (Permophiles No. 19, p. 3-4). In a detailed formal proposal of the Guadalupian as the international standard for the Middle Permian Series, (Glenister *et al.,* 1992) listed desirable attributes of international standards, and concluded that this stratotype possesses virtually all. Boundaries of the upper two component stages (Wordian and Capitanian) were treated in less detail, but were further amplified by Kozur (1992). A field symposium to review these latter boundaries, Guadalupe II, is under consideration. Meanwhile, the data exist for a decision on the base of the Series, defined within the evolutionary conodont cline from *Mesogondolella idahoensis* to *M. serrata* (Glenister *et al.*, 1992, p. 876-880; L.L. Lambert and B.R. Wardlaw, in prep.). The question of two, three or four-fold subdivision of the System is yet to be resolved (Permophiles No. 21, p. 8-10), but this need not and should not preclude early agreement on selected combinations of stages.

C. Base of Upper Permian Series. Formal definition of the base of an Upper Permian Series is yet to be agreed upon, although acceptable boundary stratotypes have been documented in Transcaucasia and South China (Kotlyar *et al.*, 1984; Kotlyar *et al.*, 1989; Sweet *et al.* eds., 1992). Precise relationship of the base of the lower Upper Permian Stage (Dzhulfian of Transcaucasia or Wuchiapingian of South China) to the top of the upper Guadalupian Capitanian Stage remained uncertain until recently. However, new discoveries of conodonts, radiolarians, fusulinaceans and ammonoids above the traditional top of the Capitanian Stage in West Texas (Kozur, 1991; Wardlaw, in press) now confirm that the Dzhulfian and part of the Dorashamian (Changxingian) stages are present there in objective stratigraphic superposition. Consequently, any one of several reasonable choices for the base of the type Upper Permian Series will allow precise correlation with the West Texas succession, thus affording the basis for a refined redefinition of the top of the Guadalupian and its uppermost Capitanian Stage. In turn, this will enhance the status of the Guadalupian as the international standard for the Middle Permian Series.

D. Cathedralian Stage. Classic Lower Permian stages (Asselian, Sakmarian, Artinskian) have type areas in the Urals, and have been the subject of intensive investigation for decades. They already serve effectively as international standards, and the 1991 joint ICS meeting in Perm authorized establishment of a working group (B. Chuvashov, Chair) to provide formal proposals for the base of the Sakmarian and Artinskian (Permophiles No. 19, p. 4). The base of the Asselian and coincident systemic boundary, considered earlier herein, are the responsibility of the C/P BWG.

Definition of the Artinskian Stage implicates its relationship to the basal Guadalupian Roadian Stage. Faunal studies of the West Texas Lower Permian succession, particularly of fusulinaceans and conodonts, have suggested that an interval of stage dimensions separates the top of the Artinskian from the base of the Roadian. The type section of this stage should be selected in objective stratigraphic succession above the type Artinskian or below the type Roadian, in order to minimize dependence on subjective correlations. The interval in question corresponds generally to the Kungurian of the Urals, but restricted sedimentary facies and consequent paucity or absence of the more useful biostratigraphic groups (ammonoids, fusulinaceans, conodonts) precludes utility of this stage as international standard. Normal marine facies and diverse biota make the sub-Roadian interval of West Texas a more attractive choice, although there may be access problems with prospective type sections. The Cathedralian Stage has been proposed (Ross and Ross, 1987, p. 145) for this interval, based upon the Cathedral Mountain Formation that directly underlies the type Road Canyon Formation. The 1991 joint ICS meeting in Perm authorized establishment of a working group (B.C. Wardlaw, Chair) to investigate the desirability of formalizing this sub-Roadian stage (Permophiles No. 19, p. 4).

E. Permian/Triassic Boundary. Definition of the base of the Triassic and recognition of component Upper Permian stages are so interrelated that they should be considered together. Attractive candidates for Upper Permian stratotypes are reasonably well known from Transcaucasia and South China. Traditionally, the base of the Triassic is defined by the appearance of the ceratitid ammonoid *Otoceras woodwardi* (Tozer, 1988), a representative of the most advanced otoceratids. Ancestral otoceratids, the Araxoceratinae, are widespread, and their appearance coincides closely with the base of the Dzhulfian Stage and concurrent base of the Upper Permian (Spinosa and Glenister, in press). However, there is no known instance in which confidently identified *Otoceras* overlies the succession of Araxoceratinae in objective stratigraphic succession. A possible explanation for this situation is that *Otoceras* may be congeneric with advanced araxoceratins from the post-Dzhulfian Dorashamian Stage (Bando, 1979), but is merely better preserved and larger than this comparable but penecontemporaneous material. Strong independent support for these suggested correlations is provided by conodont studies (Sweet, 1992), in which the range of *O. woodwardi* is interpreted as corresponding approximately to the Dorashamian Stage. Collectively these considerations seriously detract from the potential value of *O. woodwardi* for definition of the base of the Triassic. Responsibility for this boundary lies primarily with the Triassic Subcommission and its P/T BWG. However, the resolution of the joint ICS meeting in Perm (Permophiles No. 19, p. 5) bears repeating, namely to "Urge the Permian/Triassic boundary working group to:

a) evaluate new data concerning boundary especially from conodonts, and

b) investigate the possibility of placing the boundary higher in the succession than *O. woodwardi*".

Again, definition would be best "... devised arbitrarily but for convenient, practicable recognition within a single evolutionary continuum ...".

F. Series-Level Groupings. Traditionally, the Permian System has been subdivided into Lower and Upper Series, but both tripartite and tetrapartite groupings have been proposed (Glenister *et al.*, 1992; Leven, 1992). All three alternatives should remain open for now, but it seems premature to focus on groupings of stages before agreement on definition of the stages themselves. Four series, with boundaries at the base of the Asselian, Artinskian, Roadian and Dzhulfian (or Wuchiapingian) could prove to have grossly similar durations (Menning, 1992), a desirable but unessential quality. Twofold subdivision may be favoured for priority considerations, and the threefold subdivision could maintain geographic coincidence of virtually all stage groupings. Again, the case has been made for de-emphasis of the search for "natural" groupings, either biologic or ecologic. Overall, it seems prudent to maintain awareness of the eventual need for series groupings, but to await stage definitions before final decision on coupling them into series.

III. Schedule

International Geological Congress XXX, Beijing (China), August 1996, represents an achievable goal for consummation of agreements on a number of chronostratigraphic horizons bounding and within our Permian System. Possibilities for profitable international exchanges will occur at the Pangea Conference, Calgary (Canada), August 15-19, 1993; the International Symposium on Permian Stratigraphy, Guiyang (China), August 29-31, 1994; International Congress on Carboniferous-Permian XIII, Kraków (Poland), August 28-September 2, 1995; and probably elsewhere. However, only with active prior international communication through publications such as Episodes and Permophiles, followed by mail ballots, can we hope to capitalize on these opportunities.

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B.F. Glenister
Department of Geology
The University of Iowa
Iowa City, IA 52242-1379
U.S.A.

4. NEWS FROM THE CARBONIFEROUS-PERMIAN BOUNDARY WORKING GROUP

The WGCP is in the process of change. Chairman Wu, after serving admirably and setting the new active course of the working group has retired from the working group for health reasons. This set the working group back a bit, but we seem to be on the move once again. The working group is comprised of the following continuing voting members:

B.I. Chuvashov
J. Utting
C.M. Henderson
B.R. Wardlaw
C.A. Ross
J. Yanagida

Retiring from voting membership in 1992 were:

N.W. Archibold
R. Ingvat
M.V. Durante
Rui Lin
M. Hüniken
Wu Wang-shi

Nominated for working membership are:
V.I. Davydov
Wang Zhihao
C.B. Foster
Zhou Zuren
H. Kozur

Nominated for Chairman:
B.F. Glenister

Nominated for Vice-Chairman:
B.I. Chuvashov (continuing)

Nominated for Secretary:
B.R. Wardlaw (continuing)

We are awaiting the acceptance of the new members and the voting for the leadership, to then get to the business at hand. We hope to seriously consider the boundary proposal of Davydov and others (Permophiles, 1990) in the near future. Future meetings will be in conjunction with the Permian Subcommission, at the International Symposium on Permian Stratigraphy, Environments, and Resources (South China) in 1994, the Carboniferous Congress in 1995, and the IGC in 1996.

B.R. Wardlaw
United States Dept. of the Interior
Geological Survey
Reston, Virginia 22092
U.S.A.

5. NEWS ABOUT THE PERMIAN-TRIASSIC BOUNDARY WORKING GROUP

Following the request made by the ICS and the assemblies of the Subcommissions on Permian and Triassic stratigraphy in Kyoto to reactivate the P/T boundary Working Group, a meeting with the following agenda is planned during the PANGEA Conference in Calgary, August 15-19, 1993:

a. business meeting (new membership, program for the next years, etc).
b. scientific talks and proposals.

Participants to the PANGEA Conference interested in boundary problems are kindly invited to take part at this meeting.

Concerning the chairmanship of the Working Group:

1. Dr. Tozer is no longer Chairman of the Working Group, having served in this capacity since 1981 (Chairman of ICS bodies should be replaced after eight years).

2. Voting members of the P/T boundary Working Group have been kindly asked to express their vote on a new chairmanship.

3. Votes expressed by the WG Members give the following results:

- Prof. Yin Hongfu (Wuhan, China) is elected as new Chairman of the WG with 17 approvals (abstentions 0, objections 0);

- Prof. Yuri Zakharov (Vladivostok, Russia) is elected as new Vice-Chairman of the WG with 17 approvals (abstentions 0, objections 0);

A. Baud
Chairman of the Subcommission on
Triassic Stratigraphy
Geological Museum
UNIL - BFSH2
CH-1015 Lausanne
Switzerland

6. IGCP PROJECT 272: LATE PALAEOZOIC AND EARLY MESOZOIC CIRCUM-PACIFIC EVENTS, 1992

The following meetings were held:

1. Chicago, U.S.A. and field visit, Jackson, Wyoming to Boise, Idaho, June 28 to July 11: 40 participants from five countries.
2. Kyoto, Japan (29 IGC), August 24 to September 3: Symposium - Approximately 60 from 14 countries: Business meeting - 10 from 13 countries.

3. Vladivostok, eastern Siberia and field visit Vladivostok, Nakhodka and Dalnegorsk, September 6 to 13: 60 from seven countries.

Symposia and field visits have now been held (including the 1992 programme) in eastern Australia, New Zealand, Brazil, Argentina, U.S.A., Japan and eastern Siberia (Primorye and Sikhote-Alin).

This year's activities have provided information particularly on the following events:

1. The remarkable nature of the mid-Permian (twofold Permian subdivision). This was examined on the craton and terranes of North America and in Primorye and is marked in all these areas by regression followed by widespread transgressive and/or angular unconformity. In Primorye and in western America and to a lesser extent in cratonic North America, large scale predominantly intermediate and acidic volcanicity occurs. Discussion at the meetings indicated that this has worldwide

character and is often accompanied by the beginning of strong compressive folding. In the Upper Permian most sedimentary basins in the world have volcanics (often ignimbritic) and or volcanic detritus, a feature quite different to that of the present world. This time is also important for mineral formation as, for example, in both cratonic and terrane North America. The project has not been able to follow this up to any extent and this would be an objective for further work.

2. Although questions remain on stage definitions, further information shows the Midian-Dzhulfian boundary (Middle to Upper Permian of Japanese scale) is another time of strong, tectonic, volcano-magmatic, environmental and biological change.

3. The major regression of the uppermost Permian. In North America, both craton and terrane, a distinct hiatus is present compared with eastern Asia (Japan, China, Indo-China, Vietnam, Thailand and Primorye) although in Primorye and Japan a distinct angular unconformity is found.

4. A distinct event at the beginning of the Anisian was tabulated in New Zealand, China and in the Tethyan and North American regions. This could form the basis of further synthesis.

5. The end Ladinian and Carnian-Norian (Middle to Upper Triassic event is complex and the project has pointed the way to how synthesis might be undertaken.

6. A major change occurs at the Triassic-Jurassic boundary with a breakup of the widespread carbonate platforms by deep tensional faulting and the initiation of a vast episode of predominantly basic volcanism with strong changes in the environment affecting the sea, land and atmosphere and its life. Next to the end Palaeozoic and the end Cretaceous, is the major change of life associated with this boundary.

As 1992 is the last active year of the project, a summary of the overall achievements follows.
The objective of the project was to identify geological events in the Late Palaeozoic and Early Mesozoic in the Circum-Pacific particularly in terms of their correlation in time and to compare them with other parts of the World.

A major outcome has been to show that significant events are coincident or closely associated in time with the units of the Standard World Geological Stratigraphical Scale on which the World Standard Geological Time Scale is based. In addition, although it was not an objective of the Project, an important contribution has been made towards developing the reliability and preciseness of the Permian and Triassic time scales.

All the events tabulated below are associated with strong regressive-transgressive events, giving considerable confidence in their recognition.

1. The late Carboniferous is a time of significant continentality. This is terminated by widespread marine transgression in the earliest Permian accompanied by a change from marked compression to more predominantly tensional and vertical movement and greater basic magmatic activity. The biological change although distinct is not major.

2. The mid-Permian is again marked by a distinct regression distinct biological change and remarkably widespread folding and predominantly acidic and intermediate volcanic activity.

3. The project has been able to tabulate for the first time a major change within the Upper Permian associated with the Midian-Dzhulfian boundary where there are important biological, sea-level and tectonic and magmatic-volcanic events. This boundary has often been taken as the top of the Middle Permian.

4. More work has been done on the Permian-Triassic, not only marked by perhaps the most far reaching regression of the Phanerozoic and major extinctions but apparently traumatic volcanism, angular unconformity and strong compressive and apparently vertical movements.

5. The events of the Lower-Middle and the Middle-Upper Triassic seem similar in character to the Midian-Dzhulfian. Strong compression seems associated with deep crustal fracturing or "rifting" accompanied by strong magmatic-volcanic activity with a consequent affect on the environment.

6. At the Triassic-Jurassic boundary there is apparently a major change in earth structure, ending, for example the carbonate platforms characteristic of the Triassic and their palaeoecological and life systems. The Jurassic is marked by widespread deep crustal fracturing sometimes referred to the breakup of Pangaea, basic magmatic-volcanic activity, major changes in the environment and a major change in life possibly second within the Phanerozoic only to that of the Permian-Triassic and the Cretaceous-Tertiary.

With the exception perhaps of the Carboniferous-Permian the major biological changes accompany the events detailed above. The biological changes in between appear to be of a lesser order as for example the changes between the stages of the interval between the mid-Permian and the Midian-Dzhulfian boundary and between the two stages between the Midian-Dzhulfian and the top of the Permian.

In the work of the project, there is a distinct indication that the times of major change recognized, coincide with important mineralization and formation of deposits of commercial importance. This might be of interest for further amplification. No close association between climate and palaeomagnetic change with these events has so far been recognized, although a distinct world warming may occur at the mid-Permian from the development of cosmopolitan marine faunas at this time.

Consideration of terranes has not been within the scope of the project, but the work has shown some interesting relationships such as the similar stratigraphical development of the western North American terranes and the adjacent cratonic area. The terranes largely differ in their magmatic-volcanic development.

J.M. Dickins
Project Leader
Australian Geological Survey
Organization
P.O. Box 378
Canberra, A.C.T., 2601
Australia

7. IGCP PROJECT 359: TETHYAN, CIRCUM-PACIFIC AND MARGINAL CONDWANAN LATE PALEOZOIC AND EARLY MESOZOIC CORRELATION (BIOTA, FACIES, FORMATIONS, GEOCHEMISTRY AND EVENTS)

I. Short Name of Project

Correlation of Tethyan, Circum-Pacific and Marginal Gondwanan Permo-Triassic

II. Brief Outline and Main Objectives of the Project

The proposed project is a successor to IGCP Project 272: Late Palaeozoic and Early Mesozoic Circum-Pacific events and intercontinental correlation. Late Palaeozoic and Early Mesozoic are the intervals known for the integration and separation of Pangaea, the closure of the Palaeotethys and opening of the Mesotethys. Remarkable phenomena include late Palaeozoic glaciation and succeeding extensive evaporite and reef formations, the end-Palaeozoic regression, the Permo-Triassic biotic macroextinction, strong orogenies (Hercynian, Uralian, Hunter-Bowen and Indosinian) and widespread volcanism (e.g. the Tunguss Trap and the Emeishan Basalt) and magmatism. These events resulted in the formation of enormous reserves of coal, petroleum, evaporites, phosphorites and metal-ores. The Late Palaeozoic-Early Mesozoic thus constitutes a time interval particularly important both for understanding the Earth's history and for exploration of mineral resources.

The proposed project should be complementary with the ongoing international Workshop for Global Sedimentary Geology Program Project 2: Pangea and Subcommissions on the Carboniferous, Permian and Triassic. It will emphasize the following events:

1. Biotic events. This includes evolutionary history of major fossil groups, their stratigraphic zonation and intercontinental correlation. The Permo-Triassic macro-extinction will be further investigated in more regions, and involving more aspects with higher accuracy. Study of the Triassic-Jurassic extinction will also be carried out.

2. Sea-level events. The project will pursue more reliable stratigraphic correlations and more comprehensive basinal analysis on an intercontinental scale. Sea level changes accomplished through sequential stratigraphy, ecostratigraphy and other approaches will be established from Carboniferous to Triassic to complement Vail and Haq's works. Major regressions (such as the Permo-Triassic one) and their influence will be specially worked at.

3. Palaeogeographic, palaeoclimatic and palaeobiogeographic events. Implications of the evolution of Palaeotethys, Mesotethys and Palaeo-Pacific on palaeogeography, palaeoclimate and palaeobiogeography will be expounded.

Different hypotheses on the history of Pangaea, Tethys and Palaeo-Pacific will be examined with information from interdisciplinary researches.

4. Tectonic, volcanic and possible extraterrestrial events. This project will study the Hercynian, Hunter-Bowen and Indosinian Orogenies and their results in Tethysides and Cimmerides, as well as the major volcanic activities and reliability of the alleged Permo-Triassic extraterrestrial event. Besides traditional approaches of petrography and structural geology, emphasis will be placed on data from geochemistry, palaeontology, stratigraphy and palaeogeography.

Prof Yin Hongfu

8. PERMIAN IN WESTERN ASIA

Recent paleontologic and stratigraphic research gave the following results (see fig. 1):

- Complete sections of Devonian-Triassic Jurassic sediments exist at the North of autochthonous Taurus called **Tauridia.** This record presents minor sedimentation gaps between Asselian and Artinskian marked by a special ferrigenous facies "*Girvanella* limestone" and sandy limestones and sandstones.

- **Tauridia** presents Lower Paleozoic detritals, transgressed by Mesozoic, Middle Upper Triassic or younger carbonates without any relics of Middle-Upper Carboniferous or Lower Permian (Güvenç, 1981).

- At the South of **Tauridia** the Lower Paleozoic sediments (Cambrian-Ordovician-Silurian) are covered partly by continental red Devonian detritals and transgressive Lower Carboniferous marine carbonates.

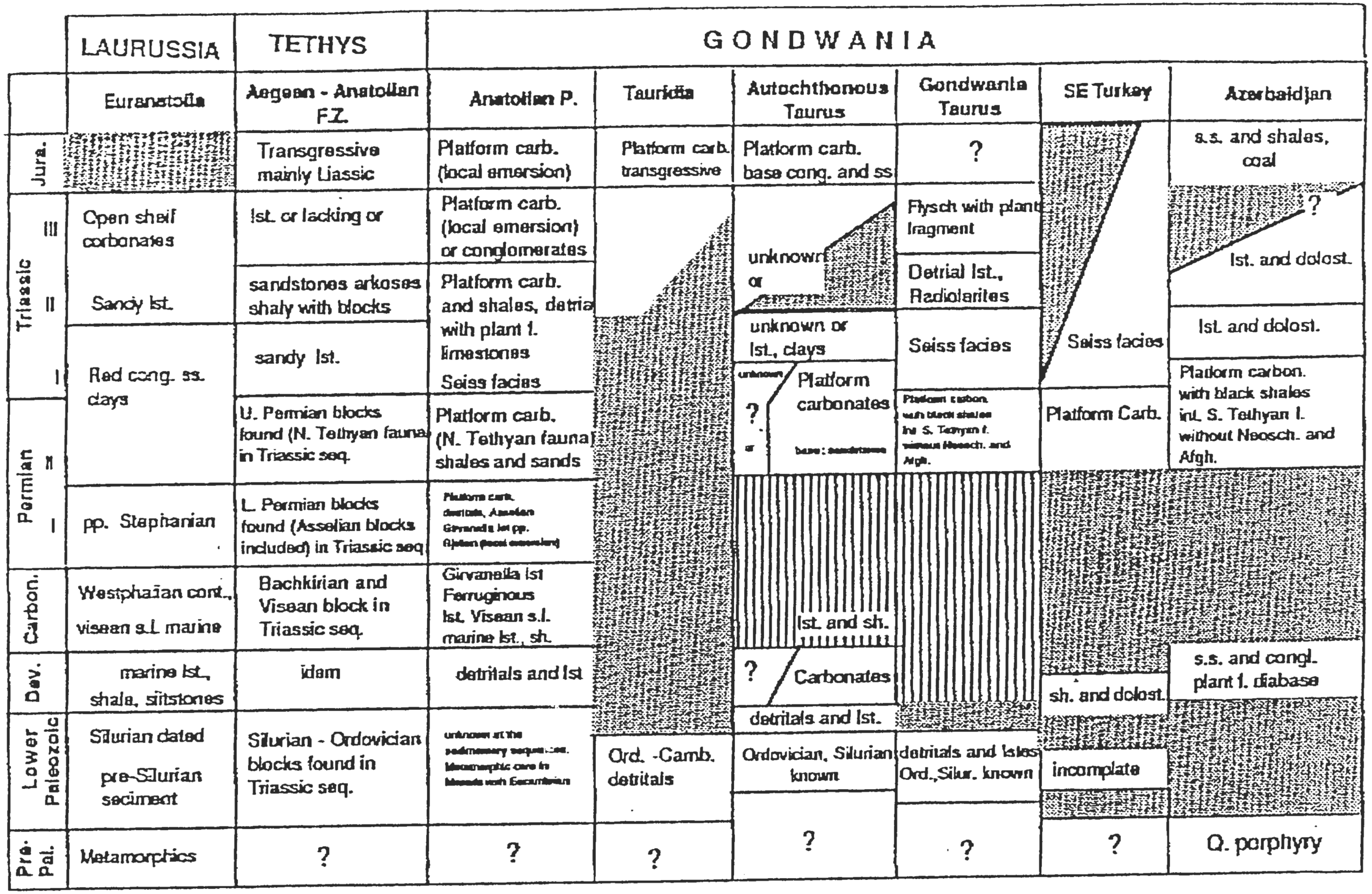

Fig. 1: Correlation of different sections of Euranatolia (Laurussia), Aegean-Anatolian Fracturation Zone and Gondwania (Anatolian Platform, Tauridia and Gondwanian or Southern Gulf of Tethys)

The sequence presents an important gap between Lower Carboniferous and Upper Permian. The Upper Permian black carbonates and shales present an Azerbayjanian fauna and distribution of these sediments is limited at the South of **Tauridia** as a second, restricted gulf of Tethys on Gondwania (or Gondwanaland). By the way, the Gondwania is limited to the north by the North Anatolian Fault (NAF or KAF) including Anatolian Platform of the Middle-Upper Carboniferous and Lower Permian, and at the North of this fault. The Carboniferous-Permian sediments present Moessian-Sythian Platform affinities.

At the South of NAF detrital Triassic and probably Jurassic p.p. sediments containing different carbonate blocks of all sizes (Silurian, Devonian, Carboniferous and Permian and sometimes Middle Triassic in age) are seen from Euboa, Hydra, Mitilini and Chios islands in the Aegean Sea, Karaburun, Bergama, Biga Peninsula, Gemlik, Bursa, Bilecik, Sivrihisar, Ankara, Çorum, Tokat, Turhal up to Erzincan in Anatolia. A fracturation zone is overthrusted mainly onto the South and presents different metamorphic and sedimentary tectonic units (Güvenç, 1982). The metamorphic units are sometimes covered by so-called continental Liassic sediments.

Two new projects are being undertaken, the first at the Aegean-Anatolian zone, in Tauric (Yayla) Belt of Crimea, at the Big Caucasus in the Belaya Valley, Deezy series and in Azerbayjan (Nahchivan), and the second in the Urals, Pre Caspian depression and Taurus Mountains (allochthonous units of Southern Gulf of Tethys).

Different institutions of Russia, Turkey, Caucasian and Central Asia republics will contribute to these projects.

The aim of these projects concerning the Permian is to establish the detailed stratigraphy, marine fauna and flora of Permian sequences of Anatolia, Crimea, Caucasia and Azerbayjan and to determine the faunistic and floristic (algae) bioprovinces of the Northern (Aegean-Anatolian Zone, North of Taurus, Crimea, Caucasus) and Southern (South of Taurus, S.E. Turkey, and Azerbaydjan) Gulfs of Tethys. In this project one of the objectives is also to establish the origin (Sythian or Anatolian Platform ?) of Permian limestone blocks of the Aegean-Anatolian zone, Crimea and Caucasus.

These projects are also open to the institutions in other countries and to international institutions and may cover up to the Pamir in the future.

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Tuncer Güvenç
Ismail Hakki Demirel
Eurasian Geology Group
University of Hacettepe
Faculty of Engineering
Beytepe, 06532 Ankara
Turkey

9. NEWS FROM THE AUSTRALIAN PERMIAN

Following a five week visit to Australia by Katya Bondareva, VNII Okeangeologya, St. Petersburg, small-foram species that occur in both the late Ufimian-Kazanian of the Arctic Basins and the Russian Platform, were identified in Australian assemblages. Their Australian occurrence confirms, through direct evidence, the presence of Ufimian/Kazanian deposits, particularly in Queensland. Earlier faunal studies had relied on more circumstantial evidence of generic comparisons and stratigraphic position to identify possible Kazanian deposits. To aid the study, 19 holotypes from A.A. Gerke's (1950) Nordvik Basin collection were studied and re-illustrated using the environmental (or variable pressure) SEM. The E SEM does not require specimens to be metal (e.g. gold)-coated for study and is therefore ideal for holotype material. Hitherto Gerke's types were known only from line-drawings. Also restudied were foram thin-sections from collections of Gerke (1950) and Sossipatrova (*in* Kalashnikov and others, 1981). Crespin's (1958) Australian Permian types were also re-examined, and are to be re-illustrated using the E SEM. Complete details of the studies by Bondareva, Foster, and Palmieri are being submitted currently for publication elsewhere. This comparative foram study coincides with the completion of a detailed systematic appraisal of Permian foraminiferida from the Bowen Basin, Queensland (eastern Australia) by Palmieri (in press; *Queensland Geology*, Geological Survey of Queensland). The visit was made possible through the Bilateral Science and Technology Program of the Australian Government Department of Industry, Trade and Commerce, and the generous co-operation of the Australian Geological Survey Organisation (AGSO), Dr. D.W. Haig, Department of Geology, University of Western Australia; the Geological Survey of Queensland; and Dr. Vince Palmieri. This project is part of a continuing comparative palaeontological study of the Australian Permian coordinated by Clinton Foster, AGSO.

C.B. Foster
Australian Geological Survey Organisation
G.P.O. Box 378
Canberra A.C.T. 2601
Australia

10. ZONAL DIVISIONS OF THE BOUNDARY DEPOSITS OF THE CARBONIFEROUS AND PERMIAN IN SECTIONS OF DIFFERENT FACIES IN THE SOUTH URALS

The International Congress "The Permian System of the World" took place in August 1991 in Perm. This was preceded by field-trips to the most important sections of the Carboniferous and Permian in the Urals. The participants of the Congress paid especial attention to the problem of the Carboniferous and Permian boundary, and, in particular, the choice of key-sections, which probably would be the most valid for establishing the boundary. As a stratotype for the Carboniferous and the Permian boundary, the section along the Aidaralash stream (Kazakhstan) has been proposed. Here there is a thick sequence of polymict flysh with numerous interlayers of the background argillites. The Aidaralash section contains fusulinids, ammonoids, and conodonts, that have become the standard for establishing the stratotype boundary deposits of the Carboniferous and Permian. The main difficulty establishing the biostratigraphical succession at Aidaralash is the frequent occurrence of reworked organic remains. For this reason, the use of an additional section (paratype) has been suggested. The section along the Usolka River and Dalny Tulkas stream consist of carbonate and carbonate-clay rocks, deposited on the boundaries of the west side of the Preuralyan fore-deep trough. From the Moscovian stage of the Middle Carboniferous to the Artinskian stage of the Lower Permian these units can be traced uninterrupted, thereby indicating gradual deepening of the basin of sedimentation. This package, which begins with bioclastic limestone of shallow-water origin, of the inner shelf, is overlain by micritic limestone and the carbonaceous, argillaceous beds of the Upper Carboniferous. The latter were formed in deep shelf conditions in the zone influenced by upwelling. This explains the scarcity of macro-faunal remains in Gzhelian deposits, and the common occurrence in this part of section of phosphorite-bearing intercalations.

In the Asselian the deepening of the basin is accompanied by the formation of thin-laminated marls with aphanitic limestone argillites, and by the episodic appearance of graded-bedded limestones. A great advantage of the Usolka section is the minimum reworking and the extreme abundance of conodonts in the boundary layers of the Carboniferous and the Permian. However, unlike the Aidaralash section levels with fusulinds and ammonoids are rare. (2, 7, 8).

Detailed data concerning the distribution and composition of assemblages of ammonoids, fusulinids and conodonts in the Aidaralash and Usolka sections have been published (2, 3, 5, 7, 8). However these data, which served as a foundation for the zonal sequence of the boundary deposits of the Carboniferous and the Permian in the respective sections, are interpreted differently by various specialists. In the notes given below all factual material has been analysed in detail; correlation of the Usolka and Aidaralash sections has been made, and certain conclusions concerning the position of the Carboniferous-Permian boundary have been made.

As noted previously, fusulinids in the Usolka section are determined at a few levels. The main emphasis when comparing fusulinids, ammonoids and conodonts zones between the Carboniferous and the Permian, will be concerned with the Aidaralash section. Before discussing the main problem, we shall make necessary explanations, concerning the usage of the respective groups of fossils for zonal sequence of the boundary deposits of the Carboniferous and Permian in the Urals.

At the base of the Asselian of the East-European platform and the Urals there has previously been singled out the "lower" fusulinid zone *Schwagerina fusiformis-Sch. vulgaris*. The characteristics of this zone have been determined by variable composition of the fusulinid complex, in which the index-species were not used for the determining the lower boundary, but purely as a formal function. Moreover, in the majority of the sections they were often not present. A consistent feature has been observed in the distribution of schwagerines, including the fact that their rare representatives, known approximately for 10% of the studied sections, are usually associated with the upper parts of the zone. This peculiarity served as a basis for the subdivision of the "lower" zone into two separate zones: the lower - *Daixina bosbytauensis-D. robusta* Zone - without schwagerines, or with single schwagerines, and the upper - *Schwagerina vulgaris* Zone in which schwagerines may be present. The base of the lower zone has been determined by the appearance of the robust *Daixina vozhgalensis*, *D. robusta*, *D. bosbytauensis* (in the South Urals) and also the occidentoschwagerines; the lower boundary of the upper zone has been associated with the appearance of the index-species or the abundance of schwagerines. That is to say, determination of the zone depends on the facies of the deposits. It is necessary to stress, that the level of the first appearance of *Sch. vulgaris* in different sections is variable, and very often their first appearance is in the higher "middle" zone (*Schwagerina moelleri-Pseudofusulina fecunda* Zone).

The characteristics of this last zone have been determined by the complex of fusulinids. Like the preceding zone, the index-species (*Sch. moelleri-P. fecunda*) may be either absent from the assemblage or appear at any level within the zone.

In 1989 at the conference in Sverdlovsk, when fusulinid specialists of the Carboniferous and the Permian boundary deposits met, they proposed to divide the *Sch. moelleri-P. fecunda* Zone into two sub-zones - the lower *Pseudofusulina nux* and the upper - *Pseudoschwagerina uddeni* sub-zones. Of these sub-zones only the first had a clear lower boundary, which had been determined by the first appearance of the index-species, the position of which in the evolutionary line *Pseudofusulina krotovi-P. sphaeroidea-P. nux* had been previously determined. The systematic analysis of published data from the Urals and adjoining districts of the platform shows, that *P. nux* is a long ranging form and can only serve as an indicator of the lower boundary of the *Sch. moelleri-P. fecunda* Zone. The determination of the upper sub-zone according to fusulinids, has the same drawback as the schwagerines have. That is pseudoschwagerines are seldom found in this part of the section and appear at different stratigraphical levels.

Using recent data we shall subdivide the Aidaralash section, which was previously contradictory, into fusulinid zones. Here we take into account only the comparatively recent, detailed, bed by bed work of V.I. Davydov *et al.* (3, 5). The Aidaralash section has been carefully studied by a group of St. Petersburg specialists, which referred beds 1-10 to the *Sch. fusiformis-Sch. vulgaris* Zone, and beds 21-30 - to the *Sch. moelleri-P. fecunda* Zone. V.I. Davydov compared beds 9-10 with the *Daixina bosbytauensis-D. robusta* Zone, beds 20, 21 and partially 22 were included in the *Sch. vulgaris* Zone and the higher part of the section up to bed 27 inclusive, included in the *Sch. moelleri-P. fecunda* Zone. It is important to note that according to the data of V.P. Pnev and his colleagues, and V.I. Davydov, the first schwagerines and paraschwagerines, occur in bed 10.

According to V.I. Davydov in bed 20 there is the following fusulinid complex: *Triticites* (?) *fornicatus* Kanm., *Rugosofusulina stabilis* Raus., *Dutkevitchia ruzhencevi* (Raus.), *Schwagerina kumajica* Scherb., *Sch. kolvica* Scherb., *Sch. aff. shamovi* Sherb., *Sch.* aff. *fusiformis* Krot., *Pseudofusulina exuberata* Sham., *P. differta* Sham., *P. nux* (Schelw.), *P. portentosa* Sham., *P. versabile* Bensh. and others. In bed 22 supplementing this complex are *Psedofusulina rhomboides* Sham. et Scherb., *P. declinata* Korzh., *P. decurta* Korzh., *P. parafecunda* Sul. and others. In all the carbonate sections of the Urals and the East of the platform this complex characterizes the *Sch. moelleri-P. fecunda* Zone. In our view the fusulinids of bed 20 determine the lower boundary of the *P. nux* Sub-zone. That is if one keeps rigidly to the principle of determining of the boundary according to the first appearance of the typical index-species, consequently beds 20-22 should be referred to the *Sch. moelleri-P. fecunda* Zone.

The higher level of the lower boundary of the *P. nux* Sub-zone (from bed 26) has been subsequently accepted by V.I. Davydov, and accordingly he referred to the *Sch. vulgaris* Zone the fusulinids of bed 25, which include *Dutkevitchia fallax* (Scherb.), *D. ruzhencevi* (Raus.), *Schwagerina moelleri* Raus., *Paraschwagerina ishimbajica* Raus., *Pseudofusulina parva* Bel., *P. exuberata* Sham., *P. conspecta* Sham. et Scherb. and others.

What are the reasons for such divergence in the stratigraphic subdivision of the Aidaralash section according to fusulinids?

1. The upward transposition of the lower boundaries of the *Sch. vulgaris* and *Sch. moelleri-P. fecunda* zones is caused first by the substitution of the index-species of these zones. These index-species have been used as indicators of the boundaries, but this approach is used incompletely and inconsistently by V.I. Davydov.

2. The second reason is the desire to correlate the Carboniferous/Permian boundary using phylogenetically well-founded ammonoids with the analogous boundary based on fusulinids. In the Usolsk section stratigraphically significant ammonoid assemblages (according to M.F. Bogoslovskaya) have been found at two levels: in the upper part of bed 16 and in bed 18 - separated by about 5 metres. In bed 16 taxa include *Neopronorites* sp., *Agathiceras uralicum* (Karp.), *Juresanties* aff. *primitivus* Max. M.F. Bogoslovskaya believes that these ammonoids can be correlated with the Aidaralash assemblages from the Sch. vulgaris Zone, (beds 20-25 - according to V.I. Davydov).

Ammonoids from bed 18 in the Usolsk section include the following species: *Neopronorites tenuis* (Karp.), *Artinskia nalivkini* Ruzh., *Agathiceras uralicum* (Karp.), *Svetlanoceras* aff. *strigosum* Ruzh. According to M.F. Bogoslovskaya this assemblage corresponds to that from *Sch. moelleri-P. fecunda* Zone (beds 26-28) of the Aidaralash section.

There is one more section with which one can compare the ammonoid assemblages of Usolka. We refer to the famous section of Asselian deposits along the Yuruzan River, from where S.V. Maksimova described monographically the ammonoids from two levels of the Holodnolozhskian horizon. One of these levels belongs to the lower part of the *Sch. moelleri-P. fecunda* Zone, the other - to its upper part (tables 1 & 2). Comparison of the systematic composition of assemblages with the earlier mentioned ammonoid assemblage from the Usolsk section, allows one to

Table 1

species	*Sch. moelleri-P. fecunda* Zone	
	lower part	upper part
Uraloceras serpentinum	+	
Eoasianites trapesoidalis	+	
Juresanites primitivus	+	
Eoasianites subhanieli		+
Artinskia nalivkini	+	+
Neopronorites magnus	+	
Prostacheoceras juresanense		+

compare the lower Yuruzan complex of ammonoids with the Usolsk ammonoids of bed 16, and the upper one - with Usolsk ammonoids of bed 18.

The identifications of conodonts, found in the Usolsk and Aidaralash sections, were made by V.V. Chernykh. During the Permian Congress at the conodont colloquium Scott Ritter (U.S.A.) acquainted participants with holotypes of some species of conodonts, originally described by Gunnell. The study of Gunnell's holotype collection indicated the desirability of revising previous concepts concerning the systematics of conodonts of Carboniferous and Permian boundary deposits. In consequence some corrections have been made in the distribution of some stratigraphically important species of conodonts in the Usolsk and Aidaralash sections. In particular we mention the conodont *Stretognathodus wabaunsensis* Gunnell, the appearance of which has been accepted as indicating the Carboniferous/Permian boundary. This species is associated with closely related forms, such as *S. acuminatus* Gunnell. Later we shall discuss some facts which influence our opinions concerning these and other species.

The holotype of the species *S. wabaunsensis* was chosen by Gunnell. This specimen is at the bottom of the evolutionary range of the Upper Carboniferous lobose streptognatodans with the weak dividing of the ribs in the additional lobe. Unfortunately neither the original description, nor the poor photo given by Gunnell, reflect accurately this feature of the holotype. Before studying the holotypes, we, like the majority of Russian conodont specialists, referred to *S. wabaunsensis* only those specimens of the one-lobe streptognatodans, the edges of which formed clearly expressed nodes - that is more evolutionally advanced, than those described by Gunnell. So it is clear, that stratigraphically *S. wabaunsensis* - in Gunnel's opinion may appear earlier, than those highly developed forms which we (up to present) have identified as *S. wabaunsensis*.
Primitive lobate streptonatodans are known in the Usolsk section from bed 14, where they occur in association with *S. elongatus* and the typical Gzhelian conodonts *S. pawhuskensis*, *S. ruzhencevi*, *S. zethus*. There are no fusulinids in this bed, but they are present in bed 13, where the *T. stuckenbergi* Zone is determined by them. Judging by the presence of *S. elongatus*, and *S. ruzhencevi*, bed 14 undoubtedly belongs to the higher zone, at least to *J. jigulensis*, or, more probably, the *D. sokensis* Zone. Thus, the first *S. wabaunsensis* probably appears in this zone.

The discovery in bed 3 of the Aidaralash section of the conodont *S. wabaunsensis* indirectly confirms this supposition. The specimen found here, is more advanced, than the forms, in bed 14 of the Usolsk section, which suggests a higher stratigraphical level of bed 3 of the Aidaralash section in comparison with bed 14 of Usolsk section. It is of interest to note, that the above-mentioned conodonts accompanying *S. wabaunsensis* in bed 14 are absent in bed 3 in Aidaralash. According to fusulinids, bed 3 is referred to the high part of the *D. sokensis* Zone.

So, establishing in both sections the level of the first appearance of the conodont *S. wabaunsensis*, does not result in a conflict of the fusulinid and conodont data: in both sections this species is present at the base of the Gzhelian stage and, probably, at the base of the *D. sokensis* Zone.

Now some remarks concerning the conodont, which we, up to present, identified with species *S. acuminatus* Gunnell. On the photo of this form given in Gunnell's work the rupture of one of the parapets on the level of the end of the median ridge is distinctly visible. This feature was used by us when diagnosing similar forms. However, a survey of Gunnell's holotypes showed, that *S. acuminatus* in reality doesn't have rupture of the parapet and differs

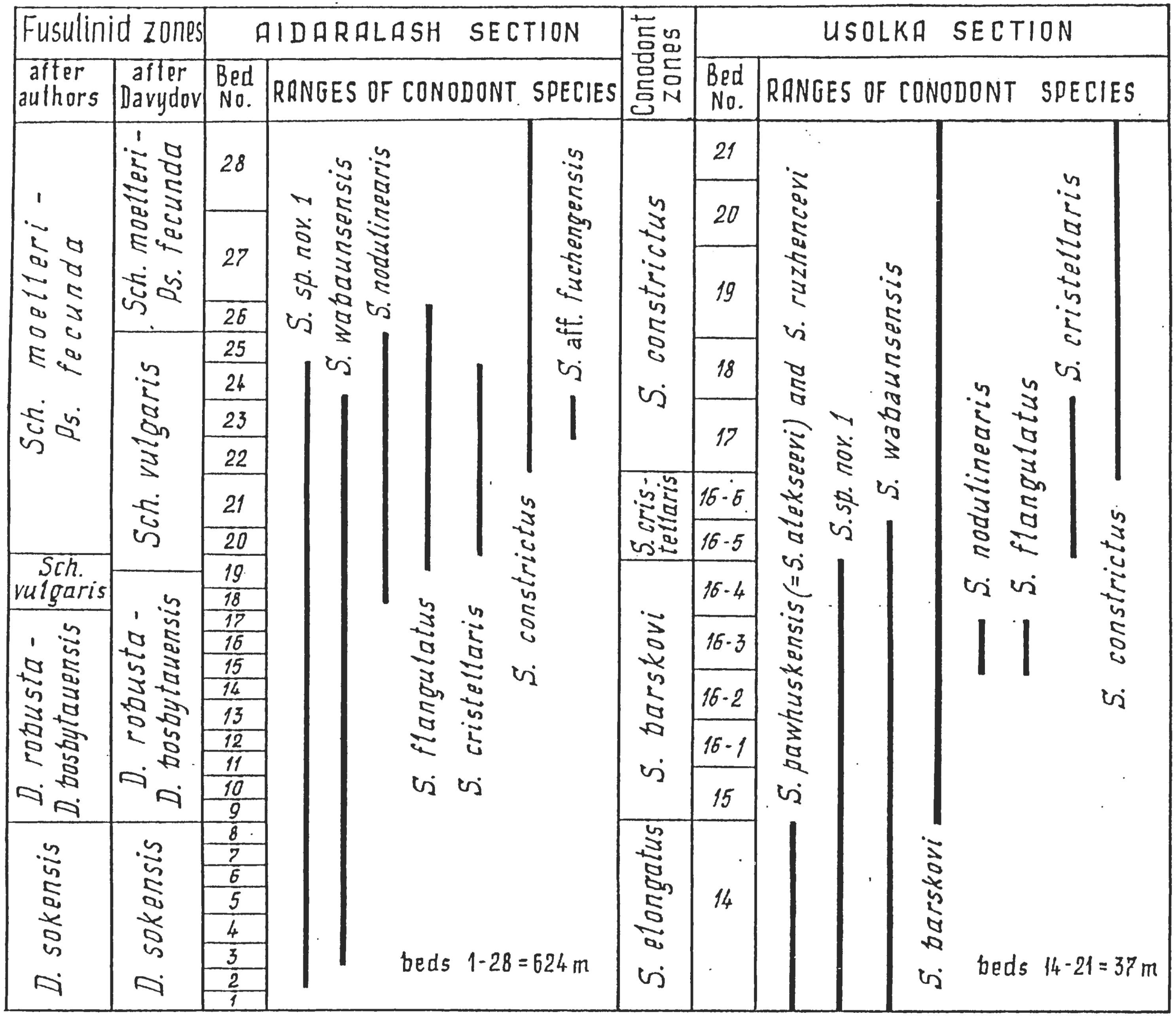

Table 2 Correlation of the Aidaralash and Usolka sections according to fusulinids and conodonts
(Chuvashov, Chernykh and Mizens)

from *S. wabaunsensis* mainly by a longer platform and a bit more development of the nodes on the additional lobe and more probably, these species should be synonymised. The rupture of the parapet is well seen on the holotype *S. walteri*, but this species has the additional lobe with two rows of nodes. So the species, earlier identified by us as *S. acuminatus*, is possibly a new one (*S.* sp. nov. 1). In the Usolsk section this species appears in bed 14, which, according to us, is correlated with the fusulinid *D. sokensis* Zone. In the Aidaralash section the first appearance of *S.* sp. nov. 1, earlier identified as *S. acuminatus*, is at the same stratigraphical level in bed 2. Consequently, this morphologically well-defined species appears in both sections at similar stratigraphical levels, established in the Aidaralash sections by fusulinids.

Now some remarks concerning the upper boundary of the *D. sokensis* Zone, which, according to our interpretation, is situated in the Usolsk section between beds 14 and 15, and is accompanied by a noticeable renewing of the conodont complex. First of all in bed 15 there are no typical Gzhelian forms such as *S. pawhuskensis*, *S. ruzhencevi*, *S. zethus*, which are common in bed 14. Secondly in bed 15 appear peculiar streptognatodans with a broad platform and the noticeable two-sides or one-side pinch of the platform on the level of the end of the middle ridge. Part of such forms with the symmetric (two-sides) pinch of the platform, fully coincides with the diagnosis *S. barskovi*. The author of this species (H. Kozur), who has looked at the collection of the Asselian conodonts agrees with this identification. Up to present these forms have been referred by us to *S.* aff *barskovi*. As far as the close forms are concerned, with one-sided pinch of the platform, they should be regarded as a new species S. sp. nov. 2. This species is easily recognized, and it occurs frequently in bed 15 and is absent in bed 14. So it's quite possible that the upper boundary of the fusulinid *D. sokensis* Zone can be determined by the level of the first appearance of *S. barskovi* and the *S.* sp. nov. 2. Bed 15 is also characterised a great number of narrow simplixoided streptognatodans. These are unknown in bed 14 but range up to the base of bed 16. In the Aidaralash section the upper boundary of the *D. sokensis* Zone is not recognisable by conodonts.

The lower boundary of the fusulinid *Sch. vulgaris-Sch. fusiformis* Zone in the Aidaralash section according to fusulinids, occurs in bed 19 (level 19/6). At that level is the appearance of the characteristic conodonts *S. nodulinearis* and *S. flangulatus*. In the Usolsk section this level corresponds with the base of bed 16/3, which we (from a comparison with the Aidaralash section) correlated with the base of the *Sch. vulgaris-Sch. fusiformis* Zone. This is because the common stratigraphical considerations as the fusulinids haven't been found here. Now taking into account the Aidaralash data, these considerations gain a great importance.

To continue up section at Aidaralash the first appearance of the zonal conodont *S. cristellaris* is in bed 20, that is in the fusulinid *Sch. vulgaris* Zone (according to V.I. Davydov). In the Usolsk section *S. cristellaris* appears beginning with bed 16/5, but fusulinids are absent. However on the right shore of the Yuruzan River 1,2 km from the khutor Kazarbakh this conodont occurs with fusulinids, surely pointing to its presence within the *Sch. vulgaris* Zone. The data of the Aidaralash section supports these results, but they show the possibility of extending the range of *S. cristellaris* in to the fusulinid *Sch. moelleri-P. fecunda* Zone.

Finally, we will consider the question of the lower boundary of the overlying *Sch. moelleri-P. fecunda* fusulinid zone. According to the data this boundary coincides with the appearance of the ammonoid zones *Schumardites-Vidrioceras*and*Svetlanoceras-Juresanites*, which the specialists believe indicate the Carboniferous/Permian boundary.

The analogue of bed 20 of the Aidaralash section one can regard with some degree of possibility as equivalent to the upper part of bed 16 (1 m out of the total thickness of 6 m), whereas bed 22 - surely correlates with bed 17 of the Usolka section.

Thus in both sections there is a questionable interval, corresponding to the upper part of bed 16 of the Usolka River and the beds 20-21 at Aidaralash, which in our view, should belong to the fusulinid *Sch. moelleri-P. fecunda* Zone, and more exactly -to the *P. nux* Sub-zone, which, probably, could be correlated with the conodont *S. cristellaris* Zone. The position of this conodont zone according to the fusulinid scale should have been made clear from the data of the other sections. At present it is clear, that the base of bed 20 of the Aidaralash section either corresponds to the very upper part of the *Sch. vulgaris* Zone, or, which is more possible, can be combined with the lower boundary of *Sch. moelleri-P. fecunda* Zone.

1. In bed 22 at Aidaralash the first conodonts of the characteristic species *Streptognathodus constrictus* have been determined, in association with which in Usolsk (bed 17), and in some other sections, there appears the first mesogondolella that makes this stratigraphical level easily recognized by conodonts.

2. The factual data available concerning the conodonts and fusulinids in the Usolsk and Aidaralash sections don't result in serious contradictions in the stratigraphical conclusions. Both groups of fossils largely complement each other, allowing one to make more reliable comparison of the zonal units of the conodont and fusulinid scales.

3. It is significant that, in the Aidaralash section, where reworking of sediments is considerable, the zonal conodonts and the accompanying assemblages, determined according to their first appearance in the section, are practically the same as those established for the Usolka section, where reworking is insignificant. The additional collections of conodonts, made by us in 1989 at the Aidaralash section from the carbonate-clayish concretions (to lessen the possibility of reworking) did not significantly change the levels of the first appearance of the index-species of zones. Thus *S. cristellaris*, earlier known from the calcarenites of bed 21, has been found in carbonate concretions of bed 20.

These facts allow us to make a general conclusion about the effectiveness of the biochronological scale, marked according to the criterion of the first appearance of species in conditions of considerable reworking. It is clear, for example, that the scales, built according to the other criteria, and in particular according to "escape" would have been found less effective in these conditions. Nevertheless, it is preferable, that the initial scale should be established at sections, in which the reworking is minimal. The Usolka section satisfies this demand, and directly confirms the study of the succession of the first appearance of the index-species in the Aidaralash section.

4. The change in our appraisal of the systematics and characteristics of such important species as *S. wabaunsensis, S. barskovi*, results in à change of the position of the lower boundary of the corresponding conodonts zones. Thus the lower boundary of the *S. wabaunsensis* Zone (if this zone is to be preserved in the conodont scale) should be picked at the base of the fusulinid *D. sokensis* Zone, and the corresponding boundary of *S. barskovi* Zone - at the base of the *D. robusta-D. bosybytauensis* Zone. Incidentally, it is necessary to note that we didn't use this zone and didn't include it in the proposed zonal scale, because it is known that the conodonts, from which Kozur described the species *S. barskovi*, were from South Urals sections, where redeposition is widespread; this prevents precise age determination of the deposits, and the conodonts.

5. Finally, a great number of conodonts from the Carboniferous/Permian boundary beds were described by Gunnell a long time ago and the descriptions were accompanied by poor quality photos. These problems have led to contradictory interpretations by various workers of many stratigraphically important species of conodonts. It is therefore a top priority to carry out the careful revision of the taxonomy of conodonts from this stratigraphic interval by a number of paleontologists from various countries.

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B.I., Chuvashov
V.V. Chernykh
G.A. Mizens

11. THE SCHULTERKOFEL SECTION IN THE CARNIC ALPS, AUSTRIA: IMPLICATIONS FOR THE CARBONIFEROUS-PERMIAN BOUNDARY

The Lower *Pseudoschwagerina* Limestone of the Schulterkofel section of the Carnic Alps (Austria) offers a good opportunity to establish the Carboniferous-Permian boundary in this region, because the shallow marine carbonate facies contain abundant fusulinid limestone beds with only a few, thin clastic intercalations. Therefore this section was measured and sampled in detail, especially its upper part, and special attention was given to fusulinid limestones (Kahler & Krainer, 1993).

The studied section is located on the steep northwestern flank of the Schulterkofel mountain (2091 m) in the central Carnic Alps (Southern Alps), south of Kirchbach in the Gail valley, near the Austrian-Italian border.

In this cliff the upper part of the Carnizza Formation (Auernig Group) and the overlying Lower *Pseudoschwagerina* Limestone (Rattendorf Group) are well exposed and only the uppermost part of the Lower *Pseudoschwagerina* Limestone is missing.

The Lower *Pseudoschwagerina* Limestone is composed of shallow marine limestones with intercalated thin siltstone- and sandstone beds.

Fusulinid limestones are represented by two types of wackestones, both containing large quantities of smaller foraminifers. The fusulinid wackestones rich in sessile foraminifers (*Calcitornella*, *Ramovsia limes*) indicate that the fusulinids represent an autochthonous fauna and that reworking of fusulinid tests was only a subordinate process in a few fusulinid grainstones. This is a very important fact in relation to the discussion of the Carboniferous-Permian boundary in this section.

Limestones rich in fusulinids were found only within the bedded limestone facies both below and above siliciclastic intercalations. This may indicate that the best living conditions for fusulinids existed immediately before and especially after the climax of a regressive phase (sea-level lowstand). The fusulinid limestones were deposited within an protected, shallow-marine shelf environment with normal salinity.

Pseudoschwagerinid fusulinids appear in the upper part of the Lower *Pseudoschwagerina* Limestone, in samples SK 107d (indeterminable species) and SK 108, i.e. between 92 m and 93 m above the base of the section within a bedded limestone facies, immediately above the uppermost clastic intercalation.

The fusulinid fauna is represented by about 30 species belonging to only a few genera. Species of *Triticites* and *Rugosofusulina* dominate, whereas those of *Daixina* and *Pseudofusulina* are rare. A characteristic feature of the fauna is the strong similarity with fusulinid faunas described from Russia as well as from Middle and East Asia. Some of the described fusulinids are new for the Carnic Alps.

The first appearance of *Pseudoschwagerina* and *Occidentoschwagerina* (*Occidentoschwagerina alpina* Zone) in the upper part of the Lower *Pseudoschwagerina* Limestone in the Schulterkofel section defines the position of the Carboniferous-Permian boundary.

According to the fusulinid fauna, the Lower *Pseudoschwagerina* Limestone of the Schulterkofel section is for the most part of Late Carboniferous age (Gzhelian E with *Rugofusulina praevia*, corresponding to the *Daixina sokensis* Zone of the standard fusulinid zones sensu Kahler, 1974, Rotai, 1975; see also Watanabe, 1991).

The uppermost part of the Lower *Pseudoschwagerina* Limestone, however, above the uppermost clastic horizon, is of Early Permian age (Early Asselian) due to the occurrence of *Pseudoschwagerina* and *Occidentoschwagerina alpina* which corresponds to the "*Schwagerina*" *fusiformis*-"*Schwagerina*" *vulgaris* zone of the Russian fusulinid biostratigraphy.

In conclusion, in the Carnic Alps the Carboniferous-Permian boundary is distinctly marked by the first appearance of pseudoschwagerinids and *Occidentoschwagerina alpina*; it lies in the upper part of the Lower *Pseudoschagerina* Limestone. This boundary corresponds to the proposal as discussed by (Kahler, 1985:26) for the definition of the Carboniferous-Permian boundary (for details see Kahler & Krainer, 1993).

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Franz Kahler
Linsengasse 29
A-9020 KLAGENFURT

Karl Krainer
Institut für Geologie und Paläontologie
Universität Innsbruck
Innrain 52
A-6020 INNSBRUCK

12. LATE MURGABIAN MAP AND PALEOENVIRONMENTS OF THE TETHYS

The late Murgabian map is the first (oldest map) of a 14 map set (Murgabian to Tortonian) titled "Atlas Tethys Palaeoenvironmental Maps", J. Dercourt, L.E. Ricou & B. Vrielynck, editors.

This map (Fig. 1) shows Tethys at the time between Hercynian orogeny and Alpine rifting. The late Murgabian time corresponds to the *Neoschwagerina margaritae-Eopolydiexodina* (fusulinid) Zone, to the late *Waagenoceras*-early *Timorites* (ammonoid) Zone or to the *Merrillina divergens*, *Neogondolella sosioensis*, *N. siciliensis*, *N. asserata* and *N. postserrata* (conodont) Assemblage Zone. During this time interval occurs a global maximum flooding surface and high stand marine deposits. Characteristic microfauna and biofacies greatly help the correlations. Based on recently published works, we propose a numerical age of 266-264 Ma and equivalence with the following local stages:

- early Tatarian (Urals),
- middle to late Maokouan (China),
- late Wordian to early Capitanian (W. Texas),
- early Midian of Transcaucasia.

Palinspastic reconstruction for Murgabian time is derived from paleomagnetic and geologic constraints. Four major plates are accounted for:

- Gondwana,
- Laurasia,
- SE Asia and
- the "Permian-Triassic Transit Tethys".

One of the main characteristics of the late Murgabian paleoenvironmental reconstruction is the development of giant shallow carbonate platforms. Most of the reef developments are situated on the African-Arabian margin.

The main terrigenous marine deposits are situated on the north margin of India and on northwest Australia. They also occur along the Eurasian margin from Dobrogea to Kopel Dagh (northeast Iran). Large mixed terrigenous or fine clastic - evaporitic basins are located in the north part of the side of the Urals and on the Arabian platform. The north Caspian depocentre is filled with a very thick pile of evaporites. Large scale continental to marginal marine deposits occur on the northeast Indian plate, on the African plate, on the Brazilian craton and along the southern part of Eurasia.

Recently, new Permian Neotethys deep marine or oceanic sediments have been discovered. They are located north of the Gondwanian margin, from Sicily to Timor, outcropping in melange zone or as exotics. Paleotethys remnants are present in Chios (Greece), in west Turkey, Greater Caucasus, within trapped oceanic sediments of east Iran and within oceanic sediments and radiolarites of northwest Thailand and Yunan.

The complete Atlas (14 maps, Murgabian to Tortonian) with notes, can be ordered from:

CCGM/CGMW
77 rue Claude Bernard
F-75005
Paris, France.

(Price: US$ 185 + $10 shipping).

A. BAUD
Musée de Géologie, UNIL-BFSH2
CH-1015 Lausanne, Switzerland

J. MARCOUX
Sciences physiques de la Terre
Université de Paris VII
2 Place Jussieu, F-75005 Paris, France

R. GUIRAUD
Centre Géologique et Géophysique,
Univ. Montpellier II, F-34095 Montpellier, France

L. RICOU
Département de Tectonique
Université de Paris VI, 4 Pl. Jussieu
F-75252 Paris, France

M. GAETANI
Department of Earth Sciences
University, Via Mangiagalli 34
I-20133 Milanom, Italy

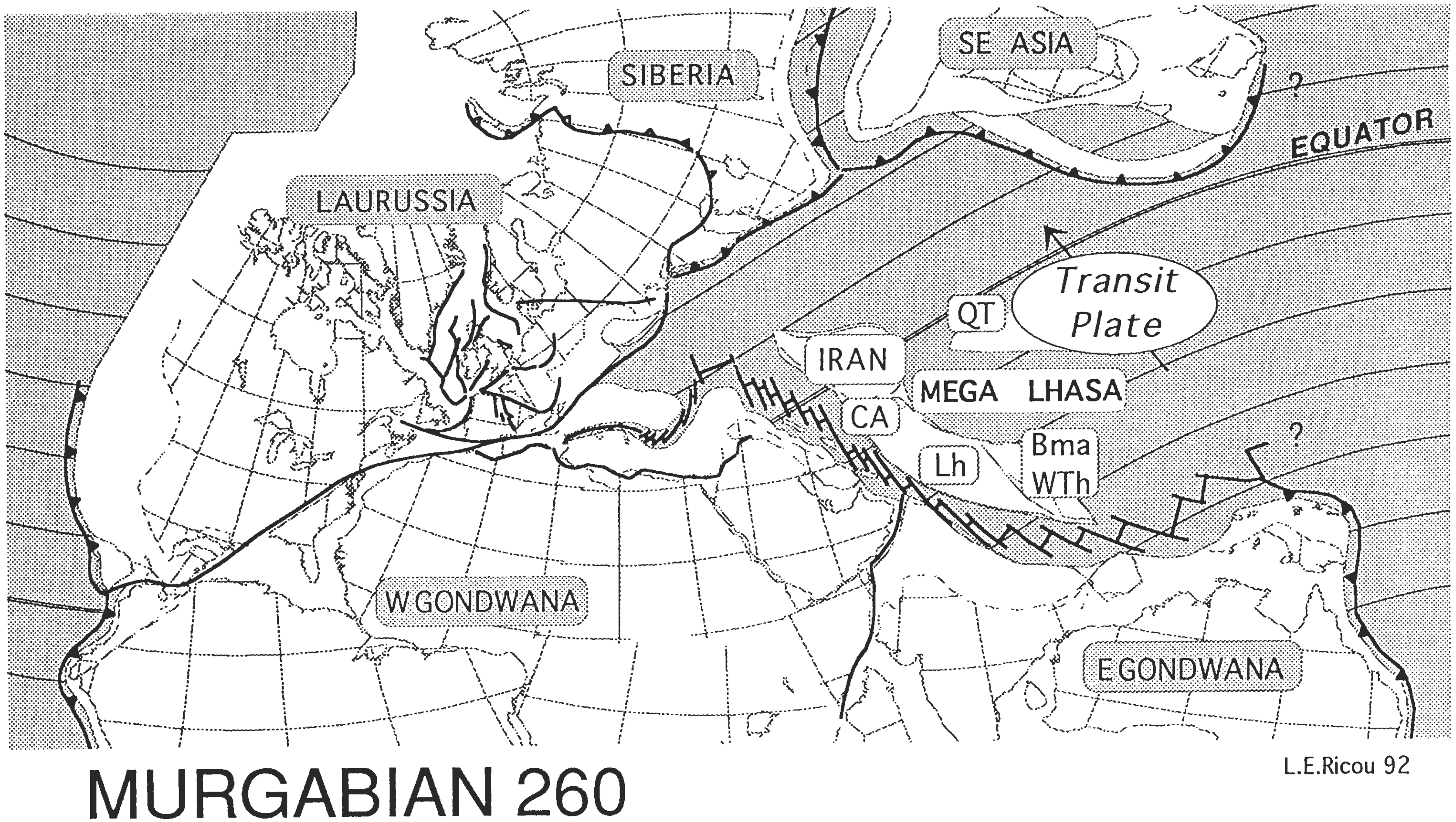

Fig. 1: Plate reconstruction for Murgabian time (L.E. Ricou)

13. PERMIAN ECOSYSTEMS IN ANTARCTICA AND PATAGONIA

After the extensive research that has taken place on plant-bearing sequences of Permian age from Antarctica and Patagonia within the last 10 years, it is now possible to formulate a primary understanding of the composition of the flora and its relationships with the paleoenvironments, as well as the paleoclimatic control. This has been based on an interdisciplinary approach to the study of fossil floras, linking data coming from sedimentology, paleobotany, biostratigraphy, paleoxylology, paleoecology, palynology and coal petrology. Based on this, a first synthesis of the Permian ecosystems for that part of the Gondwana supercontinent has been outlined; a highly contrasting scenario takes places when comparing Antarctica and Patagonia in terms of their paleofloristics, paleoecology and climatic control.

Plant communities in both subcontinents of Gondwana, Antarctica and Patagonia do not show many features in common, particularly during the early Permian. In Antarctica, after almost a complete lack of any vegetational cover during the earliest Permian due to glacial events, the region was gradually occupied by a forest basically composed of the "glossopterid complex" that, step by step, colonized all kinds of environments related to fluvial basins (Taylor *et al.*, 1992; Cúneo *et al.*, in press). The forests developed were high producers of phytomass that gave rise to huge peatland accumulations on flood plains, resulting in the plant communities and the general landscape. The scheme outlined above was maintained up to the late Permian in the whole Transantarctic basin, perhaps with a little decreasing in humidity levels due to the raising of a volcanic arc that acted as a geographic barrier in the S.W. Antarctic paleomargin (Cúneo *et al.*, 1991).

A completely different scenario took place in Patagonia where a highly diversified vegetation, associated with extended deltaic plain systems, has been recorded in the Tepuel-Genoa basin, from latest Carboniferous to early Permian strata (Andreis and Cúneo, 1989; Andreis *et al.*, 1992). One of the most important features in this case is the presence of Euramerican lineage taxa, such as sphenophylls, tree-ferns and some seed-ferns. Coal measures are also present in early Permian formations of Patagonia; they are thick but not extensive laterally.

Middle to Upper Permian beds of the La Golondrina basin, in southern Patagonia, bear phytotaphocoenoses, which are still differentiated from coeval records from the rest of Gondwana, but showing a higher participation of elements of the "glossopterid complex" (Archangelsky *et al.*, 1992). This situation suggests a geographical location of Patagonia more related to the Gondwana realm, a case rather different from that in the earliest Permian. In summary, in Antarctica we have an almost classical Gondwana situation. That is to say very impoverished vegetation at the beginning of the Permian due to maximum distribution in the southern hemisphere of the late Paleozoic glaciation, that evolves to warmer conditions from the mid-Permian. On the other hand the Patagonian subcontinent shows vegetational features controlled by subtropical conditions that, during the rest of the Permian, were maintained, although they show a closer relationship with the rest of Gondwana by the end of the Permian and the early Triassic.

Gondwana Phytogeography During the Permian

This project, which started in 1991, is intended to demonstrate that, during the Permian, the so called Gondwana or *Glossopteris* realm/flora was not necessarily an homogeneous unit in terms of paleofloristics, paleoecology and climates, as traditionally interpreted, and that in most cases this interpretation has been the result of an erroneous understanding of the "glossopterid complex". This is particularly important when considering the biological knowledge concerning many plant groups in the region, as well as their biostratigraphic, ecologic and climatic control, from which, a completely different panorama can emerge. In this study, a new approach has been developed incorporating the use of statistical techniques, such as multivariate analysis, with appropriate computer programs. Based on this, some promising results have shown that Gondwana is phytogeographically a dynamic supercontinent through the Permian, and that a strong differentiation in the vegetation, intimately associated with latitudinal and longitudinal gradients, may have taken place (Cúneo, 1991). This is also useful for a better understanding of the paleoclimatic and paleogeographic features in the region, in particular when the tectonic evolution of the western Gondwana margin is analyzed.

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Dr. N. Ruben Cúneo
Museo Paleontologico E. Feruglio
Av. 9 de Julio 655
Trelwe (9100)
Chubut
Argentina

14. RESEARCH ON THE PERMIAN OF THE BOHEMIAN MASSIF IN THE CZECH REPUBLIC

Geological studies of the Late Palaeozoic of the Bohemian Massif during the last few decades have been carried out mostly in areas being explored for coal deposits. These underlie the platform cover formations where the development and deep structures were not sufficiently known. Intense drilling and geophysical investigation yielded not only new data on the deposits of coal and other industrial materials, but also on the extent, lithology, tectonic structure and stratigraphy of the Permian sediments in the Czech Republic. New data were obtained especially from the Central Bohemian and Sudetic regions, where the Late Palaeozoic sediments underlie platform cover formations. The studies were mainly focused on the deep structure and complete stratigraphical sequence of basinal fills.

The Permian rocks of the Czech Republic are represented by molassoid fills of the intermontane depression of the Bohemian Massif and are exclusively of continental origin. According to the division of Falke (1972), they belong to the Variscan (Central European) province and originated in the postgeosynclinal phase of the Variscan orogenic cycle. The development of these basins suggests a gradual cratonization of the individual parts of the Bohemian Massif. In the Autunian, the filling of the depressions was terminated. The Saxonian and Thuringian sediments are already of the platform type.

The lower Autunian sediments are represented in all the Czech Permian basins. In the Stephanian C and lower Autunian periods the area of sedimentation was of the largest extent of all the continental Late Palaeozoic sedimentary covers of the Bohemian Massif. During the upper Autunian, Saxonian and Thuringian the sedimentation area was reduced.
Stratigraphical Review

The Permo-Carboniferous basins are developed in the following regions:

1) Sudetic area (with the most complete stratigraphical sequence from Namurian to lower Triassic),

2) Central and western part of the Czech Republic (with the stratigraphical sequence from Westphalian B to lower Autunian, in the Krusné hory Mts. from Westphalian A to Permian),

3) The fillings of the Blanice and Boskovice furrows stratigraphically correspond with upper Stephanian and mostly lower Autunian.

The dating and biostratigraphy of the Permian basins in the Bohemian Massif are based mostly on the study of fossil floras which are richly represented in the coal-bearing formations. Palaeobotanical findings can be combined with the results of palynological and zoopalaeontological studies. The present state of knowledge is given in this contribution below.

Some lithostratigraphic units are not palaeontologically documented. The stratigraphy of these sediments is based on marker bands which facilitate the correlation of individual districts as well as that of entire basins. Among them horizons of tuffaceous layers are the most important.

The Permo-Carboniferous sedimentation, with respect to the uplift of the Massif, migrated from its central part to the margins and the sedimentation trend moved from the west to the east. The youngest deposits (postsaalian sediments) were therefore preserved in the north-eastern part of the Massif only.

The Permian sediments are missing in western part of the Czech Republic - the deposition of the Late Palaeozoic ended during the Stephanian period. Lithostratigraphic correlations suggest they are present in the region of Central Bohemia and the Krusné hory Mts., although there is no biostratigraphic evidence to confirm this. The most complete development of the Permian can be observed in the

Sudetic region and in the so called furrows (Blanice and Boskovice), where the presence of Permian rocks is supported by palaeontological data. The complete Permian sequence, as far as stratigraphical development and regional extent is concerned, exists in the Sudetic region, where the post-saalian strata up to the lower Triassic are developed as well. The largest extent of the Permian on the territory of the Czech Republic can be assigned to the upper Stephanian to lower Autunian periods. Several dozen boreholes in the Mseno and Roudnice basins make it possible to approximately outline hidden Permo-Carboniferous sediments between the Kladno Basin (in the west) and the Krkonose Piedmont Basin (in the east).

New data were also obtained from the Ceská Kamenice Basin, where a borehole northwest of Ceská Lípa yielded a complete profile through the Late Palaeozoic strata belonging to the upper Stephanian to lower Permian. The sequence, corresponding in the Central Bohemian region to the Líne Formation, indicates, in terms of lithological development, a similarity with the Sudetic Permo-Carboniferous facies. In the stratigraphical sequence it is possible to distinguish an equivalent of the Vrchlabí Formation with the Rudník (Hermanovy Sejfy) Horizon at the base and the Semily Formation (upper Stephanian).

Stratigraphical studies in the Krkonose Piedmont, Mnichovo Hradiste and Mseno basins confirmed the correlation of the Semily and Vrchlabí formations in the Sudetic region with the Líne Formation in the Central Bohemian region.

The research of the deep structure of the basin fills enables us to consider the Mnichovo Hradiste Basin as a key area for the stratigraphical correlation of the Central Bohemian and Sudetic regions as well as the Blanice Furrow.

Deep drilling carried out in the frontier area between the Czech Republic and Poland enabled a correlation between the Czech and Polish flanks of the Intra-Sudetic Basin (R. Tásler-V. Holub, 1982), where a complete profile of its fill was obtained near Broumov in the Czech flank of the basin through the entire Permian and Carboniferous basinal fill from the Broumov Formation (of Autunian age) to the base (2,500 metres).

A new correlation between the Intra-Sudetic and the Krkonose Piedmont basins was proposed in which a new classification of the Broumov Formation should be emphasized (V. Holub-H. Kozur, 1981, R. Tásler-F. Valín, 1982).

Palaeontology

Palaeontological research of the uppermost Stephanian and Permian has been focused on the Krkonose Piedmont Basin in recent years. The Rudník and Háje horizons of the Vrchlabí Formation (early Autunian age) have been studied in detail. A five hundred metre long stratigraphical section along the new road cut at Vrchlabí offered plenty of material for study.

During the phytopalaeontological research carried out by Z. Simunek, thirty eight plant fossil taxons have been discovered in the Rudník Horizon near the town Vrchlabí.

The species *Annularia carinata*, *Calamites gigas* and *Calamostachys dumasii* from sphenopsids, *Rhachiphyllum schenkii* and *Gracilopteris bergeronii* (from callipterids have been newly determined. *Neuropteris cordata*, *Neuropteris zeilleri* and *Taeniopteris abnormis* from pteridophylls are included among the species identified at this locality.

Dicranophyllum longifolium was determined from the Rudník Horizon for the first time. The Háje Horizon was studied in the neighbourhood of Semily and sphenopsids (*Calamites gigas*, *Calamostachys dumasii*), pteridophylls (*Pecopteris* ex. gr. *plumosa-dentata* and *Odontopteris* cf. *lingulata*) were determined at that horizon. *Walchia piniformis*, *Otovicia hypnoides*, *Culmitzschia angustifolia* and *C.* speciosa were recorded as well. The palaeobotanical research verified the affiliation of the Rudník and Háje horizons with lower Autunian, the *Autunia conferta* Zone. As far as the floral data are concerned, both the horizons are very similar. During the sedimentation of the Háje Horizon the impoverishment in the species of flora known in the Rudník Horizon occurred. It is evidently caused by progressive aridity. In spite of the fact that the series *Arhardtia scheibei* occurs rarely in both horizons, it is not possible to assign stratigraphically the Háje Horizon to the upper Autunian *Arhardtia scheibei-Rhachiphyllum lodovensis* Zone, as was proposed by H. Kozur (1990). The species *Rhachiphyllum lodovensis* does not occur in the Krkonose Piedmont Basin and abundant discoveries of *Neurodontopteris auriculata* in both above-mentioned horizons do not support this conclusion (last occurrences of the *N. auriculata* are known from the lower Autunian only).

Palynological research has been performed by J. Drábková. Pollen grains are more abundant than spores in the Rudník Horizon miospore assemblage. Monosaccate pollen grains form 92 percent of the assemblage. The genus *Potonieisporites* is dominant. The genus *Florinites* is relatively abundant, while genera *Candidispora* and *Wilsonites* occur sporadically. Bisaccate pollen grains total about 5 percent, the genus *Vittatina* 2.5 percent and trilete and monolete spores 0.5 percent. The following genera of bisaccate pollen are present:

Pityosporites
Vesicaspora
Alisporites
Lueckisporites
Illinites
Protohaploxypinus
Limitisporites

In the miospore assemblage of the Háje Horizon small monolete spores are abundant and comprise 76 percent of the miospore assemblage. The genus *Punctatosporites* is the most abundant. The genus *Laevigatosporites* is less frequent. The spores of the Triletes group form 20 percent of the total amount (7 percent *Leiotriletes*, 6 percent *Calamospora*, 3 percent *Verrucosisporites*, and rare *Polymorphisporites*, *Punctatisporites* and *Cyclogranisporites*). Monosaccate pollen grains of the Háje Horizon are represented mainly by the genera *Potonieisporites* and *Florinites*. The genera *Candidispora*, *Wilsonites*, *Nuskoisporites*, *Vestigisporites* are not abundant. The following genera of bisaccate pollen are present:

Illinites
Pityosporites
Alisporites
Limitisporites
Vesicaspora
Jugasporites
Lueckisporites
Protohaploxypinus, etc.

The Rudník and the Háje horizons can be classified with the *Vittatina costabilis* Zone (Clayton *et al.* 1977). The high proportion of *Vittatina* and the diversity of bisaccate forms in the coal-barren samples of the Háje Horizon demonstrate that the Háje Horizon is younger than the Rudník Horizon. The genus *Polymorphisporites* is abundant within the Háje Horizon and has a biozone peak in the middle part of the *Vittatina costabilis* Zone.

The research of the Permian fauna, performed by J. Zajíc and S. Stamberg, has been besides the Krkonose Piedmont Basin and focused on the Intra-Sudetic and the Central Bohemian basins. This research led to a biozone, based on vertebrates, being established at the Stephanian/Autunian stratigraphical level. The study of ichtyolites (teeth, scales, etc.) appears to be very promising for defining the Carboniferous/Permian boundary. The existence of a bioevent at this stratigraphical level is presumed. The amphibian *Melanerpeton* sp. K was described from the Krkonose Piedmont Basin (lower Autunian). New uppermost Stephanian taxa discovered in the Central Bohemian area (for example, hybodont shark ?*Limnoselache* sp. or amphibian *Branchierpeton* cf. *B. saalensis* are comparable with discoveries in coeval beds of the Saale Basin (Germany). Faunal research has been directed recently to finishing the research of Stephanian acanthodians, description of new palaeoniscoid fish and to the comparison of the Stephanian fauna of the Czech Republic with the fauna of the Plateau Central in France (in collaboration with D. Heyler and C. Poplin).

The continuing discussion on the stratigraphical division of the Cental Bohemian region has shown that in spite of a long tradition and advanced stage of research many problems are still unsolved. Further detailed stratigraphic work is needed on the Líne Formation. Worth mentioning are the difficulties with the correlation of marker horizons of this formation in the Kladno and Roudnice basins.

Sedimentological and litho-facies research of the Thuringian in the Czech Republic carried out by V. Holub and K. Stapf of the Mainz University in Germany yielded some new results. The first findings of organic origin were found there: bacterium-pellets, halobacterium stromatolites and ooids. Typical calcrete caliches occur and prove the existence of the sabka facies during that time span. Local thin limestone crustification were discovered in the upper part of the Autunian strata in the Sudetic and Central Bohemian regions.

Issued in the last decade were the geological and palaeogeographical map of the Bohemian Massif (Czech Republic) at 1: 1 000 000 scale (V. Holub *et al.*, 1981), and the geological map of the Broumov area (R. Tásler-V. Prouza *et al.*, 1980) and of the Krkonose Piedmont Basin (V. Prouza-R. Tásler *et al.*, 1985) both at 1:100 000 scale. The Atlas of the palaeogeographical and palaeofacial maps of the Permo-Carboniferous (V. Holub-J. Pesek-V. Skocek) and the geological map 1:500 000 (V. Holub-V. Prouza) are in preparation.

The Carboniferous/Permian boundary, according to recent data, displays a specific situation. It occurs partly within lithological continuous sequence. However, in some areas a sedimentary break is developed. We shall discuss this in the next contribution.

V.M. Holub
Geological Survey of the Czech Republic, Prague
Malostranské nám. 19
Czech Republic

15. RECENT PUBLICATIONS OF INTEREST

The Guadalupian: Proposed international standard for a Middle Permian series

The present volume comprises a selection from papers presented at the International Congress: Permian System of the World. This meeting was held August 5-10, 1991, in Perm, Russia, on the occasion of the 150th anniversary of Roderick Murchison's founding of the Permian System. It gained in significance because for the first time in over fifty years foreign registrants were able to participate in excursions to view Permian type sections. Meetings of the Subcommission on Permian Stratigraphy and the lower and upper Boundary Working Groups for the System were also held to coincide with the Congress.

From the program and papers selected by the original Russian Congress editorial board of:

Drs. V.I. Chuvashov
V.A. Molin
V.A. Chernykh
V.P. Ozhgibesov
V.V. Chernykh
N.A. Sofronitsky
V.J. Kopnin

the selection and editing of an initial group of papers was made by Chuvashov, Glenister, Nairn and Wardlaw. This selection was based upon broad scientific interest and more specifically to reflect questions of global correlation of the Permian System. A second selection of papers will appear in subsequent issues of *International Geology Review*. Each will carry a footnote identifying it as a paper contributed to the Permian Conference.

Perm Papers with a narrow focus will appear in the Occasional Publications of ESRI (new series) of the University of South Carolina. Field guides developed for the Perm Conference also will appear in this publication series.

International Geology Review
Vol. 24, No. 9 September 1992

16. TAPHONOMY AND PALYNO-POPULATION

Newer interpretative methodology has been introduced for the estimation of the loss of fossil spores and pollen in palynofloras. Earlier palynological investigations in Gondwana apparently indicated that several sequences were barren of, or impoverished in, palynomorphs. Recently a group of palaeopalynologists - Dr. R.S. Tiwari, B.K. Misra and (Ms) Vijaya, at the Birbal Sahni Institute of Palaeobotany, Lucknow have taken up the taphonomic studies of spores and pollen in the Gondwana Sequence of India. This sequence ranges in age from Early Permian to the late Early Cretaceous. The post-mortem history of the palynomorphs in this sequence indicates some specific depositional alteration in the exines and organizations of spores and pollen. It has been found that it is the taphonomic factor, viz. nacrolysis, biostratinomy and diagenesis, which make the sediments barren, impoverished or palynoferous.

The advent of the Gondwana sequence is witnessed by a glacio-fluvial environment with rare marine transgressions during the Asselian-Sakmarian Talchir Formation. At this level, the palynoassemblage recovered makes a case for studying the mechanical damage due to ice movements. The biochemical oxidation and aerobic degradation within the aerial and subaerial environments have also occurred in this fluvio-glacial regime. The identification of such phenomena indicates that the assemblage of spores and pollen in Talchir had been much richer than so far estimated.

Sediments rich in haematite, phosphorite or pyrite provide other cases of specific environments within the Upper Permian and Lower Triassic sequence. The Lower Triassic red-beds have different taphonomic factors than that of the coal measures. In the inter-trappean beds of Early Cretaceous period, an environment resulting in intensive thermal alteration prevailed. The Peri-Gondwanic Tethyan Himalayan region had experienced high magnitude of tectonic upheaval and this ultimately effected the preservation of spores and pollen.

In the glacio-fluviatile-lacustrine suite (Lower Permian Talchir Formation), the prominent modes of disintegration in palynomorphs are - breaking and shearing of exine, mainly in the boulder bed matrix, because of moraine movement. In this suite, the more striking feature observed is the hyaline-glassy appearance of certain spores and pollen. This seems due to aerial and subaerial oxidation of exines during nacrolysis. Predominance of brown to brown - black colour is also dominant in Talchir Formation; this may be the resultant of deep burial of sediments. Darkening of colour in palynomorphs from the Tethys zone is more intensive.

In the chocolate shales and pyrite-rich sediments, there is some evidence of thermal alteration of spores and pollen. The ironstone shales exhibit a relatively higher degree of thermal activity, but the chemical corrosion of the exine is more prominent than the darkening of their colour.

The taphonomical study attempted has led to the development of a new parameter for determining the true composition of palynofloras.

Dr. (Ms.) Vijaya
Senior Scientific Officer
Birbal Sahni Institute of Palaeobotany
53 University Road
Lucknow 226 007

17. CURRENT RESEARCH ON BRYOZOANS

My associates and I presently have three manuscripts on Permian bryozoans in press or in the final stages of preparation. The article on fenestrate bryozoans of the Toroweap Formation of southern Nevada is in press in the Journal of Paleontology. The manuscript on the bryozoans of the Murdock Mountain Formation of northern Nevada is in the final stages of preparation and will be submitted in the very near future. A joint paper on the Permian bryozoans of the Productus Group, southern New Zealand is also in the final stage of preparation and will be submitted to a New Zealand journal for publication. That paper is a joint publication authored by myself, Miriam McColloch, Hamish Campbell, and Charles Landis. As soon as these last two papers are finished and submitted, I plan to return to the major revision of the Permian Bryozoa of the Salt Range, Pakistan.

Ernest H. Gilmour
Professor of Geology
Department of Geology
Eastern Washington University
Cheney, WA 99004
U.S.A.

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