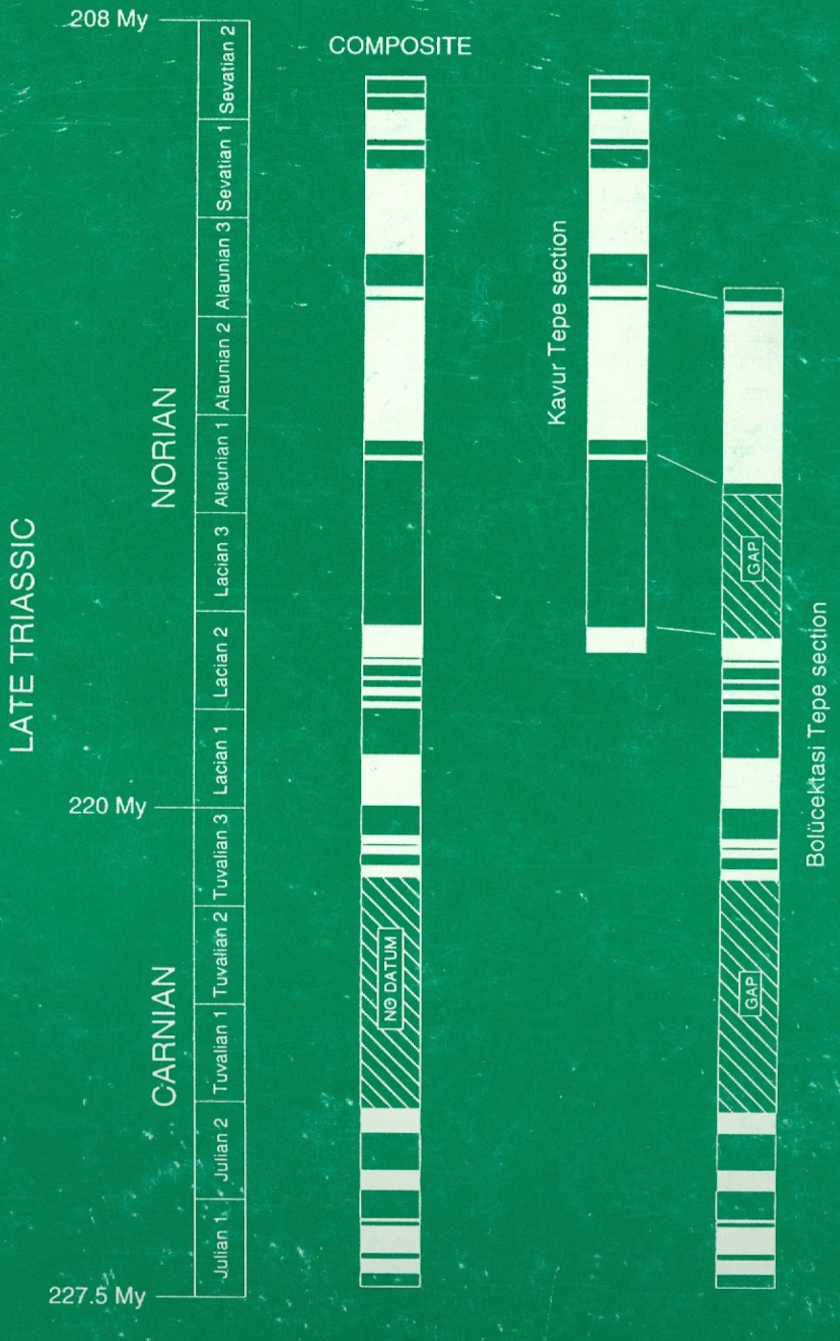
# ALBERTIANA





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ALBERTIANA

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The primary aim of ALBERTIANA is to promote the interdisciplinary collaboration and understanding among the members of the I.U.G.S. Subcommission on Triassic Stratigraphy. Within this scope ALBERTIANA serves both as a newsletter for the announcement of general information and as a platform for discussion of developments in the field of Triassic stratigraphy. ALBERTIANA thus encourages the publication of announcements, literature reviews, progress reports, preliminary notes etc. - i.e. those contributions in which information is presented relevant to current interdisciplinary Triassic research.

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*Cover:*
*Comparison between the magnetographic sequences from Bolücektası Tepe and Kavur Tepe, southwestern Turkey (see pp. 66-68)* *(submitted by J. Marcoux)*

SUBCOMMISSION ON TRIASSIC STRATIGRAPHY

## MINUTES OF THE IUGS EXECUTIVE COMMITTEE MEETING

(January 25-28, Pretoria, South Africa)

### Report of the ICS

*This is the report on our STS activities given by F. Hervé at the IUGS Executive Committee Meeting*

#### Mesozoic Subcommissions

#### TRIASSIC

F. Hervé (commentator) said that he was impressed by the work of this Subcommission. It had produced a definition of the stages of the Triassic which is reported in its publication ALBERTIANA No. 10, which also contains other aspects of the 1992 activities. He further said that the group is planning three meetings for 1993; the Meeting of the Anisian-Ladinian Boundary Working Group in the Southern Alps and in Hungary; the Meeting of the Permian-Triassic Boundary Working Group during the Shallow Tethys Symposium in September*; and the Meeting of the Continental Triassic Working Group in Albuquerque in October. Hervé remarked that ALBERTIANA lists officers along with voting and corresponding members, but that not a single one is from South America. He hoped that this might be considered by the Subcommission.

* Meeting postponed until 1994 (A. Baud)

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## PANGEA CONFERENCE

## SHORT REPORT FOR THE STS

### Aymon Baud

More than 900 geoscientists participated in the very successful Pangea Conference, August 15-19, 1993 in Calgary, Alberta (Canada) which was organized by B. Beauchamp and A. Embry.

Sixty of the 370 talks or posters presented at the conference concerned the Triassic and Triassic boundaries.

Triassic sequence stratigraphy was addressed by no less than 124 contributions. Ten speakers discussed the mass extinction and recovery at the Permian-Triassic boundary and three speakers addressed the Triassic-Jurassic boundary. Fourteen reports on Triassic palaeontology and biochronology were presented and the Triassic of western Canada was the subject of one session with talks. The Permian-Triassic Boundary Working Group held two business sessions during the meeting with Prof YIN Hongfu as the new chairman. The IGCP project 359 "Tethyan, Circum-Pacific and marginal Gondwanan Late Palaeozoic and Early Mesozoic Correlations" also held their first meeting (see the report on p. 17).

The next Pangea meeting will be organized during the International Permian Symposium, August 28-32, 1994, in Guiyang, China.

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## NEXT MEETING OF OUR SUBCOMMISSION

A plenary meeting of our Subcommission on Triassic Stratigraphy will be organized during the "Shallow Tethys 4" Conference, September 9-12, 1994 in Albrechtsberg/Vienna (Austria). During this conference a P/T Boundary Working Group meeting and a regional IGCP Project 359 meeting will be organized (see also Prof. Yin Hongfu's announcements on p. 28, p. 31).

**Agenda for the STS meeting:**

September 10, 1994: $14.^{00}$-$18.^{00}$ - scientific session
$20.^{00}$-$22.^{00}$ - business meeting

An excursion to the Carnic Alps (Carboniferous to Triassic) will be organized by Prof. E. Flügel, September 5-8, 1994.

Approximate costs (in US $):

| | | |
|---|---|---|
| Registration | $ | 150.- |
| Accommodation in Albrechtsberg (per person, per day) | $ | 20.- |
| Excursion | $ | 300.- |

Please contact Dr. Edith Kristan-Tollmann, Scheibenbergstraße 53/6, A-1180 Wien, Austria for more information, the "Shallow Tethys 4" 2nd circular and inscription. Please send title and abstract of contributions to the STS scientific session and suggestions for the STS business meeting to Dr. A. Baud, Chairman of the STS, before June 30, 1994.

## IGCP PROJECT 343

## CORRELATION OF EPICRATONIC TETHYAN BASINS - SHORT REPORT

### Aymon Baud

The new IGCP Project 343 had two meetings this year. During the first meeting held in Paris, a new chairman, Dr. Cavelier from Orléans (France) and two vice-chairmen, Dr. Dudich (Budapest) and Prof. Sandulescu (Bucharest) were elected. There are three themes of the project which are of some interest for our subcommission:

(1) Interscale correlations for some palaeontological groups (Leader: Dr. P. de Wever, Paris)

(2) The Permian-Triassic boundary crisis (Leaders: S. Crasquin-Soleau, Paris, A. Baud, Lausanne and J. Marcoux, Paris)

(3) Relations in the epicratonic Peritethyan basins between Triassic marine onlaps, local tectonics and global events (tectonic, climatic etc.) (Leader: L. Courel, Lyon)

The second meeting was in Bucharest, September 28 - October 2, 1993, with a field trip in the Dobrogea guided by Prof. Gradinaru (Bucharest). Good opportunity was given to the 33 field trip participants to examine and sample key sections comprising the Hallstatt facies which range there in age from late Olenekian to early Norian. One of the most interesting sections which crops out in a large quarry north of the Redd Hill area consists of an apparently complete succession from upper Anisian to lower Ladinian red to grey nodular limestone with conodonts and ammonoids - a possible candidate for the Anisian-Ladinian boundary stratotype!

Please contact Dr. A. Baud, chairman of the STS, for more information about this IGCP project.

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## ABOUT E.T. TOZER's CHRONOSTRATIGRAPHIC CONSIDERATIONS

(ALBERTIANA, 11, p. 32-37)

## A REPLY

### A. Baud

Readers unfamiliar with the STS meeting in Lausanne (October, 1991) and with the role and mandate of the STS may be disturbed by Toyer's (1993) paper. It is not my purpose to write five pages on the subject as Tozer did but rather only a short comment. As chairman of the

STS, I organized a meeting of our subcommission in Lausanne with the help of Prof. Gaetani and Prof. Guex (October 1991; see Gaetani, 1992). My "dictatorial" intent according to E.T. Tozer was to organize a vote on Triassic stages. Dr. Tozer, along with other members, participated both in the general discussion before the vote and in an informal vote at that time. In February 1992 he voted along with other members of the Subcommission by formal written ballot. By participating in this vote he obviously accepted the democratic rules of the International Commission on Stratigraphy. The results of the vote have been published (Baud, 1992) accompanied by a very clever editorial written by our secretary (Visscher, 1992), but one year later Tozer (1993, p. 32) disputed the majority rule! Such inconsistency discredits him.

Concerning the ongoing activities of the STS, I thank Prof. Gaetani for the very fine work done by his Working Group on Stage Boundaries (Gaetani, this issue p. 5-9) and all the scientists working on these very difficult Triassic stage boundary problems. As I mentioned at the Lausanne meeting, the work which our subcommission is involved in is challenging enough. We should leave behind the absolute sterile discussion continually raised by E.T. Tozer and now use the Triassic stage terminology printed on the 1992 ALBERTIANA 10 cover.

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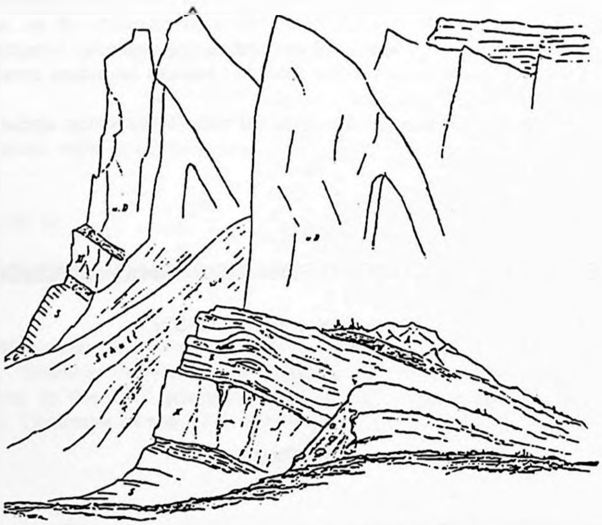

Ansicht der Geister-Spitzen.

Standpunct: Soluschadia, SO von St. Ulrich in Gröden.

## ANISIAN/LADINIAN BOUNDARY FIELD WORKSHOP

### Southern Alps - Balaton Highlands 27 June - 4 July 1993

**Maurizio Gaetani**

Some 30 scientists from 11 countries (Austria, Canada, Czech Republic, Germany, Italy, Hungary, Rumania, Serbia, Slovenia, Spain, Switzerland) attended the field-workshop. It was jointly organized by teams from Milano, Zürich and Budapest. Three days of field observations were dedicated to sections in the Southern Alps, one day to the long transfer to Hungary, one and a half day to field observations in Hungary. The workshop was concluded by the final discussion in the afternoon on Saturday July 3rd. The weather was fair except for the day in Stabol Fresco, Giudicarie, which was foggy and rainy. Except for some initial customs problems connected with the bus arrival from Hungary, the logistics satisfied the people attending the workshop. Discussions were lively, but respectful. The field-guide book is exhaustive and it has been sent to the members of the Subcommission and the *ad hoc* Working Group established during the 1991 Lausanne meeting.

I am satisfied with the results. It was unrealistic to suppose that at the end of the workshop we could already propose to the Subcommission where to draw the base of the Ladinian. But we obtained the following results:

1 - Most of the people involved had the opportunity to see sections, which are the best known at present in the areas which are classical from a historical point of view. All were there, except A. Dagys who had visa difficulties. They may now judge and give their advise on the base of what they personally know.

2 - The original definition by Bittner (1893) includes all the Buchenstein in the Ladinian. Participants agreed to search for a solution which allows the easiest correlations, also if this would imply that part of the Buchenstein should be considered of Late Anisian age in the future.

3 - The correlation between the Southern Alps and Balaton has been established with great accuracy for the lower part of the critical interval. Instead, it is now clear that the upper part of the critical interval is poorly represented in Hungary, because of a possible gap or condensation. The succession seems to be less reduced in the Felsöörs section, but as matter of fact, ammonoids from the Nevadites Zone have not yet been reported. Fig. 1 summarizes this correlation.

4 - Concerning ammonoids, participants agreed that the Trinodosus Zone is Anisian in age and the Curionii Zone is Ladinian in age.

The base of the Curionii Zone is defined by the appearance of *Eoprotrachyceras curionii*. In the critical interval between these two zones, participants agreed that no more than two ammonoid zones should be identified. The exact base and the names of these two zones still remain to be decided.

The lower one may be defined by the appearance of species belonging to the genus *Kellnerites*, or could also include the *Lardaroceras* beds, described by Balini (1992). The zonal name could be Reitzi Zone, notwithstanding *Reiziites reitzi* is only shortly present in the middle part of the zone.

The upper one could be defined by the appearance of species of the genus *Nevadites*, or could, as supported by P. Brack and H. Rieber (1993, p. 449) also include species of genus *Ticinites*. This appeared to be a proposal for which the majority doesn't seem to be enthusiastic. No suggestions have been made for the name of the zone, to replace the name *Nevadites* (Krystyn, 1983).

During the final discussion in Vörösbereny, L. Krystyn, Vienna, exhibited some of the relevant specimens from the Epidravros section, Greece, and illustrated the main steps of the ammonoid evolution through the critical interval, during which Ceratitids are substituted by Trachyceratids and Ptychitids by Arcestids.

5 - As far as the conodonts are concerned, it appeared that some differences in the scales are due to the different interpretations of taxa. Very exhaustive work has been done in Hungary, but condensation casts doubts on the detailed results. The appearance of *Gondolella trammeri* down in the *Halilucites costosus* horizon could be only apparent, its true appearance in non-condensed sections could also be later (or earlier, as claimed by H. Kozur). The need of more intense bed-by-bed etching on relevant sections in the Southern Alps was pointed out by most participants and A. Nicora promised to do her best on the matter, as soon as possible. At present there is a fairly inconspicuous event which may be recognized near the base of the lowest zone of the critical interval (Reitzi Zone, if it will be called so), characterized by changes within the *constricta* lineage.

The most relevant event seems to be linked to the appearance of *Gondolella trammeri*, which seems to be nearer to the FO of the *Nevadites* than to the FO of the *Ticinites*. But more research is needed on this point. Also to be noted is the fact stressed by M. Orchard (Vancouver) of the scarcity of *G. trammeri* in North American sections. The base of the Curionii Zone is once more rather inconspicuously marked by conodonts with appearance of forms of the *transita* group.

6 - Other relevant groups which were considered during the workshop are daonellids, radiolarians and palynomorphs.

The daonellids seem to have a great potential, also for correlations between the Tethyan and Boreal realms. However, knowledge on this group is patchy and in none of the analyzed areas there is a continuous record of Daonellids, especially in the Curionii Zone.

As far as the radiolarians are concerned, we were all instructed that after a period of erected spines in the Anisian, there is a deflection of them in beds correlative to the *Kellnerites* appearance. The radiolarian scientists claim that a boundary drawn with the FO of *Oertlispongus inaequispinosus* should be good.

The palynomorphs have a great importance, especially for correlations to the Germanic Trias and to the Boreal province. All the attempts done in the past to have palynological data on Bagolino and Giudicarie sections were unsuccessful. Instead P. Brugman in his thesis, identified in the Plattenkalke of the Frötchbach section at the Bagni di Ratzes (Dolomites), an assemblage

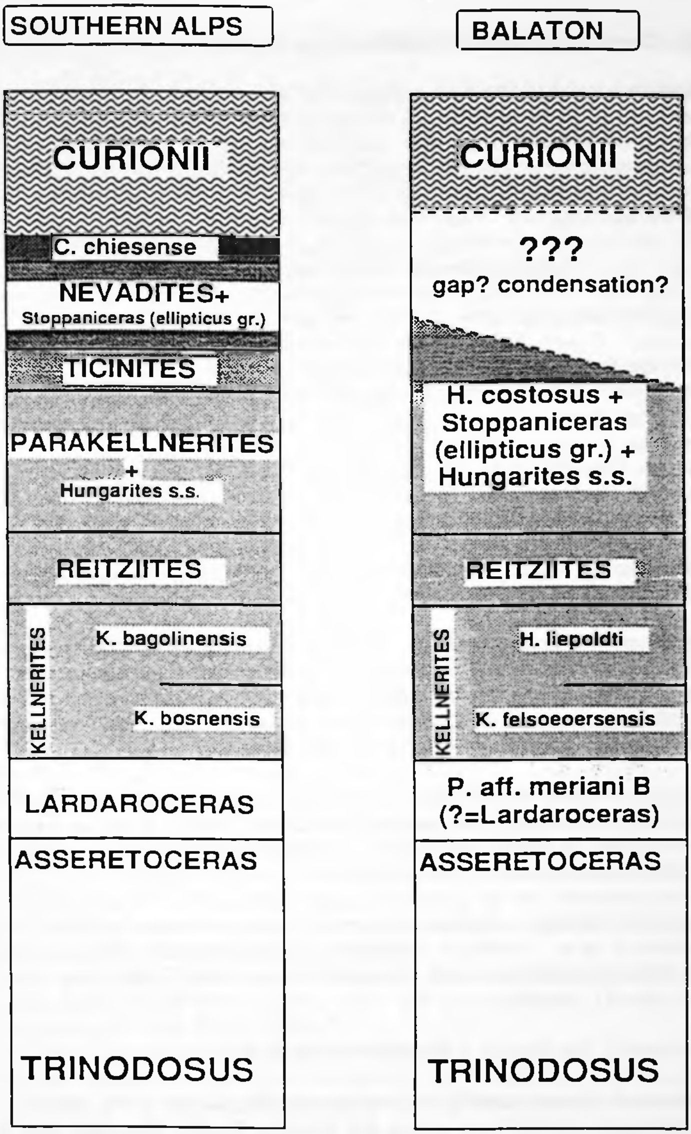


*Fig. 1 - Ammonoid correlations between Brescia-Giudicarie and the Balaton areas. The thickness of the ammonoid horizons is proportional to the rock-thickness in Brescia-Giudicarie area.*

characterized by *Cannanoropollis* and *Kuglerina* in beds partly correlative to the Reitzi Zone.

These forms already belong to the assemblage that will persist during most of the Ladinian. The Plattenkalke contain an ammonoid fauna which is in part correlative to the Reitzi Zone. An equivalent palynomorph assemblage has been recognized in a borehole in Hungary by P. Brugman and in outcrops by F. Góczán, in beds attributed also to the Reitzi Zone. It should also be considered that palynomorphs are not widely studied in the academic world and most data are with the oil companies.

**Possible positions of the base of the Ladinian.**

There are three possible positions for the base of the Ladinian.

1 - **The base of the Reitzi Zone** (with the problem whether to include the *Lardaroceras* beds). Advantages: (i) history. The boundary will roughly coincide with the base of the Buchenstein in its type-area. (ii) best identification by palynomorphs, which have great potential for correlation. (iii) radiolarians also show a significant change. However, their distribution is at present so patchy known that this seems to me a minor argument. (iii) the Daonellids with the *elongata* lineage could also be significant.
Disadvantages: (i) not a very significant change in the ammonoid evolution record. Especially within the Leiostraca there are almost no changes at this level. Very poor correlations with the Boreal realm. (ii) Also for conodonts this horizon is not particularly significant and they cannot be recognized in a eupelagic facies.

2) **Base of the Nevadites Zone** (especially if the *Ticinites* beds are excluded). Advantages: (i) major turning point in the ammonoid evolution, with progressive appearance of first Trachyceratids substituting the Ceratitids and also major change in the Leiostraca, with Arcestids substituting Ptychitids. (ii) major change in the conodont fauna, at least within the Tethys. Disadvantages: (i) no palynological evidence; (ii) no radiolarian evidence.

3) **Base of the Curionii Zone.** (i) well defined horizon, with final affirmation of Trachyceratids. It represents the easiest correlation to Nevada and Boreal realm as far as ammonoids are concerned. Disadvantages: (i) poorly defined by conodonts; (ii) not defined by radiolarians and palynomorphs, no data at present for daonellids.

For all three possible solutions, palaeomagnetism does not seem to yield any suggestions. According to Marcoux et al., (1993) in Dobrugea (Agighiol section) the polarity is normal in the critical interval. This is confirmed by G. Muttoni, Milano, who is doing his Ph.D. thesis on this matter.

Schedule for future.

As always, more work ! Next meeting point in Vienna, September 9-13, 1994. A meeting of the Triassic Subcommission will be held during the Shallow Tethys Congress (see ALBERTIANA, 11, p. 39; ALBERTIANA 12, p. 17, 24, 26-27). I would like to arrive at a final proposal in 1995, in order to submit the proposal to the Commission of Stratigraphy of the IUGS at the Beijing Congress, 1996.

**Other activities of the Working Group.**

During the 1991 Lausanne meeting, an *ad hoc* Working Group has been established to define the base of the stages Anisian, Ladinian and Carnian.

As far as the base of the Anisian is concerned, at present the situation is as follows. There are four relevant areas under investigation, three in the Tethys and one in Nevada. The Tethys areas are: Dobrugea in Rumania, Chios in Greece and Oman on the Arabian peninsula. For Dobrugea, at present no papers have been submitted for printing, after the talk of E. Gradinaru in Lausanne. The paleomag samples have been drilled by a French team and they are currently being studied. For Chios, a reappraisal of the Marathovuno sections has been published in 1992 (see ALBERTIANA 11, p. 47) and the paleomag is studied by G. Muttoni, Milano and D. Kent, New York. For Oman, first data on ammonoids have been published by T. Tozer and a detailed conodont paper has been submitted recently by M. Orchard (see ALBERTIANA, 11, p. 37). Paleomag work is also in progress by a French team, but very recently I was informed that it is remagnetized.

The ammonoids from the Nevada sections were recently worked out by H. Bucher, Vancouver (Bucher, 1989). Conodonts, after the Nicora (1977) paper, are now being reconsidered by M. Orchard.

To start a discussion on the boundary position, we have to wait until these papers are at least accepted for printing. I am confident that also this boundary could be formally defined for the Beijing Congress.

No good news instead of the base of the Carnian. There is a major problem, caused by a different opinion of most of the conodont workers, who include the equivalent of the *Frankites regoledanus* zone in the Carnian. In my opinion, a lot of bed by-bed work is still to be done and a solution is far.

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## HOW MANY NEWSLETTERS HAVE WE GOT AND HOW MANY DO WE NEED ?

**E.T. Tozer**

Some readers of ALBERTIANA, until recently the one and only Newsletter for the Subcommission on Triassic Stratigraphy (STS), are probably unaware that it is no longer the only periodical dealing with Subcommission matters.

ALBERTIANA, with its 12th issue celebrates its 10th birthday. It was conceived and initiated in 1983 by Carmina Virgili and Henk Visscher. Carmina was then Chair of the STS. Henk, then and now is Secretary General. The intention was to provide a Newsletter to keep everybody informed about the activities of the Subcommission and its subordinate organisations, such as the Permian-Triassic Boundary Working Group (PTBWG). Short articles and lists of current Triassic literature have also been included. Ever since the beginning it has been produced at Dr. Visscher's laboratory in Utrecht. Dr. M. Boersma edited numbers 1-7; present editor is Dr. Hans Kerp. All Triassic workers are indebted to these people who have made "ALBERTIANA" such a successful publication. It is attractively printed and bound. It has an ISSN number. Present plans call for the publication of two issues a year. It is automatically distributed to all members of the Subcommission and can also be obtained from agents in the USA and Europe, as spelled out in a recent issue (No. 11, p. 66, April 1993). Well printed and edited, adequately advertised, and, most important, widely distributed, it serves the role of a Newsletter in an admirable fashion.

In the past two years two additional newsletters concerned with Triassic matters have appeared. First to appear was "Triassic News 1" distributed by A. Baud, Chairman of STS. This document is not exactly a model of what any Newsletter should be. It bears no date and does not give its place of origin. Baud was evidently the author but this is not explicitly clear, particularly as there is reference to "we" in the preamble referring to its preparation. "Triassic News 1" dealt mostly with the Lausanne STS meeting (October, 1991) and included lists of new Voting and Corresponding Members. The list of Corresponding Members was inaccurate, omitting Beth Carter and Mike Orchard, who had been elected at Lausanne. At my behest Baud distributed a communication (March 2, 1992) indicating that Carter and Orchard were, in fact, Corresponding Members. This is recorded in the full STS membership list (ALBERTIANA 10, p. 4,5, November 1992). "Triassic News 2" was an improvement. It has a date (July, 8, 1992), and author (A. Baud) and a place of origin (Lausanne). It deals mostly with the question of how many stages should be recognized in the Triassic, indicating that a majority of STS members favour two Lower Triassic stages (Induan and Olenekian), and recognition of the Rhaetian as the youngest Triassic stage. These matters are also recorded in ALBERTIANA 10 (page 10, November 1992).

This year a Newsletter of the Permian-Triassic Boundary Working Group (PTBWG) has appeared. So far there have been two issues, no. 1, August 1993, no. 2, September 1993. These have been distributed by Professor Yin Hongfu, the newly elected Chairman of this Working Group. Distribution seems to have been only to the members of the Working Group. As with "Triassic News 1" authorship is not indicated and the place of origin is not given. Both issues contain items dealing with the question of the P-T boundary.

I suggest that in the interests of all persons concerned with Subcommission matters these two Newsletters are superfluous and should be discontinued. The affairs of STS and the working groups are best dealt with in a single publication - ALBERTIANA. Everything in these extra newsletters would be better placed in ALBERTIANA. With this procedure those concerned with STS and PTBWG affairs can feel confident that they are abreast of recent thoughts, decisions and developments by consulting one, well produced and widely distributed publication. ALBERTIANA's wide distribution ensures that all those concerned with STS affairs, not merely members of the Subcommission and its working groups, may be kept informed of STS affairs. The existence of additional newsletters, not widely distributed and in some cases of uncertain provenance means that Permian and Triassic workers can no longer be sure that ALBERTIANA is providing full news coverage of STS activities. Admittedly much of the data in Triassic News 1 and 2 has found its way into ALBERTIANA. It remains to be seen if the information in the PTBWG Newsletters will be similarly treated. But this does not mean that the perpetrators of these Newsletters can defend their necessity. ALBERTIANA exists to do the job. With two issues a year it can do it promptly. It has always done it well and until recently has been alone in the field. ALBERTIANA should regain its position as the sole disseminator of STS news and information.

ALBERTIANA

Comments, reactions or contributions to ALBERTIANA?
Send it to the editor!

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!!! NOTE THE NEW POSTAL CODE !!!

# PALAEONVIRONMENTAL MAPS OF THE TETHYS

**Jean Marcoux**

The late Anisian and late Norian palaeoenvironmental maps of the Tethys presented here are part of a 14 map set (Murgabian to Tortonian) titled "Atlas Tethys Palaeoenvironmental Maps", J. Dercourt, L.E. Ricou & B. Vrielynck, editors.

The complete Atlas (14 maps, Murgabian to Tortonian) with explanatory notes (ca. 300 pp.) can be ordered from: CCGM/CGMW, 77 rue Claude Bernard, F-75005 Paris, France (Price: US$ 185.- + US$ 10.- for shipping and handling)

Note: by the beginning of 1994 a revised and reduced set of the Permian and Triassic maps (Late Murgabian, Late Anisian and Late Norian) in A3 format (full colour) with notes and comprehensive references, will be available. More information can be obtained from Aymon Baud (Musée Géologique, UNIL, BFSH2, CH-1015 Lausanne, Switzerland).

## Late Anisian (237 to 234 Ma)

**Jean Marcoux, Aymon Baud, Luc-Emmanuel Ricou, Maurizio Gaetani, Leopold Krystyn, Yves Bellion, René Guiraud, Christian Moreau, Jean Besse, Yves Gallet and Hervé Théveniaut**

**Abstract**

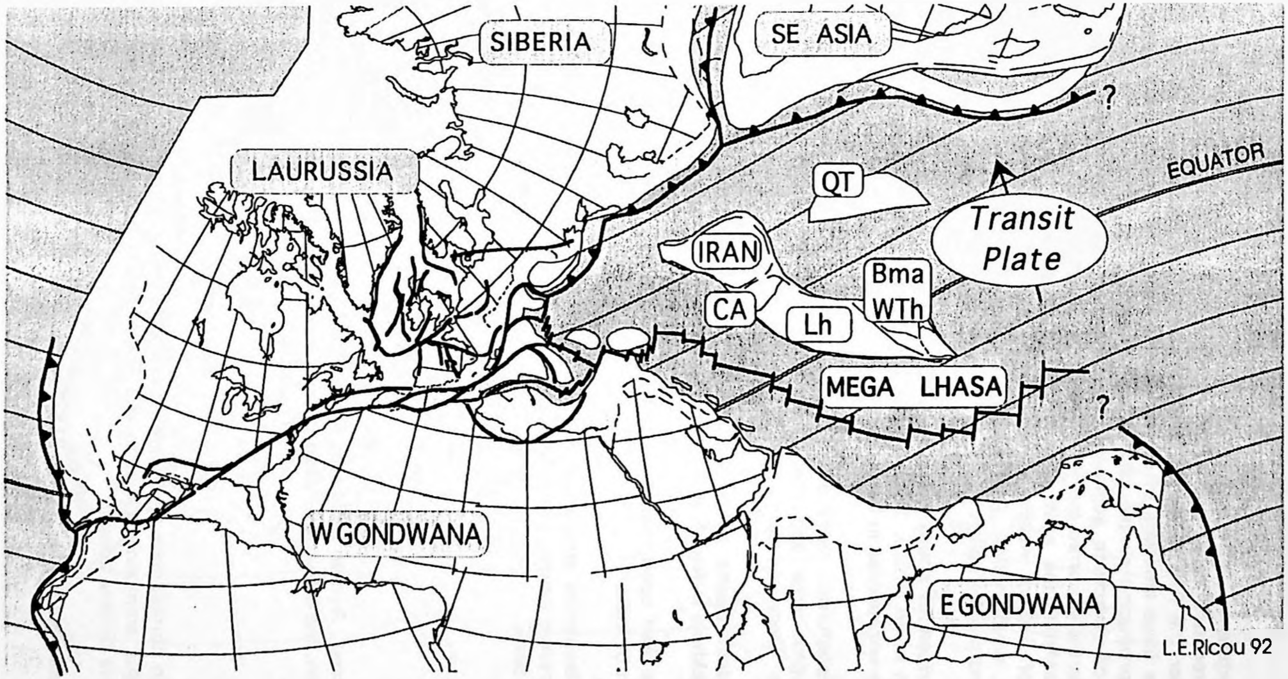
There is general agreement about Upper Anisian biochronology including the *Paraceratites trinodosus* and the *R. reitzii/Kellnerites* ammonoid zones and the *Gondolella bifurcata* and *G. constricta* conodont zones. Controversies exist, however, about the *Nevadites* ammonoid zone and the *G. trammeri* conodont zone.

We propose here a numerical age of 237-234 Ma.

A transgressive-regressive cycle begins during the last part of the Middle Anisian, corresponding to a second-order cycle of the Vail et al. classification, which encompasses the Late Anisian and most of the Ladinian.

Palinspastic reconstructions are derived from palaeomagnetic and geological constraints.
Four major plates (figure 1) are accounted for: Gondwana, Laurasia, Southeast Asia and Tr-Transit Tethys.

# ANISIAN (235 Ma) PLATES and MICROPLATES




CA: Central Afghanistan; Lh: Lhasa block; Bma: eastern Burma; WTh: western Thailand; QT: Qiantang block

### Main palaeoenvironments

1 - Shallow carbonate platforms: one of the main characteristics of this Late Anisian palaeo-environmental reconstruction is the high carbonate productivity: the Late Anisian was the first time period after the Permo-Triassic crisis during which carbonate platform communities were able to produce large amounts of carbonates. However, this was mostly due to microbial and algal activity, producing simple carbonate banks and not complex carbonate build-ups. Early dolomitization of carbonate sediments was widespread. The development of large shallow carbonate platforms occurred in the following areas: the northwestern Indian margin in the Salt Ranges and Kashmir; the south Mediterranean margin, the Taurus and Oman margins; the western end of Tethys where at least five isolated platforms are present; the southern Transcaucasus, western Iran, Alborz and part of eastern Iran, Central Afghanistan, to eastern Burma; west and south Thailand.

2 - Shallow terrigenous shelves: the main terrigenous marine deposits are situated in northwest Australia and in north Africa. They also occur along the active Eurasian margin from Crimea to Tarim. They are widespread in boreal seas.

3 - Evaporitic platforms: there are two large evaporitic basins: one is located in Iraq, north Arabia and Zagros area and the other in south-west-central Europe: middle Muschelkalk evaporite of the "Germanic basin".

4 - Slope and deep basins: these are mainly recorded along the northern margin of India, from Zanskar to Thakkhola in Nepal, and in Oman as the Hawasina and Sumeini series.

5 - Pelagic rise and open marine plateaus: these are recorded from Oman to Timor via the northern margin of India.

6 - Fluvial and lacustrine environments: broad continental deposits occur in eastern Australia, in eastern and northern Africa, in the Brazilian craton and on the northern Atlantic rifts around the Rockall-Hatton Bank.

## Late Norian (215 to 212 Ma)

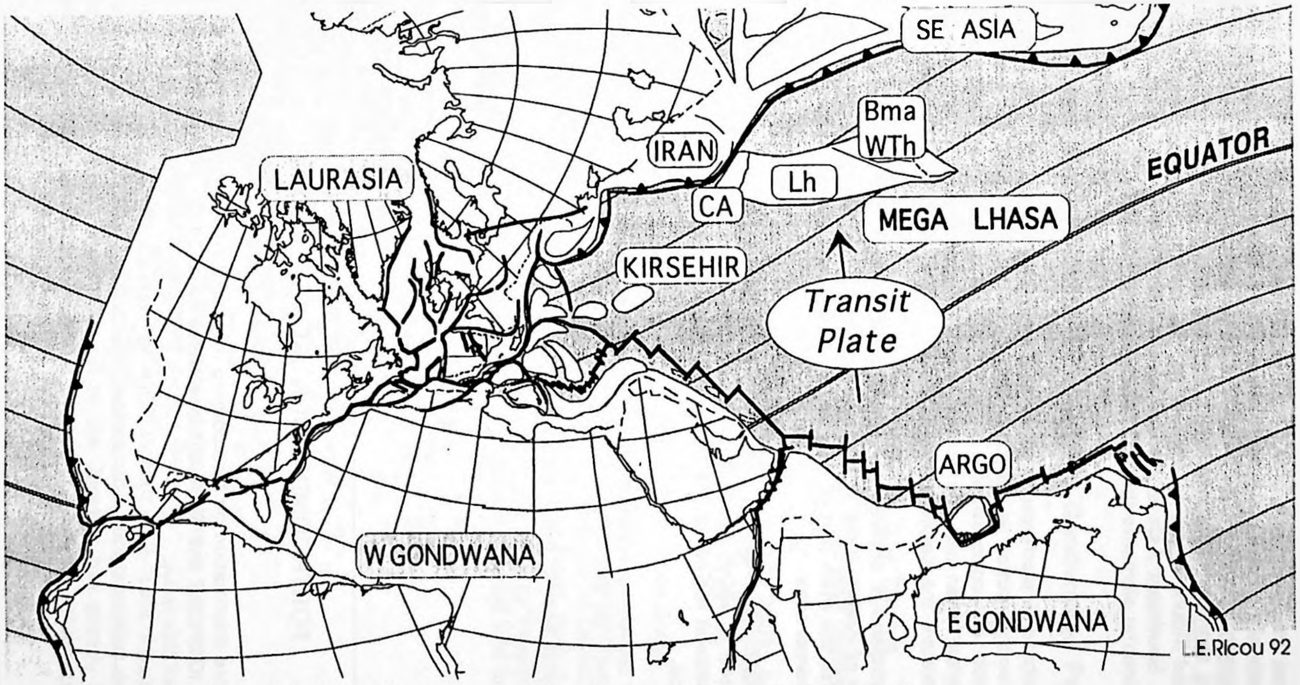
**Jean Marcoux, Aymon Baud, Luc-Emmanuel Ricou, Maurizio Gaetani, Leopold Krystyn, Yves Bellion, René Guiraud, Jean Besse, Yves Gallet, Etienne Jaillard, Christian Moreau and Hervé Theveniaut**

### Abstract

The Late Norian corresponds to the *Halorites macar/Himavatites columbianus* and the *Sagenites quinquepunctatus* ammonoid zone, to the *Epigondolella bidentata* conodont zone and the last *Monotis salinaria* bivalve zone.

We propose here a numerical age of 215-212 Ma.

# NORIAN (210 Ma) PLATES and MICROPLATES




CA: Central Afghanistan; Lh: Lhasa block; Bma: eastern Burma; WTh: western Thailand;

The Norian forms the lower part of a transgressive-regressive cycle (second-order cycle) which ends in the Hettangian. The Late Norian consists of a depositional sequence (third-order cycle). Palinspastic reconstruction for the Norian is derived from the well constrained Early Jurassic fit through entering slight modifications which account for the lattermost Triassic displacement.
Four major plates (figure 2) are accounted for: Gondwana, Laurasia, Southeast Asia and the Tr Tethys Transit. Southeast Asia is partially shown on the map and is achieving coalescence of its various continental elements through the Indosinian orogeny.

### Main palaeoenvironments

1 - Shallow carbonate platforms: one of the main characteristics of this late Norian palaeoenvironmental reconstruction is the development of large shallow carbonate platforms (Dachstein type) which are concentrated on the western end of the Tethys and in part of the Taurus-east Zagros-Oman belt. On the Tr Tethys Transit Plate they are present in central and northern Afghanistan, the Karakorums-southeast Tibet and western Thailand.

2 - Shallow terrigenous shelves: the main terrigenous marine deposits are situated on the northern margin of Arabia, India and Australia. They also occur along the Eurasian active margin from Dobrogea to the main part of accreted Iran and Qian-Tang (Nayband type series). They are widespread in boreal seas.

3 - Mixed terrigenous evaporitic platforms: large mixed terrigenous or fine clastic-evaporitic basins are located in south-west-central Europe; the Norian is the time of the Keuper clastic-evaporite depositional regime of the "Germanic Basin" and of the so-called "Carpathian Keuper" in eastern Europe.

4 - Fluvial and lacustrine environments: large scale continental deposits occur on the north-eastern Indian plate, on the African plate, on the Brazilian craton.

5 - Slope and deep basins: these are mainly recorded along the northern margin of Gondwana, from Sicilia-Lagonegro to India (as the Lamayuru type series), via Budva-Pindos, Antalya, Oman (as the Hawasina and Sumeini series).

## FORTHCOMING CONGRESSES AND MEETINGS

For more information on forthcoming meetings and congresses refer to p. 2, to the IGCP 359 and PTBWG Newsletters on p. 21, p. 28, p. 30, p. 31 and p. 32 of this issue.

**IGCP PROJECT ANNUAL REPORT** **PROJECT No. 359**

## IGCP Project short title:

## Correlation of Tethyan, Circum-Pacific and marginal Gondwanan Permo-Triassic

Duration and status: **1993-1997**

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Date of submission of the report: October 1, 1993

Signature of the Leader

### 1. Summary of major achievements of the project in the past

This newly established project is a successor of IGCP Project 272 "Late Palaeozoic and Early Mesozoic Circum-Pacific events". During the past project, the understanding of events associated with the key stages of the Carboniferous up to the Jurassic has greatly been enhanced. We also inherited the precious interconnection and cooperation among scientists established by the Project 272.

## 2. Achievements of the project this year

### 2.1. General scientific achievements

#### 1. The Permo-Triassic boundary in the Tethys and the Circum-Pacific

The discovery of latest Permian conodonts in the lowermost Blind Fjord Fm. of Arctic Canada (Henderson) and the *Hypophiceras-Otoceras*-Bed of Greenland (Kozur), both previously regarded as earliest Triassic. Discoveries of a *Hindeodus parvus-Isarcicella isarcica* conodont sequence in deep-sea deposits of Sicily (Kozur) and of latest Permian ammonoids of the South China type in the Russian Far East (Zakharov). These new data shed new lights on the problem of the biomarkers of the P/T boundary. The Chinese working group submitted a proposal to formally recognise *H. parvus* as the index fossil for the P/T boundary, which has been widely echoed by Permo-Triassic workers. During the Calgary meeting chaired by Yin Hongfu on August 16, 1993 four sections have been recommended as candidates for the Global Stratotype Section and the Point of the P/T boundary. Shortcomings and merits of these sections and biomarkers were discussed in detail during this meeting.

#### 2. Permo-Triassic events in the Tethys and the Circum-Pacific

In their monograph on "Permo-Triassic events of South China" Yang et al. (1993) gave a comprehensive indication of the sea-level change, volcanism, geochemical anomaly and biotic mass extinction in South China. Wu Shunbao (in Yang et al., 1993) demonstrated that the transgression in South China initiated not in the earliest Triassic but in the latest Permian. Noé, Baud and Henderson (all in the Pangea abstract, 1993) displayed similar situations in the Southern Alps, the Middle East and Arctic Canada. Many sequence stratigraphy workers placed the sequence boundary not at the biostratigraphic P/T boundary, but in the topmost Permian (Gaetani for the Southern Alps, 1993, Pangea abstract). Thus, as a supplement and revision of the traditional view of the global-scale earliest Triassic transgression, the initiation of the P/T transgression now seems to be heterochronous from the latest Permian to the earliest Triassic.

Based on facies (black laminated shale etc.), fauna (*Lingula, Claraia*), and geochemical anomalies (negative excursions of carbon isotope and C/S ratios as well as a cerium anomaly) in the Dolomites, Idaho, Salt Range and Changxing, Hallam (1993, Pangea abstract) convincingly revealed the anoxic event at the P/T boundary. The P/T boundary anoxic event is also supported by the findings in Sicily and Japan. Isozaki (1993, Pangea abstract) reported the P/T boundary layer in a pelagic chert occurring in the Jurassic accretionary complex in central Japan. The boundary claystone is characterized by dark colours, rich organic material, and by the ubiquitous occurrence of pyrite, which indicate deep-sea anoxia.

#### 3. P-T sequence stratigraphy

Leven and Kotlyar suggested a quadripartite subdivision of the Permian sequence of the Tethys and Arctic Russia respectively. Yin showed that the Late Permian to Middle Triassic curves of sea level changes for South China are quite different from Haq et al.'s global pattern. Baud, Gaetani, Hirsch, Lucas and Noè dealt with the Upper Permian and Triassic of the Tethys and the U.S.A. There now seems to be a consensus of a majority on the Permian sequence subdivision but not yet on that of the Triassic.

### 4. P-T geological settings

The compilation of Tethyan palaeoenvironmental maps by French and Swiss members (Marcoux, Baud et al.), displaying palaeogeographical reconstructions of the Tethys at key stages of the Permo-Triassic seems to be a major advancement. Dickins argued that the current concept of Pangea is "a simplistic picture". Stanley wrote on the Circum-pacific terranes during the Triassic.

### 2.2. List of meetings with approximate attendance and the number of countries involved

1 - In association with the Pangea Conference (August 15-19, Calgary, Canada) and the field excursions. Twenty-five members from fifteen countries attended the meeting and submitted thirty papers. Two business meetings have been held by this project with more than fifty participants. About twenty people joined the project during the meeting.
2 - Seventeen persons from six institutions participated in the inaugural meeting of the Chinese group (24-25, Beijing, China).

### 2.3 Number of publications (including maps): List of major or most important publications

Four books, twenty papers, thirty abstracts and four maps were published. A volume on the Permo-Triassic of the Tethys and Circum-Pacific is currently being prepared by the leaders of IGCP Project 359, with Dickins, Yang and Yin as chief editors. The volume will be published by Cambridge University Press. Papers from last year's IGCP 272 meeting in Vladivostok are now being edited by IGCP Project 359 leader Baud; they will soon be published as a symposium volume.

### List of important publications

BEAUCHAMP, B. and EMBRY, A. (Eds.). 1993. Program and abstracts of Pangea Symposium, Carboniferous to Jurassic, 361 pp. (including 30 abstracts of contributions of Project 359 members)

DERCOURT, J. et al., 1993. Atlas of Tethys Palaeoenvironmental Maps. 17 Maps with explanation. Paris, France.

GAETANI, M., 1993. Symposium on Anisian/Ladinian boundary field workshop (Southern Alps-Balaton Highlands). 118 pp., 13 pls.

KURUSHIN, N.I., 1993. Triassic palaeoheterodont and heterodont bivalves of Siberia. Trudy Instituta Geologii i Geophyziki, no. 742, 86 pp., 14 pls., Nauka, Novosibirsk, Russia (in Russian).

WIGNALL, P.B. and HALLAM, A., 1993. Griesbachian (earliest Triassic) palaeoenvironmental changes in the Salt Range, Pakistan and southeast China and their bearing on the Permo-Triassic mass extinction. Palaeogeogr., Palaeoclimatol., Palaeoecol., 102: 215-237.

YANG, Z. et al., 1993. Permo-Triassic events of South China. 153 pp. Geological Publishing House, Beijing, China (in English).

YIN, H. et al., 1993. The Triassic of Qinling Mountains and adjacent areas. 211 pp., 20 pls. China Univ. Geosc. Press, Wuhan, China (in Chinese).

### 2.4. List of countries involved in the project

According to letters from group leaders and individuals, IGCP Project 359 now has 154 participants plus 27 who attended project meetings or who were enlisted by group leaders but whose participation still requires their personal confirmation. It covers twenty-five countries. One copy of the list of membership will be sent to Dr. Babuska for reference.

| | | | |
|---|---|---|---|
| Australia* | Austria | Canada | China* |
| France | Germany | Hungary* | India |
| Iran* | Italy* | Israel | Japan* |
| Jordan | New Zealand | Poland | Russia* |
| Slovakia | Slovenia | Spain | Switzerland* |
| Turkey | United Kingdom* | U.S.A.* | Vietnam |
| Yugoslavia | | | |

(* indicates countries active this year)

### 2.5. Activities involving other IGCP projects, IUGC or major participation of scientists from developing countries

Cooperative relationship has been established between this project and the Permian and Triassic Subcommissions of the IUGS, IGCP Projects 306 (Stratigraphic Correlation in S.E. Asia, Leader Vu Khuc), 321 (Gondwana Dispersion and Asian Accretion, Leader Ren Jishun), 335 (Biotic Recovery from Mass Extinctions, Leader D. Erwin) and a GSGP Project (Pangea, Carboniferous to Jurassic, Leader B. Beauchamp). Contact has been made with Project 343 (Stratigraphic Analysis of Peritethyan Basins, Leader J. Dercourt). Meetings during this year and in 1994 are and will be largely realized by joint sponsorship with them. Six developing countries (China, India, Iran, Jordan, Turkey and Vietnam) have participated in this project with 39 scientists; China and Iran are working actively.

## 3. Proposed activities of the project for the year ahead

### 3.1. General goals

1 - A comprehensive study of the Permo-Triassic of the concerned regions. This includes the publication of completed works (see 3.3) and commencement of new studies. The workshop meeting (Calgary, August) established a panel responsible for making a draft of an interregional correlation chart: A. Baud (Western Tethys), H.F. Yin (Eastern Tethys), M. Dickins (marginal Gondwana), G. Stanley (Circum-Pacific), W.T. Holser (chemostratigraphy), G. Besse (magneto-stratigraphy), S. Lucas (terrestrial Permo-Triassic).

2 - The study of the Permo-Triassic boundary is one focus of this project. The workshop meeting recommended four sections as candidates for the Global Stratotype Section and the Point of the P/T boundary: Meishan in Changxing, Shangsi in Guanyuan, West Hill in Selong and the Guryul Ravine in Kashmir. Further work on these sections has been planned. Members of the China University of Geosciences (Wuhan) are working on Late Permian to Middle Triassic ecostratigraphy and sequence stratigraphy of the first two sections. The sea level curves worked out by them show remarkable differences to those of Haq et al. (1988). They are also working on the anoxic event at the P/T boundary with A. Hallam and G. Wignall, in Changxing with H. Hansen. Members of the Nanjing Institute of Geology and Palaeontology are working on conodonts collected from Changxing, and are preparing field excursions to the first two sections during the International Symposium on the Permian Stratigraphy, Environments & Resources, 1994. Drs. Chen, He and Geldsetzer (Canada) will visit the Selong section, Tibet in

1994. Contacts are under way with Indian participants about further work in the Guryul Ravine. This will be discussed in business meetings next year.

**3.2. Specific meetings and field trips**

The following meetings, either independent or in association with other projects and meetings, have been scheduled for 1994:

- IGCP 359 Meeting on the 9th International Symposium on Gondwana Geology, Geophysics and Mineral Resources, Hyderabad, India, January 10-14, 1994; with five field excursions and a satellite meeting "Contribution of palaeobotany to Gondwana geology" in Lucknow (January 6-7). Dr. Dickins will chair this IGCP meeting to discuss the Permo-Triassic of marginal Gondwana and its correlation with the Tethys and Circum-Pacific.
- International Symposium on Permian Stratigraphy, Environments & Resources, Guiyang, Guizhou, China, August 28-31, 1994; jointly sponsored by the Nanjing Institute of Geology and Palaeontology, GSSP Project Pangea, IGCP Project 306 and our IGCP Project 359, with excursions to Changxing, Guanyuan, Xingjiang and Guizhou. The IGCP 359 Meeting will discuss the results as stated in paragraph 3.1.
- The 4th International Symposium on Shallow Tethys, co-sponsored by IGCP Project 359, will be held from September 8-11, 1994 in Albrechtsberg, Austria, with a pre-excursion (September 4-7) and a post-excursion (September 12-15). In addition Prof. Jean-Jacques Chateauneuf will organize an excursion on the continental Permian of Spain and France organized for IGCP Project 359. The IGCP Project 359 business meeting will concentrate on western Tethyan Permo-Triassic correlations.
- The possibility of a joint meeting co-sponsored by IGCP 359 and 306 (Stratigraphic correlation in Southeast Asia) in Hanoi, Vietnam, 1995 is now under discussion.

Three of these four meetings will take place in developing countries.

**3.3. Proposed major publications**

A monograph summarizing all the work carried out on the Circum-Pacific Permo-Triassic is scheduled to be submitted to Cambridge University Press by the end of this year. In addition to the abstracts already published in the 'Pangea abstracts' volume, part of the members' contributions will be published in the 'Symposium of Pangea'. A monograph on 'Upper Permian to Middle Triassic ecostratigraphy and sequence stratigraphy of the Yangtze Platform and its margins' (in Chinese) has been submitted to the Science Press, Beijing.

Projected funding request

Considering the high level of activities and the large scale of involvement we request the highest level of funding for 1994. The project has been active in a vast area of the world, especially in developing countries, and has generated a high level of geological work and cooperation. Publications of this project, although it is still in its first year, have attained a remarkable level and quantity. Participation in meetings, often across the ocean or continent, is expensive especially for scientists from developing countries. For the sake of keeping impetus of the very welcomed project and especially better teamwork with developing countries, we strongly propose recommendation of the project at the highest level for next year.

*Request for extension, on-extended-term status, or intention to propose successor project*

### 6. Summary

This project has had a very hopeful beginning. Membership has rapidly increased to more than 150 participants and its subjects seem to be very attractive among scientists. Within less than one year remarkable results have been reported on the Permian and Triassic boundaries, events, and geological developments, and active works are underway. Two meetings have taken place and another three are scheduled for 1994. A quantity of high level publications has been issued and others are being prepared. The project is going steadily towards its goal: comprehensive compilation of the Permo-Triassic boundary, organism evolution, sea level changes, palaeoenvironments, as well as tectonism and volcanism of the Tethys, the Circum-Pacific and marginal Gondwana. Vigorous participation of the developing countries is a distinctive character and the hope of this project largely lies on this aspect.

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## FAR EASTERN AND SIBERIAN PERMIAN-TRIASSIC EVENTS
## (Annual Report 1993 of the IGCP 359 Russian National Working Group)

**Yuri D. Zakharov**

### Summary of achievements

1 - A representative complex of Late Changxingian ammonoids has recently been discovered in ashstone and siltstone of the uppermost part of the Lyudyanza Horizon (Kapreevka Siltstone) in South Primorye: *Changhsingoceras*, *Xenodiscus*, *Xenodiscidae* gen. n., *Dzhulfoceras*, *Huananocerae*, *Liuchengoceras*, *Tapashanites?*, *Sinoceltites*, Pleuronodoceratidae n. gen. 1 and Pleuronodoceratidae n. gen. 2 (Zakharov and Oleinikov, 1993). New data confirm the existence of a complete section for the Upper Permian in South Primorye and allow the correlation of the uppermost Lyudyanza Horizon (*Huananoceras qianjiangense* beds) with the upper zones of the Changxing Formation in South China and the uppermost Dorashamian (*Pleuronodoceras occidentale* Zone) in Transcaucasia.

The presence of ash layers and acidic tuff in the uppermost Dorashamian of the West Pacific (South Primorye) confirms Yin Hongfu et al.'s (1992) idea about existing extensive intermediate to acidic volcanism during the P/T boundary time interval.

2 - New data on main events in Permian stratigraphic sequences of the Arctic have been reported by G.V. Kotlyar (1993).

3 - Some problems of ammonoid ecology, mode of formation of the phosphorite concretions and the peculiarities of $P_2O_6$ distribution in main cephalopod facies during the Late Paleozoic and Mesozoic were recently discussed by Yu.D. Zakharov and E.L. Shkolnik (1993). Nodules with a high $P_2O_6$ content, a product at a terminal stage in phosphate diagenesis, seem to have been formed while ammonoids with tissues were sporadically spread within the sediments enriched

by organic matter. The spikes of phosphate accumulation within the Late Paleozoic and Mesozoic fall mainly within the time of maximum expansion of the humid climate belt (Early-Middle Carboniferous, Early Permian, Murgabian, Late Midian-Early Dzhulfian, Middle Induan [only within the Boreal realm], Middle Anisian, Ladinian, Early Carnian, Early Norian, Pliensbachian, Toarcian, Bajocian) partially connected with transgressions.

4 - N.I. Kurushin (1992) has described thirty-three species, including eleven new ones, of paleoheterodont and heterodont bivalves from the Triassic of different places of Siberia (Taimyr, Anabar, Olenek, Lena, Verkhoyansk, Yana, Indigirka, Omolon, etc.).

### Selected publications

KOTLYAR, G.V., 1993. Main events in Permian stratigraphic sequences of Arctic. In: Carboniferous to Jurassic Pangea. Abstract book. Calgary.

KURUSHIN, N. I., 1992. Triassic paleoheterodont and heterodont bivalves of Siberia. Novosibirsk: Nauka, 87 p. (in Russian).

ZAKHAROV, Y.D. and OLEINIKOV, A.V., 1993. New data on the problem of the Permian - Triassic boundary in the Far East. In: Carboniferous to Jurassic Pangea. Abstract book. Calgary.

ZAKHAROV, Y. D. and SHKOLNIK, E.L., 1993. Role of ammonoid remains in Late Paleozoic and Mesozoic phosphatogenesis. Bull. Mosk. obstch. ispyt. prirody, otd. geol., 68(2): 72-82. (in Russian).

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IUGS UNESCO

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◇ Remark: persons, institutions and countries indicated with ◇ still need to be fixed and confirmed

The following pages contain the newsletters of IGCP Project 359 and of the Working Group on the Permian-Triassic Boundary. Some of the information given in these newsletters is also included in the foregoing annual report of IGCP Project 359. Because these newsletters had a restricted distribution, they are reproduced here. Only the lists of participants and the announcements of meetings have partly been omitted, at least as far as this information is given elsewhere in this issue.

The Editor

# TETHYAN CIRCUM-PACIFIC AND MARGINAL GONDWANA LATE PALEOZOIC AND EARLY MESOZOIC CORRELATION (BIOTA, FACIES, FORMATIONS, GEOCHEMISTRY AND EVENTS)

IGCP PROJECT 359 (1993-1997) NEWSLETTER No. 2 - August 1993

Leader: YIN Hongfu, Palaeontology Laboratory, China University of Geosciences, Wuhan, Hubei, 430074, China. Tel: 0186 27 72136 ext. 404, Fax: 01086 27 701763

Co-leaders: J. M. DICKINS, Australian Geological Survey Organization, P. O. Box 378, Canberra, A.C.T. 2601, Australia. Tel: (06) 2805439 (O), (06)2487638 (H). Fax: 061 06 2488178; Aymon BAUD, Musee Géologique, UNIL-BFSH2, CH-1015 Lausanne, Switzerland. Tel: 0041 21 6924820. Fax: 041 21 6924897; YANG Zunyi, Department of Geology, China University of Geosciences, 29 Xueyuan Road, Beijing, 100083, China. Tel: 1086 01 2022244 ext. 257, Fax: 01086 01 201 4873

## Items for discussion at the inaugural meeting of Project 359 (Calgary, August 1993)

### Organization

According to letters from group leaders and individuals, so far the number of participants of IGCP Project 359 has increased and they are from twenty countries, namely, Australia, Canada, China, Czechoslovakia, Hungary, India, Iran, Italy, Japan, Poland, New Zealand, Russia, Slovakia, Slovenia, Switzerland, Turkey, United Kingdom, U.S.A., Vietnam and Yugoslavia. Russia and Japan have reported to have organized very large groups, consisting of 43 persons from 7 institutions and 44 persons from 27 institutions respectively. Chinese participants consist of 17 persons from 6 institutions. The rest totals 32 persons of 26 institutions.

### Objectives

The aims of this project, as described in the first circular (March, 1993), are to summarize and correlate biotic, sea-level change, paleogeographic, palaeoclimatic, tectonic and volcanic information on the Late Paleozoic to Early Mesozoic in order to reach a better understanding of this key period in geological history and its mineral resources. For practical reasons, i.e. limited time and funding, we have to lay our emphasis on the Permian and Triassic of the Eurasian and Gondwanan Tethys and the Asian, North American and Australasian parts of the Circum-Pacific, although contributions from all regions and periods covered by the subject are equally welcome. For effective interregional correlations, it is advised to concentrate our joint researches on just a few targets. These may include:

- Major events of this interval, such as the end-Permian and end-Triassic regressions, geochemical anomalies, mass extinction and, in the former, volcanic events.

- Tectonic phases accompanied by volcanic, paleogeographic and paleoclimatic changes bearing overall influences, such as the Indosinian and/or Hunter Bowen Orogenies.

Suggestions for concrete objectives for our project are urged to be set forth and discussed at the meeting during the Pangea Conference.

## Meetings

The following meetings, either independent or in association with other projects and meetings, have been scheduled:

- IGCP 359 Meeting during the 9th International Symposium on Gondwana Geology, Geophysics and Mineral Resources, Hyderabad, India, January 10-14, 1994; with five field excursions and a satellite meeting on the "Contribution of Palaeobotany to Gondwana Geology" in Lucknow (January, 6-7). (Correspondence: Secretary of the Organizing Committee, 9th Gondwana Symposium, International Wing, Geological Survey of India, Jawaharlal Nehru Road, Calcutta 700 016, India). The IGCP 359 meeting is to be chaired by Dr. Dickins and will discuss the Permo-Triassic of marginal Gondwana and its correlation with the Tethys and Circum-Pacific.
- International Symposium on Permian Stratigraphy, Environments and Resources, Guiyang, Guizhou, China, August 28-31, 1994; sponsored by the Nanjing Institute of Geology and Palaeontology in conjunction with IGCP 359, IGCP 306, Pangea Project GSGP and other projects, with excursions to Changxing, Shangsi, Xingjiang and Guizhou. The IGCP 359 meeting is to be chaired by Prof. Yin to concentrate on eastern Tethyan and Circum-Pacific Permo-Triassic correlations. There are also good sections for Triassic sequence stratigraphy in the vicinity of Guiyang, suitable for one day excursions. (Correspondence: Dr. Wan Xiang-dong, Secretariat of Organizing Committee for ISP, 1994, Laboratory of Palaeobiology & Stratigraphy, Nanjing Institute of Geology Palaeontology, Chi-Ming-Ssu, Nanjing, 210008 China; Tel. 86-25-714443, Fax. 86-25-712207).
- A IGCP 359 meeting at the Shallow Tethys 4 Conference September 9-12, 1994, ALbrechtsberg/Vienna, Austria (see p. 2 of this issue). This meeting will concentrate on western Tethyan Permo-Triassic correlations.
- The possibility of a joint meeting co-sponsored by IGCP 359 and 306 (Stratigraphic correlation in Southeast Asia) in Hanoi, Vietnam, 1995 is now under discussion.
- A special symposium for IGCP 359 has been tentatively scheduled for the 30th International Geological Congress, 1996, Beijing, China. We anticipate that synthetic work on Permo-Triassic correlation of the Tethys, Circum-Pacific and marginal Gondwana will be contributed to this symposium.

Participants, especially those from North America and the Central Tethys, are urged to look for possibilities to organize a IGCP 359 meeting in their respective region.

## Work plan

The correlations have to begin with stratigraphy, especially biostratigraphy. Nevertheless, we should not indulge ourselves in stratigraphy itself, which is mainly the work of the Subcommissions on Stratigraphy and their working groups. Emphasis should be laid on our objectives of which the stratigraphic framework serves as the basis. However, for the first years of our project interregional stratigraphic correlations associated with correlations of events and phases are essential, without these further integration of information would be impossible. This will become the main subject of our meetings in 1994.

We hope that this stage will be passed over quickly to a further synthesis of intercontinental correlation of biotas, sea-level changes, tectonic movements and so on. For this sake we suggest to form a small panel, of which each member is in charge of working out the stratigraphic framework (together with events and phases) of a fairly large part of our research area, e.g., the western and central Tethys, the western Circum-Pacific, etc. The panel will meet in 1994 or early 1995 to establish a workable general correlation chart of the Permo-Triassic as a basis for further discussion and synthesis. We hope that we will have a good data base and synthesis to compile a book which should be ready for publication by 1997.

## TETHYAN CIRCUM-PACIFIC AND MARGINAL GONDWANA LATE PALEOZOIC AND EARLY MESOZOIC CORRELATION (BIOTA, FACIES, FORMATIONS, GEOCHEMISTRY AND EVENTS)

IGCP PROJECT 359 (1993-1997) NEWSLETTER No. 3 - September 1993

### Distribution of the newsletter

Due to financial and administrative difficulties in delivering the newsletter to the very large number of participants, the newsletter has originally only been sent to the national working group leaders.

### Membership and addresses of participants

According to letters from the group leaders and individuals, the number of participants of IGCP Project 359 has increased and presently includes scientists from twenty-three countries, namely, Australia, Canada, China, Czechia, Germany, Hungary, India, Iran, Israel, Italy, Japan, Poland, New Zealand, Russia, Slovakia, Slovenia, Spain, Switzerland, Turkey, United Kingdom, U.S.A., Vietnam and Yugoslavia. Russia and Japan reported that very large groups have been formed, consisting of 43 persons from seven institutions and 44 persons from 27 institutions respectively. Chinese participants consist of seventeen persons from six institutions. The rest totals more than fifty persons from more than thirty institutions.

### Achievements in 1993

Two meetings have been held by this project during the Pangea Conference (August 15-19, 1993; Calgary, Canada). More than fifty persons attended the plenary meeting. After an introduction on the aim, organization and work plan of the project, Dickins, Ross, Baud, Besse, Gaetani, Zakharov, Kotlyar, Holser and others talked on recent achievements on the time scale, magneto- and chemostratigraphy. The meeting decided to form a panel working on interregional correlations of Permo-Triassic formations, biotas, palaeoclimates, tectonic and magnetic events. The panel meeting was held in the evening of August 19. The following persons were assigned to be responsible for making a draft of an interregional correlation chart: A. Baud (Western

Tethys), H. Yin (Eastern Tethys), M. Dickins (marginal Gondwana), G. Stanley (Circum-Pacific), W.T. Holser (chemostratigraphy), G. Besse (magnetostratigraphy, still needs to be confirmed), S. Lucas (terrestrial Permo-Triassic). The dates of other meetings to show and discuss these charts have been tentatively set for the Guiyang and Albrechtsberg meetings in 1994.

Major advancements have been achieved with regard to biostratigraphic findings, anoxic events at the P/T boundary, as well as the discovery of the latest Permian vs. earliest Triassic transgression in many continuous sections. For more information one is referred to Newsletter 2 of the PTBWG which is also published in this issue of ALBERTIANA.

The Chinese group held its inauguration meeting in April. Members of the China University of Geosciences (Wuhan) are working on Late Permian to Middle Triassic ecostratigraphy and the sequence stratigraphy of the Yangtze Platform. The sea-level curves they worked out show remarkable differences when they are compared with those of Haq et al. (1988). They are also working on the anoxic event at the P/T boundary together with A. Hallam and G. Wignall, and on the magnetostratigraphy of the P/T boundary in Changxing with H. Hansen. The English version of the "Permo-Triassic events of South China" (Yang et al., 1992) has just been published by the Geological Publishing House, Beijing. Members of the Nanjing Institute of Geology and Palaeontology are working on conodonts collected in Changxing and they are preparing the International Symposium on Permian Stratigraphy, Environments and Resources, 1994. Drs. Chen, He and Dr. Geldsetzer (Canada) will visit the Selong section, Tibet in 1994.

The Russian group discovered a late Changxingian ammonoid fauna of the South China type (*Pseudotirolites* fauna) and an acidic tuff and volcanic ash layer at the top of the Permian, indicating a northward extension of both the fauna and the boundary volcanism. It was attempted to establish the sequence stratigraphy of Arctic Russia. They also published a monograph on the Triassic bivalves of Siberia. Members from Australia, Switzerland and the U.S.A. contributed to the concept of Pangea, paleogeography of the Tethys and terranes of the Circum-pacific. A number of members from Germany, Israel, U.S.A. and Italy reported results on Permian and Triassic sequence stratigraphy, biostratigraphy and fossils. Members from Italy and Hungary published works on the Anisian and Ladinian of the Southern Alps and Hungary, which are included in the "Anisian-Ladinian boundary field workshop" book (Ed. M. Gaetani), as well as a continuous deep-water Permian-Triassic section showing the *H. parvus-I. isarcica* sequence and an anoxic event. Members of the Japanese group reported results on Japanese Permian corals and brachiopods, and also an interesting discovery of a Permo-Triassic sequence in a Jurassic accretionary complex, denoting deep-sea anoxia at the erathem boundary. Iranian members presented two papers, respectively on the Upper Permian and Triassic of Iran at the Calgary meeting.

*Members are requested to use the logo of IGCP 359 for future contributions!*

Forthcoming meetings

The following meetings, either independent or in association with other projects and meetings, have been scheduled for 1994:

- IGCP 359 Meeting on the 9th International Symposium on Gondwana Geology, Geophysics and Mineral Resources in Hyderabad, India, January 10-14, 1994 (see IGCP 359 Newsletter 2, reproduced on p. 28 of this issue).
- International Symposium on Permian Stratigraphy, Environments, Resources, Guiyang,

Guizhou, China, 28-31 August, 1994 with excursions to Changxing and Shangsi (see IGCP 359 Newsletter 2, reproduced on p. 28 of this issue).

- The 4th International Symposium on Shallow Tethys, co-sponsored by IGCP Proj. 359, will be held from 9-12, September, 1994 in Albrechtsberg/Vienna, Austria, with a pre-excursion (September 5-8) and a post-excursion. The IGCP Project 359 meeting will continue on panel works and concentrate on western Tethyan Permo-Triassic correlations (for further information on Shallow Tethys 4 see p. 2 of this issue).
  In addition Prof. Jean-Jaques Chateauneuf will organise an additional excursion in the continental Permian of Spain and France. The date of this excursion still has to be fixed. For more information please contact Prof. J.-J. Chateauneuf, Geological Survey Board BRGM, Avenue de Concyr, BP. 6009, F-45060 Orléans Cedex 2, France.

## PERMIAN-TRIASSIC BOUNDARY WORKING GROUP

NEWSLETTER NO. 1 AUGUST 1993

### Membership

Up to now 21 persons have been involved in the PTBWG. The list is as follows[1]: Dr. Aymon BAUD (Switzerland), Dr. J. M. DICKINS (Australia), Dr. H. M. KAPOOR (India), Dr. Heinz KOZUR (Hungary), Dr. LIAO Zhuoting (Nanjing Institute of Geology and Palaeontology, Academia Sinica, Chi-Ming Ssu, Nanjing 200008, China, Fax: 01086 25 712207), Prof. J. MARCOUX, Prof. Keiji NAKAZAWA (28-2, Koyama Shiouchikawara-cho, Kita-ku, Kyoto, Japan 603), Dr. D. NEWELL (Invertebrate Paleontology, American Museum of Natural History, Central Park west at 79th St. New York, NY 10024, U.S.A.), Dr. A.N. OLEYNIKOV (Russia), Dr. A. RAMOVS (Slovenia), Dr. RUI Lin (China), Dr. SHENG Jinzhang (Nanjing Institute of Geology and Palaeontology, Academia Sinica, Chi-Ming-Ssu, Nanjing 210008, China, Tel: 01086 25 637452, Fax: 01086 25 712207), Prof. W.C. SWEET (Department of Geological Sciences, The Ohio State University, 107 Mendenhall Laboratory, 125 South Oval Mall, Columbus, OH 43210-1398, Fax: 001 614 292 7688), Dr. E.T. TOZER (Energy, Mines and Resources Canada, 100 West Pender St., Vancouver, British Columbia, V6B IR8, Canada, Tel. 001 604 666 9292, Fax: 001 604 666 1124), Dr. J. UTTING (Canada), Prof. H. VISSCHER (Laboratory of Palaeobotany and Palynology, Universiteit Utrecht, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands, Tel: 031 30 532629, Fax: 031 30 535096), Prof. Carmina VIRGILI (Spain), Dr. WANG Yigang (c/o Dr. Paul L. Smith, Dept. of Geological Science, University of British Columbia, 6339 Stores Road, Vancouver, British Columbia, V6T 2B4, Canada), Prof. YANG Zunyi (China), Prof. YIN Hongfu (Chairman; China) and Dr. Yu.D. ZAKHAROV (Vice-chairman; Russia).

[1] Because most PTBWG members are also involved in IGCP 359 refer to the list of partipants of IGCP 359 on p. 19-22 for the full addresses. Only the addresses of the PTBWG members who do particpate in IGCP 359 are given here.

For the purpose of efficiency we need a relatively small group consisting of members who are actively working in this field. Members who are no longer active will be asked whether they wish to resign or retire from their duties.

## Work plan

### 1. Forum in Albertiana and PTBWG Newsletters

We urge you to send your papers to Albertiana or the PTBWG Newsletter (c/o Yin) on the following topics:

- Recent achievements on P/T boundary stratigraphy, geochemistry, events and other related subjects.
- Introductions to and comments on the world's most important sections.
- Discussions on the index fossils of the P/T boundary.
- Proposals on the Global Stratotype Point and Section.

### 2. Meetings and excursions

1993: PTBWG meetings in Calgary, between August 15-19 (Pangea meeting).

1994: PTBWG meeting during the International Symposium on Permian Stratigraphy, Environments and Resources, Guiyang, Guizhou, China (see p. 28).

- A PTBWG meeting on the 4th International Symposium on Shallow Tethys (see also p. 2 of this issue).

1994-5: Suggested PTBWG meetings and excursions in one or more localities, among them India (Guryul Ravine), Austria (Gartnerkofel), Transcaucasia (Dorasham) and Iran (Kuh-e Ali, Abadeh), pending contacts with possible sponsoring institutions and persons in respective countries. Attempts to reach a consensus of the majority on the choice of the GSSP.

1996: PTBWG Meeting on 30th International Geological Congress, 1996, Beijing, China, to take some voting procedure toward decision on the GSSP.

### 3. Questionnaire circulation and voting

1994: Circulation of the questionnaire to collect the opinions of the PTBWG members.

1996: Suggested voting of the PTBWG, on the condition that opinions on index fossils, best sections, geochemical, eventostratigraphic and related researches become mature, to make some kind of decision on the GSSP.

## PERMIAN-TRIASSIC BOUNDARY WORKING GROUP

NEWSLETTER NO. 2 SEPTEMBER 1993

### Recent advancements

#### 1. Biostratigraphic findings

In SW Ellesmere Island, Arctic Canada, Henderson (1993, Pangea abstract) reported the discovery of the late Changxingian conodonts *Neogondolella subcarinata* and *N. deflecta* from the lowermost Blind Fjord Formation, 1 m above the erosional surface of the underlying Van Hauen Formation, at the traditional "P/T boundary". This horizon belongs to the "*Otoceras* Bed". However, in the type section of the Griesbachian in Griesbach Creek, northern Ellesmere Island, the first occurrence of *Otoceras* is found at 22 m above the erosional surface. Because no Changxingian strata have been reported from the Arctic, the possibility that these conodonts are reworked is low. If they are indeed not reworked, this discovery implies that the transgression in the Arctic commenced already in the latest Permian, and casts a doubt whether the lower part of the *Otoceras* Bed could be Permian.

Kozur (1993, Pangea abstract) reported an Upper Permian slope sequence with red deep-water claystones, allodapical limestones and calcareous sandstones which contain pelagic and shallow-water fossils from the Sosio Valley, Sicily. There the Changxingian is overlain, without a break, by 2 meters of laminated, brownish weathered clays (anoxic event), that contain only *Hindeodus parvus*. *Isacicella isarcica* has been found in the lowermost Induan slope limestones. This report shows that *H. parvus* can be found in a deep-water facies and that an anoxic event occurred in deep water at the P/T boundary.

Zakharov (1993, Pangea abstract) reported a late Changxingian ammonoid faunule, containing six genera identical to those from the *Pseudotirolites* fauna of South China, from the mudstone of the uppermost part of the Lyudyanza Horizon in South Primorye. This is a northward extension of that fauna.

At the PTWBM meeting Kozur reported that he has found the early Changxingian conodonts *Neogondolella subcarinata* and *N. orientalis* in the lower *Hypophiceras* Bed, the late Changsxingian conodonts *Hindeodus latidentatus* in the *Otoceras boreale* Bed, and *Hindeodus parvus* in the *Ophiceras* Bed in samples from Greenland which originally were sent to Prof. W. Sweet. However, Tozer argued that there is not a complete section to support this conodont sequence and their concurrence with concerned ammonoids.

#### 2. The anoxic event at the P/T boundary

Based on facies (black laminated shale etc.), fauna (*Lingula, Claraia*), and geochemical anomalies (negative excursions of carbon isotope and C/S ratios as well as a cerium anomaly) in the Dolomites, Idaho, the Salt Range and Changxing, Wignall and Hallam (1992, Palaeogeogr., Palaeoclimatol., Palaeoecol., 93) and Hallam (1993, Pangea abstract) convincingly revealed the anoxic event at the P/T boundary. The P/T boundary anoxic event is also supported by data from the Sosio Valley (see above) and Japan. Isozaki (1993, Pangea abstract) reported the P/T boundary layer in a pelagic chert, occurring in a Jurassic accretionary complex in central Japan, which "consists of ca. 20 m thick light-grey to olive-green siliceous claystone closely associated with jet-black carbonaceous claystone. Late Permian and Early Triassic red-bedded radiolarian cherts are stratigraphically under- and overlying. Paleozoic radiolarians were completely replaced by the Mesozoic ones across the boundary. The boundary claystone is characterized by dark colours, rich organic material, and the ubiquitous occurrence of pyrite that indicate deep-sea anoxia".

### 3. Latest Permian vs. earliest Triassic transgression

Wu Shunbao (in Yang et al., 1992: Permo-Triassic events of South China), demonstrated that the transgression in South China did not initiate in the earliest Triassic but in the latest Permian. Noe (1993, Pangea abstract) indicated that in the Dolomites (Southern Alps), the transgression began in the Tesero Oolite-Sparite which is latest Permian, and the P/T boundary lies in the overlying bed between a mixed oolite/algae laminite and a thin microsparitic unit. This view is echoed by Baud and Henderson (both in the Pangea abstracts).

It is interesting to note that a majority of the sequence stratigraphy workers did not place the sequence boundary at the biostratigraphic P/T boundary, but at the topmost Permian. In the Salt Range, Haq et al. (1988) set the sequence boundary at the base of the Upper Permian Chhidru White Sandstone (SST), and marked the earliest Griesbachian as TST. Embry did the for the Sverdrup Basin and Gaetani for the Southern Alps (both in the Pangea abstracts).

We have noted that, in many other localities where the P/T boundary is not continuous but has hiatuses, i.e. in inner shelf and neritic areas where the transgression came later, the sequence boundary will concur with the P/T boundary; there will be no SMST or LST in the underlying Permian and the transgression commenced in the earliest Triassic. However, there are exceptions; Marzolf (1993, Pangea abstract) set the sequence boundary at the topmost Guadalupian (SMST) and the lowermost Moenkopi Formation - the *Meekoceras* Bed - was taken as TST). Hence we see that the initiation of the P/T transgression is heterochronous in continuous and discontinuous sections.

## Meetings and work plan

### The Calgary meetings

During the Pangea meeting (August, 15-19; Calgary, Canada), two PTBWG meetings were held. More than fifty people attended the plenary session (August 16, $20.^{00}$-$21.^{30}$), which dealt with the membership and a general scientific discussion on the working group. Dr. S. Lucas' suggestion to form a terrestrial Permo-Triassic boundary working panel was approved. Achievements in relation to the index fossils of the P/T boundary, e.g., new findings of *Hindeodus parvus* in Sicily and Greenland as well as conodonts in (or below) the *Otoceras* Beds on Ellesmere Island, were introduced. Four candidates for the GSSP of the Permo-Triassic boundary have been proposed, i.e. (1) the Meishan section in Changxing, Zhejiang, (2) the Shangsi section in Guanyuan, Sichuan, (3) the Western Hill section in Selong, Tibet, and (4) the Guryul Ravine section in Kashmir. Brief recommendations of these four sections will be published in Permophiles and ALBERTIANA. The Chinese groups are now working on the Meishan and Shangsi sections and are preparing the pre-meeting field excursions of the International Permian Symposium (1994). Prof. Hallam, Dr. Wignall (U.K.) and Prof. H. Hansen (Denmark) will work on anoxic events and the magnetostratigraphy of these sections respectively. Drs. Geldsetzer (Canada), Chen Chuzhen and He Guoxiong will visit the Selong section next year; the faunal sequence of this section has raised a bit of disagreements in recent years. Dr. Henderson and others will work on the type section of the Griesbachian in Ellesmere Island in 1994. Further communications and an evaluation of these four sections will be presented at the Guiyang and Albrechtsberg meetings next year.

According to the proposal of the chairman, a small meeting of mainly PTBWG members was held on August 17 ($17.^{00}$-$19.^{00}$). Participants included Baud, Dagys, Jin, Kozur, Newell, Rui, Tozer, Yin and Zakharov. This meeting discussed the main boundary problems in detail. Kozur and Zakharov supported *H. parvus* as the index fossil for the P/T boundary; Dagys opposed to take only conodonts into consideration and emphasized the importance of *Otoceras*; Yin suggested to reconsider a delineation within the lineage of *Otoceras* evolution in order to allow a synchronous correlation with *H. parvus*. Tozer, Baud and Rui commented on the actual situation and on a possible solution of the problems with regard to the boundary sections and fossils. Newell remarked the significant P/T boundary anoxic event which was put forward by Ballan and he suggested to set the boundary at the world-wide anoxic event in connection with the maximum transgression, mass extinction and anomalous geochemical spike, which was echoed by some participants.

**MEMBERS AND INTERESTED PERSONS ARE STRONGLY URGED TO WRITE TO THE EDITOR OF ALBERTIANA OR THE EDITOR OF THE NEWSLETTER OF THE PTBWG CONCERNING THE P/T BOUNDARY PROBLEM**

## Membership

The chairman of the STS, the chairman and vice-chairman of the PTBWG have discussed the membership of PTBWG. Among the twenty-one persons who were member of the PTBWG up to 1993, Dr. Oleynikov is no longer active and we agreed to let him resign from his duties.

Fourteen persons have applied or have been recommended to become member of the PTBWG. The chairmen proposed the following four persons as new voting members on the basis that they are currently actively working on P/T boundary[2]: Dr. D. Baghbani (Iran), Dr. C. Henderson (Canada), Dr. G. Kotlyar (Russia) and Prof. W.T. Holser (U.S.A.). The chairmen also suggested the following six persons as corresponding members: Dr. B.F. Glenister (U.S.A.), Dr. S. Lucas (U.S.A.), Dr. M. Menning (Germany) and Dr. S. Noe (Germany). These nominations have to be verified and we have to await comments from the current members and acceptance of the recommended persons themselves.

2 For full addresses refer to the membership list of IGCP 359 on pp. 19-22 of this issue.

# THE TRANSCAUCASIAN SECTIONS DORASHAM 2 (AZERBAIDZHAN) AND SOVETASHEN (ARMENIA), TWO CANDIDATES FOR P/T BOUNDARY REFERENCE SECTIONS

**G.V. Kotlyar, H. Kozur, and Yu.D. Zakharov**

At the meeting of the P/T Boundary Working Group during the Pangea Symposium, August 1993 in Calgary, five proposals for P/T boundary stratotype candidates have been made, among them an unspecified Transcaucasian candidate, proposed by ZAKHAROV. Two candidates for Transcaucasia are proposed in the present paper, the Dorasham 2 section (stratotype of the Dorashamian) and the Sovetashen section. Before a stratotype for the P/T boundary is definitely chosen, all the proposed sections are reference sections for the P/T boundary. Some of these sections can later also be used as reference sections (hypostratotypes).

The stratotype for the P/T boundary should be situated in the tropical Tethyan warm-water belt that has the most diverse faunas, it should have an uninterrupted fossiliferous section across the P/T boundary, in which phylomorphogenetic lines of at least one stratigraphically important fossil group that straddles the P/T boundary (conodonts or ammonoids) should be recognizable. Moreover, the sections should be well accessible and sample transport to abroad should be guaranteed.

Fossil-rich continuous sections in the Tethyan warm-water belt are only known from South China, Transcaucasia (including northern Iran), central Iran, the Southern Alps and adjacent areas, and western Sicily (Sosio Valley area). In the Southern Alps only shallow-water deposits without ammonoids are present, but the phylomorphogenetic lines among the stratigraphically most important *Hindeodus-Isarcicella* group is better represented than in most of the pelagic sections. A section of the Southern Alps (e.g. the easily accessible Tesero section) could be chosen as hypostratotype for the P/T boundary in shallow-water deposits. In western Sicily an unique P/T boundary section is present in the base of a slope facies, containing both pelagic and shallow-water microfossils. Preliminary results about this section are published in GULLO and KOZUR (1993). This section has not yielded macrofossils near the P/T boundary, but the richest open-sea microfaunas in the world with a very early radiation of Triassic faunas in the lower *Isarcicella isarcica* Zone.

The sections Dorashamian 2 and Sovetashen represent fully marine continuous Tethyan warm-water sequences in the critical stratigraphic level. The microfacies of thin sections from a series of samples overlapping the top of the *Paratirolites* beds, which are until now regarded as Triassic by some specialists, has been studied. In our opinion there is no gap at the P/T boundary in these sections. The first appearance of *H. parvus* coincides in the more marginal section of Sovetashen with a shallowing. Nevertheless, the facies remains pelagic and a high oxygen level is not only indicated by the red colour of the sediments with the first *H. parvus*, but also by the very strong bioturbation. Only the overlying stromatolitic limestones could be subtidal deposits (or represent disaster associations), before a new deepening begins. In the more basinal Dorasham 2 section the shallowing is not so well recognizable, but also present.

In both sections rich micro- and macrofaunas are present in the uppermost Permian and lowermost Triassic, among them the stratigraphically most important conodonts, ammonoids, bivalves and brachiopods. The fauna is unrestricted, the P/T boundary lies within highly oxidized reddish pelagic beds, a nearly unique situation in the world.

The distribution of the macrofauna (ammonoids, nautiloids, bivalves, brachiopods) of the Transcaucasian section is well known since RUZHENCEV and SARYCHEVA (1965). Newer investigations have shown the presence of the Late Changxingian *Pleuronodoceras occidentale* Zone (ZAKHAROV, 1985, 1986, 1992; KOTLYAR, 1991). The Changxingian (Dorashamian) is represented in both sections by the most complete ammonoid succession in the world, from the bottom to the top: the *Iranites transcaucasicus-, Dzhulfites spinosus-, Shevyrevites shevyrevi-, Paratirolites waageni- (Paratirolites kittli-)* Zones. The *Phisonites triangulus* Zone, placed into the basal Dorashamian by ROSTOVCEV and AZARJAN (1971) is regarded as the uppermost Dzhulfian ammonoid Zone, in agreement with RUZHENCEV et al. (1965). The basal Triassic is represented by *Ophiceras, Lytophiceras* and *Claraia*. The newest data on the lithostratigraphic successions and distribution of the macrofaunas are published in VEHOUNY et al. (1984), ZAKHAROV (1985, 1986, 1992) and KOTLYAR (1991).

The conodont distribution of the Transcaucasian sections was published by KOZUR et al. (1978). The Sovetashen section, not regarded in this paper, was investigated in detail by KOZUR (in press). The most important data from this investigation are:

1 The *Phisonites triangulus* Zone contains only *Clarkina orientalis* (BARSKOV & KOROLEVA), but no *C. subcarinata* (SWEET). It has therefore the typical conodont fauna of the late Dzhulfian. This confirms the view of RUZHENCEV and SARYCHEVA (1965) that the *Phisonites triangulus* Zone belongs according to its macrofauna to the latest Dzhulfian. The later assignment of this zone to the Dorashamian is based rather on lithostratigraphic reasons, because with this zone begins a transgression.
2 The interval from the *Iranites transcaucasicus* Zone up to the top of the *Paratirolites waageni* Zone is characterized, among other species, by the rich and dominant occurrence of *C. subcarinata*.
3 The *Pleuronodoceras occidentale* Zone is characterized by *Clarkina changxingensis* (WANG & WANG), *C. deflecta* (WANG & WANG), *C. transcaucasia* KOZUR, *C. orientalis* (BARSKOV & KOROLEVA) and *Hindeodus latidentatus* (KOZUR, MOSTLER & RAHIMIYAZD). *C. subcarinata* is still present in the lower part of this zone, but missing in the upper part. In the uppermost 10 cm of the Dorashamian sensu ZAKHAROV (1985) *Hindeodus parvus* (KOZUR & PJATAKOVA) is present and all the above mentioned *Clarkina* species have disappeared. The conodont faunas indicate that the *P. occidentale* Zone sensu ZAKHAROV and PAVLOV (1986) corresponds to the late Changxingian and to the transitional beds of South China.
4 Above the horizon with stromatolites *Isarcicella isarcica* is present.

In the Dorasham 2 section all decisive Changxingian and lowermost Triassic conodont guideforms are present as well. The exact range has to be re-investigated after very dense new sampling regarding also new taxonomic results. However, also in this section the conodont succession, reported above from the Sovetashen section, is present and the first appearance of *H. parvus* lies within the upper part of the predominantly reddish shales and marls.

Because of the predominantly red coloured rocks and missing tectonic or metamorphic overprint (CAI = 1), the sections Dorasham 2 and Sovetashen are very suitable for palaeomagnetic investigations. According to the first data by KOTLYAR et al. (1984) and ZAKHAROV AND SOKAREV (1991) the interval of the Dorashamian and of the basal *Ophiceras* beds are normally polarized, followed by a reverse-polarized interval in much of the *Ophiceras* faunas s.l.. Only within the *Paratirolites* beds, a short reversed-polarity event is present.

In the Sovetashen section, also carbon isotope investigations have been carried out (BAUD et al., 1989). The minimum in the $\delta^{13}C$ curve lies within the uppermost Dorashamian sensu ZAKHAROV, exactly where *H. parvus* appears. The same biostratigraphic position of this carbon isotope event at the base of the *Hindeodus parvus* Zone can be observed in South China and in the Southern Alps.

Summarizing the above results, we can state that the sections Sovetashen and Dorasham 2 in Transcaucasia are excellently suitable for definition of the P/T boundary. Unfortunately, for the moment the section Dorasham 2 is not accessible for political reasons. For this reason, we support a P/T boundary stratotype in South China, but we propose as reference sections Dorasham 2 and Sovetashen.

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# A POSSIBLE NONMARINE GSSP FOR THE PERMIAN-TRIASSIC BOUNDARY

Zheng-Wu Cheng and Spencer G. Lucas

**Abstract**

The nonmarine Permian-Triassic boundary section exposed on the southern limb of the Dalongkou anticline near Jimusar, Xinjiang, western China, records apparently continuous deposition across the boundary, produces a great diversity of fossils and has been studied intensively. When a nonmarine GSSP is chosen for the Permian-Triassic boundary, the Dalongkou section will be a strong candidate.

## Introduction

The Permian-Triassic (P-T) boundary marks the most significant extinction of shelled marine invertebrates of the Phanerozoic. Discussion of this extinction, and the identification of a global stratotype section and point (GSSP) in marine strata has been both extensive and subject to lively debate during the last decade (for example, see Tozer, 1988; Kozur, 1989; and Teichert, 1990). Somewhat less attention has been devoted to the P-T boundary in the nonmarine realm (but see, for example, Olson, 1989 and King, 1990).

The establishment of GSSP's is one of the principal goals of the International Commission on Stratigraphy (Cowie et al., 1986), and we believe should be undertaken in both marine and nonmarine strata. A GSSP for the P-T boundary has not been agreed upon in marine strata, and there has been little discussion of a possible GSSP for the nonmarine P-T boundary. Although we do not here formally propose a GSSP for the nonmarine P-T boundary, the section discussed here represents a strong candidate when a formal proposal becomes appropriate.

## Nonmarine Permian-Triassic boundary

The principal problem in identifying a GSSP for the nonmarine P-T boundary is that there is usually an unconformity or gap in fossil representation (or both) associated with this boundary (Olson, 1989; Lozovsky, 1991). A notable exception is the section exposed on the southern limb of the Dalongkou anticline near Jimusar in the Xinjiang Autonomous Region of western China (Fig. 1). This section, located on the southern margin of the Junggur depositional basin (44°03'N latitude, 88°22'E longitude) is extremely fossiliferous and appears to record essentially continuous nonmarine deposition across the P-T boundary.

## Suitability as a GSSP

The Dalongkou section is a strong candidate for the nonmarine P-T boundary GSSP because of the intensity of study it has received, absence of major structural complications, absence of major time gaps and diversity of fossils. Its only drawback is the previous lack of permanent, dedicated, convenient, free international access. However, recent political developments have altered this problem so that the area is now more accessible than it has been for decades.

The earliest studies of this section were by P.L. Yuan in 1928 (Yuan and Young, 1934a,b; Yuan, 1935), which revealed fossils of Late Permian and Early Triassic dicynodont reptiles. Subsequent studies were undertaken in 1950-1962 by the Chinese Ministries of Geology and Petroleum Industry. During 1963-1966, the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) of the Academia Sinica collected fossil vertebrates at and near Dalongkou (see Memoirs of the IVPP, Academia Sinica, no's. 10 [1973] and 13 [1978]). Since 1979, a variety of Chinese institutions have carried out extensive investigations that resulted in numerous publications, including two volumes: number 3 of series 2 of the Geology Memoirs of the Ministry of Geology and Mineral Resources (1986) which consists of 8 articles published in 262 pp with 64 plates; and the volume titled "Research on the Boundary Between Permian and Triassic in Tianshan Mountains of China" published by China Ocean Press (1989: 174 pp., 44 plates). Both volumes are in Chinese but contain extended English summaries. Yang et al. (1992) presented a very brief English-language overview of the Dalongkou section.

The southern limb of the Dalongkou anticline is a relatively simple structure in which strata dip to the south at angles ranging from 190 to 240 degrees. Very little folding is associated with the P-T transition zone, so the stratigraphic sequence is easily established (Fig. 1; Li et al., 1986, fig. 1).

In the Dalongkou section (Fig. 1), the P-T transition is within the Guodikeng Formation of the Cangfanggou Group. The boundary is placed between two silty mudstone beds (units 53 and 54 of the measured section: Fig. 1), which is apparently a conformable transition. Lystrosaurus first appears at this horizon.

The Dalongkou section produces a diversity of fossils, which include palynomorphs, megafossil plants, bivalves, ostracods, conchostracans and vertebrates. These fossils are broadly distributed through the section. Their diversity is well documented in articles in the volumes listed above.

## The Dalongkou Section

The following description of the P-T transition zone on the southern limb of the Dalognkou section corresponds to Figure 1. All thicknesses are in meters.

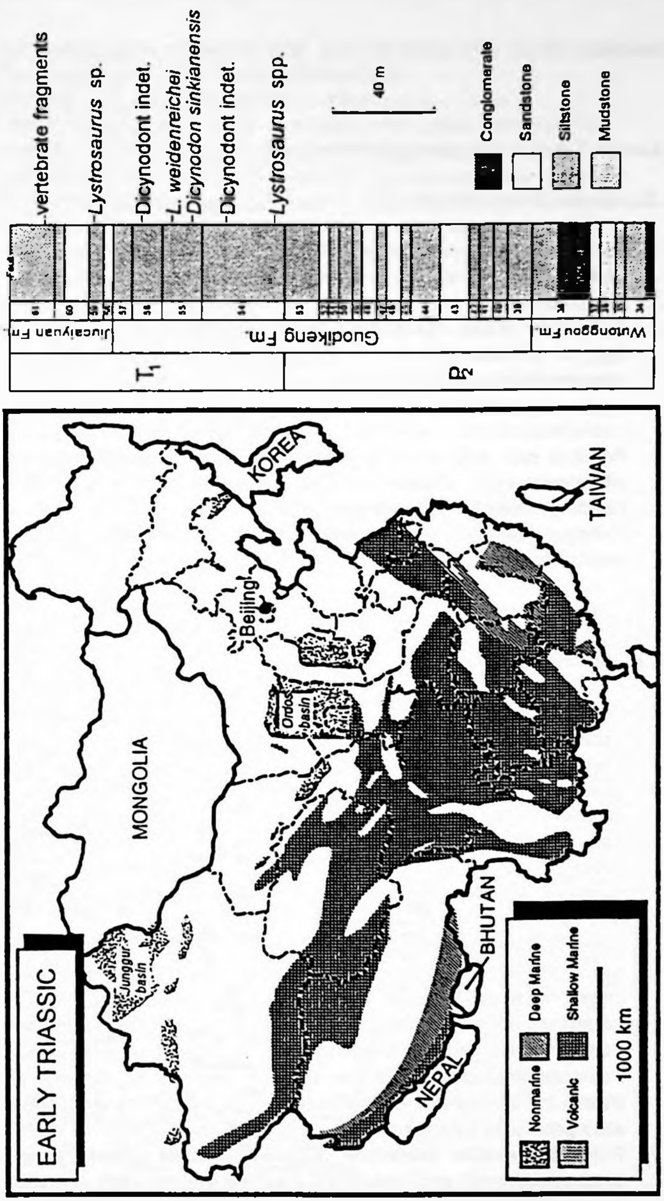


*Fig. 1.* *Early Triassic paleogeographic map of China and P-T boundary section on the southern limb of Dalongkou anticline (located in the northwestern Junggur basin of northwestern China on the paleogeographic map). Stratigraphic position of fossil vertebrates indicated.*

Quaternary sediments

-----unconformity-----

Upper Permian-Lower Triassic Cangfanggou Group:

Lower Triassic Jiucaiyuan Formation (T1j):

| | | |
|---|---|---|
| 61. | Purplish red, silty mudstone intercalated with thin layers or bedding of grayish green sandstone and siltstone; contains vertebrate-bone fragments. | 14.92 |
| 60. | Yellowish green, thinly-bedded lithic sandstone with partings of purplish red silty mudstone; laminar bedded at the top; unidentified conchostracans. | 13.19 |
| 59. | Purplish red, silty mudstone intercalated with grayish green siltstone, silty mudstone and lithic sandstone; laminar bedding; contains *Lystrosaurus* sp. | 8.10 |
| 58. | Yellowish-grayish green medium-thick bedded lithic sandstone; upper part contains sandstone concretions. | 3.03 |

-----conformity-----

Upper Permian-Lower Triassic Guodikeng Formation (P2-T1g):

| | | |
|---|---|---|
| 57. | Purplish red and grayish brown, silty mudstone with intercalated beds of grayish green lithic sandstone. | 8.83 |
| 56. | Purplish red silty mudstone interbedded or banded with grayish green silty mudstone; fine laminar bedding; conchostracans: *Falsisca* sp., *Beijianglimnadia* sp., *Cyclotunguzites* sp., *Difalsisca elongata* Liu, *D. grandis* Liu; Dicynodontia indet. | 10.52 |
| 55. | Purplish red, silty mudstone with finely rippled bedding or fine laminar bedding. | 16.02 |
| 54. | Mainly purplish red, silty mudstone unevenly interbedded with grayish green and yellowish green, thin-bedded siltstone; laminar bedding and sandstone concretions in the siltstone; base of unit produces conchostracans: *Falsisca qitaiensis* Liu, *F. beijiangensis* Liu, *F. dalongkouensis* Liu, *Beijianglimnadia rotunda* Liu, *B. multilinearis* Liu, *Sphaerestheria* cf. *S. minuta* Liu; Dicynodontia indet.; base of unit also produces *Lystrosaurus* sp. | 33.31 |
| 53. | Purplish red silty mudstone with interbeds of grayish black silty mudstone and greenish gray mudstone and grayish green siltstone; palynomorphs: *Klausipollenites schaubergeri* (Potonié & Klaus) Jansonius, *Alisporites australis* de Jersey, *Vitreisporites pallidus* (Reissinger) Nilsson, *Pteruchipollenites reticorpus* Ouyang & Li, *Lueckisporites virkkiae* Potonié & Klaus | 15.05 |

| | | |
|---|---|---|
| 52. | Yellowish green siltstone with grayish black silty mudstone; finely rippled or fine horizontal bedding. | 3.47 |
| 51. | Purplish red silty mudstone. | 3.12 |
| 50. | Variegated grayish black and yellowish green siltstone unevenly intercalated with silty mudstone; palynomorphs: *Apiculatisporis spiniger* (Leschik) Qu, *Limatulosporites fossulatus* (Balme) Forster, *L. parvus* Qu, *Alisporites sublevis* (Luber), *Protohaploxypinus limpidus* (Balme & Hennelly) Balme & Playford, *Striatoabieites richteri* (Klaus) Hart, *Lueckisporites virkkiae* Potonié & Klaus, *Taeniaesporites pellucidus* (Goubin) Balme | 6.27 |
| 49. | Brownish red, thinly bedded silty mudstone with fine horizontal bedding. | 3.68 |
| 48. | Yellowish green and grayish yellow siltstone with much more yellowish gray-grayish black silty mudstone in the upper part with fine horizontal bedding; conchostracans: *Falsisca* sp., *Beijianglimnadia* sp. | 5.87 |
| 47. | Grayish black silty mudstone; palynomorphs: *Cirratriradites* sp., *Cordaitina rotata* (Luber) Samoilovich, *Klausipollenites schaubergeri* (Potonié & Klaus) Jansonius, *Hamiapollenites limbalis* Zhang; conchostracans: *Falsisca* sp., *Huangestheria* sp., *Beijianglimnadia* sp. | 4.92 |
| 46. | Yellowish brown, thin-bedded siltstone containing numerous nodules of micritic limestone, with horizontal bedding. | 5.60 |
| 45. | Grayish brown, silty mudstone containing nodules of micritic limestone. | 4.58 |
| 44. | Mostly grayish black silty mudstone with partings of purplish red and purplish gray bands as well as siltstone and nodules of micritic limestone; fine horizontal bedding; palynomorphs: *Cyclogranisporites aureus* (Loose), *Calamospo-ra pallida* (Loose) Schopf, Wilson et Bentall, *Alisporites sublevis* (Luber), *A. australis* de Jersey, *Vitreisporites pallidus* (Reissinger) Nilsson, *Decussatisporites multistrigatus* Hou & Wang, *Triletes* spp., *Triangulatisporites* cf. *T . triangulatus* (Zerndt) Potonié et Kremp. | 10.62 |
| 43. | Mostly yellowish green siltstone and pelitic siltstone interbedded unevenly with multicolored pelitic siltstone with intercalations of lithic sandstone, with calcareous nodules and fine horizontal bedding; palynomorphs: *Cordaitina rotata* (Luber) Samoilovich, *Alisporites sublevis* (Luber), *Vitreisporites pallidus* (Reissinger) Nilsson; bivalves: *Palaeanodonta* cf. *P. parallela* (Amalitsky), *P. brevis* Liang; conchostracans: *Cornia* sp., *Polygrapta* sp. | 13.30 |
| 42. | Mostly grayish brown mudstone with fine horizontal bedding and yellowish green fine sandstone at the top; megafossil plants: *Knorria* sp. *(Lepidodendron)*, *Lepidostrobophyllum* sp. nov.; conchostracans: *Estheria* sp. | 2.76 |
| 41. | Yellowish green siltstone; top part is thinly-bedded silty mudstone intercalated with calcareous mudstone; horizontal bedding. | 5.31 |

| | | |
|---|---|---|
| 40. | Grayish brown silty mudstone; top part is brownish red pelitic siltstone intercalated with yellowish green silty pelitic siltstone; contains few calcareous nodules; fine horizontal bedding; palynomorphs: *Vesicaspora fusi* Zhen, *Alisporites sublevis* (Luber), *Platysaccus alatus* (Luber). | 5.17 |
| 39. | Alternating beds of yellowish green siltstone with grayish black silty mudstone intercalated with calcareous mudstone and a layer of yellowish green lithic sandstone. | 7.84 |

-----conformity-----

**Upper Permian Wutonggou Formation (P2)**

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# CANDIDATES FOR GLOBAL STRATOTYPE SECTIONS OF THE PERMIAN-TRIASSIC BOUNDARY

Yin Hongfu

The Permian-Triassic Boundary Working Group held a meeting during the Pangea Conference (August 15-19, Calgary, Canada). This meeting proposed four sections as candidates of GSS for the P/T boundary. They are: (1) Meishan in Changxing, (2) Shangsi in Guangyuan, (3) Xishan (Western Hill) in Selong, and (4) the Guryul Ravine in Kashmir. Following the suggestion of the participants, brief introductions of the Selong and Guryul sections are given here. The Meishan and Shangsi sections have been introduced in ALBERTIANA 11, p. 20-25. Proposals for other candidates are encouraged. Further evaluation is planned for the next PTBWG meeting in Guiyang and the Albrechtsberg meeting in 1994. Details on these meetings are given in Newsletter no. 2 of the PTBWG and and this issue of ALBERTIANA.

Due to the fact that the first three sections are compiled by Yin while the fourth is prepared by Nakazawa, the location of the boundary and the style of writing are somewhat different.

## The Selong-Xishan (Western Hill of Selong) section of Nyalam, Xizang (Tibet)

### Locality

This section (28°39'N, 85°50'E) is exposed along the Tingri-Gyirong Highway, about 1 km from Selong Village, Menbu District, Nyalam County, southern Tibet. About 30 km eastward, this highway joins the Lhasa-Kathmandu Highway. The strata dip to the NW with an angle of about 40 degrees and can be traced along the strike.

### Stratigraphy

Rao and Zhang, 1985; Wang et al., 1989; Yao and Li, 1987 (for these references please refer to ALBERTIANA 11: 26-30); Xia Fengsheng and Zhang Binggao, 1992, Age of the Selong Group in Xishan, Selong of Xixang and the Permian-Triassic boundary. Journal of Stratigraphy, 16 (4): 256-264 (in Chinese).

### Description according to Wang et al. (1989)

### Lower Triassic Kangshare Formation

| | | |
|---|---|---|
| Unit 6 | (Dienerian to Spathian): Light grey limestones alternated with reddish limestones intercalated with calcareous shales, in which 9 ammonoid and 6 conodont zones can be recognized (abbreviated here). | 5.86 m |

| | | |
|---|---|---|
| Unit 5 | (Griesbachian): The upper part consists of light grey limestones with *Ophiceras* and *Neogondelella carinata*.<br>The lower part *1 consists of brownish-yellow, light-grey dolomitic limestone and limestones with two fossil beds.<br>The upper bed of the lower part yields *Otoceras woodwardi* and *Hindeodus parvus*.<br>The lower bed of the lower part itself contains two horizons: the upper horizon yields *Otoceras latilobatum* and *H. parvus*, while the lower horizon yields these same fossils plus *Neogondolella changxingensis*. Xia and Zhang (1992) recorded the conodonts *Hindeodus minutus*, "*H. parvus*", *Neogondolella carinata* and *Xaniognathus curvatus* from this bed and they argued that the *H. parvus* of Wang et al.'s is not the real *H. parvus* but a species which appeared already in Unit 4. However, Wang, Z.H. et al. maintain that it is really *H. parvus* (in press). | 1.13-1.5 m |
| | ----- hiatus *2 ----- | |
| | **Permian Selong Group** | |
| Unit 4 | (Changxingian): Grey, dark grey limestones with brachiopods: *Waagenites* cf. *barusiensis*, *Araxathyris* sp. *Paracrurithyris pigmaea*, *Phyricodothyris* sp., conodonts: *Neogondolella* cf. *changxingensis*, *N.* cf. *carinata*.<br>Xia and Zhang (1992) recorded conodonts: *Hindeodus minutus*, "*H. parvus*", *Neogondolella betteri*, *N. liangshanensis*, *N. rosenkrantzi*, *Xaniognathus elongatus* and held that Unit 4 belongs to Wujiapingian (Dzhulfian). However, Wang, Z.H. et al. argue that the former three are not correctly identified (in press). | 0.06-0.17 m |
| | ----- hiatus *2 ----- | |
| Unit 1-3 | (Prechangxingian): Grey and dark grey limestones intercalated with calcareous shales in the middle and upper parts, yielding brachiopods (list abbreviated). Xia and Zhang (1992) recorded Qixian (Artinskian to Bolorian) | 28,76 m |
| | **Description according to Rao and Zhang (1985)** | |
| | **Lower Tulong Formation** | |
| 8. | Light grey limestones yielding Dienerian ammonoids and conodonts (list abbreviated) | 2.00 m |

| | | |
|---|---|---|
| 7. | *3 Light grey thin-bedded limestones with ammonoids: *Otoceras* sp. *Ophiceras* cf. *tibeticus, O. demissum, O. serpentinus, Lytophiceras sakuntala, Anotoceras nala;* conodonts: *Hindeodus parvus, H. anterodentatus, Neogondolella subcarinata changxingensis, N. tulongensis, N. carinata,* etc. | 0.70 m |
| 6. | Light grey, greyish yellow dolomitic limestones, ammonoids are concentrated at the basal bedding surface: *Otoceras latilabotum, O.* sp., *Glyptophiceras* cf. *lissarensis, Ophiceras* sp.; conodonts: *Hindeodus typicalis, H. parvus, H. minutus, Neogondolella subcarinata changxingensis, N. deflecta, N. tulongensis, N. carinata, Isarcicella isarcica* *4 etc. | 0.25 m |
| 5. | Light greyish yellow argillaceous dolomites | 0.10 m |

----- conformity *5 -----

**Upper Permian Selong Group**

| | | |
|---|---|---|
| 4. | Grey bioclastic limestones with corals: *Gertholites curvatus, Thamnopora densa, Pseudofavosites irregularis, Trachyppora* sp., *Sinkiangopora* sp. and crinoid stems | 4.15 m |
| 2-3. | Limestones with brachiopods (list abbreviated) | 11.48 m |
| 1. | Greyish green calcareous shales yielding abundant productids and a few corals. | 12.07 m |

Note 1. This lower part corresponds to Bed 6 (or plus 5) of Rao and Zhang (1985), about 0.2-0.4 m in thickness.

Note 2. There are two small hiatuses between the Permian and Triassic strata, with some reworked Permian brachiopods, corals and crinoids being observed just above the irregular top surface of Permian strata and between Unit 4 and Unit 3 of Wang et al. (1989).

Note 3. Bed 7 corresponds to the upper part of Unit 5 (Wang et al., 1989).

Note 4. The mixed fossil list causes some confusion as to whether they have been reworked. There are doubts that *I. isarcica* comes from samples from Bed 6. The fossil identification needs careful re-investigation.

Note 5. According to Wang et al. (1989) this is a hiatus, see note 2.

## The Guryul Ravine section

### Locality

Entrance of the Guryul Ravine about 10 km southeast of Srinagar, near Khunamuh Village, India. It is located at 75° E and about 34° N.

### Access

Easily accessible by car within one hour from Srinagar.

### Stratigraphy

The marine fossiliferous strata covering the Upper Permian Zewan Formation and the Lower Triassic Khunamuh Formation are completely exposed along the ridge of the east side of the valley. Their stratigraphy and fossils have been described in detail by the collaborative work of the Japanese group and the staff of the Geological Survey of India (Nakazawa et al., 1975. The Upper Permian and Lower Triassic in Kashmir, India. Mem. Fac. Sci., Kyoto Univ., Ser. Geol. & Mineral., 42 (1), 106 p., 12 pls. and Nakazawa and Kapoor, (Eds.), 1985. The Upper Permian and Lower Triassic Faunas of Kashmir. Palaeont. Indica, N.S. 46, 204 p., 21 pls. The Permian-Triassic transition beds are represented by Member D of the Zewan Formation and Member E of the Khunamuh Formation. The lithology and the fossil occurrences are given in Figure 1.

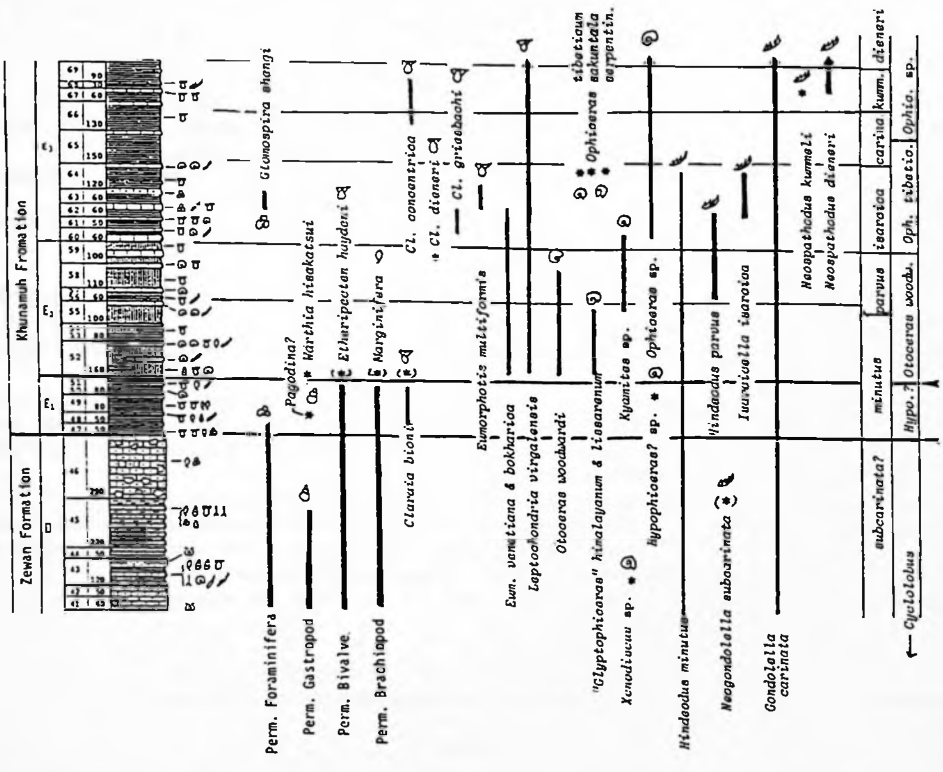

*Fig 1. Columnar section of the P/T transition beds at Guryul Ravine and range chart of fossils*

Member D is mainly composed of arenaceous limestone and calcareous sandstone of a very shallow marine facies. Member E consists of shale and limestone turbidite showing a transgressive facies. The merit of this section is a relatively thick development of the *Otoceras woodwardi* Zone (Unit $E_2$ of Member E), generally considered as the standard of the earliest Triassic fossil zone, in a continuous section. The demerit is the uncertainty of the geological age of the underlying beds (Unit E1 of the Khunamuh Formation and Member D of the Zewan Formation), and hence the uncertainty of the global correlation of this part. Geochemical and magnetostratigraphical studies are also required. Two possible Permian-Triassic boundaries have been proposed, which are a subject of discussion. One of them is a boundary reported by Nakazawa et al., 1975, that is the Unit E1/Unit E2 boundary. This is based on the correlation of *O. woodwardi* Zone with *O. boreale* and *O. concavum* zones together in the Arctic region. The other boundary considered by Teichert et al., 1970 (Science, 167, p. 174-175) and Nakazawa, 1992 (ALBERTIANA 10, p. 174-175; Nakazawa, 1993, in press) is the Member D/Member E boundary, that is the Zewan/Khunamuh Formation boundary. This is based on the occurrence of *Claraia* in Unit E1 (Teichert et al., op. cit.) or the correlation of the *O. woodwardi* Zone (Unit E2) with *O. boreale* Zone, and Unit E1 with *O. concavum* Zone and its possible equivalents (the Tesero Horizon of the Werfen Formation in the Southern Alps, the mixed fauna bed 1 of the Chinglung Formation in South China, and the Lower Unit of the Kathwai Member in the Salt Range region ?) (Nakazawa, op. cit.).

The Permian foraminifers and brachiopods from Unit E1 in Fig. 1 are not essentially different from those of the Zewan Formation. Bivalves, *Etheripecten haydeni, Claraia bioni, Nuculopsis*? sp. and *Palaeoneilo* sp. are limited in vertical distribution to Unit E1, except for the reworked(?) occurrences of the first two species in the basal part of Unit E2. Other bivalves are common in the Zewan Formation. Accordingly, the fauna of Unit E1 is much more allied to that of the Zewan Formation than to that of the rest of the Khunamuh Formation. *Cyclolobus walkeri* was reported from the uppermost part of Member C of the Zewan (Nakazawa et al., 1975). *Hypophiceras*? sp. from Unit E1 is represented by a small external cast which generic identification is uncertain. The occurrence of *Neogondolella subcarinata* in Member D (Budurov et al., 1984) needs reexamination. For the second option for the Permian/Triassic boundary one is referred to Nakazawa, 1992 (op. cit.).

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## A PROPOSAL FOR THE GLOBAL STRATOTYPE SECTION AND POINT (GSSP) OF THE PERMIAN-TRIASSIC BOUNDARY - A COMMENTARY

E.T. Tozer

The proposal of the Chinese Working Group on the Permian-Triassic Boundary (Yin, 1993) requires comment.

Despite the title of their submission, the Chinese Working Group do not, in fact, propose a GSSP. According to "Guidelines for Boundary Stratotypes" (Cowie, 1986), "Boundary definition utilizes a unique point in a rock sequence that represents, if properly selected, a unique instant of time, thus defining unequivocally a standard against which other sequences can be correlated." Cowie (op. cit.) goes on to indicate that fossils alone cannot define a GSSP because "The use of biological and palaeontological species in defining boundaries is subjective ...."

The Chinese Working Group (p. 6) propose that "The base of the *Hindeodus parvus* Zone is here recommended as the Global Stratotype Point of the Permian/Triassic Boundary". A specific stratigraphic section and locality for the GSSP is not given. Lacking reference to a stratigraphic sequence, this does not constitute a GSSP proposal in the terms outlined by Cowie (op. cit.). In their summary (p. 20) the Group states "*H. parvus* is suggested as the index fossil for the basal Triassic, and *Otoceras* and *Hypophiceras* as potential index fossils". The summary statement conveys the sense of their proposal. The title does not.

In contrast with the proposal by the Chinese Working Group, the suggestion that the Permian-Triassic boundary be defined at the base of Unit 5 in the Selong Section, Tibet (Wang et al., 1989, p. 222; Tozer, 1993, p. 36) follows the correct procedure. In the marine facies there is general consensus that conodont and ammonoid faunas are the most useful and significant for recognizing and correlating the earliest Triassic rocks. Ammonoid and conodont faunas are known from the Selong section. Although they make no explicit designation, the Chinese Working group seems to favour a GSSP in one of the sections in southeastern China (Meishan or Shangsi). There is a grave objection to designating a GSSP in one of these sections, namely the complete absence of well preserved determinable ammonoids of any significance in the Triassic part of the section.

**References**

COWIE, John W. 1986. Guidelines for Boundary Stratotypes. Episodes, 9 (2): 78-82.

TOZER, E.T. 1993. Triassic Chronostratigraphic Divisions considered again. Albertiana, 11: 32-37.

WANG Yigang, CHEN Chuzhen, RUI Lin, WANG Zhihao, LIAO Zhuoting and HE Jinwen. 1989. A potential global stratotype of the Permian-Triassic Boundary. Developments in Geoscience, Science Press, Beijing: 221-229.

YIN Hongfu. 1993. A proposal for the global stratotype section and point (GSSP) of the Permian-Triassic Boundary. The Chinese Working Group on the Permian-Triassic boundary. Albertiana 11: 4-30.

## BRITISH TRIASSIC PALAEONTOLOGY: SUPPLEMENT 16

G. Warrington

Since the completion of the writer's previous supplement (No. 15; ALBERTIANA, 10: 31-32) on British Triassic palaeontology, the following works relating to aspects of that subject have been published or have come to his notice:

**BECKLY, A., DODD, C.** and **LOS, A.** 1993. The Bruce Field. Pp. 1453-1463 in PARKER, J.R. (ed.) 1993 (q.v.).

**BOOTH, J., SWIECICKI, T.** and **WILCOCKSON, P.** 1993. The tectonostratigraphy of the Solan Basin, west of Shetland. Pp. 987-998 in PARKER, J.R. (ed.) 1993 (q.v.).

**COCKS, L.R.M.** 1993. Triassic pebbles, derived fossils and the Ordovician to Devonian palaeogeography of Europe. J. Geol. Soc. Lond., 150: 219-226.

**GAYER, R.A.** and **CORNFORD, C.** 1992. The Portledge-Peppercombe Permian outlier. Proc. Ussher Soc., 8: 15-18.

**GLASMANN, J.R.** and **WILKINSON, G.C.** 1993. Clay mineral stratigraphy of Mesozoic and Paleozoic red beds, Northern North Sea. Pp. 625-636 in PARKER, J.R. (ed.) 1993 (q.v.).

**GREEN, G.W.** 1992. British Regional Geology: Bristol and Gloucester region (3rd Edition). London: HMSO for the British Geological Survey, xi+188pp.

**GUANZHONG WANG.** 1993. Xiphosurid trace fossils from the Westbury Formation (Rhaetian) of southwest Britain. Palaeontology, 36: 111-122.

**HAMBLIN, R.J.O., CROSBY, A., BALSON, P.S., JONES, S.M., CHADWICK, R.A., PENN, I.E.** and **ARTHUR, M.J.** 1992. United Kingdom offshore regional report: the geology of the English Channel. London: HMSO for the British Geological Survey, x+106pp.

**JACKSON, D.I.** and **MULHOLLAND, P.** 1993. Tectonic and stratigraphic aspects of the East Irish Sea Basin and adjacent areas: contrasts in their post-Carboniferous structural styles. Pp. 791-808 in PARKER, J.R. (ed.) 1993 (q.v.).

**MADER, D.** 1992. Evolution of Palaeoecology and Palaeoenvironment of Permian and Triassic Fluvial Basins in Europe. Volume 1. Western and Eastern Europe, xliv+1-738pp. Volume 2. Southeastern Europe and index, xxii+739-1340pp. Gustav Fischer Verlag, Stuttgart and New York.

MADER, D. 1992. Nottingham area (England): Buntsandstein-facies and Keuper-facies. Pp. 155-225 in MADER, D, 1992 (q.v.),

MADER, D. and LAMING, D. 1992. South Devon (England): New Red Sandstone (Upper Carboniferous, Permian and Triassic). Pp. 15-154 in MADER, D. 1992 (q.v.).

NAYLOR, D., HAUGHEY, N., CLAYTON, G. and GRAHAM, J.R. 1993. The Kish Bank Basin, offshore Ireland. Pp. 845-855 in PARKER, J. R. (ed.) 1993 (q.v.).

PARKER, J.R. (ed.). 1993. Petroleum Geology of Northwest Europe: Proceedings of the 4th Conference, London, 1992. Volume 1, xxx+1-785pp., Volume 2, xxvi+786-1542pp. Geological Society, London.

POWELL, J.H., COOPER, A.H. and BENFIELD, A.C. 1992. Geology of the country around Thirsk. Mem. Br. Geol. Surv., 1:50000 geological sheet 52 (England and Wales). HMSO, London, xii+129pp.

STEEL, R.J. 1993. Triassic-Jurassic megasequence stratigraphy in the Northern North Sea: rift to post-rift evolution. Pp. 299-315 in PARKER, J.R. (ed.) 1993 (q.v.).

THOMAS, J.B., MARSHALL, J., MANN, A.L., SUMMONS, R.E. and MAXWELL, J.R. 1993. Dinosteranes (4,23,24-trimethylsteranes) and other biological markers in dinoflagellate-rich marine sediments of Rhaetian age. Organic Geochemistry, 20: 91-104.

WARRINGTON, G. 1993. The Permo-Trias of Devon - a new look. Journal of the Open University Geological Society, 13.2: 33-38. (Symposium edition, Exeter 1992).

WIGNALL, P.B., CLEMENTS, R.G. and SIMMS, M.J. 1989. The Triassic-Jurassic boundary beds of the City of Leicester. Trans. Leics. Lit. & Phil. Soc. 83: 25-31.

WILSON, A.A. 1993. The Mercia Mudstone Group (Trias) of the Cheshire Basin. Proc. Yorks. Geol. Soc., 49: 171-188.

This contribution is published with the approval of the Director, British Geological Survey (N.E.R.C.).

# RECENTLY PUBLISHED BOOKS

## Hans Kerp

**H. Hagdorn and A. Seilacher (Eds.), 1992. Muschelkalk - Schöntaler Symposium 1991. Sonderbd. Ges. f. Naturk. Württemberg, 2: 1-288. Goldschneck-Verlag Werner K. Weidert, Stuttgart, Korb, 1993. ISBN 3-926-129-11-5. DM 78.-**

This special volume of the publications of the Natural History Society of Württemberg contains the contributions to the Schöntaler Muschelkalk Symposium which was held in August 1991 and forms a welcome addition to the excellent field guide which was published by H. Hagdorn, T. Simon and J. Szulc (1991, see Albertiana, 10: 43).

The majority of the contributors to this meeting prepared a manuscript for publication. In addition, this volume contains the abstracts of the other contributions, two important new papers on Muschelkalk stratigraphy and a number of short communications on interesting new discoveries. Altogether, the book contains 31 papers and 5 abstracts, most of them dealing with the Muschelkalk, not only from the Germanic Basin but also from other areas. This book covers the area reaching from Spain to Poland and this joint effort has been conceived by a group of 51 scientists from eight European countries.

The introduction briefly summarizes the history of Muschelkalk research, thereby clearly pointing out the progress that has been made in the last decades. The papers are grouped into four chapters. Each chapter has a short introduction summarizing the most important results.

The first group of papers is presented under the heading "Geological framework of the Germanic Basin". This chapter includes papers on the Germanic Muschelkalk Basin and its relation to the Tethys, the sequence stratigraphy of the German Muschelkalk, and early Alpine tectonics and lithofacies succession in the Silesian part of the Muschelkalk Basin. The second chapter deals with the lithostratigraphy, facies and geochemistry of the Muschelkalk. It includes a proposal for a lithostratigraphical subdivision and nomenclature of the German Muschelkalk and several papers on various aspects (e.g. lithostratigraphy, sedimentology, facies, palaeogeography, geochemistry, diagenesis) of the Muschelkalk in specific areas (e.g. north-eastern Germany, northwest Germany, Thuringia, Hessen, Ardennes-Eifel, Hungary). The third chapter is entitled Biostratigraphy, Ecostratigraphy and Palaeobiogeography. A wide variety of stratigraphically important fossils is discussed in a series of ten contributions. The palynological record is interpreted chronostratigraphically and sequence-stratigraphically. Zonations and correlations with ceratids, conodonts, bivalves, brachiopods, foraminifera, echinoderms, selachians and reptiles are discussed. The bio-, eco- and chronostratigraphical importance of specific marker beds is pointed out. The fourth chapter contains a number of papers on the palaeontology and palaeoecology of the Muschelkalk. These papers address the "Fossillager-stätten", reef types of the Muschelkalk, and several groups of fossils, e.g. crinoids, holo-thurians, sponges, bryozoans and ceratids. One paper deals with the microboring spectrum of macrobenthic fossils. The inside covers show two tables with the chrono- and biostratigraphy of the Musschelkalk.

| Gruppe | Untergruppe | Leitbänke | Standard-Zonen n. KOZUR 1974 Ceratiten-Zonen n. HAGDORN 1991 | Conodonten n. KOZUR 1974 | Crinoiden n. HAGDORN & GŁUCHOWSKI 1993 | Chronostratigraphie n. KOZUR 1974: Unterstufe | Chronostratigraphie n. KOZUR 1974: Stufe | VISSCHER et al. 1993: Unterstufe | VISSCHER et al. 1993: Stufe |
|---|---|---|---|---|---|---|---|---|---|
| Muschelkalk | Oberer | moH-HB | *semipartitus*<br>*dorsoplanus*<br>*weyeri* | 7 | *liliiformis* | Longobard | Ladin | Fassan | Ladin |
| | | | *nodosus* | 6 | | Fassan | | | |
| | | | *praenodosus*<br>*sublaevigatus* | 5 | | | | | |
| | | moM-CB<br>moM-HB | *enodis*<br>*postspinosus* | 4 | | | | Illyr | Anis |
| | | moM-RB<br>moT-SB | *spinosus*<br>*evolutus* | 3 | | | | | |
| | | | *compressus*<br>*robustus*<br>*pulcher* | 2 | | Illyr | Anis | | |
| | | moT-TB | *atavus* | 1 | | | | | |
| | Mittlerer | | | | | | | | |
| | Unterer | muWS | Assemblage-Zone mit *Neoschizodus orbicularis* und *Judicarites* | | *silesiacus* | | | .... ? .... | |
| | | muWT | *Decurtella decurtata* | *kockeli* | *dubius* | Pelson | | Pelson | |
| | | muWO | Assemblage-Zone mit *Beneckeia buchi*, *Myophoria vulgaris* und *Dadocrinus* | *germanicus*<br>„*nevadensis*" | *acutangulus*<br>*Dadocrinus* | Aege/Bithyn | | | |

*Biostratigraphy and chronostratigraphy of the Muschelkalk (from Hagdorn and Seilacher, 1993)*
moH-HB = Hauptterebratelbank, moM-CB = *cycloides*-Bank, moH-RB = *reticulata*-Bank, moT-SB = *Spiriferina*-Bank, moT-TB = *Tetractinella*-Bank

This richly illustrated volume covers a wide range of topics related to the Muschelkalk of the Germanic Basin and elsewhere. It presents a wealth of new information and new interpretations of this classical unit, which was originally defined by Von Alberti, the founder of the Triassic system. Most contributions are in German, all the other ones are in English. All papers in German have an English abstract. Unfortunately the prefaces to the four chapters which are excellent summaries of the state-of-the-art are in German only. This is, however, my only (minor) point of criticism. Despite the slight differences in style between the individual papers, which are unavoidable in a multi-author publication like this, the book looks very attractive. The printing, also of the numerous line drawings and photographs, is excellent and this reasonably priced book has an attractive hard cover which illustrates the Schöntal monastery where the meeting took place. The editors should be congratulated with this volume which undoubtedly will find its way to Triassic workers.

**Contents of the Muschelkalk volume:**


MOSTLER, H., Das Germanische Muschelkalkbecken und seine Beziehungen zum tethyalen Muschelkalkmeer. pp. 11-14.

AIGNER, TH. and BACHMANN, G.H., Sequence stratigraphy of the German Muschelkalk. pp. 15-18.

SZULC, J., Early Alpine tectonics and lithofacies succession in the Silesian part of the Muschelkalk Basin. A synopsis. pp. 19-28.

RÖHL, U., Sequenzstratigraphie im zyklisch gegliederten Oberen Muschelkalk Norddeutschlands. pp. 29-36.

BEUTLER, G., Lithologisch-paläogeographische Karte Muschelkalk, Maßstab 1:1,5 Mio (IGCP Projekt 86 "SW-Rand der Osteuropäischen Tafel"). p. 37.

BEST, G., RÖHLING, H.-G. and BRÜCKNER-RÖHLING, S., Synsedimentäre Tektonik und Salzkissenbildung während der Trias in Norddeutschland. p. 37.

HAGDORN, H., HORN, M. and SIMON, TH., Vorschläge für eine lithostratigraphische Gliederung und Nomenklatur des Muschelkalks in Deutschland. pp. 39-46.

BEUTLER, G., Der Muschelkalk zwischen Rügen und Grabfeld. pp. 47-56.

GAERTNER, H., Zur Gliederung des Muschelkalks in Nordwestdeutschland in Tiefbohrungen anhand von Bohrlochmessungen. pp. 57-64.

BACKHAUS, E. and SCHULTE, M., Geochemische Faziesanalyse im Unteren Muschelkalk (Poppenhausen/Rhön) mit Hilfe des Sr/Ca-Verhältnisses. pp. 65-72.

ERNST, W., Der Muschelkalk im westlichen Thüringen. pp. 73-78.

LUKAS, V., Sedimentologie und Paläogeographie der Terebratelbänke (Unterer Muschelkalk, Trias) Hessens. pp. 79-84.

GAERTNER, H. and RÖHLING, H.-G., Zur lithostratigraphischen Gliederung und Paläogeographie des Mittleren Muschelkalks im Nordwestdeutschen Becken. pp. 85-103.

BOCK, H., HARY, A., MÜLLER, E. and MULLER, A., Der Muschelkalk an der Ardennen-Eifel-Schwelle. p. 104.

BRÜCKNER-RÖHLING, S. and LANGBEIN, R., Lithostratigraphie des Mittleren Muschelkalks in der Bohrung Hakeborn-211 (subherzynes Becken) und Logkorrelation zwischen Thüringer Becken, Subherzyn und Norddeutschem Becken. pp. 105-110.

ROTHE, M., Die Wüste im Wasser: Zur Fazies, Geochemie und Diagenese des Mittleren Muschelkalks in N-Bayern. pp. 111-115.

KLOTZ, W., Lithologie, Fazies und Genese des "Wellenkalks" im Unteren Muschelkalk. p. 116.

OCKERT, W., Die Zwergfaunaschichten (Unterer Hauptmuschelkalk, Trochitenkalk, mo1) im nordöstlichen Baden-Württemberg. pp. 117-130.

BARTHOLOMÄ, A., Fossilführung des Tonhorizontes alpha von Unterohrn. pp. 131-132.

TÖRÖK, Á., Storm influenced sedimentation in the Hungarian Muschelkalk. pp. 133-142.

VISSCHER, H., BRUGMAN, W.A. and VAN HOUTE, M., Chronostratigraphical and sequence stratigraphical interpretation of the palynomorph record from the Muschelkalk of the Obernsees well, South Germany. pp. 145-152.

URLICHS, M., Zur Gliederung des Oberen Muschelkalks in Baden-Württemberg mit Ceratiten. pp. 153-156.
BUDUROV, K., CALVET, F., GOY, A., MARQUEZ-ALIAGA, A., MARQUEZ, L., TRIFONOVA, E. and ARCHE, A., Middle Triassic stratigraphy and correlation in parts of the Tethys realm (Bulgaria and Spain). pp. 157-164.
HAGDORN, H. and GLUCHOWSKI, E., Palaeobiogeography and stratigraphy of Muschelkalk echinoderms (Crinoidea, Echinoidea) in Upper Silesia. pp. 165-176.
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**YIN Hongfu, YANG Fengqing, HUANG Qisheng, YANG Henshu, LAI Xulong et al. (Eds.), 1992. The Triassic of Qinling Mountains and neighboring areas. China University of Earth Sciences Press, Wuhan, 211 pp. ISBN 7-5625-0620-5/P.215. (in Chinese with an extensive English summary)**

This book presents the first comprehensive study on the Triassic of the rather inaccessible Qinling Mountains and its neighbouring areas. The Triassic is a key period in the geologic history of Qinling Mountains, beginning with extension and down-punching to form thick geosynclinal deposits and ending up with Indosinian Orogeny, which caused not only the folding up of Qinling Mts. but also final incorporation of North China and Yangtze Platform. Several kinds of mineral resources are known to be related to these strata, among them are gold (Mingshan area of South Qinling), mercury and stibium (central part of West Qinling area), coal, rock salt and gypsum (Dabashan area along northern border of South Qinling).

This study is based on a five-year research project. Altogether twenty-three sections with a total length of 164.1 km have been measured. Five regions can be distinguished in the area studied, i.e. (1) north Qinling, (2) the northern belt of central Qinling, (3) the southern belt of central Qinling, (4) the northern belt of south Qinling, and (5) the southern belt of south Qinling. For each of the regions the lithostratigraphy, biofacies and fossils have been studied and correlations have been established. The palaeogeography and the geological history of the Qinling Mountains and adjacent areas are discussed. The book concludes with an informative English abstract of thirteen pages. All figure and table captions are in Chinese and English.
The book includes an appendix with descriptions of a number of fossil groups, such as radiolarians, brachiopods, gastropods, bivalves, ammonoids, conodonts, trace fossils and plants (including palynomorphs) and a selection of fossils is figured on twenty plates which are mostly of good quality.

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**YANG Zunyi, WU Shunbao, YIN Hongfu, XU Guirong and ZHANG Kexin (Eds.), 1991., Permo-Triassic events of South China. Geological Publishing House, Beijing, 190 pp. ISBN 7-116-00842-X/P.724. (in Chinese with an extensive English summary)**

This multi-author book presents the contributions of the Chinese Working Group to IGCP Project 203 and its predecessor, IGCP Project 106. Permian-Triassic boundary sections have been worked out all over South China. Nineteen sections have been measured and many rock samples and fossils have been collected and studied. Examination of the different sections gave new evidence for fixing the P/T boundary and for the choice of the boundary stratotype. New data have become available on the volcanism and the composition of volcanic rocks, the mass extinction and the origin of the boundary clay. Geochemical studies of the boundary clay indicate that catastrophic events have taken place. Detailed studies of the fossils from the boundary interval have resulted in new ideas on the biotic decline, mass extinction and its causes and biotic alternation at the P/T boundary. This multidisciplinary study indicates that a series of catastrophies took place near the P/T boundary. The individual chapters present new data on and discuss the Late Permian-early Triassic transgression and regression, volcanic events, geochemical anomalies and geological events, mass extinction and biotic alternation at the P/T boundary and temporal correlations and mass-extinction events.

The authors conclude that regression took place in the Late Changxingian. It is noteworthy that this regression and the succeeding regression did not occur right at the P/T boundary, but rather below it; the new transgression set in within the Permian. A line of marked biotic decline matches with the line separating the Shanxingian transgression from the new regression. Volcanic material, of various types, has been discovered all over South China. More and more clayrocks occurring near the P/T boundary have been proven to be the result of illinitization and montmorilonitization. The composition of volcanic material appears to change regularly in time and space and the relationship between clayrocks and volcanism, and microspherules and volcanism have been studied in detail. A large quantity of microspherules were obtained from the boundary clay and they can be differentiated into several types: of biological, volcanic and probably also of extra-terrestrial origin. Volcanic activities intensified biotic mass extinction and the most conspicuous extinction phase is found at the P/T junction, which is also a period of frequent volcanic activity. The large quantity of green algae in the clayrocks indicate an unfavourable environment in which pelagic forms became largely extinct. The main cause for the mass extiction is the emission of carbondioxide which resulted in a lowering of the pH value of the surface water layer of the open ocean and shallow water regions, hindering the deposition of calcium carbonate and the development of calcareous organisms. Platinum metals like iridium appear to be unevenly distributed in the various areas and the rare-earth elements in the boundary beds show two distribution models. Chalcophile elements are most strongly enriched in the boundary beds while siderophile elements are rare, which is suggested to be due to volcanic activity. The boundary beds show an increase of As, Se, Ag, and Au and a decrease of Na, Mg, Ca, Fe, Mn, Co and Zn. Elemental analysis (B, Ca, Mg, Sr, V, Ga, Ti, Fe and Mn) shows that the salinity of the sea water was fairly high by the Late Permian, whereas it is relatively low by the end of the Permian. These data are supported by oxygen and carbon isotope values. Most groups of organisms show a clear alternation at the P/T junction and some of them became totally extinct, although it should be noted that several group were already in decline, e.g. corals, fusulinids and trilobites. During the Changxingian groups like brachiopods, ammonoids and non-fusulinid foraminifera were still fairly abundant, but they show a marked alternation. Certain calciophile taxa show a strong decline or became even extinct at the P/T boundary. The authors suggest that the P/T mass extinction was the result of a number of causes which include sea level changes, volcanism, changes of ecotopes, oxygen deficiency, changes in salinity, temperature changes, acidity of the seawater and pollution by poisonous substances. Their relation is summarized in the table reprinted below.

| Leading events | Tributary events | Ultimate event |
|---|---|---|
| Transgression & regression<br>Volcanic eruptions | ecotope changes<br>oxygen deficiency<br>salinity oscillation<br>temperature rise and fall<br>marine acidity<br>pollution by poisonous substances<br>Catastrophe group | mass extinction |

*Catastrophies in the P/T transitional period in South China (From Yang et al., 1991)*

The distribution of taxa in the Meishan, Puqi, Shangsi, Huayingshan and the Anshun sections in China and the Guryul Ravine section in Kashmir suggest an abrupt the mass extinction. The time estimated for the mass-extinction event is less than 100,000 years.

The book has an extensive and clearly written summary in English and two English tables summarizing the catastrophies in the P/T transitional interval and the stages of biotic bloom and decline at the P/T junction in South China. The figure captions are bilingual but it is a pity that the captions of the photo plates are only in Chinese.

**M. GAETANI (Ed.), 1993. I.U.G.S. Subcommission on Triassic Stratigraphy - Anisian/Ladinian boundary field workshop Southern Alps - Balaton Highlands, 27 June - 4 July 1993. Milano, 118 pp.**

This field guide of the Anisian/Ladinian boundary field workshop has been produced by collaborators of the Dipertimento di Scienze della Terra of the Università degli Studi in Milano, the ETH-Paläontologisches Museum in Zürich, the Magyar Allami Földtani Intezet in Budapest, the Department of Geology of the Eotvos Lorand University in Budapest and the Geological and Paleontological Section of the Hungarian National Museum in Budapest. The list of contributors includes M. Balini, P. Brack, T. Budai, L. Dosztaly, M. Gaetani, F. Góczán, S. Kovács, A. Nicora, A. Oravecz-Scheffer, H. Rieber and A. Vörös.

The guide contains a general chapter with an introduction, the history of the Ladinian and its base in the Alps and Balaton and the zonation proposed for the critical interval (ammonoids zonation in the western Tethys and conodont zonation in the central-western Tethys and North America). The second chapter deals with the Southern Alps and contains a general introduction on this area and road logs of three field trip days (Bagolino, Stabol Fresco and Seceda). The third chapter deals with the Balaton Highlands. The megatectonic setting and structural units of Hungary, the Triassic of the Balaton Highlands and the biostratigraphic schemes applied at the Anisian/Ladinian boundary in the Balaton Highlands are described. In this latter section the biostratigraphy, the ammonoid zonation, conodont and radiolarian biostratigraphy, palynomorph zonation and benthic foraminifer zonation are briefly summarized. Road logs of the two excursion days in the Balaton Highlands are given (Aszofö, Vaszoly, Mencshely, Szentantalfa, Felsöörs, Szentkiralyszabadja and Vörösbereny). The guide concludes with an extensive and up to date reference list. This very attractive and informative excursion guide is illustrated with a large number of tables, correlation charts, sections and maps and the characteristic fossils, mostly ammonoids and conodonts, are depicted on thirteen excellent photo plates.

*Announcement*

**THE NONMARINE TRIASSIC**

Bulletin 3, 1993. Edited by Spencer G. Lucas and Michael Morales

This comprehensive 500-page volume contains more than 90 articles on all aspects of the Nonmarine Triassic. It can be ordered for US $ 50.- plus $ 5.- for postage and handling from Dr. Spencer Lucas, New Mexico Museum of Natural History, 1801 Mountain Road NW, Albuquerque, NM 87104, U.S.A. Make cheques payable to: "NMMNH Foundation Paleo".

# ANNOTATED TRIASSIC LITERATURE

**Hans Kerp and Henk Visscher**[1]

AIGNER, TH. and BACHMANN, G.H., 1993. Sequence stratigraphy of the German Muschelkalk. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 15-18.

The authors present a sequence stratigraphy of the German Triassic. At least 13 sequences can be recognized; the Muschelkalk comprises two sequences. The sequences boundaries are set at the basis of the "Rötquartzit", at the basis of the evaporites of the Middle Muschelkalk and at the basis of the "Lettenkeuper". Maximum flooding occurred during the Late Muschelkalk ("*cycloides*-Bank").

BACKHAUS, E. and SCHULTE, M., 1993. Geochemische Faziesanalyse im Unteren Muschelkalk (Poppenhausen/Rhön) mit Hilfe des Sr/Ca-Verhältnisses. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 65-72.

The "Wellenkalk" of the Lower Muschelkalk was studied geochemically, with special emphasis on Sr concentrations. The highest Sr-concentrations were measured between the grain-rich marker beds. From these data the authors derive that the "Wellenkalk" sediments have been deposited in a saline to highly saline environment. The bioclastic-bearing carbonates near the marker beds formed the barrier with the open sea.

BALINI, M., 1992. New genera of Anisian ammonoids from the Prezzo Limestone (southern Alps). Atti Tic. Sc. Terra, 35: 179-198.

Four new genera and three new species of Anisian ammonoids from the Prezzo Limestone are described. *Asseretoceras* gen. n. comprises taxa first described by ASSERETO (1963): *Bulogites camunus* (type species), *B. gosaviensis raricostatus* and *B. reiflingensis opimus. Megaceratites* gen. n. is only represented by *M. fallax* sp. n. and includes ceratitids with an unusual ontogenesis: the involute, compressed and weakly ornamented inner whorls suddenly change into nearly evolute and nearly depressed strongly ornamented outer whorls. *Ronconites* gen. n. (type species *R. tridentinus* sp. n.) shows, as well as large size, an almost subrectangular whorl section, a flattened ventral side, and a typical suture line showing on the lateral sides four saddles: the first saddle top is located in a lower position in relation to the other tree tops which are on the same level and the depth of the lobes decreases from the first to the third. *Pisaites* gen. n. (type species *P. carinatus* sp. n.) is characterized by the subrectangular whorl section and the relatively wide and roundly keeled ventral side.

[1] The help of Dr. Zwier Smeek (Utrecht), Sabine Gibas and Heike Hagemann (Münster) in tracing literature is gratefully acknowledged.

**Bartholomä, A.**, 1993. Fossilführung des Tonhorizontes alpha von Unterohrn. In: H. **Hagdorn** and A. **Seilacher** (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 131-132.

Facies and fossil content of two minor cycles in the Upper Muschelkalk (Tonhorizont $\alpha 1$ and $\alpha 2$; lowest *spinosus*-Zone) of West-Hohenlohe are analyzed.

**Bazhenov, M.L., Chauvin, A., Audibert, M.** and **Levashova, N.M.**, 1993. Permian and Triassic paleomagnetism of the southwestern Tien Shan: timing and mode of tectonic rotations. Earth and Planetary Sci. Letters, 118: 195-212.

Volcanic rocks of the Lower Permian Luchob Formation and sedimentary rocks of the presumed Upper Permian Hanaka and Middle-Upper Triassic Madighen formations were studied in three localities in the southwestern Tien Shan. Primary magnetizations were isolated in Lower Permian and Triassic rocks, whereas the remanence of reversed polarity in the Hanaka Formation acquired during the Kiaman superchron may be slightly younger than the rock age. Inclinations in all three formations agree with the European reference data, but declinations are deflected westward. The authors argue that these deflections are due to the Late Permian-Triassic (but pre-Rhaetian) counterclockwise rotations and partly due to Late Cenozoic counterclockwise rotations. Inclinations in Permian and Lower Triassic rocks throughout the Tien Shan foldbelt, the Junggar Basin and north Tarim are also in agreement with the reference data, implying that, within the error limits, this part of Central Asia was already welded together with Kazakhstan and the European plate in the Permian. Westward-deflected declinations throughout this region are accounted for not by movements of large blocks such as the Tarim but by domino-fashion Late Permian-Triassic rotations by strike-slip.

**Beutler, G.**, 1993. Der Muschelkalk zwischen Rügen und Grabfeld. In: H. **Hagdorn** and A. **Seilacher** (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 47-56.

The subsurface Muschelkalk strata from northern Germany, known from many boreholes, could be correlated stratigraphically with outcrops in classical areas in Sachsen-Anhalt and Thuringia. This allows the reconstruction of the palaeogeography. The author also discusses facies developments in the area studied.

**Bodzioch, A.**, 1993. Sponges from the epicontinental Triassic of Europe. In: H. **Hagdorn** and A. **Seilacher** (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 235-244.

The author summarized the occurrences of sponges in the Muschelkalk of SW Germany, Thuringia, Silesia and the Holy Cross Mountains. Two new taxa are described. The well identifiable sponges mostly belong the Lysacinosa. The unequivocal sponges are early Pelsonian in age, whereas the youngest ones are Longobardian. In the early Illyrian Silesia they formed bioherms and larger mounds. The palaeoecology of the Muschelkalk sponges is briefly addressed.

**Bourquin, S., Boehm, C., Clermonté, J., Durand, M.** and **Serra, O.**, 1993. Analyse facio-séquentielle du Trias du centre-ouest du bassin de Paris à partir des données diagraphiques. Bull. Soc. géol. France, 164(2): 177-188.

The subsurface Triassic formations in the west-central of the Paris basin comprise the Donnemarie Sandstones, the Intermediate Shales and the Chaunoy Sandstones. Detailed analysis of wireline logs from fifteen wells through this succession allows facies characterization and the evolution of the sequences to be determined. First the lithologies were determined thanks to both "classical" and "geochemical" logs. Next "high resolution" logs (dipmeter and formation microscanner) were used to determine textures and structures. The lithologies contain three main mineralogic poles: quartz, clay (essentially illite), dolomite with occasionally anhydrite. The vertical distribution of the facies allows the recognition of various sequences in each formation. First fining-upwards sequences are observed in the Donnemarie Sandstones (conglomerate to sandstones) and in the Chaunoy Sandstones where several types of evolution occur: conglomerate to sandstone, conglomerate to sandstone and dolomites or shales... Second the Intermediate Shales show an evolution corresponding to shale-anhydrite sequences. The limits of sequences allow a better correlation at the scale of the region and the Triassic formations in these continental deposits. An uranium-rich horizon which may be isochronous marks the top of the Intermediate Shales and their equivalents in sandstone facies (in the west). A progressive onlap results from the pre-existing basement topography reconstructed from the wireline log correlations between wells.

Brückner-Röhling, S. and Langbein, R., 1993. Lithostratigraphie des Mittleren Muschelkalks in der Bohrung Hakeborn-211 (subherzynes Becken) und Logkorrelation zwischen Thüringer Becken, Subherzyn und Norddeutschem Becken. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 105-110.

A Middle Muschelkalk sequence from a borehole in the Subhercynian Basin was studied in detail and is correlated with the Middle Muschelkalk of the North German Basin and the Thuringian Basin. Microfacies are studied and geophysical well logs indicate that the Middle Muschelkalk was a time of relative palaeogeographic and palaeotectonic stability.

Budurov, K., Calvet, F., Goy, A., Marquez-Aliaga, A., Marquez, L., Trifonova, E. and Arche, A., 1993. Middle Triassic stratigraphy and correlation in parts of the Tethys realm (Bulgaria and Spain). In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 157-164.

Three carbonate platforms can be distinguished in the Triassic of the Iberian Peninsula (Catalonia and SE Iberian Ranges), viz. in the Lower Muschelkalk (Anisian), Upper Muschelkalk (Ladinian) and the Imon Formation (Norian?); the Triassic of Spain is germanotypic. In Bulgaria, the sedimentation in the Triassic starts with continental siliclastics passing into marine sediments at the end of the Scythian; this regime continues until the end of the Triassic. Pelsonian and Illyrian foraminifera zones established in Bulgaria have also been recognized in Spain. Both in Spain and in Bulgaria, the Middle Triassic conodont zones range from the Pelsonian through the Fassanian. Anisian bivalves are cosmopolitic; they are known from Spain, Bulgaria and from the German Muschelkalk. Faunal provinces developed during the Ladinian when Spain became part of the Sephardic Province of the Tethys. The ammonoid faunas clearly started to differentiate during the Anisian with the development of the Balkanic and the Sephardic provinces of the Tethys. During the Ladinian some Germanic representatives of *Ceratites* reached as far south as the Baleares. The Middle Triassic faunas of Spain and Bulgaria belong to the Tethys.

**Coli, M.** and **Fazzuoli, M.**, 1992. Cosiderazioni sulla lithostratigrafia e sull'evolutione sedimentaria delle Formazioni Retico-Liassiche del Nucleo Metamorfico Apuano. Atti Tic. Sc. Terra, 35: 43-60.

Shallow water carbonate sedimentation began in the Apuan Alps zone in Late Triassic time and had persisted until Late Hettangian. In the lithostratigraphic succession two superimposed shallow water carbonate bodies can be recognized: the lower dolomitic "Grezzoni" and the upper "Carrara Marble". Grezzoni consists mostly of dolomitized oolitic grainstones and peritidal stromatolitic dolomites, representing shoal and back-shoal environments. Carrara Marble consists mostly of fenestral mudstones to packstones representing a back-shoal environment: subtidal mudstones and possible oolitic grainstones are subordinate. In the Northern Apuan Alps, interposed between the two shallow water carbonate units, there is a calcareous marly unit (Marmo scistoco), deposited below fairweather wave base and therefore representing a phase of deepening. Elsewhere, this unit is absent and there is a residual and karst breccia, that records a shallowing phase of limited area extension, possibly connected with tectonic uplift, between the Grezzoni and the Carrara Marble. The extensive shallow water environment of the Carrara Marble persisted up to the Hettangian-Sinemurian boundary, when the Appennine margin drowned and the sedimentation of pelagic deposits began. Some aspects of the sedimentary evolution in the Apuan Alps zone differ with respect to that of the rest of the northern Apennines, where shallow water deposits like Grezzoni are missing or reduced (Pania di Corfino Formation), and where limestones and marls of deeper environment (La Spezia Formation), corresponding to the Marmo scistoso, are widely present. The Carrara Marble shows sedimentary features very similar to those of the Calcare Massiccio of the Tuscan Nappe, with which it is correlatable.

**Cowan, E.J.**, 1993. Longitudinal fluvial drainage patterns within a foreland basin-fill: Permo-Triassic Sydney Basin, Australia. Sedimentary Geology, 85: 557-577.

The north-south trending Permo-Triassic Sydney Basin (southern sector of the Sydney-Bowen Basin) is unique compared to many documented retro-arc foreland basins, in that considerable basin-fill was derived from a cratonic source as well as a coeval fold belt source. Quantitative analysis of up-sequence changes in sandstone petrography and palaeoflow directions, together with time-rock stratigraphy of the fluvial basin-fill, indicate two spatially and temporally separated depositional episodes of longitudinal fluvial dispersal systems. A longitudinal drainage-net similar in geometry to the modern Ganga River system (reduced to 60% original size) explains many of the palaeoflow patterns and cross-basinal petrofacies variation recorded in the basin-fill. The Late Permian to Early Triassic rocks reveal a basin-wide southerly directed fluvial drainage system, contemporaneous with east-west shortening recorded in the New England Fold Belt. In contrast, the Middle Triassic strata reveal a change to an easterly directed fluvial system, correlated to a shift in orogenic load to a NW-SE orientation in the fold belt northeast of the basin. The detailed petrofacies variation in the deposits of the second longitudinal fluvial dispersal system reveals vertical jumps in the petrofacies compositions, with uniform compositions between jumps. The petrological jumps are interpreted as the result of minor fault adjustments in the fold belt, resulting in changing rates of sediment supply to the foreland basin. Uninterrupted erosion of the same terrain most likely caused the compositional uniformity between jumps. The identification of longitudinal fluvial systems, with transverse variation in detrital composition, is likely to help resolve the tectonic history of the adjacent coeval fold belt.

DE ZANCHE, V., GIANOLLA, P., MIETTO, P., SIORPAES, C. and VAIL, P.R., 1993. Triassic sequence stratigraphy in the Dolomites (Italy). Mem. Sci. Geol., 45: 1-27.

A major handicap to correlations within the Triassic in the Dolomites has always been the difficulty of comparison between carbonate platform deposits, often "undifferentiated", and the corresponding basinal successions. By means of an integrated approach of lithostratigraphic, biochronostratigraphic and sequence stratigraphic methodologies a number of 3rd order depositional sequences have been recognized, far more numerous than in the cycle chart of Haq et al. (1987): six in the Scythian, four in the Anisian, three in the Ladinian, four in the Carnian, at least two in the Norian. Data from Norian and Rhaetian are very uncertain. From the biochronological point of view a new ammonites standard zonation has been used (Mietto and Manfrin, in progress), ranging from Early Anisian to Early Carnian, integrated fro the Carnian by the ammonite scale in Krystyn (1978). Therefore depositional sequences in this interval are well dated. Volcanism is an independent variable in the depositional sequences. As a consequence, it causes greater difficulty in recognizing the eustatic signal. However, the latter can be identified in those areas where volcanism is either lacking or moderate. In spite of syndepositional extensional tectonics, which influences the accommodation space, it seems to be demonstrated that, when a good biostratigraphic setting is available, the eustatic signal is always recognizable. It worth underlining that in this work the authors' only goal is the proposal of a general frame for the Triassic sequence stratigraphy in the Dolomites. Detailed contributions on particular arguments or stratigraphic intervals will be given in the future.

ERNST, W., 1993. Der Muschelkalk im westlichen Thüringen. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 73-78.

Thicknesses and facies of the Muschelkalk in West Thuringia between the Thuringian Forest and the Hainich Hills is influenced by larger and smaller palaeogeographic units of the basement. Apart from the basin morphology, sealevel fluctuations may have influenced facies and thickness of the Muschelkalk.

ERNST, R. and LÖFFLER, TH., 1993. Crinoiden aus dem Unteren Muschelkalk (Anis) Südniedersachsens. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 223-233.

The stratigraphical investigations in the Upper "Terebratelbank" and the "Wellenkalk 3" Member (Lower Muschelkalk Group, Anisian) of Southern Lower Saxony produced sedimentological and paleoecological data in connection with the collecting of cephalopods, brachiopods, remarkable Crinoidea. Older published data about the fossil contents of this stratigraphical range were analyzed too. A tempestite horizon at the base of the Upper "Terebratelbank" conserved a population of chelocrinids with 20 arms, which were part of a hardground paleoecological community. Compared to *Chelocrinus carnalli* (BEYRICH, 1856) from the stratigraphically younger "Schaumkalk" Beds in Central Germany, this new population shows a different shape of the theca and a presence of cirri. For the time being this morphological type is classified as *Ch.* aff. *carnalli*. The stratigraphic importance of this specific "Terebratelbank type" is shown by its possible correlation potential between the Lower Saxonian "Terebratelbank" Member and the Rüdersdorf "Schaumkalk" facies (Brandenburg beds). The described *Holocrinus* sp. nov., based on a new and nearly complete individual from the Upper "Terebratelbank" Beds, definitely is a new holocrinoid. This is approved by the cup and cirri organization and the comparison with other holocrinid species and their discussed taxonomy.

**Fiechtner, L., Friedrichsen, and Hammerschmidt, K.**, 1992. Geochemistry and geochronology of Early Mesozoic tholeiites from Central Morocco. Geol. Rundsch., 81(1): 45-62.

From Central Morocco (Central High Atlas, Middle Atlas, Haute Moulouya) continental tholeiites were investigated geochemically and geochronologically. These tholeiites are intercalated within continental redbeds of the Early Mesozoic (Triassic-Liassic). The major, trace and rare earth element contents classify these volcanic rocks as basaltic to andesitic-basaltic, quartz-normative tholeiites. Some trace element ratios (e.g. Zr/Nb, Zr/Y, Y/Nb, Ti/V) suffer a heterogeneous source with a composition similar to MORB (P- to N-type). The enriched LILE contents, the negative Nb anomaly and the initial $^{87}Sr/^{86}Sr$ ratios (0.7064-0.7069) reveal the presence of a crustal component up to 13-17 wt%. $^{87}Sr/^{86}Sr$ ratios of carbonate mineral separates from different lava flows show different cycles of alteration; however, the major and trace element chemistry together with Sr isotope evidence, indicate that the alteration phases are not submarine in origin. $^{40}Ar/^{39}Ar$ age determinations on translucent plagioclase phenocysts yield extrusion rates which range between 210.4 ± 2.1 Ma and 196.3 ± 1.2 Ma. These ages correspond to a stratigraphic period between the Norian (Rhaetian?) and the Upper Sinemurian.

**Fontaine, J.M., Guastella, G., Jouault, P. and De La Vega, P.**, 1993. F15-A: a Triassic gas field on the eastern limit of the Dutch Central Graben. In: J.R. Parker (Ed.), Petroleum Geology of Northwest Europe: Proceedings of the 4th Conference. Geological Society, London, pp. 583-593.

The F15-A gas field lies at the eastern margin of the Dutch Central Graben, the reservoirs being found within the overpressured Triassic Main Buntsandstein Formation. The discovery well, F15-4, was drilled in 1985 and was subsequently followed by the two appraisal wells, F15-5 and F15-7. Structurally speaking, the F15 area is located in an intermediate structural compartment between the Central Graben, to the west and the Schill Grund High, to the east. The structure consists of a NNE-SSW-trending turtle back anticline, plunging to the south, with gently dipping flanks to the east and west. Northwards, closure is provided by a NW-SE-oriented erosional trough which cuts deeply into the Lower Triassic and is filled by Upper Triassic/Jurassic sediments.

The primary reservoir is the Volpriehausen Sandstone Member, which is very fine to coarse grained and irregularly cemented by dolomite, anhydrite and halite. Four lithofacies have been recognized: dunal, interdunal, ephemeral fluviatile (distal wadi) and playa-lake related. These facies show a coarsening-upward profile, caused by the successive depositional environments becoming increasingly arid as they grade from playa lake to dunes. A seismic amplitude study was carried out, based on the links between porosity and seismic response at the reservoir level, to identify the areas with the best potential reservoir development.

**Gaertner, H.**, 1993. Zur Gliederung des Muschelkalks in Nordwestdeutschland in Tiefbohrungen anhand von Bohrlochmessungen. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 57-64.

The Muschelkalk in NW-Germany has been subdivided lithostratigraphically by means of borehole measurements in more than 400 boreholes, particularly by gamma ray and sonic logs. The cyclicity of the Muschelkalk which comprises 13 units in the Lower, 6 cycles in the Middle and 10 cycles in the Upper Muschelkalk is discussed.

GAERTNER, H. and RÖHLING, H.-G., 1993. Zur lithostratigraphischen Gliederung und Paläogeographie des Mittleren Muschelkalks im Nordwestdeutschen Becken. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 85-103.

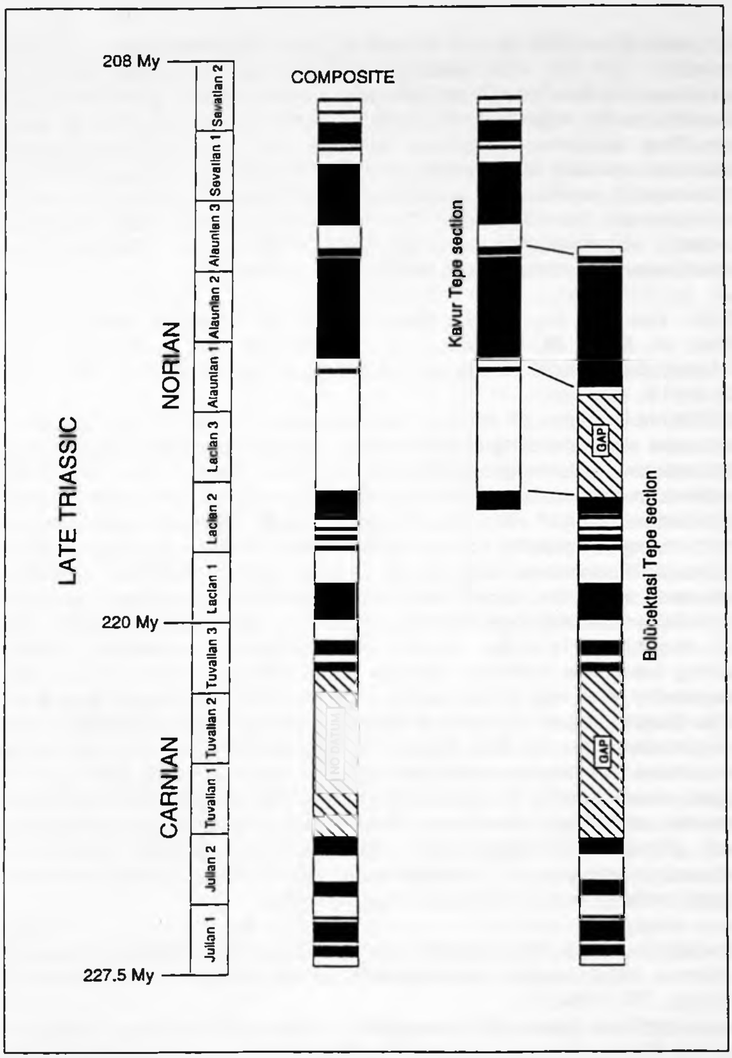
The halite-bearing "Mittlerer Muschelkalk" can be lithologically subdivided into subcycles in the wells of the Northwest German Lowlands and the German sector of the North Sea on the basis of geophysical well logs. The cyclicity can be recognized and correlated throughout the basin in spite of differences in lithology and thickness. Logs of typical wells at various palaeogeographical locations, e.g. basins or swells document the newly set up detailed lithostratigraphic subdivision. Six different salt layers can be recognized. Distribution maps of the halite in these salt layers and isopach maps give a tentative picture of the subsidence pattern in the basin and show the palaeogeography and palaeotectonics during "Mittlerer Muschelkalk" times.

GALLET, Y., BESSE, J., KRYSTYN, L., MARCOUX, J. and THÉVENIAUT, H., 1992. Magnetostratigraphy of the Late Triassic Bolücektası Tepe section (southwestern Turkey): implications for changes in magnetic reversal frequency. Phys. Earth Planet. Inter., 73: 85-108.

A magnetostratigraphy study of light-pink to white pelagic limestones from the Bolücektası Tepe section (southwestern Turkey) provides a magnetic polarity sequence well calibrated with the conodont zonation for the Lower Carnian and uppermost Carnian-Middle Norian (Late Triassic). Thermal (between 400 and 550°C) and alternating field (30-60 mT) demagnetizations isolate the characteristic remanent components. Rock magnetic experiments suggest that magnetite is the dominant carrier, but a small hematite fraction also exists in the Lower Carnian light-pink limestones. A major sedimentary gap (Middle-Upper Carnian) divides the section in two submembers which reveal two statistically different mean directions, differing in declination by about 30°. A sequence of 39 polarity intervals is obtained, 18 in the Carnian (ten in the Lower Carnian and eight in the uppermost Carnian) and 21 in the Lower-Middle Norian. The magnetic reversal frequencies which can be derived from these results, together with the available magnetostratigraphic data for the Middle-Early Jurassic, Triassic and Late Permian, show a pattern which is in rough agreement with suggested 150-200 million year time constant in the reversal process since the Kiaman superchron. However, significant short-period fluctuations in reversal frequency cannot be excluded.

GALLET, Y., BESSE, J., KRYSTYN, L., THÉVENIAUT, H. and MARCOUX, J., 1993. Magnetostratigraphy of the Kavur Tepe section (southwestern Turkey): A magnetic polarity time scale for the Norian. Earth Planet. Sci. Newsl., 117: 443-456.

The authors present the magnetostratigraphy of the late Triassic pelagic Kavur Tepe section from the Taurides (southwestern Turkey). The section investigated is about 30 m thick and consists of fine-grained whitish limestones. The biostratigraphy, based on the conodont zonation, gives an age from the Lacian 2 zone (lower Norian) to the Sevatian 2 zone (upper Norian). The paleomagnetic analyses indicate very favourable behaviour, with two magnetic components which can be isolated both by thermal and AF demagnetization. The magnetization is carried by magnetite and goethite, which are clearly evident in IRM experiments. The first component of normal magnetic polarity has roughly the direction of the present-day field. The high unblocking temperature component shows directions of both polarities. In total, fifteen magnetic polarity intervals are observed within the Kavur Tepe section. The characteristic calculated Fisherian mean direction is particularly tightly grouped: $D$ = 220.2° and $I$ =




*Comparison between the magnetographic sequences obtained from Bolücektası Tepe and the Kavur Tepe sections (southwestern Turkey). The nummerical time frame has been estimated using the rough concept of equal duration for the ammonoid zones. The polaritysequence of the Kavur tepe section is given according to a southern hemisphere origin for this section. From these results, a composite Norian (almost complete) and Carnian (not complete) geomagnetic polarity sequence is established and shown on the left part of the figure.*

*Submitted by J. Marcoux*

32.1°, with $K = 40.9$, $\alpha_{95} = 1.7°$ and $N_{samp} = 179$ (after bedding correction). Polarity correlations with two other sections in Turkey and in Austria (Northern Calcareous Alps) show that the Kavur Tepe sediments were deposited in the southern hemisphere. By combining the magnetostratigraphic results from the Bolücektası Tepe (1) and the Kavur Tepe sections, an almost complete Norian magnetic polarity sequence is established, showing 30 magnetic intervals that are well calibrated with the conodont and ammonoid zonations. A magnetic reversal frequency close to about 2.7 reversals/Myr is derived for the Norian. This medium frequency is in agreement with the hypothesis of a long time constant (150-200 Myr) in the changes of the magnetic reversal frequency since the Kiaman reversed superchron.

GRADSTEIN, F.M., VON RAD, U., GIBLING, M.R., JANSA, L.F., KAMINSKI, M.A., KRISTIANSEN, I.-L., OGG, J.G., RÖHL, U., SARTI, M., THUROW, J.W., WESTERMANN, G.E.G. and WIEDMANN, J., 1992. Stratigraphical and depositional history of the Mesozoic continental margin of central Nepal. Geol. Jb., 77: 3-141.

The Thakkhola region of central Nepal contains at least 1.5 km of coastal to neritic and (upper) slope deposits of Late Triassic to mid-Cretaceous (latest Albian) age. New paleomagnetic, paleobiogeographic and paleoflow data confirm that the strata were deposited on the northern Gondwana margin bordering Tethys while Thakkhola lay at mid-latitudes (28-41° S). Late Triassic coastal deposits, belonging in the Thini Formation, are overlain by Lower-Middle Jurassic shelf units assigned to the Jomosom and Bagung Formations; thick Lower Jurassic carbonates of the Jomosom Formation correspond with the most northerly paleolatitude recorded, probably reflecting Thakkhola's rapid drift into the subtropics. The Late Jurassic to Early Cretaceous drift again into higher latitudes resulted in deposition of terrigenous clastics. A hiatus spanning late Early Callovian through Early Oxfordian time corresponds to a global transgression that may reflect accelerated sea-floor spreading in both the Atlantic and Pacific Oceans. Upper Jurassic dark shales of the Nupra Formation, correlative with the regionally extensive Spiti Shale, are deep shelf to slope deposits, laid down along the northern Gondwana continental margin; septal strength indices for cephalopods suggest water depths in excess of 250 m. The shales contain an Indo-SW Pacific ammonite assemblage, but also a diversified aggulitinated foraminiferal assemblage of Boreal affinity. Such deep-water foraminiferal assemblages probably had a large cosmopolitan component. The shale is intensely deformed and its overmature condition probably reflects in part Cenozoic orogenic events.

GRAUVOGEL-STAMM, L., 1993. *Pleuromeia sternbergii* (Münster) Corda from the Lower Triassic of Germany - further observations and comparative morphology of its rooting organ. Rev. Palaeobot. Palynol., 77: 185-212.

Three rather well preserved rhizophores of *Pleuromeia sternbergii* from the type-locality Bernburg (Saale, Germany), as well as Mägdefrau's specimen have been re-examined. They provide new data which serve as a basis for reconsidering their structure. For the first time a very small rhizophore, probably immature, is described and figured. The characteristic features, e.g. rhizophore anatomy, number of lobes, root structure, arrangement, sequence of initiation and course of traces are analyzed and discussed. Careful consideration of root-scar arrangement, furrow structure and root-trace course yields the first structural evidence demonstrating the organization of the vascular system, the process of root production, the weak cortex development and the long root retention in *P. sternbergii*. Comparisons are made with the living genus *Isoetes* and other lobed and furrowed lycopods.

**Guanzhong Wang**, 1993. Xiphosurid trace fossils from the Westbury Formation (Rhaetian) of Southwest Britain. Palaeontolgy, 36(1): 111-122.

The abundant and diverse trace fossils attributed to xiphosurid activity on sandstone soles at Westbury on Severn are described and interpreted. The xiphosurids seem to have been active in this area mainly after major storm event sedimentation. Two patterns of scratches, three types of lunate marks, and a bilobate furrow assignable to *Cruziana perucca* are distinguished. The lunate marks and one pattern of the scratch marks are assigned to *Selenichnites* isp. The marks were produced either during carnivorous feeding or burrowing for concealment. Variation in the traces is attributed to variable formation and preservation, sediment grain size, mud cohesiveness, as well as sediment thickness above the trace-taking sole surface, which modified the behavioral activity of the trace maker.

**Hagdorn, H.** and **Gluchowski, E.**, 1993. Palaeobiogeography and stratigraphy of Muschelkalk echinoderms (Crinoidea, Echinoidea) in Upper Silesia. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 165-176.

The authors discuss the distribution of a number of echinoderms and crinoids in the eastern part of the Muschelkalk Basin. Their distribution was mainly determined by salinity. Sea-level changes allowed the westward migration of several relative tolerant forms. Some crinoids and echinoderms have also a rather limited stratigraphical distribution. There are sufficient skeletal elements showing diagnostic characters to establish a biostratigraphic zonation on the basis of echinoderms. This crinoid stratigraphy is only applicable in Silesia, because some index forms do not occur further westwards and northwards. However, this stratigraphy might be applicable in the Alps and the Tatra Mountains.

**Hagdorn, H., Horn, M.** and **Simon, Th.**, 1993. Vorschläge für eine lithostratigraphische Gliederung und Nomenklatur des Muschelkalks in Deutschland. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 39-46.

The Muschelkalk lithostratigraphy is based on ecostratigraphical and lithostratigraphical marker beds which allow exact bed-by-bed correlations of logs over hundreds of kilometres. Due to regional traditions, a variety of synonyms and homonyms developed, which, however, led to some confusion. The Muschelkalk working group of the German "Perm/Trias Subkommission" has reviewed the terminology and this paper presents the results of this revision. The Muschelkalk is now subdivided according to the international recommendations into groups, subgroups, formations and members. The marker bed concept is maintained. Formalized descriptions of a formation and a member of the Lower, Middle and Upper Muschelkalk are given.

**Hagdorn, H.** and **Ockert, W.**, 1993. *Encrinus liliiformis* im Trochitenkalk Süddeutschlands. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 245-260.

The SW-German Trochitenkalk (Upper Anisian) consists of up to 16 m thick encrinites which were on a regional shoal or shallow carbonate ramp and which grade into mudstones intercalating with crinoidal packstones towards the deeper ramp. A series of successions have been studied and attention has been given to the lateral development and vertical distribution. Detailed observations allow the reconstruction of the life habit and ecology of *Encrinus liliiformis*, a Mesozoic crinoid with "Palaeozoic" characters.

**Hagdorn, H. and Simon, Th.**, 1993. Ökostratigraphische Leitbänke im Oberen Muschelkalk. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 193-208.

Ecostratigraphic marker beds in the Upper Muschelkalk are characterized by temporary faunal immigrations from outside the Germanic Basin. These exotic elements comprising stenohaline epibionts fingerprint several shell beds. Ideally they occur in one bed only, thus forming reliable marker horizons. Their biostratigraphic range may comprise up to two stages. The ecostratigraphic marker beds of the Upper Muschelkalk are reviewed and interpreted sequence-stratigraphically. Migration routes are deduced from the distribution of marker beds.

**Hankel, O.**, 1993. Early Triassic plant microfossils from Sakamena sediments of the Majunga Basin, Madagascar. Rev. Palaeobot. Palynol., 77: 213-233.

Microfloral assemblages have been recovered from Sakamena sediments exposed in the northern part of Majunga Basin (Andreba area, northern Madagascar). The assemblages are characterized by association of cavate spores, taeniate pollen and acritarchs including marine phytoplankton. A very close affinity exists with palynofloras from marine Early Triassic strata of the Salt Range of Pakistan. The composition of the present assemblages suggests that the Sakamena section examined is time equivalent with the upper part of Mittiwali Member of the Mianwali Formation. It is concluded that the Sakamena assemblages are of early Smithian age. There is also a close correspondence with the Early Triassic assemblages of the *Kraeuselisporites saeptatus* Zone of Western Australia recorded from marine sediments of the Perth Basin (Kockatea Shale) and the Carnarvon Basin (lower part of Locker Shale). Other Gondwana palynofloras which are regarded here as comparable and coeval to the present assemblages all come from continental strata. These are Early Triassic assemblages of eastern Australia (*Protohaploxypinus samoilovichii* Zone), India (Purnea microflora), and Kenya (Lower Mariakani assemblages). In southern Madagascar, equivalent assemblages are those from the Upper Sakamena (Zone II B) of the Morondava Basin.

**Huon, S., Cornée, J.-J., Piqué, A., Rais, N., Clauer, N., Liewig, N. and Zayane, R.**, 1993. Mise en évidence au Maroc d'événements thermiques d'âge triasico-liasique liés à l'ouverture de l'Atlantique. Bull. Soc. géol. France, 164(2): 165-176.

During the Late Triassic and the Early Liassic, intracontinental basins with emission of tholeiitic lavas related to early stages of the North Atlantic rifting developed along the Moroccan Atlantic margin and within the Atlasic domain. K-Ar dating of grain size fractions of Cambrian slates from the Hercynian basement and of sediments from the Triassic cover yields apparent ages decreasing with grain size from 330-300 Ma for the coarse fractions to about 220-200 Ma for the clay size fractions. These latter values indicate either a K-Ar reset of Hercynian minerals or the occurrence of neoformed phases under very-low temperature conditions during the Late Triassic - early Lias. Temperatures of 185-210°C maintained during 15 ± 10 Ma can be deduced from theoretical calculation. These values can account for the isotopic rehomogenization of fine-grained Hercynian micas of the Haut Atlas. Ascension of the upper mantle, within a thin continental crust during early stages of the Atlantic rifting is considered.

**Hüssner, H.**, 1993. Rifftypen im Muschelkalk Süddeutschlands. In: H. **Hagdorn** and A. **Seilacher** (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 261-269.

Reefs can be found in the south German Muschelkalk predominantly in two different levels (Crailsheim beds, Trochitenbank 2-4, *atavus*-Zone, and Hohenlohe beds, at the level of the Hauptterebratelbank, *dorsoplanus*-Zone). Environmental conditions have been similar at both times, but two different reef types originated. In comparing the ecological needs and the morphological abilities of reef builders in both horizons, general principles of reef formation can be recognized, independent of systematic affinities. A variety of organisms is involved in the reef building processes in the bivalve/crinoid/sponge bioherms of the Crailsheim beds. In the *Placunopsis*-reefs the processes of reef formation are short-circuit within one species. In the appendix, sponges are for the first time described as potential reef builders in the Crailsheim beds. Possible systematic affinities of a known (from other localities) and a new problematical microfossil are discussed.

**Iannace, A.**, 1993. Caratteri diagenetici dei carbonati di piattaforma del Trias Superiore Nell' Appennino meridionale e loro implicazioni paleogeografiche. Riv. It. Paleont. Strat., 99(1): 57-80.

The diagenetic features of two lithofacies assemblages found in the Upper Triassic of Lattari Mountains are illustrated. The first one, Norian in age, consists of cyclic dolomitic successions containing several horizons with synsedimentary antiform structures (*tepee*) and thick crusts of laminated cements, formed during early diagenesis. The second one, Rhaetian in age, is characterized by the striking abundance of laminated and radial fibrous (*raggioni* or giant rays) cements with respect to relict clasts of loferitic, calcareous-dolomitic former sediments. Moreover, it is emphasized that dolomitization patterns of Norian and Rhaetian age, respectively, are very different, which possibly reflects a global control. Similar Late Triassic facies outcrop in Maratea Mountains, underlying a Meso-Cenozoic succession (Verbicaro Unit) considered transitional between the appenninic carbonate platform and a pelagic, basinal domain. Both these facies assemblages are interpreted as pertaining to a platform margin complex, frequently subjected to subaerial exposures and affected by strong early diagenetic processes. It is also hypothesized that the adjacent basinal domain was located in a more westerly, "*tyrrhenian*" position. Finally, it is emphasized that the analysis of diagenetic features of Upper Triassic sequences might greatly help in palaeoenvironmental and stratigraphic reconstructions and reveals a more complex palaeogeography respect to previous and more traditional interpretations.

**Jeans, C.V.**, **Reed, S.J.B.** and **Xing, M.**, 1993. Heavy mineral stratigraphy in the UK Trias: Western Approaches, onshore England and the Central North Sea. In: J.R. **Parker** (Ed.), Petroleum Geology of Northwest Europe: Proceedings of the 4th Conference. Geological Society, London, pp. 609-624.

Population studies on the detrital heavy minerals (64-250 $\mu$m, specific gravity >2.92) of the Trias in the North Sea Basin demonstrate that there are well-defined regional and stratigraphical variations which are of use in correlation and palaeogeographic reconstruction. Two provinces are recognized: a region comprising the Southern North Sea, onshore England and the English Channel; and a Central North Sea Area. The heavy mineral assemblages of the Triassic sandstones of the Southern North Sea, onshore England and the English Channel are dominated by tourmaline. Wide-ranging correlation between the Southern North Sea and the English Channel has been achieved by using an horizon at which the heavy mineral assemblage is particularly rich in tourmaline. More detailed and local correlation is possible onshore, where rapid changes in the abundance of garnet, zircon, sphene and staurolite indicate the presence of local sources supplying sand detritus to the Trias. The Triassic sands of the Central North Sea are characterized by heavy mineral assemblages dominated by zircon, garnet or apatite. The zircon-rich assemblage is associated with the Smith Bank Formation and is interpreted as having been derived from the reworking of the Permian Sandstones to the west. The apatite-rich assemblage is linked to the Skagerrak and Marnock formations and was probably derived from an eastern Scandinavian source. The garnet-rich assemblage is of more limited extent and is restricted to sediments of Early Triassic age: its origin could have been the metamorphic terrain exposed in the region of the Halibut Horst. Preliminary studies on the chemistry of apatite (%F), tourmaline (%$TiO_2$) and garnet (%CaO) grains from selected samples suggest that there is useful variation for the purposes of regional stratigraphy.

**Kozur, H.**, 1993. *Nicoraella postkockeli* n. sp., a new conodont species from the Lower Carnian of Hungary. N. Jb. Geol. Paläont. Mh., 7: 405-412.

In the Carnian of the Balaton Highland (Hungary) a homeomorph form to the Pelsonian guide from *Nicoraella kockeli* (TATGE) is present that is only distinguished by a shorter basal furrow after the basal cavity and by a less expanded lower side around the basal cavity. This species is described as *Nicoraella postkockeli* n. sp.

**Leslie, A.B., Spiro, B. and Tucker, M.E.**, 1993. Geochemical and mineralogical variations in the upper Mercia Mudstone Group (Late Triassic), southwest Britain: correlation of outcrop sequences with borehole geophysical logs. J. Geol. Soc., London, 150: 67-75.

The Mercia Mudstone Group comprises up to 1200 m of predominantly red mudstones and siltstones laid down in rift-related basins during a period of regional subsidence. Up to 150 m of undifferentiated red mudstones of Norian and Rhaetian age (Late Triassic) were examined in coastal outcrops in Devon and Somerset, southwest Britain, and mineralogical and stable isotopic studies were carried out in order to identify any subtle changes in the succession.

**Lin Qi-Bin**, 1992. Late Triassic insect fauna from Toksun, Xinjiang. Acta Palaeont. Sinica, 31(3): 331-342.

A new fossil insect fauna, the Toksun insect fauna from the Upper Triassic is described from the Huangshanjie Formation of Kerjie, Toksun county, Xinjiang. The fauna comprises 17 species. Ten new genera are classified in the Blattoidea, Plecoptera, Homoptera, Heteroptera, Mecoptera and Coleoptera.

**Liszkowski, J.**, 1993. Die Selachierfauna des Muschelkalks in Polen: Zusammensetzung, Stratigraphie und Paläoökologie. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 177-185.

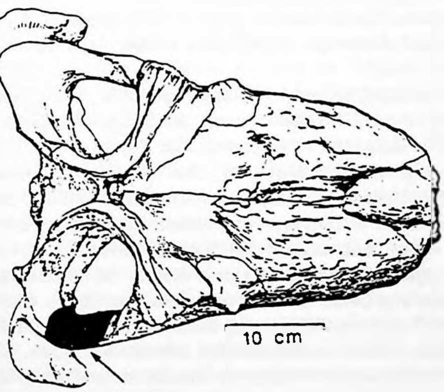
Within the two main areas of Muschelkalk outcrops in Poland (the Holy Cross Mountains and Upper Silesia), 28 selachian species from 15 genera, 8 families and 8 superfamilies have been recognized. They include both primitive (Palaeozoic) and modern (Late Mesozoic) forms, but the main elements are the typical early Mesozoic hybodonts. Their stratigraphic distribution, abundance and ecology are discussed. The distribution pattern and specific composition of the selachian assemblages were primarily related to transgressive immigration events from the eurasiatic Mesotethys slowly expanding towards the recent Mediterranean region.

López-Gómez, J. and Arche, A., 1993. Sequence stratigraphic analysis and paleogeographic interpretation of the Buntsandstein and Muschelkalk facies (Permo-Triassic) in the SE Iberian Range, E Spain. Palaeogeogr. Palaeoclimatol. Palaeoecol., 103: 179-201.

The Iberian Ranges is an Alpine structure trending NW-SE in Central Spain. They first appeared as small, intracratonic basins in the Early Permian, and experienced different periods of extensional tectonics during the Mesozoic and Cenozoic controlled by ancient (Hercynian or older) fracture systems and at least two periods of compressive, inversion tectonics. The Permian and Triassic of the SE Iberian Ranges are of "Germanic Type". Within the prevailing Buntsandstein and Muschelkalk facies, eight formations are recognized. Pollen and spore assemblages and some ammonoid horizons allow for age-assessments ranging from Thuringian (Late Permian) to Carnian (Late Triassic). Two phases of sedimentation can be distinguished during the early extensional period. The first phase (rift phase) led to the development of the lower Buntsandstein facies, bounded by two angular unconformities and subdivided into two depositional sequences (DS-1 and DS-2); the lower one is dominated by alluvial fans deposited in half-grabens and the upper one by sandy braided rivers in more symmetrical grabens. The second phase (thermal or flexural subsidence phase) led to the deposition of the uppermost Buntsandstein (Röt) and Muschelkalk facies, mostly shallow marine carbonates, subdivided into two depositional sequences (DS-3 and DS-4) with well developed lowstand, transgressive and highstand systems tracts (LST, TST and HST) intervals. The criteria for separating systems tracts and the interplay of tectonics, eustatism and the rate of sedimentation are discussed. DS-3 and DS-4 broadly correspond to 2.1 and 2.2 third order cycles, but their limits are about 3-4 my-younger; this may be explained by local tectonic factors.

Lucas, S.G., 1993. *Barysoma lenzii* (Synapsida: Dicynodontia) from the Middle Triassic of Brazil, a synonym of *Stahleckeria potens*. J. Paleont., 67(2): 318-321.

The taxonomy of *Barysoma lenzii* is reviewed. On the bases of a morphological study of the material originally described by Romer and Price (1944) the author concludes that *B. lenzii* is a junior subjective synonym of *Stahleckeria potens* Huene 1935.




*Dorsal view of the skull of* Sinokannemeyeria yingchiaoensis *showing the position of the holotype of* Fukanolepis barbaros *(black)* *(from: Lucas and Hunt, 1993)*

LUCAS, S.P. and HUNT, A.P., 1993. A review of Triassic labyrinthodont amphibians from China. Geobios, 26(1): 121-128.

Labyrinthodont amphibians from China are fragmentary fossils of capitosauroids of Early or Middle Triassic age from the northern part of the country. The two named taxa of Chinese Triassic labyrinthodonts - *Parotosuchus turfanensis* (Young, 1966) and *Bogdania fragmenta* YOUNG, 1978 - are *nomina dubia. P. turfanensis* is based on indeterminate capitosauroid skull fragments. The holotype of *B. fragmenta* is principally capitosauroid skull fragments and a centrum; it is not a metoposaurid. Recognition of *"P. turfanensis"* as an indeterminate capitosauroid removes *Parotosuchus* as evidence against a Middle Triassic age for the *Sinokannemeyeria* fauna of northern China. Recognition of *"B. fragmenta"* as an indeterminate capitosauroid removes it as evidence for a Late Triassic age of the Fukang fauna of Xinjiang.

LUCAS, S.G. and HUNT, A.P., 1993. *Fukanolepis* YANG, 1978 from the Triassic of China is not an aetosaur. J. Vertebrate Paleont., 13(1): 145-147.

Aetosaurs are armored archosaurs of Late Triassic age that have an extensive fossil record in North America (Long and Ballew, 1985; Hunt and Lucas, 1990), South America (Bonaparte, 1970) and western Europe (Wild, 1989). The only aetosaur reported from Asia (outside India) is *Fukanolepis barbaros* YANG, 1978 from the Triassic of Xinjiang, China. The authors demonstrate here that the holotype and paratype of *F. barbaros* are not aetosaurian and discuss their biochronological significance.

LUCAS, S.G., HUNT, A.P. and LONG, R.A., 1992. The oldest dinosaurs. Naturwissenschaften, 79: 171-172.

The authors document some of the oldest dinosaurs from the Chinle Group, Blue Mesa Member of the Petrified Forest Formation; Arizona, U.S.A. Other records of first occurrences of dinosaurs in other areas are discussed. They document a nearly simultaneous first record of dinosaur fossils across a broad expanse of the Late Triassic Pangaean supercontinent in the Late Carnian/Tuvalian. Furthermore, at their first appearance, both saurischian and "proornitischian" dinosaurs can already be distinguished. By the Early Norian, at least 20 genera of dinosaurs can be recognized which indicates that the origin of dinosaurs was a pre-Late Carnian event.

LUKAS, V., 1993. Sedimentologie und Paläogeographie der Terebratelbänke (Unterer Muschelkalk, Trias) Hessens. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 79-84.

The diverse faunal composition of the Terebratelbänke indicates normal marine environments. The facies distribution of the Terebratelbänke in the western part of the Hessian Basin reflects a shallow carbonate ramp environment which can be further subdivided into inter- and supratidal flat, shallow lagoon and shallow "open" marine basin. The lithologies are reviewed and nearly all facies types, which are arranged in small NE-SW trending belts, show responses to storm processes. The facies development within the Terebratelbänke is diachronous and reflects parts of transgressive episodes. However, their base and top are isochronous. Each of the Terebratelbänke represents an interval with a duration which is probably less than 15.000 years. The formation of the Terebratelbänke is addressed.

**Mahler, H. and Sell, J.**, 1993. Die "vulgaris/costata-Bank" (Oberer Muschelkalk, Mitteltrias) - ein lithostratigraphisch verwertbarer biostratigraphischer Leithorizont mit chronostratigraphischer Bedeutung. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 187-192.

The horizon of the joint appearance of *Myophoria vulgaris* and *Costatoria costata*, previously known only from the Röt of Upper Silesia, Rüdersdorf and the eastern Thuringian basin, has been located in the Obere Röttonsteine of Mainfranken. The *vulgaris/costata* bed is situated concordantly above the Rötquarzit and has roughly constant thickness regardless of different facies. Thus, it seems to represent an isochronous layer at least in the regions of Rüdersdorf, eastern Thuringia, Upper Franconia, Mainfranken, the East Hessian depression, Hohenlohe, the Bauland and Odenwald. The growing number of radial ribs during phylogeny of the *Costatoria costata* group is interpreted to bear chronostratigraphic potential. This phylogenetic pattern was identified to appear synchronously in the Germanic Basin as well as in the Tethys realm. It reflects a faunal exchange and a multiple migration of members of the *Costatoria costata* group into the Germanic Basin during deposition of the Upper Buntsandstein.

**Metwally, M.H.M.**, 1993. An analysis of the ranges of pectinid genera (Bivalvia) and their paleoecological interpretation. N. Jb. Geol. Paläont. Mh., 4: 193-208.

An analysis of pectinid genera from the Early Silurian to Holocene shows that major breaks in the frequency of pectinid genera occurred at three intervals: the Late Devonian, Late Permian and Late Cretaceous (loss); and at the Early Cretaceous, Middle Triassic and Eocene (gain). These turnovers seem to be marked by an abnormally high rate of extinction of most genera followed by radiation of new ones. These paleoecological parameters that controlled each break are discussed.

**Morgan, R.K. and Cutts, P.L.**, 1993. Low-angle faulting in the Triassic of the South Viking Graben: implications for future correlations. In: J.R. Parker (Ed.), Petroleum Geology of Northwest Europe: Proc. of the 4th Conference. Geological Society, London, pp. 569-579.

A detailed study of bedding geometry in the Triassic strata of the Crawford Field, South Viking Graben, has revealed steep-bedding dips, in excess of 40° towards the west, sandwiched between Permian and Middle Jurassic to Cretaceous strata dipping gently eastwards. Reconstructions show an area of Triassic strata to be cut out at a high angle against the underlying Permian. This bedding geometry has been interpreted to indicate the presence of a detachment horizon towards the top of the Permian section onto which faulting within the Triassic has flattened. This faulting is pre-Middle Jurassic in age and affects the entire Triassic section in the region of the Crawford Field. The extent of bedding rotation is such that a considerable thickness of Triassic section has been cut out against the fault and detachment surface.

The formation of planar shear fractures is associated with faulting in the Triassic strata. Most of these fractures parallel the fault trend and are interpreted to have formed during the early stages of fault movement, as they presently dip at a low angle towards the east. Cataclastic processes have dramatically reduced porosity along the fractures which may now represent permeability baffles. Recognition of this intra-Triassic structure means fault and roll-over geometries must be carefully modelled before any attempt at stratigraphic correlation within the Triassic can be made. Equally, if this style of faulting is more widespread, then areas of Triassic strata previously considered internally 'uncorrelatable' may well benefit from a closer examination of bedding attitude and structure.

MØRK, A., VIGRAN, J.O. KORCHINSKAYA, M.V., PCHELINA, T.M., FEFILOVA, L.A., VAVILOV M.N. and WEITSCHAT, W., 1992. Triassic rocks in Svalbard, the Arctic Soviet islands and the Barents Shelf: bearing on their correlations. In: T.O. VORREN, E. BERGSAGER, Ø.A. DAHL-STAMNES, E. HOLTER, B. JOHANSEN, E. LIE and T.B. LUND (Eds.), Arctic Geology and Petroleum Potential. NPF Special Publication 2, Elsevier, Amsterdam, pp. 457-479.

Triassic rocks are of great interest for exploration in Arctic areas as they have proved to include both good hydrocarbon source rocks and potential hydrocarbon reservoir rocks. A major seaway with deposition of marine clastic shelf sediments can be followed from Alaska through the Canadian Arctic to north Greenland and the Barents Shelf. While marine sedimentation dominated throughout most of the Triassic in the western part of the Barents Shelf, including Svalbard, continental clastics developed as a response to major tectonic activity in the east (Uralian folding), and to local tectonics in the west (e.g. Loppa High). Clastic shallow marine and continental sediments, gradually covered the larger part of this shelf during the Triassic Period. On the Barents Shelf, the most comprehensive litho- and biostratigraphic framework for strata of Triassic age has been developed on Svalbard. The excellent outcrops and the long history of geological research on Svalbard has resulted in an ammonoid based zonal system that is correlated further to Arctic Canada and East Siberia. Seismic data and exploration wells have established the existence of a thick Triassic succession offshore, and it is correlated lithologically and with the help of palynomorphs to the sections on land. Shallow drilling programs have improved the correlation between onshore and offshore successions by providing a record of Triassic ammonoid fossils and well preserved palynomorphs. Correlation of the Triassic successions has been further extended to Franz Josef Land, and the southeastern part of the Barents Shelf with adjacent land areas as Kolguyev and northern Timan-Pechora Basin.

MORTON, N., 1993. Potential reservoir and source rocks in relation to Upper Triassic to Middle Jurassic sequence stratigraphy, Atlantic margin basins of the British Isles. In: J.R. PARKER (Ed.), Petroleum Geology of Northwest Europe: Proceedings of the 4th Conference. Geological Society, London, pp. 285-297.

Atlantic margin basins from the Celtic Sea to the Hebrides and North Minch, west of the British Isles, and in the Northern North Sea, have the same major genetic sequences in the Upper Triassic to Middle Jurassic. The basins were tectonically related, and six major sequences can be recognized throughout. The tectono-stratigraphic evolution of the basins was through two episodes of extension comprising: syn-rift phases (1) Late Triassic to Early Sinemurian and (4) Latest Toarcian to Late Bajocian; thermal and loading sag phases (2) Mid Sinemurian to earliest Toarcian and (5) Late Bajocian to Late Bathonian (except North Sea ?); and stabilization phases (3) Toarcian and (6) Late Bathonian and Callovian.

MOSTLER, H., 1993. Das Germanische Muschelkalkbecken und seine Beziehungen zum tethyalen Muschelkalkmeer. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 11-14.

During Upper Scythian, Lower Anisian and early Upper Anisian times, the Germanic Basin and the Alpine deposition area were exposed identical, partly tectonically controlled sedimentation, overlain by sea-level fluctuation. Only tectonically initiated crust segments led to connections with the pelagic Tethys. At the beginning of the Illyrian, partly not earlier than Lower Ladinian (Fassanian) times, the Alpine region was included in the unstable shelf area. Since then the Alpine Triassic is distinguishable by its distinct facies deviation. Dispersion routes from the pelagic Tethyan are discussed.

OCKERT, W., 1993. Die Zwergfaunaschichten (Unterer Hauptmuschelkalk, Trochitenkalk, mo1) im nordöstlichen Baden-Württemberg. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 117-130.

The fossil content of the Zwergfaunaschichten, marker beds which have previously only been described on the west side of the river Neckar, has been analyzed. The Zwergfauna (dwarfed fauna) is dominated by gastropods and - less abundant - by small endobenthic bivalves. This fossil community in the Hohenlohe area is restricted to the upper part of the Zwergfaunaschichten. In its lower part, normal sized endobenthonts are dominating. Nautilids among them indicate fully marine conditions. Above the Zwergfaunaschichten, the Trochitenbank 1 (encrinite bed) contains a fossil community dominated by epibenthic shell ground dwellers (crinoids, byssate and cemented bivalves, the articulate brachiopod *Coenothyris vulgaris* and *Tetractinella trigonella*). The lithostratigraphical unit of the Wulstkalke in Lower Franconia is correlated with the lower part of the Zwergfaunaschichten.

OTTONE, E.G., ALVAREZ, P.P. and BENOIT, S.V., 1992. Late Triassic plant microfossils from the Rancho de Lata Formation, Main Cordillera, Argentina. Micropaleontology, 38(3): 261-278.

A palynological assemblage consisting of thirty-five species of spores and pollen grains, distributed among twenty-seven genera has been recovered from the lower section of the Rancho de Lata Formation, Main Cordillera of San Juan Province, Argentina. One new genus of monosaccate pollen grains, *Variapollenites* Ottone, together with seven new species, *Anapiculatisporites sandrae*, *A. pamelae*, *Variapollenites rhombicus*, *V. curviplicatus*, *V. trisulcus*, *Platysaccus olivae*, and *Equisetosporites cinctus* are proposed. The present microfloristic assemblage is of the Ipswich Type, and considered as late Triassic in age.

RADULOVIĆ, V., UROŠEVIĆ, D. and BANJAC, N., 1992. Upper Triassic brachiopods from the Yugoslavian Carpatho-Balkanides (Stara Planina Mountain). Senckenbergiana Lethaea, 72: 61-76.

Earlier identifications of Upper Triassic brachiopods from the Yugoslavian Carpatho-Balkanides are reviewed. The rhynchonellid genus *Fissirhynchia* PEARSON, 1977 with *F. vidlicis* (UROVŠEVIĆ, 1981) and the terebratulid genus *Coenothyris* DOUVILLÉ, 1879 with *C. radulovici* (UROVŠEVIĆ, 1988) are redescribed. *Coenothyris acuta* n. sp. is introduced. The geological range of the genus *Coenothyris* is now extended as *C. vulgaris* (SCHLOTHEIM, 1820) → *C. acuta* → *C. radulovici* developed as an evolutionary lineage from Mid to Upper Triassic. Stratigraphical columns are provided to show the occurrence of the brachiopod fauna.

RAKÚS, M., 1992. Cephalopod fauna from the Hybe Member of Kössen Fm. in Choč Nappe (West Carpathians). Západné Karpaty, 16: 35-42.

The author describes the cephalopod fauna of the Hybe Member. The fauna is represented by one species of nautiloid cephalopods - *Cenoceras hybense* sp. n. and a representative of the genus *Pleuroacanthites*. This taxon is the evidence of the extension of the uppermost parts of the Hybe Member into the Lower Hettangian. The problem of stratigraphic range of the Kössen Fm. in the West Carpathians is discussed as well.

**Rasmussen, A., Kristensen, S.E., Van Veen, P.M., Stølan, T. and Vail, P.R.**, 1992. Use of sequence stratigraphy to define a semi-stratigraphic play in Anisian sequences, southwestern Barents Sea. In: T.O. Vorren, E. Bergsager, Ø.A. Dahl-Stamnes, E. Holter, B. Johansen, E. Lie and T.B. Lund (Eds.), Arctic Geology and Petroleum Potential. NPF Special Publication 2, Elsevier, Amsterdam, pp. 439-455.

Sequence stratigraphic interpretation of the Anisian Kobbe Fm. provides new insight into semi-stratigraphic trap potential on the eastern Loppa High, SW Barents Sea.

Detailed biostratigraphical and lithostratigraphical analysis of exploration wells combined with seismic interpretation of several cyclic sequences, permit delineation of lithofacies and depositional environments within different systems tracts. Five depositional sequences can be recognised in the Anisian. Each sequence is usually tens to hundreds of metres thick and spans a time interval of one to two million years. Several sequences display basal erosional surfaces at their boundaries and are interpreted as type-1 sequence boundaries. Sequence boundaries appear more conformable in the distal portion of the basin. The reservoir potential of the systems tracts constituting each sequence has been evaluated. The most promising reservoir intervals are anticipated in a prograding wedge, interpreted as a lowstand systems tract, and the basal part of the overlying transgressive systems tract, belonging to the Middle Anisian. Potential petroleum source rocks are recorded from condensed sections of transgressive- and early highstand systems tracts. A large anticlinal closure south of the Swaen Graben crossing the depositional trend of the prograding wedge provides the main prospect in this area.

**Rein, S.**, 1993. Zur Biologie und Lebensweise der germanischen Ceratiten. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 279-284.

Ceratite steinkerns documenting reactions to pathologic or traumatic events allow conclusions as to the biological organization of ceratites and their mode of life. Aragonite callus bands in the hypostracum producing furrows on the steinkern surface as well as conchioline layers of the endostracum producing conellae on the steinkern demonstrate that the increased weight of the shell was not selective. The sense of equilibrium important for nektonic organisms seems to have been secondary, for individual ceratites with their extremely displaced soft parts and siphuncles (asymmetrical phragmocone) and other types of irregular spirals caused by injuries (forma *fastigata* Credner 1875, forma *conclusa* Rein 1989) have obviously not been harmed in their individual growth. Moreover, the ceratite animal was able to sustain temporary failure of the hydrostatic apparatus (forma *septadeformata* Rein 1990). This evidence is completed by epizoans incrusting the ceratite shell in several generations. Thus overfreightened, the buoyancy of the ceratite cannot be physically explained. As epizoans obviously did not inhibit the growth of the ceratites it can be assumed that they were vagile benthic animals.

**Röhl, U.**, 1993. Sequenzstratigraphie im zyklisch gegliederten Oberen Muschelkalk Norddeutschlands. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 29-36.

In terms of sequence stratigraphy, the Middle and Upper Muschelkalk represent a 3rd order cycle sensu Haq et al. (1987). Detailed analysis of microfacies, sedimentology and geochemistry in the North German Muschelkalk allow a rather exact resolution of chronostratigraphy and facies, which may be recognized in several hierarchically arranged units (cycles). The depositional setting is discussed.

**Rothe, M.**, 1993. Die Wüste im Wasser: Zur Fazies, Geochemie und Diagenese des Mittleren Muschelkalks in N-Bayern. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 111-115.

Two lithological logs of the Middle Muschelkalk in northern Bavaria representing the basinal and the more marginal facies are represented and discussed. Facies analysis of the basinal lithotypes gives evidence for deposition of carbonates in very shallow and calm water. Occasionally the sediments were subject to emersion and erosion. The marginal facies often shows sabkha conditions. Geochemical analysis show that the partial dolomitization of the basinal facies was early diagenetic and probably occurred under hypersaline conditions. This might be explained by a seepage reflux model. Calcitic caliche cements give evidence for emersion and partial subrosion of the evaporites during Middle Muschelkalk times.

**Ruttner, A.W.**, 1993. Southern borderland of Triassic Laurasia in north-east Iran. Geol. Rundsch., 82: 110-120.

Results obtained by Iranian and European geoscientists in the critical area to the north-east of the North Iran Suture east of Mashhad are described and discussed. A slightly metamorphosed ophiolite belt, outcropping as the south easterly continuation of the previously known ophiolites of Mashhad along the north eastern perimeter of the Fariman-Torbat-e-Jam depression, proved to be either the remnant of a Permian ocean floor or more likely the remnant of a narrow ocean trough. There is as yet no proof of a Triassic age for this ophiolitic belt. To the north of this ophiolitic belt an epicontinental Triassic sequence is exposed at the southern edge of Laurasia in the erosional Window of Aghdarband. This is the result of intermittent sedimentation in a pull-apart basin along sinistral strike-slip faults. The Triassic of Aghdarband has much in common with other deposits of the Triassic Tethys; however, it shows a few unique features, e.g. the Early Anisian *Nicomedites* fauna of a palaeobiogeographic North Tethyan Subprovince, or volcanogenic sedimentation during the late Anisian and the entire Ladinian.

Permian ophiolites outcropping at the south-west corner of the Aghdarband erosional Window are transgressively overlain by basal conglomerates of this Triassic sequence. Hence the existence of a Triassic ocean south of Laurasia is very unlikely. This is an agreement with paleomagnetic data which suggest that the Central Iranian micro-continent was in direct contact with Laurasia during Triassic times. These palaeomagnetic data also suggest a clockwise rotation of the Central East Iran microplate during Triassic times (contrary to the anti-clockwise rotation of this microplate in post-Triassic times). The sinistral strike-slip faulting and compression from the south-west which controls the structure of the Triassic may be derivative sequels to this clockwise rotation. All Eo-Cimmerian deformations of the Triassic rocks (e.g. folding, thrust faulting, strike-slip faulting) had stopped by Rhaetian times.

**Schmidt, H.**, 1993. Mikrobohrspuren in Makrobenthonten des Oberen Muschelkalks in SW-Deutschland. In: H. Hagdorn and A. Seilacher (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 271-278.

The microboring spectrum of macrobenthic fossils from the Upper Muschelkalk of SW-Germany was examined. For this investigation more than 200 fossils were prepared with a special "Casting-Embedding-Technique", subsequently the resin casts were documented with a SEM. 14 morphotypes are detectable, some of them comparable with traces of recent cyanobacteria, chlorophycean algae, rhodophycean algae, sponges, annelids, phoronids and brachiopods. A remarkable diversity between the facies areas is recognizable. The greatest microboring diversity exists in shallow facies areas. The microboring associations give evidence that the deep ramp had a position within dim light conditions, but probably not deeper than 100 m. The shallow ramp extended up to 50 m.

SEILACHER, A., 1993. Fossillagerstätten im Muschelkalk. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 215-222.

The taphonomic individuality of the Germanic Muschelkalk is derived from the semi-enclosed nature of the basin, its shallowness, the low amount of terrigenous input and the dominant role of storm events. The result are time-averaged shell and bone beds (concentration lagerstaetten), but also horizons, in which contemporary bottom faunas - particularly echinoderms - are preserved as "fossil snapshots" (obrution lagerstaetten). But there are no stagnation lagerstaetten, for which the Jurassic successor basin has become so famous.

SMITH, R.I., HODGSON, N. and FULTON, M., 1993. Salt control on Triassic reservoir distribution, UKCS Central North Sea. In: J.R. PARKER (Ed.), Petroleum Geology of Northwest Europe: Proceedings of the 4th Conference. Geological Society, London, pp. 547-557.

During Triassic deposition in the Central North Sea, synforms developed on the surface of the extending Zechstein salt. In the ensuing continental environment, coarse-grained clastic sediments were deposited in such depressions. These were later preserved as sediment 'pods'. A progressive increase in coarse clastic input to the Central North Sea Basin during the Triassic was concurrent with continued salt movement and pod subsidence. During Late Triassic times the best initial reservoir quality sands were developed in the axes of TR30 sediment pods (e.g. Marnock facies). Early Fe-rich chloritization of these high-quality reservoir facies, combined with overpressure development, has resulted in the subsequent, relatively local, preservation of high-quality Triassic reservoirs, often at substantial depths. Understanding the basin-scale halokinetic controls on Triassic sequence and facies development, as well as the subsequent diagenetic effects, is crucial to establishing a framework for Triassic reservoir prediction. The paper combines the re-interpretation of newly acquired and reprocessed seismic data with sedimentological and diagenetic studies of available core material. This has enabled the generation of a model for evaluating the distribution of Triassic reservoir and hence exploration potential in the Central North Sea.

STAMATIS, A. and MIGIROS, G.P., 1993. Das tektonische Fenster von Kranea-Elasson (NW-Thessalien/Griechenland). N. Jb. Geol. Paläont. Mh., 1: 49-64.

A Mesozoic carbonate unit about 1850 m thick tectonically underlies Pelagonian schists in the Kraneas-Elassona area. Previously, these carbonates have been interpreted as an autochthonous continuation at the Olympos carbonate unit (Katsikatsos et al., 1986). A correlation with the Kraneas-Elassona carbonates is unreliable. Microfossils in non-carbonate rocks at the base of the Upper Triassic to Middle Eocene Olympic carbonates. However, a closer lithologic correlation is made with Triassic-Jurassic formations of the Velvendos area. A lithologic sequence very similar to that of Kraneas-Elassona crops out at the Polymilos locality. Structural and kinematic analysis show that the Deskati and Kraneas-Elassonas sections are separate tectonic units. During meso-Alpine folding (probably Pyrrenenan or Helvetian) the Deskati unit was emplaced to the south or southwest over the Kranea-Elassona unit. Later on a Miocene folding (Fig. 1 and 4b) resulted in the emplacement of the combined Deskati-Kraneas-Elassona units over the Olympic carbonates.

STEEL, R.J., 1993. Triassic-Jurassic megasequence stratigraphy in the Northern North Sea: rift to post-rift evolution. In: J.R. PARKER (Ed.), Petroleum Geology of Northwest Europe: Proceedings of the 4th Conference. Geological Society, London, pp. 299-315.

The syn-rift early Triassic basins of the Northern North Sea are compared with the same basins' mid-Triassic to late-Jurassic post-rift evolution. Further analysis of the post-rift interval shows that the basin had by no means a quiet or uniform development in this phase, but saw the periodic out-building of some nine major clastic wedges or megasequences, from the Norwegian and Scottish hinterlands. Megasequence boundaries have been chosen to coincide with peak transgression (marine basin) or peak retrogradation (non-marine basin), such that the megasequences have a regressive-to-transgressive structure. This is justified on the grounds of objectivity and simplicity, and the wish to identify individual megasequences with the descriptive and easily understood concept of a clastic wedge. Megasequences have thicknesses between 100 and 1200 m, are time-stratigraphic units of 6-18 Ma duration and should not be confused with higher-order, transgressive-to-regressive sequences.

The lower boundary of any post-rift megasequence is a time-line, and will not follow, except locally, a lithostratigraphic horizon. Nevertheless, the lower boundaries can be related loosely to established lithostratigraphic units in the Horda Platform and East Shetland Basin. With respect to the Triassic portion of the basin infill, such boundaries are present at the base the Scythian (lower Teist Formation), in the Upper Carnian (within middle Lunde Formation), and the Upper Rhaetian (uppermost Lunde Formation). The occurrence and broadly similar geometry of the megasequences in both continental Triassic and marine Jurassic successions strongly suggests that post-rift sequentiality was not merely caused by eustatic sea-level changes, but probably included a major contribution from subsidence-rate variation (increased subsidence rates inducing a new megasequence boundary). The main value of mapping the geometry and distribution of the megasequences lies in achieving a better prediction of lithology distribution in the main reservoir fairways, and in creating a basis or framework for analysis of higher-order sequences.

SZULC, J., 1993. Early Alpine tectonics and lithofacies succession in the Silesian part of the Muschelkalk Basin. A synopsis. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 19-28.

The author discusses the geodynamics of the Silesian part of the Muschelkalk Basin. Although the Muschelkalk Sea is commonly thought to have been a tectonically passive basin subject to eustatic fluctuations, deformations and synsedimentary structures which are frequently found basin-wide, suggest a crustal mobility. The deformations and synsedimentary structures typical for short-term convulsive events include: syndepositional faults, structures related to mass movements, flow deformation, internal breccias, stationary deformations and seismite/tsunamite couplet. Sequential analysis, supplemented by biological and chemical data indicate long-term tectonic activity in the region. The Muschelkalk Basin is believed to have been an rift-periphery basin separated from the main rifting belt by the elevated Vindelico-Bohemian Massif and had connections through the East Carpathian, Silesian and Burgundy Gates. Available data suggest a punctuated, tectonically-controlled mechanism for the opening and closing of the gates, this latter process was diachronous, shifting gradually from east to west as is shown by palaeontological and geochemical data.

TATZREITER, F. and BALINI, M., 1993. The new genus *Schreyerites* and its type species *Ceratites abichi* Mojsisovics, 1882 (Ammonoidea, Anisian, Middle Triassic). Atti Tic. Sc. Terra, 36: 1-10.

*Schreyerites*, a new genus of Anisian (Middle Triassic) ammonoids, is introduced. Type species is *Ceratites abichi*, MOJSISOVICS, 1882. *Beyrichites splendens* ARTHABER, 1896 is also included in the new genus. The genus concludes involute ceratitids showing subtrapezoidal to subrectangular whorl section and ornamentation represented by radial ribs and three series of nodes in umbilical, lateral and ventrolateral position. The suture line represents the most distinguishing feature of the genus and consists of five denticulated (ammonitic) saddles on the lateral side. the type species of the genus is revised: a lectotype is designated, a redescription of the species is given, and the suture lines of six type specimens are illustrated.

TÖRÖK, Á., 1993. Storm influenced sedimentation in the Hungarian Muschelkalk. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 133-142.

Germanotype Triassic sediments (Buntsandstein, Muschelkalk and overlying clastic deposits which are less carbonatic and evaporitic than the German Keuper) are found in the southern Hungarian Mecsek and Villány Mountains, whereas the more typically Alpine and Dinaric facies occur to the north. The palaeogeography and tectonic history of this area is briefly discussed. The Muschelkalk can be subdivided into three units: (1) Wellenkalk, (2) *Coenothyris* beds, and (3) Upper Muschelkalk. Hummocky cross stratification and ripple marks in the Wellenkalk indicates that the water depth could not have been much deeper than the storm wave base inner ramp zones; skeletal sheets and channel infills indicate inner and mid ramp zones. Synsedimentary deformation, slump structures and crumpled horizons are also very common. For the *Coenothyris* zone an outer ramp environment is suggested. Mid-ramp environments are characterized by storm-influenced brachiopods and graded skeletal layers. The upper part of the Muschelkalk becomes progressively more restricted with shoal oolites giving way to back-shoal skeletal and oncoidal packstones, which are capped by ostracode-rich wackestones of lagoonal origin. The carbonate sedimentation was terminated in the Late Triassic by the deposition of prograding terrigenous clastics over the whole area of the ramp. The overall setting was probably a ramp, largely homoclinal in type. The Middle Triassic sediments and the fauna of the Hungarian Muschelkalk show similarities to other epicontinental Triassic sequences. The difference appears in the intensity of events and in the lower diversity of the fauna.

URLICHS, M., 1993. Zur Gliederung des Oberen Muschelkalks in Baden-Württemberg mit Ceratiten. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 153-156.

Recent bed by bed collections of *Ceratites* from different Upper Muschelkalk outcrops allow a refined ceratite biozonal scheme. Twelve biozones are defined and correlated with the lithostratigraphical log.

URLICHS, M., 1993. Zur stratigraphischen Reichweite von *Punctospirella fragilis* (SCHLOTHEIM) im Oberen Muschelkalk Baden-Württembergs. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 209-212.

*Punctospirella fragilis* (SCHLOTHEIM), (Brachiopoda), has been found in northern Württemberg in several beds below, in and above the Spiriferinabank (Upper Trochitenkalk, mo1/mo2 boundary, Upper Muschelkalk). These beds are allocated to the upper *compressus* and the lower *evolutus* Zone. The Spiriferinabank itself, one of the most important marker beds of the Upper Muschelkalk, has the same biostratigraphical position in the lower *evolutus* Zone, just above its lower boundary between Northern Württemberg and Thuringia. Thus the isochrony of this bed is confirmed.

VAN VEEN, P.M., SKJOLD, L.J., KRISTENSEN, S.E., RASMUSSEN, A., GJELBERG, J. and STØLAN, T., 1992. Triassic sequence stratigraphy in the Barents Sea. In: T.O. VORREN, E. BERGSAGER, Ø.A. DAHL-STAMNES, E. HOLTER, B. JOHANSEN, E. LIE and T.B. LUND (Eds.), Arctic Geology and Petroleum Potential. NPF Special Publication 2, Elsevier, Amsterdam, pp. 515-538.

A regional study of the Triassic in the Barents Sea (18-32°E, 70-75°N) revealed seismic units that correlate seismically for hundreds of kilometers. Seismic character analysis identifies three units with a composite progradational pattern (Induan, Olenekian and Anisian). Fluvial, deltaic and marine deposits could be predicted and located relative to palaeo-coastlines. Regional predictions based on this seismic stratigraphic approach have proved invaluable when correlating and evaluating well information. Recent offshore drilling results enabled to tie these seismic units to well information and a biostratigraphic framework. The resulting stratigraphic framework identifies a succession of five supersequences, each consisting of several sequences. Supersequence boundaries may correspond to changes in lithospheric stress, affecting the regional basin configuration; supersequences represent second-order cycles, whereas sequences may be classified as third-order cycles. Part of the sequences defined in this paper may well be of eustatic origin. This sequence stratigraphic framework urges a re-evaluation of the stratigraphic framework established on Svalbard. Due to differential sediment supply, mainly derived from the Ural Mountains in the east, sequences in the Barents Sea are not distinct on Svalbard.

VISSCHER, H., BRUGMAN, W.A. and VAN HOUTE, M., 1993. Chronostratigraphical and sequence stratigraphical interpretation of the palynomorph record from the Muschelkalk of the Obernsees well, South Germany. In: H. HAGDORN and A. SEILACHER (Eds.), Muschelkalk. Schöntaler Symposium 1991. Sonderb. Ges. Nat. Württemb., 2: 145-152.

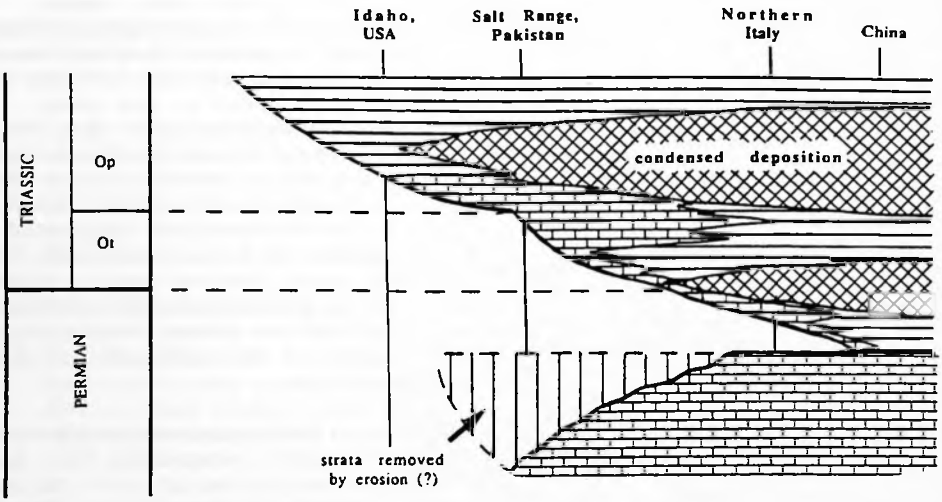
Stratigraphical and palaeoecological interpretations of palynological data allow a chronostratigraphical and sequence-stratigraphical subdivision of the Muschelkalk of the Obernsees well (Franconia). The palynology shows that the studied interval represents the Pelsonian, Illyrian (Anisian) and Fassanian (lower Ladinian). Remarkable shifts in quantitative composition of the terrestrial pollen/spore associations are recorded for the Buntsandstein/Muschelkalk boundary and the upper part of the Middle Muschelkalk (onset of a transgressive systems tract). Turn-over near the transition from the Lower to the Middle Muschelkalk and at the Muschelkalk/Keuper boundary reflect sequence boundaries. Maximum flooding surfaces can be recognized by the high dominance of marine palynomorphs (acritarchs) in the middle part of the Lower Muschelkalk and immediately above the *cycloides*-Bank.

VOLKHEIMER, W. and PAPU, O.H., 1993. Una microflora del Triasico superior de la Cuenca de Malargüe, localidad Llantenes, Provincia de Mendoza, Argentina. Ameghiniana (Rev. Assoc. Paleont. Argent.), 30: 93-100.

In the lower part of the continental Chihuido Formation, Malargüe Basin, Llantenes locality, a microflora was found with pervailing non-striate bisaccate pollen grains and freswater microplankton. Taxa characteristic for the Triassic are associated with the first representatives of the genus *Classopollis*, a genus which in Argentina becomes frequent in the Early Jurassic. The presence of *Classopollis* together with exclusively Triassic taxa suggests that this microflora is the youngest of all the Triassic microfloras known from Argentinian sedimentary basins. The Llanetes microflora is associated with plant megafossils (including large trunks). From both the Chihuido Formation and the Tronquimalal Formation, which conformably overlies the former, a Triassic *Dicroidium* flora is known.

WIGNALL, P.B. and HALLAM, A., 1993. Griesbachian (Earliest Triassic) palaeoenvironmental changes in the Salt Range, Pakistan and southeast China and their bearing on the Permo-Triassic mass extinction. Palaeogeogr. Palaeoclimatol. Palaeoecol., 102: 215-237.

Facies and faunal analysis from Pakistan and China show that the Permo-Triassic mass extinction of marine invertebrate faunas was associated with a spectacularly rapid Griesbachian transgression which lead to the widespread establishment of deep-water anoxic and dysoxic conditions. The extinction event was thus caused by habitat loss due to the extensive development of inhospitable conditions. The initial Griesbachian transgression in Pakistan produced extensive shallow, normal marine conditions in which Permian holdover taxa were able to survive until the development of dysaerobic facies in the late Griesbachian. The exceptionally complete sections of China show a three-phased deepening and extinction event beginning in the latest Permian. By the late Griesbachian a variety of dysaerobic and anaerobic facies were developed in all the regions studied. Several of these contain evidence for minimal sulphate reducing activity suggesting that marine productivity and thus organic matter flux to the sediments was very low in Early Triassic seas.




*Onlap chart for the Permo-Triassic boundary. The sudden downward shift of onlap in the late Permian is purely hypothetical (from: Wignall and Hallam, 1993)*

**WILLIAMS, G.D.** and **EATON, G.P.**, 1993. Stratigraphic and structural analysis of the Late Palaeozoic-Mesozoic of NE Wales and Liverpool Bay: implications for hydrocarbon prospectivity. J. Geol. Soc., Lond., 150: 489-499.

Interpretation of seismic lines from the offshore NE Wales area has provided information on the structural and stratigraphic evolution of the southern part of Morecambe/Liverpool Bay. Basin-wide megasequence boundaries are present between the Dinantian and overlying sequences and between the Upper Carboniferous and Permo-Triassic megasequences. Geological information obtained from seismic lines has been used to construct an E-W geological cross section and a basin analysis summary chart for the NE Wales-Cheshire onshore area.

**WINSTANLEY, A.M.**, 1993. A review of the Triassic play in the Roer Valley Graben, SE onshore Netherlands. In: J.R. PARKER (Ed.), Petroleum Geology of Northwest Europe: Proceedings of the 4th Conference. Geological Society, London, pp. 595-607.

The Roer Valley Graben is a NW-trending fault-bounded graben marking the eastern limit of the Sole Pit/West Netherlands basins. Sedimentation is composed of four megasequences. The first is a broadly regressive Carboniferous (Visean to Stephanian) sequence which is terminated by the Saalian Unconformity. This is followed by a Zechstein to Middle Jurassic megasequence comprising marine fringe facies and alluvial clastics which grade upwards into open marine sediments of Middle Jurassic age. Megasequence three is composed of syn-rift Upper Jurassic deltaics and is very sparsely preserved due to inversion-related erosion. The final megasequence is composed of post-rift Upper Cretaceous chalk and Tertiary clastics. A major inversion occurred during the Maastrichtian and subsequent erosion removed all the chalk (up to 1000 m) from the graben area but left the sequence on the flanks largely unaffected. The paper summarizes the Triassic (Buntsandstein, Muschelkalk, Keuper) stratigraphy of the area. Alluvial fan sandstones within the Main Buntsandstein and Rōt formations are the primary oil/gas reservoir target. The source rocks for the Roer Valley play are the Westphalian and Namurian coals and shales.

**XU DAO-YI** and **YAN ZHENG**, 1993. Carbon isotope and iridium event markers near the Permian/Triassic boundary in the Meishan section, Zhejiang Province, China. Palaeogeogr. Palaeoclimatol. Palaeoecol., 104: 171-175.

Systematic investigations for carbon isotopes and iridium of the Meishan section were carried out using very narrow sampling intervals. The high-resolution results demonstrate the following characteristics: (1) A large drop in $\delta^{13}C$ 7 cm above the base of the Triassic with a magnitude of about 6‰. (2) A sharp Ir peak of 2.02 ppb 10 cm above the base of the Triassic whereas the Ir mean of six samples equals 0.4 ppb. The large negative carbon-isotope shift, the Ir anomaly within a thin sublayer and microspherules all occur within a 20 cm thick section above the base of the Triassic which has been defined to coincide with an abrupt facies change from carbonate to clay. The geochemical results and the microspherules suggest that the Permian/Triassic boundary event was catastrophic and probably caused by an extraterrestrial impact.

**XUANLI YAO, TAYLOR, T.N.** and **TAYLOR, E.L.**, 1993. The Triassic seed cone *Telemachus* from Antarctica. Rev. Palaeobot. Palynol., 78: 269-276.

The compressed conifer seed cone *Telemachus elongatus* is described from the Upper Triassic of Antarctica. The ovate cone measures up to 4.0 cm long and 4.0 cm wide, and contains helically arranged cone scale complexes. Each cone scale consists of an elongated bract fused to a 5-lobed ovuliferous scale. Two or three slightly reflexed ovules are borne on the adaxial surface of the ovuliferous scale. The cone scale cuticle is thin and possesses monocyclic stomata; cuticles are present on the ovules as well. These specimens represent the first record of an early conifer reproductive axis from the Triassic of Antarctica, and confirm that the early conifers were distributed southward to Antarctica by the early Mesozoic.

ZAVATTIERI, A.M., 1992. Palinologia de la Formacion El Tranquilo (Triasico), Provincia de Santa Cruz, Argentina. Ameghiniana (Rev. Assoc. Paleont. Argent.), 29: 305-314.

The palynological record from the El Tranquilo Formation, Santa Cruz Province, Patagonia, Argentina is presented. 29 genera of spores and pollen grains have been recognized. Preliminary palaeoecological conclusions are given. The proposed age for this microflora is Middle to Late Triassic.

The papers listed above have come to the compiler's notice since the publication of the last issue of ALBERTIANA. Authors are kindly requested to send reprints or copies of the title page (with full reference and a (short) abstract, preferably in English, French or German) of their recently published papers to the editor of ALBERTIANA.

## ERRATUM

Careful readers will have noticed that the reference list of E.T. Tozer's paper "Triassic Chronostratigraphic Divisions considered again" published in ALBERTIANA 11: 32-37 was incorrect. Unfortunately the wrong file of references has been printed. Therefore the correct list of references of Dr. Tozer's paper is given below.

DAGYS, A.S., 1985. Comments on the subdivision of the Lower Triassic. Albertiana, 4: 17-19

GAETANI, M., JACOBSHAGEN, V., NICORA, A., KAUFFMANN, G., TSLEPIDIS, V., FANTINI SESTINI N., MERTMANN, D. and SKOUTSIS-CORONEOU V., 1992. The Early-Middle Triassic Boundary at Chios (Greece); Riv. It. Paleont. Strat., 98 (2): 181-204.

HOLSER, W.T., SCHÖNLAUB, H.P., BOECKELMANN, K., MAGARITZ, M. and ORTH, C.J., 1991. The Permian-Triassic of the Gartnerkofel-1 Core (Carnic Alps, Austria): Synthesis and Conclusions. Abh. Geol. B.-A., 45: 213-232.

KOZUR, H., 1992. The Problem of the Lower Triassic Subdivision. Albertiana 10: 21-22.

NAKAZAWA, K., 1992. The Permian-Triassic Boundary. Albertiana, 10: 23-30.

PAULL, R.K., 1988. Distribution Pattern of Lower Triassic (Scythian) Conodonts in the Western United States: Documentation of the Pakistan Connection. Palaios, 3: 598-605.

PAULL, R.A., PAULL, R.K. and KRAEMER, B.R., 1989. Depositional History of Lower Triassic Rocks in southwestern Montana and adjacent parts of Wyoming and Idaho. Montana Geological Society 1989 Field conference guidebook, 1: 69-90

SILBERLING, N.J. and TOZER, E.T., 1968. Biostratigraphic Classification of the Marine Triassic in North America. Geological Society of America Special Paper 110.

SWEET, W.C., 1988. A quantitative conodont biostratigraphy for the Lower Triassic. Senckenbergiana lethaea, 69 (3/4): 253-273.

TOZER, E.T., 1963. Lower Triassic ammonoids from Tuchodi Lakes and Halfway River areas, northeastern British Columbia. Geological Survey of Canada, Bulletin, 96: 1-30.

TOZER, E.T., 1965. Lower Triassic Stages and Ammonoid zones of Arctic Canada. Geological Survey of Canada, Paper 65-12.

TOZER, E.T., 1972. Triassic Ammonoids and Daonella from the Nakhlak Group, Anarak Region, Central Iran. Geological Survey of Iran, Report, 28: 29-69.

TOZER, E.T., 1984. The Trias and its Ammonoids: The Evolution of a Time Scale. Geological Survey of Canada Miscellaneous Report 35.

TOZER, E.T., 1985. Subcommission on Triassic Stratigraphy (STS), History 1968-1984. Albertiana, 3: 3-6.

TOZER, E.T., 1986. Triassic Stage Terminology. Albertiana, 5: 10-14.

TOZER, E.T., 1992. Letter to the Editor. New Zealand Geological Society Newsletter, 97: 6-7.

TOZER, E.T. and CALON, T.J., 1990. Triassic ammonoids from Jabal Safra and Wadi Alwa, Oman, and their significance. In: The Geology and Tectonics of the Oman Region, A.H.F. ROBERTSON, M.P. SEARLE and A.C. RIES, (Eds.), Geological Society of London Special Publication 49: 203-211.

VISSCHER, H., 1983. IGCP Project No. 4: A major achievement in Triassic Research - A Challenge to the STS. Albertiana, 1: 3-6.

VISSCHER, H., 1984. 1834-1984: 150 years of chronostratigraphical subdivision of Triassic rocks. Albertiana, 2: 1-4.

VISSCHER, H., 1985. Subcommission on Triassic Stratigraphy. Report 1984. Albertiana, 3: 1-2.

VISSCHER, H., 1992. The New STS Triassic Stage Nomenclature. Albertiana, 10: 1.

WANG YIGANG, CHEN CHUZHEN, RUI LIN, WANG ZHIHAO, LIAO ZHUOTING and HE JINWEN, 1989. A Potential Global Stratotype of Permian-Triassic Boundary. Chinese Academy of Sciences, Developments in Geoscience, Contribution to 28th International Geological Congress, 1989, Washington. Science Press, Beijing: 221-230.

WEITSCHAT, W. and DAGYS, A.S., 1989. Triassic biostratigraphy of Svalbard and a comparison with NE Siberia. Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg, 68: 179-213.

YIN HONGFU, 1992. Correlation Charts for the Triassic of East Asia. Albertiana, 10: 41-47.

## CHANGES OF ADDRESSES

In Germany new five-digit postal codes have been introduced on July 1st, 1993. These replace the old, four-digit codes. The following list gives the new codes for the voting and corresponding members in Germany. For full addresses refer to ALBERTIANA, 10: 2-5.

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