ALBERTIANA

LATE TRIASSIC	RHAETIAN
	NORIAN
	CARNIAN
MIDDLE TRIASSIC	LADINIAN
	ANISIAN
EARLY TRIASSIC	OLENEKIAN
	INDUAN

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10

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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: The newly approved subdivision of the Triassic

THE NEW STS TRIASSIC STAGE NOMENCLATURE

Henk Visscher

Consistently over the past decade, the two principal points of controversy among members of the STS have been (1) the subdivision of the Lower Triassic (one, two, three or four stages), and (2) the status of the Rhaetian (stage, substage or unit with no significance in global chronostratigraphy). Since no consensus could be achieved, chronostratigraphical schemes formally proposed by the STS had always the character of a compromise by providing alternatives for both the Lower Triassic and the uppermost Triassic.

For the first time in its history, Albertiana now presents a unified scheme of seven Triassic stages (front cover). This scheme is the outcome of the STS meeting in Lausanne (see this issue, p. 6-10). During this meeting it has become evident that a fair majority of STS members consider it to be realistic to (1) advocate the two-fold subdivision of the Lower Triassic into the Induan and Olenekian Stages, and (2) retain the classic concept of a separate Rhaetian Stage. The proposed scheme was ratified at the STS meeting in Kyoto (see this issue, p. 11-15).

Although some STS members and other Triassic specialists may have valid arguments to challenge the majority view, it would be unwise to continue the discussion on Triassic stage nomenclature. Let us accept the selected stages, either wholeheartedly or pragmatically, and promote their use as the basic working-units in global Triassic chronostratigraphical classification and correlation. Rather than repeating the arguments for and against, let the STS now fully concentrate on the difficult but rewarding task of (re)defining and subdividing the selected units, by using all biological, chemical and physical information that may provide meaningful criteria for reaching optimal chronostratigraphical resolution in Triassic basins throughout the world.

In the past ALBERTIANA has been published irregularly, although it was attempted to produce one issue per year. We now consider to publish two issues per year. It may not be expected that they will be as thick as the present one, but we hope that ALBERTIANA will be more up to date if it is published twice a year. However, it should be noted that this is only possible with the help of the contributors. We intend to publish ALBERTIANA in April and November. The deadline for the April 1993 issue is March 10th, 1993.

Hans Kerp (editor Albertiana)
Henk Visscher (Secretary General STS)

Unfortunately, the membership list published in ALBERTIANA 9 still included a number of errors. In addition, several people have changed address, telephone and/or fax numbers. Therefore an updated membership list is presented here. If you still encounter incorrect or incomplete addresses, please let us know. Also those who are not listed as officers, voting or corresponding members but who receive ALBERTIANA on a regular basis are kindly requested to keep us informed on changes of address.

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REPORT ON THE SYMPOSIUM ON TRIASSIC STRATIGRAPHY[1]

Lausanne, October 20-23, 1991

This symposium and the meeting of the STS were organised by the chairman (A. Baud) and vice-chairman (M. Gaetani) of the STS, by colleagues from Geological Institute of the Lausanne University (J. Guex and G. Stämpfli) and members of the STS (J. Marcoux and H. Rieber). Thanks to the generosity of the Swiss Academy of Sciences and the Swiss National Sciences Foundation, eighteen scientists from Eastern Countries and India, who are actively involved in Triassic research received partial or full financial support in order to be able to participate.

The aim of the symposium was to share and compare all the new dates on Triassic stratigraphy. More than 70 scientists from 22 countries attended the meeting. For a number of forty participants, a one day pre-symposium field trip to the classical Briançonnais Middle Triassic shallow water limestone in the Saint-Triphon hills (Rhône Valley) and to the salt mine of Bex, with late Triassic anhydrite and halite which are rich in palynomorphs, was organised by A. Baud and N. Meisser. This trip ended around a swiss fondue in the salt mine restaurant 400 m below the earth surface!

The next two days 41 oral presentations were given in three sections: (1) biochronology, (2) stages and substages, and (3) integrated stratigraphy. In addition, a new computer program on biochronology (the unitary biochronology) written by J. Savary was presented by J. Guex. The manuscripts received during and after the symposium will be published in a special volume of the "Mémoire de Géologie, Lausanne".

REPORT ON THE MEETING OF THE SUBCOMMISSION

M. Gaetani

On October 23rd, the last day of the Symposium, a Subcommission meeting was held at Lausanne University, with the following agenda:

- welcome
- reelection of the chairman and the officers
- new members of the Subcommission
- proposal and vote on early Triassic and late Triassic stages
- news of the Permian/Triassic boundary working group
- news of the Triassic/Jurassic boundary working group

[1] These reports on the Symposium on Triassic Stratigraphy and the meeting of the STS were published earlier in Triassic News 1.

- institution of a stage boundaries working group
- other reports and announcements,
- next meeting.

With the chairman (A. Baud), the past chairman (C. Virgili), three vice-chairmen (A. Dagys, M. Gaetani and E.T. Tozer), 40 participants attended this business meeting among which eighteen voting or corresponding members. After approval of a new list of members, 28 members of the STS participate to the votes, with the other non-members. J. Remane, Secretary of the International Commission on Stratigraphy (ICS) followed the debate as observer.

Election of the officers of the STS

After welcoming, the chairman read the agenda. Following the ICS statutes the position of the chairman is subject to election. A. Baud, who was eligible as chairman, left the room. He was reelected unanimously. After his reelection A. Baud thanked and proposed to ask H. Visscher to continue to act as Secretary General, also because editing of ALBERTIANA. Tozer supported this proposal, which was the approved.

Membership

A. Baud read the list of voting members which was published in Albertiana, asking for confirmation or not on this list. J. Remane pointed out that the membership is individual and members are not national representatives. The following changes were decided for the category of voting members. Dr. H. Kapoor, who is now retired, will be contacted by Dr. Tiwari, in order to know his suggestions. When Dr. Kapoor renounces, Dr. Tiwari will become a voting member. Dr. W. Weitschat, Hamburg, replaces Dr. J. Wendt as voting member. Dr. T. Koike (Japan) replaces Dr. K. Nakazawa as voting member. All these changes were approved. Dr. J.D. Campbell (Wellington, New Zealand) was also suggested to be elected as voting member. But in a letter sent to the chairman, Dr. Campbell asked to be replaced by Dr. J.A. Grant Mackie (New Zealand).

P. van Veen pointed out that Europe and traditional stratigraphy are overrepresented in the STS. He suggested to try to increase the number of representants of other geographic areas and new disciplines. J. Remane noted that the list of corresponding members may be long as we want, and in case of significant decisions corresponding members may be consulted. A list of new corresponding members was approved (see elsewhere in ALBERTIANA).

Early Triassic stages

A. Baud remarked that all the Subcommission members received the circulars and the minutes of the Washington meeting. He thought that it is now time for further steps towards the final decision. A discussion concerning the number of subdivisions in the Early Triassic was opened with talks by A.S. Dagys, F. Hirsch, E.T. Tozer, C. Virgili, A. Baud and L. Krystyn. Tozer asked for "suggestions" from all participants, not only from the voting members, in order to have the opinion of people presently working in the Triassic stratigraphy.

First question: *How many stages are needed in the Lower Triassic?*

Votes: 1 stage: 7 votes; 2 stages: 11 votes; 3 stages: 2 votes; 4 stages: 3 votes. The others abstained. Amongst people who want 2 stages, only 5 were in favour of a division in substages. It appears that a large majority is not in favour of a division, or prefer a limited division of the Lower Triassic. As far as the term Scythian is concerned, 20 preferred to use this term as series, 5 as stage, 1 would like to withdraw it, because it is a nomen dubium, while 7 abstained.

Second question: *Which names should be used in case of a two-stage subdivision?*

A lively discussion started, with talks by H. Kozur, J. Haas, L. Krystyn, E.T. Tozer, C. Virgili, F. Hirsch, W. Weitschat, A. Baud and P. van Veen. For the first stage there was a proposal to use or Induan with its stratotype in the Salt Range or Brahamian, because of priority, with its stratotype in the same area. This last suggestion received only one vote. Eighteen people voted in favour of the use of the Induan, while were 3 against and 10 abstained. The latter group of people abstained because they think that their knowledge of the problem is insufficient. For the second stage, the proposal to use the Olenekian was discussed, with Dagys' suggestion to define its stratotype in the tropical area and not in the boreal province. Tozer asked to withdraw the term Djelumian, which is accepted also by its proposer (Dagys). About the Olenekian, the poll is the following: in favour: 18; against: 6; abstained: 7.
The next poll concerned the request if the assembly wants to have a formal list of the substages now. Five people were in favour to define them now, 11 were against and 7 abstained. The general conclusion was that a subdivision in substages is desired, but that it is still too early to take formal decisions.

What is the status of the Rhaetian?

Baud remembered that in Washington it was decided to retain the term Rhaetian as a stratigraphic subdivision, but that its status (stage or substage) is still open. In the following discussion in which J. Remane, A.S. Dagys, G. Warrington, L. Krystyn, E.T. Tozer, H. Kozur and F. Hirsch participated, everybody, except Tozer, preferred to use the Rhaetian as a stage. However, the various opinions on its scope and the definition of its base were expressed. The poll to keep the Rhaetian as stage resulted in the following votes: in favour 30, against 1, abstained 2. A very large majority appears to be in favour of a Rhaetian stage. A. Baud recommended not to use the term Rhaetian as some European "stratigraphers" do, i.e. simply as a facies. Tozer asks for a poll on the concept of Rhaetian, which give the following results:

- Nobody wants the Rhaetian sensu Wiedmann et al. (1979)
- Twelve people vote in favour of the Rhaetian sensu Dagys, with the base at the appearance of *reticulatus*;
- Three people votes in favour of the Rhaetian sensu Krystyn and Golebiowski, with the base defined at the appearance of *Vandaites stuerzenbaumi*.
- Ten people abstained from voting.

Krystyn expressed his opinion that a further research will demonstrate that the two boundaries are in fact coincident, because the boreal record is incomplete and it is now easily recognizable because of an unconformity.

Working group activities

- Permian/Triassic boundary: Tozer will collect the opinions of the participants before the Kyoto meeting in 1992.
- Triassic/Jurassic boundary: G. Warrington reported that this group had a meeting in Lyon last year and last month in Poitiers, with further contributions. Five candidates for a stratotype have been selected (Peru, New York Canyon, Alps, U.K. and China?) to define the base of Jurassic which will then automatically be the top of the Triassic. The Working group will meet in the afternoon to further discussions on this topic.
- Triassic stages boundaries: as suggested by A. Baud a new working group is created and he proposed M. Gaetani as chairman of this working group. This proposal was accepted.

Reports and announcements

Baud reported on the Permian Congress held last August in Perm. C. Virgili reported on the Carboniferous and Permian Congress held in Argentina. During the excursions many Lower Triassic have been studied. Virgili announced that V. Aleman (Lima, Peru) is able to organize a field trip to the detrital Triassic succession of Cuzco area during 1993. For further information refer to C. Virgili (Paris). Y. Zakharov announced that a meeting will be organized in Prymorie after the Kyoto Congress, mainly devoted to the Permian, but to the Triassic. He distributed the first circular.

Next meeting of the STS

The next Subcommission meeting was scheduled in Kyoto, during 29th IGC, on the 31th August 1992, at 19.00.

The meeting was closed at 12.00

VOTE OF THE SUBCOMMISSION MEMBERS[1]

Results of the vote of the Subcommission members on the 39 ballots coming back.

Question 1: Did you accept the reelection of the chairman, the vice-chairman and the Secretary general as approved during the Lausanne meeting?

Approval:	37
Abstentions:	2

Question 2: Did you accept the Subdivision of the Early Triassic in two stages - Induan and Olenekian - as approved by the majority of the participants to the Lausanne STS meeting?

Approval:	30
Abstentions:	6
Objections:	3
(Comment:	2)

Question 3: Did you accept the status of the Rhaetian as a stage?

Approval:	33
Abstentions:	4
Objections:	2
(Comments:	2)

Confirming the informal vote of the STS during the Lausanne meeting, a great majority of the STS members approbated the new Triassic stage name chart.

RHAETIAN
NORIAN
CARNIAN
LADINIAN
ANISIAN
OLENEKIAN
INDUAN

[1] The results of this poll were published earlier in Triassic News 2

SUBCOMMISSION ON TRIASSIC STRATIGRAPHY

Official meeting of the Subcommission on Triassic Stratigraphy

Kyoto, August 31st, 1992: 19h^{00} - 21h^{00}

A. Baud and M. Gaetani

Chairman:	A. Baud (Lausanne)
Chairman of the ICS:	J. Remane
Officers:	M. Gaetani (Milano) who acted as secretary
Past chairman:	C. Virgili (Paris)

Participants:

Baghbani, D.	Geol. Dept, Exploration & Production, NIOC, P.O. Box 1065, Tehran, Iran (Permian and Triassic foraminifera)
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Dickins, J.M.	Geological Branch, Bureau of Mineral Resources, Geology and Geophysics, Canberra, Australia (bivalves, palaeontology and stratigraphy)
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Agenda

1. Welcoming

The chairman welcomes the attending participants and presents the agenda. He also recalls the meeting held in Lausanne, last October, who was attended by 70 participants from 22 countries. Fifteen papers have been sent and reviewed (half of them had to be partially rewritten). They will be published in 1993 in "Mémoires de Geologie". He also urges Triassic researcher to send abstracts or news concerning their work to Albertiana.

2. Comments on and after the vote of the Subcommission members as published in "Triassic news 2"

The chairman shows transparencies of the vote results concerning:
1) the election of Subcommission officers;
2) the subdivisions of the Early Triassic;
3) the state of the Rhaetian as a stage.
He also summarizes the comments he received by W. Sweet; Yin Hongfu; H. Kozur.

Remane points out that once the stages names are chosen, most of the work is yet to be done, before arriving to the formal acceptance of the stage by the approval IUGS Commission, i.e. the ICS.

The chairman states that for the time being the Triassic subdivisions would be the following:

LATE TRIASSIC	RHAETIAN
	NORIAN
	CARNIAN
MIDDLE TRIASSIC	LADINIAN
	ANISIAN
EARLY TRIASSIC	OLENEKIAN
	INDUAN

3. New membership of the Subcommission:

The chairman illustrates the composition of the Subcommission with voting and corresponding

members. After the Lausanne meeting the following list of the new membership has been proposed.

1 - Voting members:

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Vijaya	Birbal Sahni Institute of Palaeobotany, 53 University Road, 22607 Lucknow, India.

During the meeting the following corresponding members were also proposed:

Chen Zhentu	Chinese Academy of Sciences, Beijing (vertebrate palaeontology)
Olsen, P.E.	Lamont-Doherty Geol. Observatory/Columbia Univ, New York, U.S.A. (stratigraphy, sedimentology)
Paull, Rachel, K.	University of Wisconsin, P.O. Box 413, Milwaukee, WI 53201, USA (conodonts).

H. Kapoor moved to Lucknow, India and will remain voting member. Concerning the voting members, the chairman informs the assembly that Dr. H. Kozur (Budapest) asked to become a voting member. After a discussion, the request is accepted.

4. Information of the Permian/Triassic working group

The chairman of the WG, E.T. Tozer promised to prepare a report, but the assembly regrets that he cannot attend the meeting. A. Baud summarises the state of the problem, with the three possibilities for the boundary and the correlations so far suggested. He also remembers that Wang Y. Q. proposed in 1988 the Selung section in S. Tibet as stratotype for the boundary.

A discussion follows, started by A. Tollmann, H. Kozur, K. Nakazawa, H.F. Yin and S.G. Lucas. The use of additional criteria is suggested, like abiotic events or the use of microfossils instead of ammonoids. However, no decisions can be made in the absence of the WG report and recommendations. Yin Hongfu is interested to participate actively to the working group and to prepare recommendations. A. Baud is requested by the Assembly to write to E.T. Tozer.

5. News of the Triassic/Jurassic working group

No news about this WG, which is now allotted to the Jurassic Subcommission; Triassic specialists will continue to give their advice. On the suggestion of Dr. Lucas, P. Olsen gives details on the Newark project in Esotern USA, with a very good dating of a lava flow (202 Ma) just above the major palynological and vertebrate Triassic/Jurassic boundary.

6. Working agenda and composition of the stage boundary working group

M. Gaetani remembers that a working group on the Anisian, Ladinian and Carnian boundaries was established in Lausanne. As far as the Anisian is concerned, at present four sections are being studied: Dobrugea in Romania, E Gradinaru still pending, Chios, Greece (paper in press,

the paper by Milan and Berlin groups), Oman: under investigation by Krystyn and Besse) and Nevada (papers in press by H. Bucher). For the Ladinian, a week of field-meeting is scheduled for the end of June 1993, organised by Zürich, Milan and Budapest. It comprises three days in the Southern Alps (Italy) and two days in Balaton Highlands (Hungary). The detailed program will be published in Albertiana and sent to the members of the Subcommission. For the Carnian there are no proposals up to now.

7. Pangea report

The chairman informs the assembly about activities and schedules of the Pangea project, which largely comprises Triassic Topics. The next meeting is scheduled on August 16-19, 1993 in Calgary. For more information ask: PANGEA Conference c/o Geological Survey of Canada, 3303, 33rd ST, NW, Calgary Alberta T2L 2A7, CANADA.

8. Other reports and announcements

S.G. Lucas proposes to have a WG on Nonmarine Triassic time scale. The proposal is warmly accepted. Lucas distributes leaflets of the Nonmarine Triassic Symposium, to be held in Albuquerque, October 1993. It will be attended also by paleomagneticians and vertebrate paleontologists.

9. Varia

Dr. A. Tollmann presents the Shallow Tethys 4, to be held in Austria, in September 1993. Excursions will consider also some classical Triassic exposures in Austria.

The Assembly ends at 21.15.

ALBERTIANA

Comments, reactions or contributions to ALBERTIANA?
Send it to the editor!
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Tel: +49-251-833966; Fax: +49-251-834831

PROCEEDINGS OF THE SYMPOSIUM ON TRIASSIC STRATIGRAPHY

(LAUSANNE, OCT. 20-23, 1991)

J. Guex and A. Baud, editors

CONTENTS:

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A NEW ZONAL SCHEME OF THE BOREAL LADINIAN

Algirdas S. Dagys and Alexey G. Konstantinov

Introduction

The zonation and correlation of the Boreal Ladinian are not satisfying till now, which is mainly due to the taxonomic poverty and endemism of Boreal ammonoids.

The first zonal scheme of the Siberian Ladinian, proposed by Popov (1961), included two generic zones - the *Neodalmatites* and *Nathorstites* Zones (Fig. 1). A more detailed scheme with two specific zones in both the *Neodalmatites* and *Nathorstites* Beds has been published by Arkhipov et al. (1971). The main idea of this scheme (except for the position of the upper boundary) is retained in recent schemes (Fig. 1).

During the last years the main sections of the Ladinian in different regions of Siberia have been revised (Dagys et al., 1991) and successions of ammonoid assemblages were ascertained. Due to the kindness of Dr.E.T. Tozer and Dr. W. Weitschat, who have sent typical samples from other Boreal regions (Svalbard and Canada), a more or less uniform taxonomy could be applied for ammonoids of the Boreal Ladinian.

Preliminary results of monographic investigations of the Nathorstitidae, the main group of Boreal Ladinian ammonoids, allowed the establishment of a phylogenetic succession of genera within this family: gen.nov. (*"Intornites" oleshkoi*) → *Tsvetkovites* → *Indigirites* → *Nathorstites* → *Stolleyites*. This phyletic line is the basis for a new zonal scheme of the Boreal Ladinian.

There are transitional forms between most of the genera in this phyletic succession and the here proposed zonal scheme does not contain essential hiatuses. Only one zone - the *Constantis* Zone - probably includes more than one successive ammonoid assemblage. Other zones are biozones of genera or species from a single phyletic line.

Zonal scheme

"Intornites" oleshkoi Zone

Index species: *Longobardites oleshkoi* Arkhipov (1974, p. 239, pl. 11, fig. 1); Eastern Yakutia.
Paleontology: Apart from the index species, *Arctogymnites spectori* Arkh. and *Indigirophyllites* ex gr. *oimekonensis* Popov are recorded from this zone.
Lower boundary: First appearance of *"Intornites" oleshkoi* Arkh.

Tsvetkovites constantis Zone

Index species: *Longobardites constantis* Arkhipov (1974, p. 240, fig. 3, pl. 11); Eastern Yakutia.

Paleontology: The zone contains species of the genus *Tsvetkovites* with relatively thin inner whorls without distinct umbilical bullae and folds (*T. varius* Weitsch. et Lehm., *T. dolioliformis* Vav. et Korch.). *T. varius* is rather characteristic for the lower part of the zone. *Arctogymnites spectori* Arkh., *Indigirophyllites oimekonensis* Popov and *Arctoptychites omolojensis* Arkh. are common as well.

Lower boundary: Coincides with the first appearance of the index species and the genus *Tsvetkovites*.

<table>
<tr><th>Popov, 1961</th><th>Arkhipov et al., 1971</th><th>Arkhipov, 1974</th><th colspan="2">Dagys et al., 1979</th><th colspan="2">New scheme</th></tr>
<tr><td rowspan="7">Nathorstites</td><td>Nathorstites gibbosus</td><td rowspan="4">Stolleyites gibbosus</td><td colspan="2">Nathorstites tenuis</td><td>Carnian</td><td>Stolleyites tenuis</td></tr>
<tr><td rowspan="6">Nathorstites lenticularis</td><td rowspan="5">Nathorstites lentiolularis</td><td rowspan="3">Nathorstites mcconnelli</td><td colspan="2">Nathorstites lindstroemi</td></tr>
<tr><td colspan="2">Nathorstites mcconnelli</td></tr>
<tr><td colspan="2">Nathorstites mclearni</td></tr>
<tr><td rowspan="2">Suordachites neraensis</td><td rowspan="2">Indigirites krugi</td><td colspan="2">Indigirites krugi</td></tr>
<tr><td colspan="2">Tsvetkovites neraensis</td></tr>
<tr><td rowspan="2">Neodalmatites</td><td>Arctoptychites krusini</td><td>Arctoptychites krusini</td><td colspan="2">Arctoptychites omolojensis</td><td colspan="2">Tsvetkovites constantis</td></tr>
<tr><td>Longobardites oleshkoi</td><td>Longobardites oleshkoi</td><td colspan="2">Longobardites oleshkoi</td><td colspan="2">"Intornites" oleshkoi</td></tr>
</table>

Fig. 1 Evolution of ideas on the zonation of the Siberian Ladinian

Tsvetkovites neraensis Zone

Index species: *Indigirites neraensis* Popov (1946, p. 54, pl. 1, fig. 4); Eastern Yakutia.

Paleontology: Apart from the index species, other new species of the genus *Tsvetkovites* with thick inner whorls and distinct umbilical bullae and folds were encountered in the zone; last appearances of *Indigirophyllites oimekonensis* Popov and *Arctogymnites*, first appearance of the genus *Aristoptychites*.

Lower boundary: First appearance of the index species and related species of *Tsvetkovites* with thick inner whorls.

Indigirites krugi Zone

Index species: *Indigirites krugi* Popov (1946, p. 53, pl. 1, fig. 11); Eastern Yakutia.
Paleontology: The ammonoid assemblage of this zone mainly includes species of the genus *Indigirites*, i.e. *I. tzaregradskii* Popov, *I. argatassensis* Popov, *I. tozeri* Weitsch. et Lehm. *Aristoptychites kolymensis* Kipar. is also recorded from the *Krugi* Zone. In the lower part of the zone the rare last specimens of *Tsvetkovites neraensis* (Popov) were collected.
Lower boundary: Coincides with the first appearance of the genus *Indigirites*.

Nathorstites mclearni Zone

Index species: *Nathorstites mclearni* Tozer (ex MS); British Columbia.
Paleontology: The ammonoid assemblage of this zone includes the index species and *Aristoptychites kolymensis* Kipar., *Lobites kolymensis* Bytschk. and *Indigirophyllites* sp.
Lower boundary: First appearance of the genus *Nathorstites* and the index species.

Nathorstites mcconnelli Zone

Index species: *Popanoceras mcconnelli* Whiteaves (1898, p. 138, pl. 18, fig. 2); British Columbia.
Paleontology: Apart from the index species, *Nathorstites* aff. *mcconnelli* (Whit.), *Sphaerocladiscites omolonensis* Bytschk. and *Indigirophyllites* sp. have been recorded.
Lower boundary: First appearance of *Nathorstites mcconnelli*.

Nathorstites lindstroemi Zone

Index species: *Nathorstites lindstroemi* Böhm (1903, p. 64, pl. 7); Svalbard (Bear Island).
Paleontology: This zone only includes the index species and *Sphaerocladiscites omolonensis* Bytschk.
Lower boundary: First appearance of *Nathorstites lindstroemi*.

Correlation (Fig. 2)

Three ammonoid assemblages are recorded from the Ladinian of the Svalbard Archipelago (Weitschat and Lehmann, 1983; Weitschat and Dagys, 1989). The oldest assemblage from the local *Varius* Zone, including *Tsvetkovites varius* Weitsch. et Lehm., *Aristoptychites euglyphus* (Mojs.) and *Indigirophyllites spetzbergensis* (Oeb.), is correlatable with the lower part of the Siberian *Constantis* Zone, from which *Tsvetkovites varius* has been recorded (Dagys et al., 1991). The Svalbardian *Tozeri* Zone can be accepted as an equivalent of the Siberian *Krugi* Zone. Its index species *Indigirites tozeri* is very similar (or identical) to the Siberian species *I. argatasensis*.

The analogues of the Siberian *Oleshkoi, Neraensis, Mclearni and Mcconnelli* Zones are absent in the Svalbard Archipelago. *Nathorstites lindstroemi* has been recorded only from Bear Island,

where it occurs in association with trachyceratids (*Daxatina canadensis*). This uppermost part of the Ladinian may be correlated with the Siberian *Lindstroemi* Zone.

Nathorstitids were widely distributed also in British Columbia. The zonal scheme of the Ladinian for this region was elaborated by Tozer (1967), however, on the data of the Tethyan ammonoids. The *Poseidon* Zone of British Columbia containing *Arctoptychites* is correlatable with the Siberian *Constantis* Zone. Regarding its stratigraphic position, the *Oleshkoi* Zone is a possible equivalent of the *Subasperum* Zone. According to Tozer (1967, p. 29), the *Meginae* Zone contains "species of *Nathorstites* with simple, convex growth line (McLearn, 1947, pl.II, fig.6)" which are undoubtedly *Indigirites*, most probably conspecific with *I. krugi*.

NE ASIA	BRITISH COLUMBIA	SVALBARD	ALPS
Nathorstites lindstroemi	*Frankites sutherlandi*	*Daxatina canadensis*	*Frankites regoledanus*
Nathorstites mcconnelli			
Nathorstites mclearni	*Mclearnoceras mclearni*		*Protrachyceras archelaus*
Indigirites krungi	*Meginoceras meginae*	*Indigirites tozeri*	
Tsvetkovites neraensis			
Tsvetkovites constantis	*Progonoceratites poseidon*	*Tsvetkovites varius*	*Eoprotrachyceras curionii*
"Intornites" oleshkoi	*Eoprotrachyceras subasperum*		

Fig. 2 Correlation of the Boreal Ladinian

Typical *Indigirites* are recorded from the upper part of the *Meginae* Zone (Tozer, pers. comm.) and the lower part of this zone may probably be correlated also with the Siberian *Neraensis* Zone. After Tozer's data, *Nathorstites mclearni* is recorded from the Canadian *Mclearni* Zone. In British Columbia, *Nathorstites mcconnelli* is distributed in the *Sutherlandi* Zone (Tozer, 1981). The first *Stolleytes* have been recorded from the *Desatoyense* Zone, overlying the *Sutherlandi* Zone in British Columbia; the *Sutherlandi* Zone is also correlatable with the Siberian *Lindstroemi* Zone.

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THE PROBLEM OF THE LOWER TRIASSIC SUBDIVISION

Heinz Kozur

During the Triassic Workshop in Lausanne (October 21-23, 1991) a meeting of the STS took place, in which the participants of the workshop voted about the Lower Triassic subdivision. In this voting a two-fold subdivision of the Lower Triassic was proposed, unfortunately before the contents of the different Stage proposals were discussed. Even the often changed scope of the Induan and Olenekian was not discussed and not compared with the scope of the well defined terms Brahmanian, Gandarian, Griesbachian, Dienerian, Smithian and Spathian (independently from their rank as Stages or Substages).

The same procedure has happened some years ago with the Nammalian Stage of Guex (1978) in a three-fold subdivision that was in the beginning generally accepted. Today the Nammalian is totally rejected despite the fact that no new data have been proposed.

The Brahmanian was established by Mojsisovics, Waagen and Diener (1895) for the *Otoceras* Beds of the Himalayas, the Lower Ceratite Limestone and the Ceratite Marls of the Salt Range. It was the best defined Stage of the Tethyan Triassic, despite the fact that it was not defined in a single stratotype, but by beds and ammonoid faunas of two different areas (Himalayas and Salt Range).

The Gandarian Substage was established for the Lower Ceratite Limestones and Ceratite Marls of the Salt Range. It corresponds to the (upper Griesbachian and) Dienerian Stage (Lower Scythian s.str. without the *Otoceras woodwardi* Zone).

The Induan and the Olenekian have been defined for Boreal ammonoid faunas by Kiparisova and Popov (1956). The name Induan, however, was taken from the Indian subcontinent, because of the complete and ammonoid-rich development of the Lower Scythian along its northern margin. No single stratotype or even type area was chosen for the Induan. The *Otoceras woodwardi* Zone of the Himalayas defined the base of the Induan and the Ceratite Sandstone of the Salt Range defined originally the top of this stage. In this scope, the Induan was clearly different from the Lower Scythian Stages and Substages (Brahmanian, Gandarian) proposed by Mojsisovics, Waagen and Diener (1895). However, the Ceratite Sandstone is according to its ammonoid and conodont faunas a time equivalent of almost the whole Lower Olenekian (Smithian sensu Tozer, 1967). The originally defined Induan is therefore a useless Stage that compromises the largest part of the Scythian (with exception of the upper Smithian and Spathian). For this reason, Kiparisova and Popov (1964) excluded the Ceratite Sandstone from the Induan. By this new definition, the Induan became a perfect junior synonym of the Brahmanian sensu Mojsisovics, Waagen and Diener (1895), defined with the same beds in the same area.

The Brahmanian and Gandarian have because of the priority, their well defined and unchanged scope in their stratotypes, their definition in the Tethyan realm and their clear faunal contents (both ammonoids and conodonts of their type areas are well studied) the preference against all Stages and Substages established in the Boreal realm. If the *Otoceras woodwardi* Zone would be finally placed in the Triassic, the term Brahmanian has the preference. If the *Otoceras* faunas will be placed in the Permian, the term Gandarian has the preference.

Before the decision, whether one, two, three or four Lower Triassic Stages should be used, the radiometric age data of the Scythian should be re-studied (so far 3.9 my according to Harland et al., 1989, 3.5 times shorter than the Norian Stage and 3 times shorter than the Carnian stage), the pelagic Scythian faunas have to be well studied (taxonomy, ranges), and the faunal turnovers within the Scythian should be evaluated. Only after all these works, that still have to be done to a large part, voting about the subdivision of the Lower Triassic seems to be useful. In the present stage of our knowledge, such votings are contraproductive, if the majority of the voters do not know the original content of the voted Stage candidates.

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THE PERMIAN-TRIASSIC BOUNDARY

Keiji Nakazawa

Introduction

There are two problems with regard to the Permian-Triassic boundary. One is the correlation of the Permian-Triassic transition beds, or mixed fauna beds. The other is the location of boundary itself. An accurate correlation of the transition beds needs first to be cleared before the second problem can be discussed. The correlation of the *Otoceras* Zone is of special importance, because it has classically been defined as the base of the Triassic System. However, its distribution is limited to the arcto-boreal and peri-Gondwana provinces and the correlation with the Tethyan province is still in dispute. The correlation of the so-called mixed fauna beds is also of importance, but these two problems are intimately related with each other.

1. Correlation of the *Otoceras* Zone and the mixed fauna beds

The *Otoceras* Zone (*O. woodwardi* Zone of peri-Gondwana, and arcto-boreal *O. concavum* and *O. boreale* zones) is generally considered to be younger than latest Permian Dorashamian or Changxingian; mainly on the basis of conodonts (Kozur, 1977) or correlation by means of graphic methods (Sweet, 1979, 1992) the *Otoceras* Zone was partly or entirely included in the Dorashamian. In Kashmir, the upper half of the zone is characterized by *Isarcicella*? *parva*, while the lower half is characterized by *Hindeodus minutus* (Nakazawa et al., 1980); the lower half of the zone is sometimes considered as a Dorashamian equivalent. Based on recent conodont data from south Tibet (Wang et al.,1989) and from mixed fauna beds (i.e. the Tesero Horizon of the Southern Alps, Schönlaub, 1991; the mixed beds of Yangtze block, Ding, 1992) the lower half of this zone is also included in the *I*? *parva* Zone; *I. parva* is absent in Kashmir but conodonts are generally very rare in this area. It should be mentioned that the molluscan fossils associating with *Otoceras* are mostly newcomers which persisted into younger formations, e.g. *Lytophiceras*, *Proptychites*, *Kyamites*, *Eumorphotis multiformis*, *E. venetiana*, *E.* cf. *bokharica*, *Leptochondria minima*, etc., in Kashmir, *Lytophiceras*, *Paravichnuites*, *Claraia stachei*, *Promyalina* cf. *vetusta*, *Unionites* cf. *breviformis* and others in the arctic province (Nakazawa et al., 1975; Spath, 1935; Grasmuck and Trümpy, 1969; Korchinskaya and Ravilov, 1978). The fauna does not contain survivors from the Dorashamian or Changxingian. Kozur (1977) explained the difference between the *Otoceras* fauna and the *Dorashamian* fauna by means of different environmental conditions, more particularly the low salinity environment of the *Otoceras* fauna. However, many associating of the molluscan fossils mentioned above are found in the Tethys area. Therefore the *Otoceras* Zone, at least the *O. woodwardi* or *O. boreale* zone is interpreted as younger than Dorashamian. Permian-type conodonts found from the very base of the *Otoceras* Zone are considered to be survivors from the Dorashamian like the Permian-type brachiopods.

The next problem is the correlation of the so-called mixed fauna beds from the Southern Alps, Kashmir, Nepal, South Tibet, the Yangtze block and East Greenland.

1a. Southern Alps

The Tesero Horizon forming the lowermost part of the Werfen Formation in Dolomites (northern Italy) yields many Permian-type brachiopods. They belong to the genera *Orthothetina, Ombonia, Crurithyris?, Neowellerella, Schuchertella* and *Spinomarginifera* and occur together with Permian-type foraminifers and Triassic-type fossils, such as *Bellerophon vaceki, Towapteria scythica, Promyalina* spp. and *Bakevellia* spp. (Broglio Loriga et al., 1990), The Tesero Horizon is characterized by an *Isarcicella? parva-Hindeodus minutus* assemblage. Most of the overlying Mazzin Member contains the *Claraia wangi-griesbachi* assemblage and *I. isarcica* of *Ophiceras* Zone. The Tesero Horizon and the lowermost part of the Mazzin Member were referred to the Lower Griesbachian *Otoceras* Zone. I agree this correlation. The underlying Bellerophon Formation was considered to be Dorashamian, although the possibility of some time gap between the two cannot be ruled out.

1b. Kashmir

The Permian-Triassic sequence of Kashmir consists of the Zewan Formation, and the overlying Khunamuh Formation. The Khunamuh Formation is divided into the Members E to G. Member E is subdivided into three units, E_1-E_3. Unit E_1 contains Permian-type fossils belonging to the genera *Linoproductus, Lissochonetes, Dielasma?, Neospirifer, Derbyia, Pustula, Marginifera, Etheripecten, "Palaeolima", Cyrtorostra* etc. which occur in association with *Claraia*. This unit was considered as a mixed fauna bed by Teichert et al. (1970). The fauna of Unit E_2 yields the *Otoceras-"Glyptophiceras"* assemblage with an *Ophiceras-Eumorphotis* fauna. Several Permian-type species, such as, *Etheripecten haydeni, Marginifera himalayensis* and *Claraia bioni?* are found at the base of this unit, although it is not certain whether these are real survivors or not. The correlation of Unit E_1 is rather difficult. It comprises some Zewan species. Brachiopods are represented by dwarf forms but bivalves are not dwarfed. The fauna is not similar to that of the other mixed fauna beds. Based on the conformable relation with *Otoceras* Zone, this unit was considered to be latest Permian in age and older than mixed fauna beds from South China (Nakazawa et al., 1975; Sheng et al., 1984). However, it is here correlated with the Tesero Horizon in Italy and the mixed fauna bed in South China based mainly on the conformable and gradational contact with Unit E_2.

1c. Nepal

The mixed fauna is found in Nepal and South Tibet. According to Waterhouse (1978), the Lower Triassic Panjang Formation in Doplo region (Nepal) lies disconformably on the siltstone of the Permian Senja Formation. The Panjang Formation comprises *Otoceras concavum* and many Permian-type productids in the basal part. *Otoceras woodwardi* is also reported from the same place (Fuchs, 1977), but the stratigraphic relation with *O. concavum* is not certain. The transition beds were carefully examined by Tokuoka (in Kapoor and Tokuoka, 1985) in Thakkhola area in Nepal. The lower part consists of a Permian calcareous orthoquartzite. The middle part, consisting of orange-coloured dolomite, corresponds with the *Otoceras concavum* Bed of Waterhouse and contains fragments of unidentifiable brachiopods, bivalves and crinoids. The upper part is represented by bedded limestone yielding the *Isarcicella? parva-Hindeodus minutus* assemblage and is referred to as *O. woodwardi* Zone. Therefore, *O. concavum* is situated below *O. woodwardi* in this area. The *Otoceras* beds in Nepal were correlated with Units E_1 and E_2 in

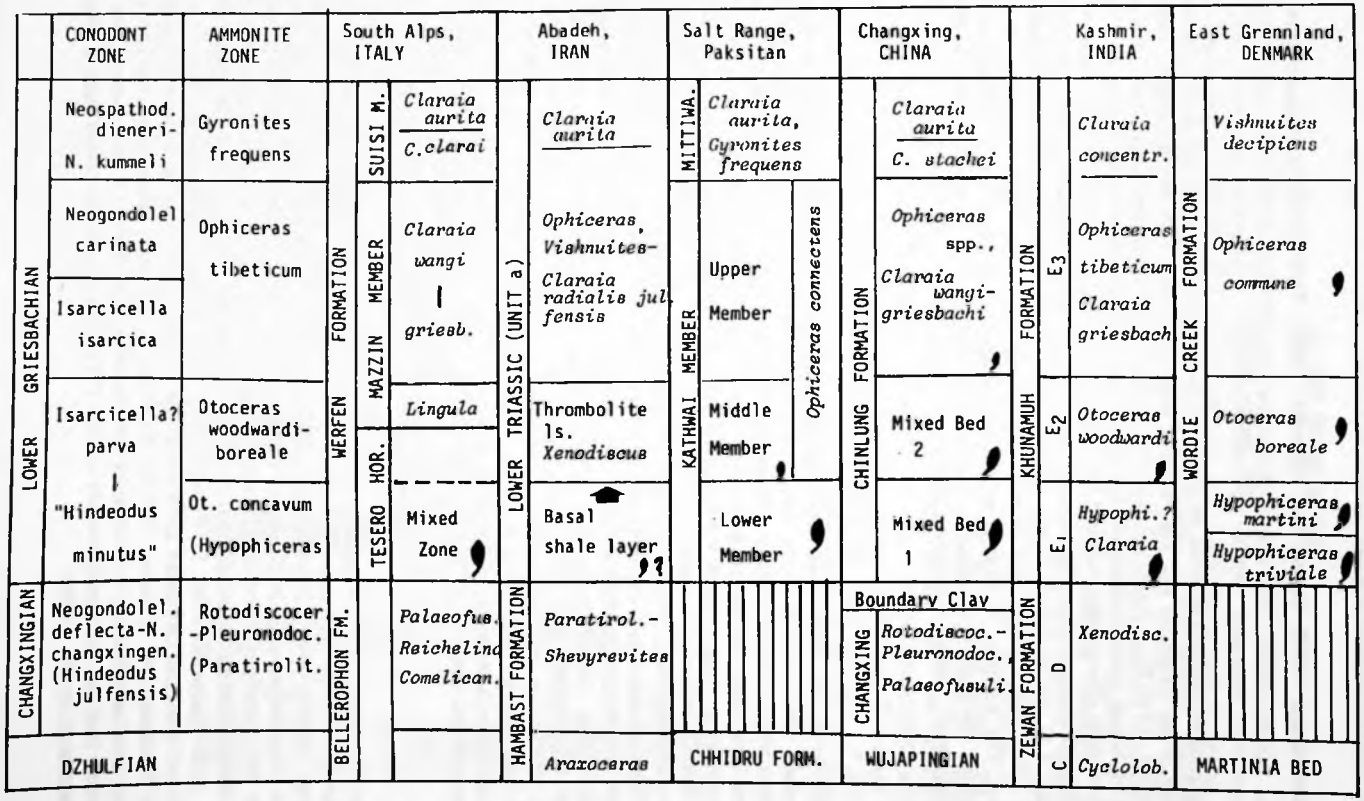


FIGURE 1 CORREATION CHART OF THE PERMIAN-TRIASSIC SEQUENCE IN THE WORLD (Nakazawa, 1992)

Permian-type fossils: abundant, common, rare.

Kashmir (Waterhouse, 1978; Kapoor and Tokuoka, 1985). This opinion is adopted here.

1d. South Tibet

A similar biostratigraphic succession as in Nepal has recently been found in the Selong-Xishan section, South Tibet (Wang et al., 1989). Here the lowermost part of the Lower Triassic Kangshare Formation (Unit 5; 1.13m - 1.5m thick) consists of dolomite and overlying dolomitic limestone. The lower part consists of the lower zone of *Otoceras latilobatum* and *Isacicella? parva-Neogondolella changxingensis* and the upper zone of *O. woodwardi* and *I.? parva-Neogondolella planata*. *Peribositra bioni* (Nakazawa) occurs in the *O. latilobatum* Zone, but judging from the illustration it is not *P. bioni*. In my opinion, the genus *Peribositra,* primarily established on the basis of specimens from mixed fauna bed 1 in Changxing section is referred to *Claraia* or *Pseudoclaraia*. The contact of Unit 5 with Changxingian limestone is an irregular surface, on which reworked Permian brachiopods, corals and crinoids are observed. The *O. latilobatum* Zone with *Claraia* sp. can be correlated with the *O. concavum* Zone of Canada and Unit E_1 from Kashmir.

1e. Changxing, South China

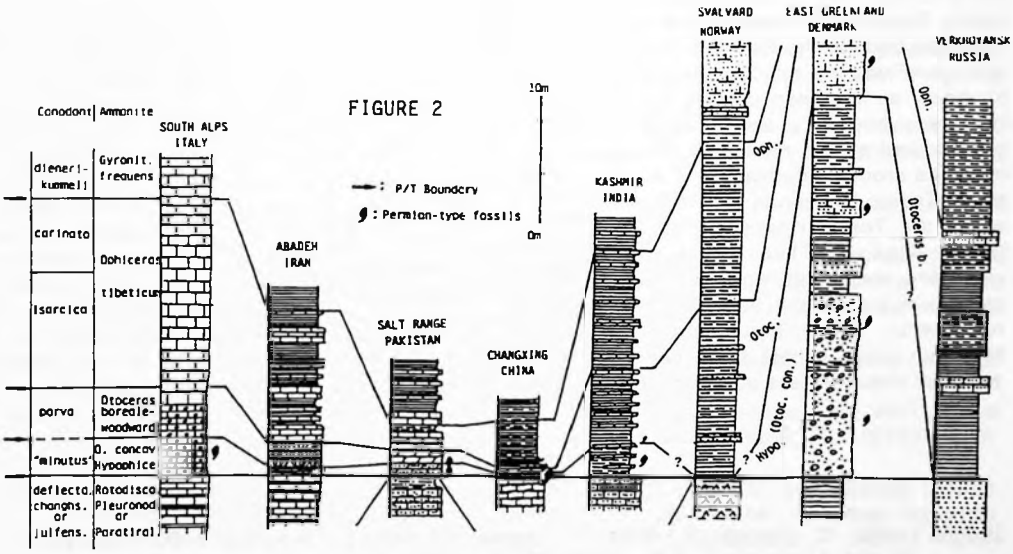
The sequence in South China was examined extensively by Chinese research groups. In the Changxing area, three mixed fauna beds, numbered from 1 to 3, are distinguished in the lowermost part of the Lower Triassic Chinglung Formation (Sheng et al., 1984). The boundary clay between Changxing Formation and Chinglung Formation which is of volcanic origin is now known to contain a *Neogondolella changxingensis - N. deflecta* assemblage and is therefore included in the Changxing Formation (Yan and Li, 1992). Mixed fauna bed 1 contains many Permian-type brachiopods (*Fusichonetes, Waagenites, Paryphella,* etc.) and Triassic-type molluscs (*Pseudosageceras, Hypophiceras, Tompophiceras, Metophiceras, Claraia,* etc.), together with the *Neogondolella carinata-Hindeodus minutus* assemblage. *N. changxingensis* is still found this bed. Mixed fauna bed 2, on the other hand, consists a small number of Permian-type brachiopods and *I.? parva*. Mixed fauna bed 3 yields only two Permian-type brachiopods assignable to *Neowellerella* and *Crurithyris* in addition to the *Ophiceras-Claraia* assemblage. *Otoceras* sp. which has been reported from mixed fauna bed 1 is strongly flattened and its identification is difficult, but the common occurrence of *Hypophiceras* spp. enables the correlation of this bed with the *O. concavum* Zone in Canada.

1f. Arcto-boreal province

Otoceras beds are known in northeast Siberia, Alaska, Arctic Canada, East Greenland, and the Svalbard Islands. The *O. concavum* Zone and the overlying *O. boreale* Zone are recognized in Canada (Tozer, 1961). The *Concavum* Zone is replaced by the *"Glyptophiceras"* beds (Spath, 1935) or the *Hypophiceras* Zone (Trümpy, 1969) in Greenland. In the arcto-boreal province, the contact with the underlying Permian is disconformable or an erosional unconformity, although a continuous sedimentation is supposed for the central part of the basin in East Greenland (Stemmerik and Piasecki, 1991). Permian-type brachiopods, bryozoans, and corals are commonly found from the *Otoceras* Zone up to the *Ophiceras commune* Zone in Greenland, but according to Teichert and Kummel (1976) all these fossils are secondarily derived ones. In Spitzbergen or Svalvard there is no evidence for the presence of the *O. concavum* Zone and the *Otoceras boreale* bed lies paraconformably on the Permian rocks of Dzhulfian age (Nakamura et al., 1990; Nakazawa et al., 1990).

1g. Salt Range region

The marine Upper Permian-Lower Triassic sequence in the Salt Range region consists of the Chhidru and Mianwali Formations. The basal member of the Mianwali Formation, called the Kathwai Member, was divided into a dolomite unit and a limestone unit (Kummel and Teichert, 1970). Many Permian-type brachiopods (e.g. *Enteletes, Orthothetina, Derbyla?, Ombonia, Crurithyris?, Spinomarginifera*), echinoids, and foraminifers are found in the lower part of this dolomite unit. They were considered to be Triassic and survivors from the Permian, because the dolomite unit contains *Ophiceras connectens*. However, Grant (1970) insisted on a Permian age for this fauna. After careful examination, the Pakistani-Japanese Research Group (1985) concluded that the Kathwai Member can be divided into three units,Lower, Middle and Upper. The Permian fossils originate from lower unit, while *Ophiceras* occurs in the middle unit. It is considered that the Lower Unit is latest Permian in age and the equivalent of the *Otoceras woodwardi* Zone is lacking in Kashmir between the lower and middle units. The lower unit is developed only at Narmia in the Surghal Range, and elsewhere it becomes very thin, usually less than 30 cm, or it is even missing. It is also noteworthy that the brachiopod fauna is somewhat similar to that of the Tesero Horizon in southern Alps. The middle and upper units are assigned to the *Otoceras woodwardi* Zone and to the *Ophiceras* Zone on the basis of conodonts of the *I.? parva-Hindeodus minutus* in the lower part and the *I.? parva-I. isarcica* assemblages in the upper part. The lower unit is here referred to the *O. concavum* Zone, although no fossil evidence has been obtained so far.



In conclusion, the so-called mixed fauna beds in Tethys - the Tesero horizon of the Werfen Formation, Unit E_1 of the Khunamuh Formation, the *Otoceras concavum* bed of Nepal, the *O. latilobatum* Zone of Tibet, mixed fauna bed 1 of South China, and presumably also the lower unit of the Kathwai Member of the Mianwali Formation and the boundary shale of the Lower Triassic in Abadeh and Julfa - are all correlated with the *O. concavum* Zone from Arctic Canada, and younger than Dorashamian or Changxingian (Table 1 and Figure 1).

2. Permian-Triassic boundary

Various proposals have been presented for the position of the Permian/Triassic boundary. Traditionally the base of *Otoceras woodwardi* Zone of Himalayas was redefined as Griesbachian/ Dorashamian (Changxingian) boundary correlating the *O. woodwardi* Zone with the *O. concavum* and *O. boreale* Zones, but this correlation needs to be reexamined as has been stated already. Later, the Lower Griesbachian/Upper Griesbachian (*Otoceras/Ophiceras*; Kozur, 1977), and the Griesbachian/Dienerian (*Ophiceras/Gyonites*; Newell, 1978) were proposed as the Permian/Triassic boundary. Yin (1985) examined the transitional bed in South China and he preferred the base of the transitional bed as the boundary, thereby retaining the possibility that the *O. concavum* Zone may be excluded from the transition bed and included in the Permian. Based on the correlation discussed above, faunal change took place at the lower and upper boundaries of the mixed fauna beds, that is, in my opinion at the base of the *O. concavum* Zone and at the lower surface of the *O. woodwardi* or *O. boreale* Zone. Except for South China, Permian elemtents are still much more common than Triassic ones in the transition beds, Triassic-type newcommers are few, and it seems more reasonable to include the transition beds in the Permian. However, I am inclined to prefer the first option for the following reasons. First, the extiction rate of the Palaeozoic organisms is most remarkable at the lower boundary as has been claimed by Yin (1985). Secondly, this boundary coincides with a sharp lithological boundary; the formation boundary can be recognized all over the world. Thirdly, the geochemical events related to the mass extinction at the Permian-Triassic boundary are usually observed around this boundary. A rapid decrease of $\delta^{13}C$ has been recognized around the base of the Tesero Horizon in Dolomites, within the boundary shale in Julfa in Iran (Magaritz, 1989), within the Tesero Horizon in the Carnic Alps (Holser et al., 1989) and in the boundary clay below mixed fauna bed 1 in Meishan (Chen et al., 1984). A decrease of $\delta^{18}O$ is also observed just below the Tesero Horizon (Magaritz et al., 1988; Holser et al., 1989). Ir and REE anomalies are reported from the boundary clay and the shale directly overlying the clay in South China (Chai et al., 1992), around the Permian-Triassic boundary in Italy (Holser, 1989), and in the limonitic sandy pebble layer beneath the *Otoceras* bed in Spiti (Bhandari et al., in press), although iridium is less abundant than at the Cretaceous-Tertiary boundary and in chondrite.

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BRITISH TRIASSIC PALAEONTOLOGY; SUPPLEMENT 15

G. Warrington

Since the completion of the writer's previos supplement (No. 14; ALBERTIANA, 9: 22-23) on British Triassic palaeontology, the following works relating to aspects of that subject have been published or have come to his notice:

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

INTERNATIONAL SUBCOMMISSION ON TRIASSIC STRATIGRAPHY

ANISIAN - LADINIAN - CARNIAN BOUNDARIES WORKING GROUP

Southern Alps and Balaton Highlands

According to the decisions taken during the Lausanne meeting, a first field workshop will be organized on the Anisian/Ladinian boundary. Aim of this field trip is to discuss the most relevant sections so far described in Italy (Southern Alps) and Hungary (Balaton Highlands). This meeting will be held during the last week of June or the first week of July 1993.

The program of the meeting will be as follows:

1st day Meeting in Brescia in the late afternoon. Transfer to the Lago d'Idro area. Overnight stay in Roncone.
2nd day Bagolino area (Val Sabbia). Sections of Bagolino and Pertica. Overnight stay in Roncone.
3rd day Stabol Fresco area (Giudicarie). Sections of Stabol Fresco, Adanà and Corno Vecchio. Overnight stay in Roncone.
4th day Transfer to Ortisei (Val Gardena). Critical sections of Rio di Bulla and Seceda. Overnight stay in the same area.
5th day Transfer to the Balaton Highlands, through Austria.
6th day Classical sections of the Balaton Highlands.
7th day Balaton Highlands. End of the meeting. Transfer to Vienna.

For logistic reasons, the number of participants should be restricted to 30. The travel will be done by bus. The bus is scheduled to leave Budapest, the meeting point for all people from Central Europe, for Brescia before the field meeting and the excursion will end at the Vienna railway station. The field excursions, illustrated with a field guide, will be guided by researchers of the ETH (Zürich), Milan University and the Hungarian Academy of Sciences (Budapest).

The basic philosophy for this meeting could be circumscribed as follows:

1 To test the biostratigraphic scales so far proposed for ammonoids, conodonts and daonellids on the visited sections.
2 To fiend out which is the most convenient position for the base of the Ladinian from the biostratigraphic point of view, taking also into account, if possible, its historical tradition.
3 To evaluate the possibilities to have also geochronological ages.

Only when a general agreement can be obtained on the previous points, a boundary stratotype can be chosen. We are not expecting to arrive to a proposal during the field excursion, but only to focus the matter and finalize future research on the matter.

If you will participate in this field meeting, please contact Maurizio Gaetani or Marco Balini before the end of October 1992. Indicate your address, telephone and fax numbers and let them know how you will reach Brescia and how you will leave Vienna.

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September, 1992

Aymon BAUD, Chairman ISTS
Maurizio GAETANI, Vice-Chairman ISTS

LETTER TO THE EDITOR

Dr. H.M. Kapoor, Birbal Sahni Institute of Palaeobotany and Retired Director of the Geological Survey of India, sent a letter from which the following paragraphs are cited:

"The new challenge" as pointed out by Dr. Henk Visscher (ALBERTIANA 9) is important in developing geological history in particular regions and I am of the view until and unless maximum episodes of one area are not correlated with the other, a clear picture of time-frame may not clearly be concluded, and so to the control stratum for different boundaries. The biotic factors, so important for stratigraphers are in some basins anomalous due to barriers and isolation hampered the exchange of pelagic and nektonic biota generally applied for defining time units. Instead older benthic elements persist due to unchanged conditions in the basin. The Kashmir Basin is an ideal example of such a basin, it has a continuous depositional history from the Late Permian to the Early Triassic, but the biota is anomalous to correlate precisely with Dorashamian. I understand that similar anomalies have also been found in South America and where they also cause correlation problems. Therefore a broader perspective for defining time units has become essential to face the challenge.

The term "Gondwana flora" to encompass the entire floral package from Early Permian to Early Cretaceous is a misnomer. In fact there is a succession of floras; the lower ones with endemic elements and the upper with many cosmopolitan taxa. In addition, an increasing number of reports on mixed floras is becoming available. Recent investigations have conclusively proven the absence of fresh-water Jurassic sediments in the subsurface of India. In the view of these discoveries, the term Gondwana is now proposed to be restricted to the group of terrestrial sediments, in the India Craton, that begin with a basal Permian glacigene epoch and terminate with a large hiatus at the top of the Triassic (Venkatachala and Maheshwari, 1991) If accepted by people from other Southern Hemisphere countries, this concept will be of significance for the understanding of geological history. In the Himalayan region remarkable changes are evident in the post-Kioto deposition (Megalodon Limestone) and point to major changes in the southern hemisphere at the end of the Triassic.

Reference

Venkatachala, B.S. and Maheshwari, H.K., 1991, Indian Gondwana redefined. Proceedings VIIth International Gondwana Symposium, Sao Paulo, 1987

NONMARINE STANDARDS FOR TRIASSIC TIME

Spencer G. Lucas

Abstract

We need to identify and further study nonmarine standards for Triassic time analogous to the marine standards in order to develop a more refined timescale for and more precise correlations of the nonmarine Triassic. Three possible standards, based primarily on tetrapods, are identified: the Cis-Uralian sequence in Russia for the Early Triassic, the Puesto Viejo, Rio Mendoza and Ischichuca Formations in Argentina for the Middle Triassic and the Chinle Group of the western United States for the Late Triassic. These standards enable the identification of tetrapod biochrons that encompass the Triassic Period.

Introduction

The work of the STS focuses on establishing a timescale for the Triassic based primarily on marine biochronology. To this end, standard sequences of rocks, or type strata, have been identified for the marine stage-ages of the Triassic (e.g., Tozer, 1967, 1984). These standard sequences provide the basis upon which precise correlations of Triassic marine strata are developed using fossils, especially ammonoids and conodonts.

Similar standard sequences need to be identified for nonmarine Triassic strata. Such identification will facilitate more precise correlations of the nonmarine Triassic and will greatly enhance the development of a nonmarine Triassic timescale. My purpose here is to pursue this idea further by suggesting some possible nonmarine standards for Triassic time. My focus will be on tetrapod faunas because they are my area of expertise and because they better resolve Triassic time than do other nonmarine Triassic fossils. However, the most extensive tetrapod faunas of the Triassic are typically accompanied by other nonmarine fossils - palynomorphs, megafossil plants, charophytes, ostracods, conchostracans, bivalves, gastropods, fishes - and thus nonmarine standards chosen for their tetrapod content should also provide detailed biostratigraphies and biochronologies based on these fossils.

A prejudice against terrestrial fossils?

In the development of a comprehensive geological timescale little effort has been devoted to nonmarine chronology. I believe this stems partly from a prejudice against the use of terrestrial fossils in long-distance correlations. This prejudice finds its roots in three ideas: (1) that terrestrial facies are so discontinuous laterally that their enclosed fossils are not widespread; (2) that evolution on land did not proceed as fast as in the marine realm, and thus terrestrial fossil

taxa do not have short chronological ranges; and/or (3) that terrestrial fossils are neither of sufficient abundance nor dense enough stratigraphically to be of use in developing detailed biostratigraphies.

A wealth of published studies of sedimentology, stratigraphy, tetrapod biostratigraphy and nonmarine micropaleontology refute these ideas. This is particularly true of Triassic terranes, where many nonmarine facies are often remarkably persistent and fossil abundance is often exceptional (witness, for example, the thousands of tetrapod fossils from the *Lystrosaurus* zone of South Africa: Kitching, 1977). My own work in the nonmarine Triassic of the western United States demonstrates a persistence of facies, abundance of nonmarine fossils and rapid evolutionary turnover of tetrapods comparable to that of Triassic ammonoids. I thus challenge anyone who still believes that terrestrial fossils cannot subdivide Triassic time as well as ammonoids to abandon that view and give the tetrapods a chance.

Early Triassic

When most paleontologists think of the nonmarine tetrapod faunas of the Early Triassic, the classic *Lystrosaurus* zone fauna of the South African Karroo basin comes to mind. It might seem natural that this outstanding fauna be the standard for the nonmarine Early Triassic. However, it has long been clear that the biochron of *Lystrosaurus* only represents a small portion (the oldest interval) of the Early Triassic. This is well demonstrated, not only in the South African Karroo basin where the *Lystrosaurus* zone is a relatively thin interval of the Beaufort Series, but in other sections where *Lystrosaurus is* found.

Of these other sections, the Lower Triassic nonmarine strata exposed in the Cis-Urals of western Russia (Fig. 1) contain extensive, superposed tetrapod faunas that span much of the Early Triassic (Ochev and Shishkin, 1989). No such complete sequence is known elsewhere. This sequence, combined with strata in the Moscow syncline immediately to the west, covers an area of more than 12 million square km, and maximum thickness is about 200 meters (Strok et al., 1984; Shishkin and Ochev, 1985). Study of the Triassic tetrapods dates back to Efremov (1937), and the tetrapod faunas are extensively published, as are the ostracods. Furthermore, taxa of labyrinthodont amphibians from the Cis-Urals are known also from Greenland and Svalbard in marine strata, and thus provide tiepoints between the Russian Early Triassic tetrapod faunas and Early Triassic marine biochronology. It thus seems that the Cis-Uralian sequence represents the best known candidate for a nonmarine standard for Early Triassic time.

Middle Triassic

Middle Triassic tetrapod-bearing strata are widespread, but present two difficult problems in the choice of a nonmarine standard for Middle Triassic time. First, most Middle Triassic tetrapod faunas are of Anisian age; there is a very real dearth of Ladinian-age tetrapods. Second, Middle Triassic tetrapod faunas are strongly facies controlled. Thus, a clear distinction can be made between aquatic/coastal faunas dominated by labyrinthodont amphibians and terrestrial/inland faunas dominated by kannemeyeriid dicynodonts (Lucas and Hunt, 1992).

The most temporally complete sequence of Middle Triassic tetrapod faunas in a single area is in Argentina. The older Middle Triassic (Anisian) faunas here are in the Puesto Viejo and Rio Mendoza Formations of Mendoza Province, whereas the younger Middle Triassic (Ladinian) faunas are from the Ischichuca Formation (the classic Chanares fauna of Romer, 1970, 1973) in the border area of San Juan and La Rioja Provinces. Total outcrop area is relatively small, no more than 100,000 square km, but the entire Middle Triassic sequence is very thick, as much

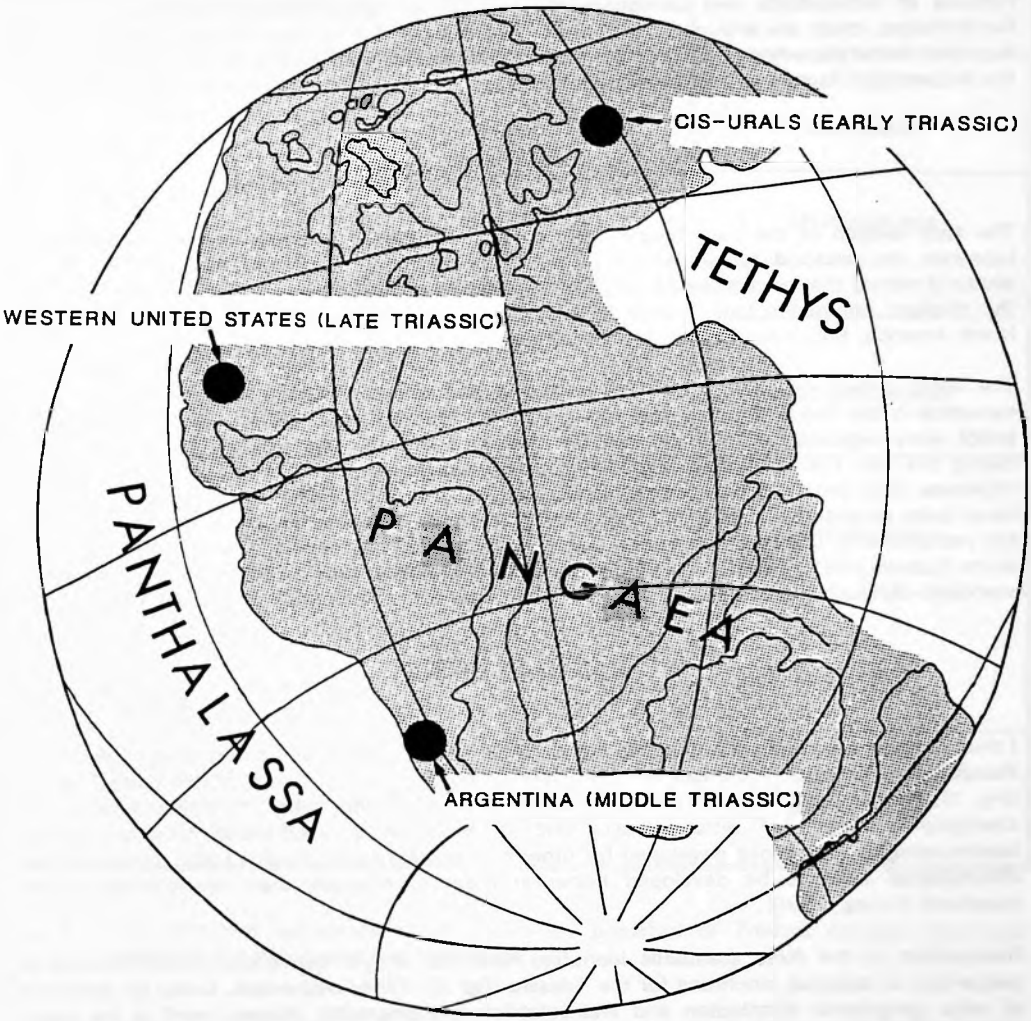

Fig. 1 Location on Triassic Pangaea of the three nonmarine standards for Triassic time advocated in this article.

as 1500 m (Stipanicic, 1983). The initial work of Frenguelli, Cabrera and Rusconi brought these tetrapod faunas to light in the 1940s, they have been extensively published (cf. Bonaparte 1970, 1982) and form the basis for a provincial biochronology (Puestoviejan and Chanarian landvertebrate ages of Bonaparte, 1966).

The Argentinean Middle Triassic tetrapod faunas are terrestrial faunas which produce abundant remains of dicynodonts and cynodonts and few or no labyrinthodonts (Bonaparte, 1970). Nevertheless, there are enough taxa from the Argentinean faunas (e.g., the dicynodont *Kannemeyeria)* found elsewhere that their correlation with aquatic faunas can be established. Use of the Argentinean faunas as a nonmarine standard for the Middle Triassic thus can be advocated.

Late Triassic

The type section of the Late Triassic, the German Keuper, is a largely nonmarine sequence. However, its tetrapod faunas are spotty, and at least one significant hiatus exists in the tetrapod record that encompasses much of late Carnian time (Olsen and Sues, 1986). Perhaps the thickest nonmarine Late Triassic sequence known is the Newark Supergroup of eastern North America. But, it too has an uneven tetrapod record.

The most widely exposed, extensively sampled and tetrapod-rich Upper Triassic nonmarine sequence is the Chinle Group in the western United States (Lucas, 1991, 1992). Chinle Group strata were deposited in a single, vast depositional basin near the western shore of Pangaea during the late Carnian-Norian. Exposures encompass an area of 2.3 million square km and thickness is as much as 600 meters. Collecting began in the 1870s, and the tetrapod faunas have been extensively published. Four distinct tetrapod faunachrons (land-vertebrate "ages") are recognized in Chinle Group strata, based principally on phytosaurs, aetosaurs and metoposaurs (Lucas, 1991, 1992). The Chinle Group thus presents itself as an obvious Late Triassic standard, although pre-late Carnian (pre-Tuvalian) time is not recorded in the Chinle Group.

A composite standard

I thus propose a composite nonmarine standard for Triassic time based on tetrapod faunas from Russia (Early Triassic), Argentina (Middle Triassic) and the western United States (Late Triassic) (Fig. 1). Further basic work on these standards needs to be undertaken, to establish better the stratigraphic ranges of tetrapod taxa and to integrate tetrapod-based biostratigraphies/ biochronologies with those developed for other nonmarine Triassic fossils. Local, provincial biochronologies need to be developed better in order to evaluate their relationships to the standards (Lucas, 1990).

Recognition of the three standards identified here also allows the tentative identification of sequences of tetrapod biochrons for the Triassic (Fig. 2). These sequences, based on tetrapods of wide geographic distribution and well-established stratigraphic ranges, need to be tested against new distributional data and other chronologies.

An important point is that Triassic terrestrial biochronologies can and should advance beyond the simple level of three Triassic intervals (variously called epochs or empires) discriminated by

GCSS			BIOCHRONS	
			Reptilia	Amphibia
TRIASSIC	LATE	RHAETIAN	*Pseudopalatus*	*Apachesaurus*
		NORIAN		
		CARNIAN	*Rutiodon*	*Buettneria*
			Palaeorhinus	*Metoposaurus*
	MIDDLE	LADINIAN	*Dinodontosaurus*	*Mastodonsaurus*
		ANISIAN	*Kannemeyeria*	*Eryosuchus*
	EARLY	INDUAN		*Parotosuchus*
			Garjainia	
		OLENEKIAN	*Lystrosaurus*	*Benthosuchus*

Fig. 2 Two tentative sequences (many others are possible) of Triassic tetrapod biochrons based on the three nonmarine standards.

earlier work (see Lucas, 1990, fig. 1). Recent analysis (Lozovsky, 1989; Lucas, 1991) indicates that much nonmarine Triassic sedimentation around the margins of the Pangaean supercontinent was genetically related to eustatic cycles. This means that sequence stratigraphy has great potential for correlating nonmarine Triassic strata independent of correlations based on

fossils. Thus, more refined biochronologies based on terrestrial fossils reinforced by sequence-stratigraphic correlations can allow us to elaborate a more precise chronology of physical and biological events on land during the Triassic than has been possible.

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The Subcommission on Triassic Stratigraphy approved the following proposal at its last meeting in Kyoto at the 29th International Geological Congress. Those who wish to participate or assist the working group in any way should contact Spencer Lucas.

PROPOSAL TO STS FOR A WORKING GROUP ON THE NONMARINE TRIASSIC TIMESCALE

August 1992

Spencer G. Lucas	New Mexico Museum of Natural History, Albuquerque, New Mexico, U.S.A.
Vladlen Lozovsky	Geological Prospecting Institute, Moscow, Russia
Cheng Zhengwu	Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China

We ask the STS to approve formation of a working group to improve correlation of nonmarine Triassic strata with the following goals:

1. To identify and study the most complete and fossiliferous nonmarine Triassic sections worldwide.
2. To identify the most complete nonmarine sections that span the Permian-Triassic and Triassic-Jurassic boundaries. Also, to identify the most complete and fossiliferous nonmarine sections throughout the Triassic.
3. To integrate biochronological data from diverse nonmarine Triassic organisms, including palynomorphs, megafossil plants, ostracods, conchostracans and vertebrates.
4. To develop a global biochronology of the nonmarine Triassic.
5. To integrate this nonmarine biochronology with Triassic marine biochronology to the fullest extent possible.

CORRELATION CHARTS OF THE TRIASSIC OF EAST ASIA

Yin Hongfu

		TETHYS Krystyn, 1983	CANADA Tozer, 1974, 1981	QUOMOLONGA Wang et al., 1976	SPITI Bhalla, 1983
LADINIAN	Longobard	*Frankites? regoledanus*	*Frankites sutherlandi*	*Protrachyceras –Joannites*	*Daonella indica*
		Protrachyceras archelaus Protrachyceras gredleri	*M. maclearni M. meginae Protrachyceras poseidon*		
	Fassan	*Eoprotrachyceras curionii*	*Eoprotrachyceras subasperum*		*Daonella lommeli*
		Nevadites			
ANISIAN	Illyr	*Parakellnerites (Tecinites polymorphus, A. avisianum, P. reitzi*	*Frechites chischa*		*Ptychites rugifer*
			Frechites deleeni	*Ptychites*	
		Paraceratites trinodosus			
	Pelson	*Balatonites balatonicus*	*Anagymotoceras varium*	*Anacrochordiceras nodosus*	*Keyserlingites dieneri + Sibirites prahlada*
	Bithyn	*Anagymnotoceras ismidicum Nicomedites osmani*			
	Aegeum	*"Aegeiceras ugra"*	*Lenotropites caurus*	*Japonites magnus*	*Rhynchonella griesbachi*
OLENEKIAN	SPATHIAN		*Keyserlingites subrobustus*		
		Tozericeras pakistanum Tirolites cassianus	*Keyserlingites pilaticus*	*Procarnites –Anasibirites*	
	SMITHIAN	*Wassatchites spiniger + A. pluriformis + A. prahiada*	*Wassachites tardus*		*Hedenstroemia mojsisovicsi*
		Meekoceras gracilitatis	*Euflemingites romunderi*	*Owenites*	*Meekoceras varaha*
INDUAN	DIENERIAN	*Flemingites rahilla*	*Vavilovites sverdrupi*	*Gyronites psilogyros*	
		Gyronites frequens	*Proptychites candidus*		
	GRIESBACHIAN	*Ophiceras connectens + Ophiceras tibeticum*	*Proptychites strigatus*	*Lytophiceras sakuntala*	*Lytophiceras sakuntala*
			Ophiceras commune		
		Otoceras woodwardi	*Otoceras boreale Otoceras concavum*	*Otoceras latilobatum*	*Otoceras woodwardi*

		VERCHOJAN Rostovstev et al., 1984	JAPAN (synthezised)	PRIMORIA Zakharov, 1978 Oleinikov et al., 1978	SW CHINA Yang et al., 1982
LADINIAN	Longobard	*Nathorstites mcconneli*	*Protrachyceras* cf. *archelaus*	*Daonella*	*Protrachyceras deprati*
		Indigirites krugi			
		A. omolonjensis			
	Fassan	*Longobardites oleshkoi*			
		Frechites humboldtensis			
ANISIAN	Illyr		*Protrachyceras reitzi*	*Ptychites oppeli*	*Protrachyceras prinum*
		Gymnotoceras rotelliforme			
			Paraceratites cf. *trinodosus*	*Paraceratites trinodosus*	*Paraceratites trinodosus*
	Pelson	*Arctohungarites kharaulakhensis*	*Hollandites*	*Acrochordiceras kiparisovae*	*Paraceratites binodosus*
	Bithyn	*Czekanowskites decipiens*		*Leiophyllistes pradyumna*	*Nicomedites yohi*
	Aegeum	*L. tardus* *G. taimyrensis*	*Leiophyllistes* cf. *pseudopradyumna*		*Parapopanoceras nanum*
OLENEKIAN	SPATHIAN	*Olenekites spiniplicatus* — *K. subrobustus*	*Subcolumbites*	*Subcolumbites multiformis*	*Procarnites oxynostus*
		Olenekites spiniplicatus — *P. grambergi* *Dieneroceras demokidovi*	*Columbites parisianus*	*Neocolumbites insignis*	*Columbites costatus*
	SMITHIAN	*Wasachites tardus*	*Anasibirites*	*Anasibirites nevolini*	*Pseudowenites oxynostus*
		Hedenstroemia hedenstroemi	*Owenites*	*Hedenstroemia bosphorense*	*Owenites costatus*
INDUAN	DIENERIAN	*Vavilovvites compressus* + *V. turgidus*	*Etolium* –*Eumorphotis*	*Gyronites subdharmus*	*Koninkites lingyunensis*
					Proptychites kwangsiensis
	GRIESBACHIAN	*Glyptophiceras nielsensi*	*Glyptophiceras*		*Vishnuites marginalis*
					Ophiceras sinensis
		O. boreale — *Otoceras indigirense* *Otoceras concavum*			

		Tethys Krystyn, 1983		Canada Tozer, 1974, 1981	Qomolongma Mt. Wang et al., 1976
RHAETIAN		*Choristoceras marshi*	*Choristoceras marshi* *Vandaites stuerzenbaumi*	*Ch. crickmayi*	
NORIAN	SEVAT	*Rhabdoceras suessi*	*Sagenites reticulatus*	*C. amoenum*	
			Sagenites quinquepunctatus	*G. cordilleranus*	
	ALAUN	*Halorites macar*	"catentate Haloriten" *Amarussites semiplicatus*	*H. columbianus*	
		Himavatites hagarti	*Himavatites hagarti* *Himavatites watsoni*		*Himavatites columbianus*
		Cyrtopleurites bicrenatus		*D. rutherfordi*	*Cyrtopleurites socius*
	LAC	*Juvavites magnus*		*J. magnus*	*Indojuvavites angulatus*
		Malayites paulckei	*Malayites paulckei* *Malayites tingriensis*	*M. dawsoni*	*Griesbachites –Goniontites*
		Guembalites jandianus	*Dimorphites selectus* *Dimorphites* n. sp. 1	*S. kerri*	*Nodotibetites nodosus*
CARNIAN	TUVAL	*Anatropites*	*Gonionotites italicus*	"*K. macrolobatus*"	*Parahauerites acutus*
			Discotropites plinii	"Upper *T. welleri*"	
		Tropites subbullatus	*Tropites subbullatus*		*Hoplotropites*
			Projuvavites crassaplicatus	"Lower *T. welleri*"	
		Tropites dilleri		*Tropites dilleri*	*Indoesites dieneri*
	JUL	*Austrotrachyceras austriacum*	"*Neoprotrachyceras oedipus*" *Austrotrachyceras triadicum*	*Austrotrachyceras obesum*	
		Trachyceras aonoides	*Trachyceras aonoides* *Trachyceras aon*	*Trachyceras aonoides*	

		Spiti Bhalla, 1983	Verchojan Dagys et al., 1979	Primoria Zaharov, 1978 Oleinikov et al., 1978	Japan (synthezised)	SW China Yang et al., 1982
RHAETIAN		*Megalodon ladakhensis* *Dicerocardium himalayense*	*Tosapecten efimovae*		*E. zabaicalica?* *E. ochotica* *E. densistriata*	
NORIAN	SEVAT		*Entomonotis ochotica*	*E. ochotica* Ambin Fm		
	ALAUN	*Spirigera maniensis* Monotis *Spiriferina griesbachi* and corals	*Entomonotis scutiformis* *Otapiria ussuriensis*	*E. scutiformis* *Otapiria ussuriensis*	*E. typica* *Otapiria dubia* *Juvavites* cf. *kellyi* (Takaguchi Fm)	*Yunnanophorus* –*Indosinion*
	LAC	*Indojuvavites angulatus*	*Pinacoceras verchojanicum*	*Pterosirenites kiparisovae*		
CARNIAN	TUVAL	*Dielasma julicum* *Tropites subbullatus*	*Sirenites vakutensis*	Sadgorod Fm	*Halobia* –*Tosapecten* –*Oxytoma* (L & M Mine Gr.) and *Sandlingites* aff. *oribasus* *Sirenites* cf. *nanseni* (Nakijin Fm)	*Thisbites* –*Discotropites*
	JUL	*Halobia* cf. *comata* *Joannites thanamensis*	*Neosirenites pentastichus* *Neoprotrachyceras seimkanense* *Protrachyceras omkutchanikum* *Nathorstites tenuis*	Kiparisova Fm *Halobia talajaensis*		*Trachyceras* *Protrachyceras*

		International & Nevada Sweet, 1971, 1986	Bulgaria Budurov, 1976 Budurov et al., 1985	Lena River Mouth Dagys et al., 1979	Sikhote Alin Burii, 1989	Qinling Lai, 1992	South Jiangsu Duan, 1987
RHAETIAN			*Miskella posthernsteini*		*Miskella posthernsteini*		
NORIAN	Sevat	*Epigondolella bidentata*	*E. bidentata*		*E. bidentata*		
	Alaun	*E. multidentata*	*E. postera*		*E. postera*		
	Lac	*E. abneptis*	*E. abneptis*		*E. abneptis*		
CARNIAN	Tuval	*Parag. polygnathiformis*	*E. nodosa*		*Metapolygnathus nodosus*		
	Jul	*Neospathodus newpassensis*	*Parag. polygnathiformis*		*Parag. polygnathiformis*		
LADINIAN	Longobard	*Carinella mungoensis*	*Parag. foliata* *Car. mungoensis*		*Parag. foliata*		
	Fassan	*Neogondolella mombergensis*	*Ng. mombergensis*			*Ng. mombergensis*	
ANISIAN	Illyr	*Ng. constricta*	*Ng. cornuta* *Parag. excelsa*		*Parag. excelsa*	*Ng. constricta*	
	Pelson		*N. kockeli*		*N. kockeli*		
	Bithyn + Aegeum	*Ng. regale*	*Ng. regale*			*Ng. regale*	
OLENEKIAN	SPATHIAN	*N. timorensis*	*N. timorensis*	*N. timorensis*	*N. timorensis*		*N. anhui.* + *Gladio.*
		Ng. jubata	*N. homeri*	*Ng. jubata*	*N. homeri*	*N. hungaricus* –*N. homeri*	*N.anhuinensis* –*N. homeri*
		N. collinsoni *N. triangularis*	*N. triangularis*	*Prionodina*		*N. triangularis*	*N. collinsoni*– *N. triangularis*
	SMITHIAN	*Ng. milleri* *N. waageni*		*N. waageni*	*N.* cf. *waageni*	*Pachycladina*– *Parachirognathus*	*N. waageni*
INDUAN	DIENERIAN	*N. pakistanensis*		*N. pakistanensis*		*N. pakistanensis*	
		N. cristagalli					*N. cristagalli*
		N. kummeli + *N. dieneri*		*N. dieneri*		*N. dieneri*	*N. dieneri* *N. kummeli*
	GRIES-BACHIAN						
		Isarcicella isarcica					
						Hindeodus parvus	*H. parvus*
		H. typicalis					

		Guangxi Yang et al., 1986	Tibet, Hubei Wang C. et al., 1976, 1981; Wang Y. et al., 1981	Salt Range Pakistani-Japan. Group, 1981	Kashmir Matsuda, 1981, 1985	West Malaysia Igo & Koike, 1975	West Australia McTavish, 1973
RHAETIAN							
NORIAN	Sevat						
	Alaun		*E. multidentata*				
	Lac		*E. abneptis*				
CARNIAN	Tuval		*Parag. polygnathiformis*			*Parag. polygnathiformis + G.malayensis + C. mungoensis*	
	Jul		*E. diebeli*				
LADINIAN	Longobard						
	Fassan		*Parag. excelsa –Ng. mombergensis*				
ANISIAN	Illyr		*Ng. constricta*				
	Pelson		*N. germanicus –N. kockeli*			*Ng. aegaea + Par. excelsa + N.timorensis + N.germanicus*	
	Bithyn + Aegeum		*Ng. regale*				
			N. timorensis	*N. timorensis*	*N. timorensis*		*N. timorensis*
OLENEKIAN	SPATHIAN	*N. homeri– N. triangularis*	*Ng. jubata* / *N. homeri* / *Pachycladina*	*N. homeri– N. triangularis*	*N. homeri– N. triangularis*		
	SMITHIAN	*N. waageni*	*Platyvillosus N. waageni*	*Ng. jubata N. waageni*	*Ng. elongata + Ng. milleri N. waageni*	*N.conservativus + N.bicuspidatus*	*Ng. jubata N. waageni*
INDUAN	DIENERIAN	*Platy. costatus*	*N. pakistanensis*	*N. pakistanensis*	*N. pakistanensis*		*N. dieneri*
		N. cristagalli	*N. cristagalli*	*N. cristagalli*	*N. cristagalli*		
		N. dieneri	*N. dieneri N. kummeli*	*N. dieneri N. kummeli*	*N. dieneri N. kummeli*		
	GRIES-BACHIAN	*Ng. carinata*	*Ng. carinata*	*Ng. carinata*	*Ng. carinata*		
		Isarcicella isarcica	*Is. isarcica*		*I. isarcica*		
		H. parvus			*H. parvus*		
		H. minutus		*H. minutus*	*H. minutus*		

NONMARINE TRIASSIC SYMPOSIUM

An International Symposium with Field Trip in Arizona and New Mexico, U.S.A.

October 17 through 24, 1993

SECOND CIRCULAR

(The third circular will be sent *only* to those who reply to this one.)

A three-day international symposium on all aspects of the nonmarine Triassic will be hosted by the New Mexico Museum of Natural History in Albuquerque, New Mexico, U.S.A. The symposium will be followed by a four-day field trip exploring continental Triassic deposits of the Lower-Middle Triassic Moenkopi Formation and the Upper Triassic Chinle Group in Arizona and New Mexico.

The symposium will be held on October 17 through 19 (immediately following the annual meeting of Vertebrate Paleontology, which will be held in Albuquerque October 13 through 16, 1993). The symposium will focus on Triassic nonmarine stratigraphy, correlation, chronology, paleontology, sedimentology, paleoclimatology, paleoecology, paleogeography, and paleobiogeography. The Subcommission on Triassic Stratigraphy has been invited to hold a meeting in conjunction with this symposium.

The field trip, beginning immediately after the symposium, will run from October 20 through 24. It will leave Albuquerque heading westward to examine classic nonmarine Triassic strata of the southern Colorado Plateau, including the Petrified Forest National Park, the Painted Desert, and Meteor Crater. A guidebook will be published for the field trip. A one-day additional trip to see the Grand Canyon is possible on October 25. The field trip will end in Flagstaff, Arizona.

SHORT PAPERS will be published for the Triassic meetings in a transactions volume. You may submit one or more short papers for the volume even if you do not plan to give a talk (which will be limited in number) or a poster, or you are unable to attend the symposium. Short papers are due April 30, 1993.

For more information on the symposium write to:

Spencer G. Lucas and Michael Morales
c/o New Mexico Museum of Natural History
1801 Mountain Road, N.W.
Albuquerque, New Mexico 87104-1375
U.S.A.

ANNOTATED TRIASSIC LITERATURE

Hans Kerp and Henk Visscher[1]

ALAVI, M., 1991. Sedimentary and structural characteristics of the Paleo-Tethys remnants in northeastern Iran. Geol. Soc. Amer. Bull., 103: 983-992.

Remnants of the Paleo-Tethys oceanic realm in the Binalood region in northeast Iran include not only ophiolite complexes but also a pile of upward-coarsening, pre-Late Triassic metasedimentary rocks that are interpreted to be abyssal plain and deep-sea flysch deposits. The sedimentology of these deposits and the structural development of the area are discussed.

ALLASINAZ, A., 1992. The Late Triassic-Hettangian bivalves turnover in Lombardy (Southern Alps). Riv. It. Paleont. Strat., 97: 431-454.

One of the major mass extinctions of the Phanerozoic took place at the Rhaetian-Hettangian boundary. According to some researchers. It might have been preceded by minor events at the end of the Carnian. This paper presents an analysis of the faunal associations in the Late Triassic Formations of Lombardy. The author concludes that a faunal crisis like a mass extinction is not recorded by the bivalve assemblages. They reflect pseudoextinctions, sudden and severe turnover, certainly depending on the changing environmental conditions. The affinity among the late Rhaetic bivalves and those of the Hettangian demonstrates that the big faunal crisis at the Rhaetian-Hettangian boundary in Lombardy is traceable back to a rapid faunal turnover consequent to rifting and sinking of the carbonate platform.

ATTREP, M. Jr., ORTH, C.J. and QUINTANA, L.R., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): geochemistry of common and trace elements II - INAA and RNAA. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 123-138.

Instrumental neutron activation methods were used to determine whole-rock abundances for 29 trace and common elements in 98 samples from the Gartnerkofel-1 core. Two iridium abundance maxima were observed, at and just below the Tesero Horizon. The upper Ir peak is associated with a pyrite bed. The other is more enigmatic but also an impact source cannot completely be precluded, the absence of other impact signatures and the accompanying increase in sulphide content suggest an enrichment mechanism associated with reducing conditions in the paleo sea floor.

BALLINI, M., 1992. *Lardaroceras* gen.n., a new late Anisian ammonoid genus from the Prezzo Limestone (Southern Alps). Riv. It. Paleont. Strat., 98: 3-28.

The new genus *Lardaroceras* and two new species. *L. krystyni* and *l. pseudohungaricum*, are described from the uppermost part of the Prezzo Limestone; a third

[1] The help of Sabine Gibas, Christian Schöttler (Münster) and Zwier Smeenk (Utrecht) in tracing literature is gratefully acknowledged.

species is left in open nomenclature. The genus comprises involute and compressed ceratids. Because of the suture line the genus is attributed to the subfamily Beyrichitinae. The stratigraphic significance is discussed.

Bandel, K., 1991. Über triassische "Loxonematoidea" und ihre Beziehungen zu rezenten und paläozoischen Schnecken. Paläont. Z., 65(3/4): 239-268.

The Triassic Loxonematoidea represent a polyphyletic group of gastropods. In this systematical study the new family Protoculidae is established and the origins and relationships of the Loxonematoidea are discussed.

Beltan, L., 1992. Ichthyofaunas from the Western Tethys during the Triassic. Géochronique, 42: 40.

Actinopterygians and Crossopterygians from the Middle to Upper Triassic of Turkey, Israel, NE Libya, Spain, Italy, Switzerland, Austria and Germany show a quasi-similarity. The author suggests that there were connections between these basins.

Benigni, C. and **Ferliga, C.**, 1992. *Anisactinella* Bittner, 1890 (Brachiopoda, Triassic): morphological structures and their functional meaning. Riv. It. Paleont. Strat., 97(3-4): 275-306.

SEM and peel observations were carried out on two taxa of the genus *Anisactinella* Bittner, 1890, namely *Anisactinella quadriplecta* (Münster, 1841) and *Anisactinella maurensis* Taddei Ruggiero, 1968. *Anisactinella quadriplecta* recovered from the San Cassiano Formation, Cortina d'Ampezzo area (Belluno) is revised. Its high variability has been put to evidence on the basis of a critical analysis.

Bizzarini, F. and **Gnoli, M.**, 1991. *Trematoceras elegans* (Münster) and other Late Triassic cephalopods from the San Cassiano Formation, Eastern Dolomites, Italy. Boll. Soc. Paleont. Ital., 30: 109-116.

A century and a half since the first discovery by Münster (1841) in the Late Triassic of the eastern Dolomites, some species of nautiloids, a bactritid, and a coleoid are revised and illustrated on the basis of new topotypic material. Some micromorphological details and a careful description of the lamellar deposits of *Trematoceras elegans* (Münster) are provided.

Blome, C.D. and **Nestell, M.K.**, 1991. Evolution of a Permo-Triassic sedimentary mélange, Grindstone terrane, east-central Oregon. Geol. Soc. Amer. Bull., 103: 1280-1296.

The Grindstone terrane in east-central Oregon is one of the few areas in western North America where large blocks of unmetamorphosed Devonian, Mississippian, ?Pennsylvanian and Permian limestones are intermixed with Permian and Lower Triassic radiolarian chert and ?Pennsylvanian, Permian and Triassic volcaniclastic rocks. The Grindstone rocks are here interpreted as a sedimentary mélange composed of Paleozoic limestone slide and slump blocks that became detached from a carbonate shelf fringing a volcanic knoll or edifice in Late Permian to Middle Triassic time and were intermixed with Permian and Triassic slope to basinal clastic and volcaniclastic rocks in a forearc basin setting. The Grindstone terrane deposits are unconformably overlain by Upper Triassic to Middle Jurassic rocks of the Izee terrane.

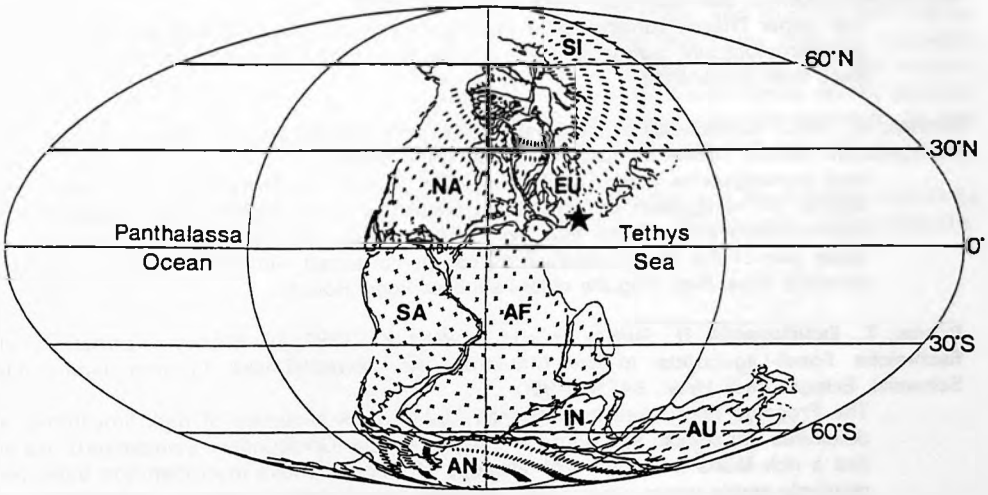
Blome, C.D. and **Reed, K.M.**, 1992. Permian and Early(?) Triassic radiolarian faunas from the Grindstone terrane, central Oregon. J. Paleont., 66(3): 351-383.

Permian and Early(?) Triassic radiolarian faunas from sedimentary mélange cherts of the Grindstone terrane in Central Oregon are described and compared with faunas from

Japan and the Tethyan regions. Co-occurrences of some species in Oregon indicate that their ranges in North America may differ from those in Japan. It is the first illustrated record of Early(?) Triassic radiolarians from North America.

BOECKELMANN, K., 1991. The Permian-Triassic of the Gartnerkofel-1 core and the Reppwand outcrop section (Carnic Alps, Austria). In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 17-36.

The Gartnerkofel-1 core (depth 330 m) comprises mainly dolomitic carbonates of the Upper Bellerophon Formation and the Lower Triassic Werfen Formation. The Bellerophon Formation is unconformably overlain by limestone-dolomite-marl alternations of the Werfen Formation. The environment in the Skythian is dominated by current and wave activity. The fossiliferous carbonates represent subtidal to supratidal conditions of an epicontinental, shallow marine shelf area. Oolithic horizons at the P/T boundary are comparable with oolithes within the Tesero Horizon of the western part of the Southern Alps. The facies distribution in the Upper Permian and Lower Triassic is typical for the situation of a carbonate ramp, situated in the area of the Southern Alps and the Dinarids, and gently inclined towards the east.



Pangaea in the Late Permian with the position of the Gartnerkofel-1 borehole (from Holser and Schönlaub 1991)

BOECKELMANN, K. and MAGARITZ, M., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): dolomitization of the Permian-Triassic sequence. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 61-68.

A study on the dolomitization of the Permian and Triassic in the Gartnerkofel-1 borehole.

BRINKMAN, D.B., XIJIN, Z. and NICHOLLS, E.L., 1992. A primitive ichthyosaur from the Lower Triassic of British Columbia, Canada. Palaeontology, 35(2): 465-474.

A systematic description of *Grippia* cf. *G. longirostris*, a primitive ichthyosaur from the Lower Triassic of British Columbia. The early evolution of ichthyosaur paddles is discussed.

BROGLIO LORIGA, C. and CASSINIS, G., 1992. The Permo-Triassic boundary in the Southern Alps (Italy) and in adjacent Periadratic regions. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 78-97.

An updated review of the Permo-Triassic boundary in the Southern Alps, including the primarily marine deposits between the Adige Valley and Carnia and the continental sequences towards the west.

BROQUET, P. and HAMEL, A., 1991. Les grès triasiques du gisement de gaz d'Hassi R'mel (Algérie). Contexte stratigraphique, sédimentologique, paléogéographique et application de la thermoluminescence. Bull. Soc. géol. France, 162: 563-573.

The Upper Triassic sandstones of the Hassi R'mel gas field (Algeria) were investigated sedimentologically, petrographically and by means of thermoluminescence in order to trace their provenance.

BUCHER, H., 1992. Ammonoids of the Shoshonensis zone (Middle Anisian, Middle Triassic) from Northwestern Nevada (USA). Jb. Geol. B.-A., 135(2): 425-465.

New investigations in the Fossil Hill Member (Favret and Prida Fms., Star Peak Group) lead to the recognition of four distinct ammonoid subzones in the late middle Anisian Shoshonensis Zone. Three new genera and fourteen new species are described. The upper part of the Shoshonensis Zone can be correlated with the "Pelsonian substage" from the Alps, excluding the older Rahnbauerkogel Horizon.

BÜRGIN, T., EICHENBERGER, U., FURRER, H. and TSCHANZ, K., 1991. Die Prosanto-Formation - eine fischreiche Fossil-Lagerstätte in der Mitteltrias der Silvretta-Decke (Kanton Graubünden, Schweiz). Eclogae geol. Helv., 84: 921-990.

The Prosanto Formation, a more than 200 m thick sequence of dark limestones and dolomites of Ladinian age from the Silvretta Nappe (Graubünden, Switzerland) has yielded a rich fauna and flora. The absence of autochthonous macrobenthos indicates a relatively stable water column with stagnant bottom layer in a small, locked basin. The reptile fauna includes small and large nothosaurids and especially the fish fauna is very rich with eleven genera; two of them being newly described.

CASSINIS, G., TOUTIN-MORIN, N. and VIRGILI, C., 1992. Permian and Triassic events in the continental domains of Mediterranean Europe. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 60-77.

A synthesis of the knowledge about Late Paleozoic and Early Mesozoic events in primarily terrestrial domains now represented in various parts of Mediterranean Europe (Italy, France and Spain).

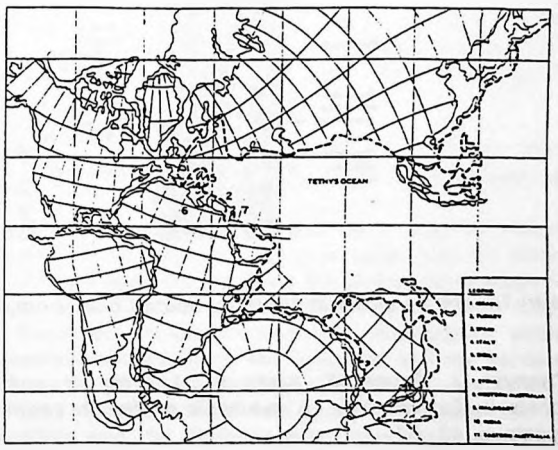
CATALANO, R., DI STEFANO, P. and KOZUR, H., 1992. New data on Permian and Triassic stratigraphy of western Sicily. N. Jb. Geol. Paläont. Abh., 184(1): 25-61.

The Sicanian paleogeographic domain (Western Sicily) belonged, at least since the Early Permian, to the passive margin of the Tethys Ocean. Continuous pelagic deep-water conditions throughout the Permian and the presence of rich pelagic Circum-pacific faunas of this age indicate a broad, unrestricted pelagic connection from the Pacific (Panthalassa) until Western Sicily at least since the Early Permian. During the Triassic pelagic conditions continued.

CHAI CHIFANG, ZHOU YAOQI, MAO XUEYING, MA SHULAN, MA JIANGUO, KONG PING and HE JINGWEN, 1992. Geochemical constraints on the Permo-Triassic boundary event in South China. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 158-168.

Elemental geochemistry of rocks at the Permo-Triassic boundary in South China indicates that the boundary event was a very complicated one, related not only to volcanic eruption, but also to a likely extraterrestrial impact. The mixing model proposed on the basis of geochemical study is supported by evidence from petrology, mineralogy, and the study of microsperules. In fact, the authors hold that both volcanic and cosmic processes operated in formation of the boundary and non-boundary clays at or near the P/T boundary in South China, and that the two processes are not necessarily antagonistic. A mixing model that holds that P/T boundary clays of South China consist of both acidic-intermediate volcanic ash and impact-spattered matter from the upper crust best explains the experimental results reported here. It is likely that the impact either triggered large-scale volcanics eruptions, or that it came just at the end of the Permian, when volcanic eruption was very active.

CIRILLI, S. and ESHET, Y., 1991. First discovery of *Samaropollenites* and the Onslow microflora in the Upper Triassic, and its phytogeographic implications. Palaeogeogr. Palaeoclimatol. Palaeoecol., 85: 207-212.

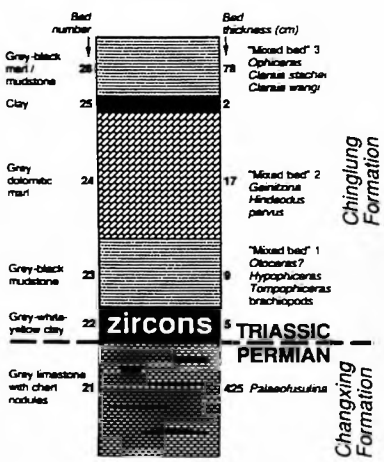


The geographic distribution of the Onslow microflora (from Cirilli and Eshet, 1991)

Core samples from the lower part of the Carnian succession in southern Israel have yielded a unique palynological assemblage. Composition and age of the assemblage are comparable to equivalent Late Triassic assemblages in Malagasy, western and eastern Australia, India, Sicily, Libya, Spain, Turkey and Syria. These assemblages are, entirely or partially, characteristic of the Onslow Microflora, a mixture of Gondwananian and Laurasian elements. The geographic distribution of this microflora can be used as an indicator of the palaeogeography of the southern margins of the Tethys in the Late Triassic.

CLAOUÉ-LONG, J.C., ZHANG ZICHAO, MA GUOGAN and DU SHAOHUA, 1991. The age of the Permian-Triassic boundary. Earth Planet. Sci. Newsl., 105: 182-190.

The 5 cm boundary clay bed in the Chinese stratotype section through the Permian-Triassic boundary has been recognised as a bentonite. SHRIMP ion microprobe dating of zircons in the bentonite indicates a magmatic age of 251.2 ± 3.4 Ma (2σ); this is the first direct constraint on a numerical age of the Permian-Triassic boundary. Future refinements of ages at this important, but poorly constrained, level of the Phanerozoic timescale may depend on re-analysis of this uniquely placed volcanic horizon, and other benthonites in the fossiliferous Chinese Upper Permian and Lower Triassic. The utility of defining the Permian-Triassic boundary in the Chines stratotype section, in the vicinity of known dateable horizons should be considered.



The Permian-Triassic boundary at Meishan, South China (from Claoué-Long et al., 1991)

CLUZEL, J., CHARVET, J., FAURE, M., ALLES, W., LAPIERRE, H. and SHU, L., 1992. Pre-Jurassic collision tectonics in Eastern Asia. A synthesis of French contributions in China, Korea and Japan. Géochronique, 42: 51.

The authors briefly discuss the timing of collision tectonics in the Palaeozoic and Early Mesozoic of Eastern Asia.

COPE, J., 1991. Further discussion on the correlation of the Triassic-Jurassic boundary in England and Austria. J. Geol. Soc. London, 148: 943-944.

A reply on E. Poole's (1991) comments on the position of the Triassic-Jurassic boundary. The author defends the choice of *Psiloceras planorbis* as marker for the Jurassic and rejects boundaries which would coincide with earth movements and widespread facies changes.

COX, C.B., 1991. The Pangaea dicynodont *Rechnisaurus* and comparative biostratigraphy of Triassic dycnodont faunas. Palaeontology, 34: 767-784.

A dicynodont from the Triassic Manda Beds of East Africa is found to belong to the kannemeyeriid genus *Rechnisaurus*, first described from India, with which the genus *Shaanbeikannemeyereria* is congeneric. The relative ages of dicynodont-bearing Triassic faunas are reviewed in the light recent changes in taxonomy and biostratigraphy.

CUIF, J.-P. and EZZOUBAIR, F., 1991. Diversité des cératoporellides triasiques. Geobios, 24: 257-266.

Living calcifying Demospongiae build calcareous structures with clearly distinctive features. Detailed studies of biomineralization patterns enable the recognition of the taxonomic position of fossils at the family level. The authors have identified several species known from the Carnian of the Dolomites and Norian of Turkey as Ceratoporellids; some of them have initially been described as Hydrozoa. Ceratoporellids were important elements in Late Triassic shallow-water faunas together with scleractinian corals and algae.

CUIF, J.-P. and GAUTRET, P., 1991. Étude de la répartition des principaux types de démosponges calcifiées depuis le Permien. Hypothèse d'une incidence des conditions océanologiques sur la biominéralisation carbonatée des spongiaires. Bull. Soc. géol. France, 162: 875-886.

A review of calcified Demospongiae since the Permian with special attention for original mineralogy of their skeletons. An alternate distribution of calcitic and aragonitic forms is demonstrated. The Carboniferous/Permian boundary is marked by the first occurrence of aragonitic skeleton sponges, with a strong acme in the Triassic. At Triassic/Jurassic boundary aragonitic forms disappear in the calcareous facies and are replaced by calcified ones.

DE ZANCHE, V., FRANZIN, A., GIANOLLA, P., MIETTO, P. and SIORPAES, C., 1992. The Piz da Peres section (Valdaorna - Olang, Pusteria Valley, Italy) - A reappraisal of the Anisian stratigraphy in the Dolomites. Eclogae geol. Helv., 85: 127-143.

In the Piz da Peres area (Valdaora - Olang, Pusteria Valley, Italy) an Anisian succession is exposed. A redefinition of the lithostratigraphy is made, and the presence of three terrigenous units of different ages (Piz da Peres Conglomerate, Voltago Conglomerate and Richthofen Conglomerate), as well as two carbonate platforms (Upper Serla Formation and Contrin Formation), is documented. This stratigraphic setting correlates with other Anisian sections outcropping in the Dolomites and the Recoaro area. Using sequence stratigraphy as an integrated approach, four Anisian depositional sequences are identified. Preliminary results indicate that these sequences can be recognized throughout the Dolomites and the Recoaro area, and might even extend to the Southern Alps.

Dickins, J.M., 1992. Permo-Triassic orogenic, paleoclimatic, and eustatic events and their implications for biotic alteration. In: W.C. Sweet, Yang Zunyi, J.M. Dickins and Yin Hongfu, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 169-174.

The author states that regression and emersion, coupled with hot climatic conditions and strong volcanic activity had a profound, adverse effect on the existing biota of the Permo-Triassic boundary interval. There is no substantial evidence of impact of extra-terrestrial bodies. The factors enumerated were certainly accompanied by changes in composition of seawater and the atmosphere, and by changes in terrestrial environments.

Dickins, J.M. and Campbell, H.J., 1992. Permo-Triassic boundary in Australia and New Zealand. In: W.C. Sweet, Yang Zunyi, J.M. Dickins and Yin Hongfu, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 175-178.

A review of Permo-Triassic boundary sequences in eight Australian basins. A well-defined Permo-Triassic boundary sequence has not been recognized in New Zealand.

Ding Meihua, 1992. Conodont sequences in the Upper Permian and Lower Triassic of South China and the nature of conodont faunal changes and the systemic boundary. In: W.C. Sweet, Yang Zunyi, J.M. Dickins and Yin Hongfu, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 109-119.

Permian and Triassic conodont features of South China are reconstructed by synthesis of information from several sections. Four Late Permian faunas are recognized. The Lower Triassic of South China is divided biostratigraphically into twelve conodont zones. A zonation scheme is presented. The author suggests that environmental changes in the latest Permian were the most important factors in causing changes in conodont faunas, primarily at the species level.

Engeser, T. and Reitner, J., 1992. Description of the first Rhaetian nautiloid (*Grypoceras rhaeticum* n.sp.) from the Kössen Beds of the Fonsjoch near Achensee (Austria). N. Jb. Geol. Paläont. Mh., 1992 (4): 231-241.

Grypoceras rhaeticum n.sp. is the first nautiloid described from the Rhaetian. It has been found in the Kössen Beds at the Fonsjoch near Achensee (Austria). The taxonomy and the designation of the type species of the genus *Grypoceras* Hyatt 1883 are discussed briefly.

Eshet, Y., 1992. The palynofloral succession and palynological events in the Permo-Triassic boundary interval in Israel. In: W.C. Sweet, Yang Zunyi, J.M. Dickins and Yin Hongfu, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 134-145.

Palynologic assemblages undergo a drastic change within the Permo-Triassic boundary interval in Israel. In the subsurface of Israel, the succession which is assigned to the Late Permian *Lueckisporites virkkiae* Zone is characterized by striate bisaccate pollen. At the top of the Permian succession is a horizon rich in reworked palynomorphs and other land-derived organic debris. In most of the boreholes studied, there is a thin layer containing abundant fungal spores, associated with land-derived reworked organic particles. This layer is difficult to detect and its recognition requires detailed sampling, which has not always been possible for the material available for this study. Acritarchs

are abundant in layers in the lower part of stratal sequence here regarded as Early Triassic. Lycopods, such as *Kraeuselisporites* and *Endosporites papillatus* are among the first representatives of land plants above the "acritarch spike". Following Visscher and Brugman's (1988) ideas on the nature of the Permo-Triassic boundary in the Southern Alps, it is suggested that palynological associations in the Permo-Triassic boundary interval of Israel represent a vegetative succession that began with a massive extinction of the Late Permian flora and was followed by a proliferation of fungi, which could survive the ecologic stress. Later, at the beginning of the Triassic, acritarchs invaded marine niches and constituted the pioneering vegetation in the ocean after the break at the end of the Permian. The first Triassic land plants are represented by lycopods, and are represented first in the record just above the "acritarch spike". This succession may be a model of a vegetative community recovering from a great ecologic shock.

FENNINGER, A., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): mineralogy of the shaly and marly interbeds. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 53-60.

A mineralogical study of the core of the Gartnerkofel-1 core. Microfacial investigations evidence a multistage dolomitization for the Werfen Beds and a penecontemporaneous one for the Bellerophon Formation. Volcanic quartz and heavy minerals indicate volcanic activity during the deposition of the basal Werfen Formation. The interbeds give no evidence for a catastrophic extraterrestrial event at the Permian/ Triassic boundary.

FIJALKOWSKA, A., 1992. Palynostratigraphy of the Keuper and Rhaetic in north-western margin of the Holy Cross Mts. Geol. Quarterly, 36: 199-220.

Six boreholes at the northwestern margin of the Holy Cross Mountains have been studied palynologically. Seven spore-pollen assemblages were distinguished in the Keuper and Rhaetian and 54 genera of pollen and spores with 94 species as well as 3 genera of acritarchs with 7 species were recognized.

FRECHENGUES, M. and PEYBERNÈS, B., 1991. Associations de Foraminifères benthiques dans le Trias carbonaté (Anisien, Ladinien-Carnien et Rhétien) des Pyrénées Espagnoles. Acta Geol. Hispanica, 26(1): 67-73.

Five successive depositional sequences are recognised in the Middle-Late Triassic succession in the central Spanish Pyrenees. Three of the present carbonate transgressive system tracts including distinct benthic foraminifera assemblages, viz. the DS 237 (late Anisian-early Ladinian), the DS 232 (late Ladinian-early Carnian = upper "Muschelkalk") and the DS 215 (Rhaetian pro parte).

FREY, J.-W. and ROSENFELD, U., 1992. The strata of Potrerillos (Prov. of Mendoza/Argentina): A regionally typical profile of the continental Triassic in southern South America. Zbl. Geol. Paläont. Teil I, 6: 1615-1632.

The Triassic strata of Potrerillos in the Cuyo Basin represent a megasequence with continuous evolution from proximal alluvial fan sediments (Rio Mendoza Formation) to proximal braided river deposits (Las Cabras Formation), meandering river deposits (Potrerillos Formation, Cacheuta Formation) and widespread lacustrine sediments (Cacheuta Formation). The Rio Blanco Formation is the base of a second fluviatile megasequence. Locally exposed, thick lacustrine sediments in the Las Cabras Formation imply a special morphotectonic position of these sediments in the basin. The

strata of Potrerillos are characteristic of the sedimentary evolution of the entire Cuyo Basin. They are representative of the tectonic state and thus of the specific tectonic position and evolution of the region.

FROSTICK, L.E., LINSEY, T.K. and REID, I., 1992. Tectonic and climatic control of Triassic sedimentation in the Beryl Basin, northern North Sea. J. Geol. Soc. London, 149: 13-26.

A sedimentological study of the Early Triassic Teist Formation from the Beryl Basin in the northern North Sea. The data indicate a distinct change in climate which is attributed to the rapid northward drift of Pangea during the Triassic period.

FURRER, H., EICHENBERGER, U., FROITZHEIM, N. and WURSTER, D., 1992. Geologie, Stratigraphie und Fossilien der Ducankette und des Landwassergebiets (Silvretta-Decke, Ostalpin). Eclogae geol. Helv., 85: 245-256.

A report of an excursion of the Swiss Palaeontological Society and the Swiss Geological Society to the Silvretta Nappe. The paper summarizes results of structural, sedimentological, stratigraphic and palaeontological studies on the cover rocks of the Silvretta Nappe. The Permian to Upper Triassic sediments of the Ducan and Landwasser area show two orders of transgressive-regressive cycles. Most of the sediments were deposited in a very shallow marine environment and are poor in index fossils. However, they have yielded important fish and reptile faunas.

GAETANI, M., GNACCOLINI, M., POLIANI, G., GRIGNANI, D., GORZA, M. and MARTENELLI, L., 1992. An anoxic intraplatform basin in the Middle Triassic of Lombardy (Southern Alps, Italy): anatomy of a hydrocarbon source. Riv. It. Paleont. Strat., 97: 329-354.

The Ladinian rocks of Central Lombardy consist of carbonate platforms (Esino Formation) subdivided by intraplatform troughs represented by either dark, well bedded limestones, marls and dolomites of poorly oxic to anoxic (Perledo-Varenna and Lierna Formations), or by grey nodular cherty limestones (Buchenstein Formation). Subsidence and deposition rates were high (>100m/Ma), both on the carbonate platforms and in the anoxic intraplatform troughs. Sedimentological study of the anoxic intraplatform rocks in the Grigne Mountains has identified twelve main lithofacies with mudstones/wackestones, both massive and laminated, forming more than 2/3 of the total thickness. Packstones and carbonate breccias, all originating or fed from the neighbouring shallow carbonate platforms, represent 6% of the total thickness in the basin. Also the dominating micrite is thought to have originated by overproduction on the carbonate platform. Concerning the depositional processes, almost 3/4 of the total thickness is interpreted as re-sedimented. Dolomitization is widespread in the marginal parts of the basin. No benthonic macrofauna is present, only sporadically the bottom oxygen content was sufficient to support a non skeletal infauna. Two depositional sequences have been detected, both causing emersion on the carbonate platform. The younger emersion was severe and the platform/basin system ceased to exist. The maturity of the rocks has been determined by various methods.

GALL, J.-C. and GRAUVOGEL-STAMM, L., 1992. EPA Workshop "Taphonomy: processes and products". European Palaeontological Association, Strasbourg, 85 pp.

A symposium book with a richly illustrated field guide (pp. 32-82) of an excursion to the Triassic fossil-lagerstätten (Muschelkalk and Buntsandstein) of the northern Vosges (France) organized by Ph. Duringer, J.-C. Gall and L. Grauvogel-Stamm.

GARCÍA-GIL, S., 1991. The sedimentological significance of a clastic wedge in the western basin margin of the Triassic Tethys (Iberian Range, Spain). Cuadernos de Geología Ibérica, 15: 209-239.

The Middle Triassic of the NW part of the Iberian Basin consists of both carbonate and terrigenous sediments. A new sedimentary model is proposed fro the clastic wedge of the Cuesta del Castillo Sandstones and Siltstones Formation, and its relation with the Upper Muschelkalk carbonate formations is discussed. The sedimentation of the Cuesta del Castillo Sandstones and Siltstones Formation took place during a relative sea level rise (high stand system tract).

GARZANTI, E. and FRETTE, M.P., 1991. Stratigraphic succession of the Thakkhola region (central Nepal) - comparison with the northwestern Tethys Himalaya. Riv. It. Paleont. Strat., 97(1): 3-26.

A review of the Cambro-Ordovician to Pleistocene history of the Thakkhola region (central Nepal). Triassic to Jurassic sedimentary units display comparable features all along the Tethys Himalaya. Owing to strong thermo-tectonic subsidence, the newly formed Indian margin was rapidly drowned in the Early Triassic, and covered by thick marly limestones in Anisian to Carnian times. The Norian was characterized by very fine-grained quartzo-feldspathic detritus derived from the rejuvenated Indian foreland, while exclusive quartzose detritus suggests latitudal drift towards more humid climates or more subdued relief in the Rhaetian.

GHORABI, M. and HENRY, B., 1992. Etude paléomagnétique dans les formations détritique du Jebel Hairech (Tunisie) et implications stratigraphiques et structurales. Bull. Soc. géol. France, 163: 187-194.

A palaeomagnetic study of the detrital formations of Hairech, Tunisia. Two remanent magnetizations were found. The formations are of Permian-Triassic age (Upper Permian-Muschelkalk).

GRAUVOGEL-STAMM, L., 1991. *Bustia ludovici* n.g. n.sp., a new enigmatic reproductive organ from the Voltzia Sandstone (early Middle Triassic) of the Vosges (France) - Its bearing for the lycopod origin. N. Jb. Geol. Paläont. Abh., 183: 329-345.

A new enigmatic reproductive organ is supposed to be the first lycopsid reproductive organ from the Voltzia Sandstone. Classification is difficult because of features pointing to different groups of lycopods. The possible evolutionary relationship with the early vascular land plants (zosterophylls and rhyniophytes) is discussed.

HANKEL, O., 1992. Late Permian to Early Triassic microfloral assemblages from the Maji ya Chumvi Formation, Kenya. Rev. Palaeobot. Palynol., 72: 129-147.

Plant microfossils are described from the a possible Permian-Triassic transition in the Karoo sequence of the Mombassa Basin, Kenya. The drilled section does not show discontinuities and yielded two distinct assemblages, one of Late Permian age and the other of Early Triassic age. The position of the Permian-Triassic boundary in the studied sequence is discussed.

HAO WEI-CHENG, 1992. Early Triassic marine ostracods from Guizhou. Acta Micropal. Sinica, 9(1): 37-44. (in Chinese with English summary)

The author describes seven genera and eleven species of ostracods, associated with bivalves and conodonts, from the Lower Triassic in Zhenfeng and Zunyi, Guizhou Province. Three new species are described with diagnoses in English. The genus

Carinaknightina is for the first time recorded from China and allows correlations with the Salt Range, West Pakistan.

HAUSCHKE, N., 1991. Durchwurzelte Sedimentfolgen in der Trias des Cuyo-Beckens, W-Argentinien. N. Jb. Geol. Paläont. Abh., 183: 307-328.

Two sedimentary sequences containing root structures are described from the continental Triassic of the Cuyo Basin, which is taphrogenic in origin. The sedimentology of the studied sequences is discussed.

HAUSCHKE, N., NORDHAUS, J. and ROSENFELD, U., 1989. Geochemical studies in Triassic sediments of the Potrerillos Area (Cuyo Basin, Western Argentina): first results. Zbl. Geol. Paläont. Teil I, 5/6: 1027-1042.

Geochemical analyses of 60 mostly pelitic samples of the continental Triassic section of Potrerillos (W Argentina) and statistical processing of the results yield clear facies indications. Lithologic formations are, with one exception, relatively uniform facies units of an alluvial fan system. Distribution of elements and statistical processing allow to differentiate prevailing alluvial fan facies, predominating fluvial facies and lacustrine facies. Especially useful in the present investigation is the factor analysis.

HODYCH, J.P. and DUNNING, G.R., 1992. Did the Manicouagan impact trigger end-of-Triassic mass extinction? Geology, 20: 51-54.

The authors use U-Pb zircon dating to test whether the bolide impact that created the Manicouagan crater of Quebec also triggered mass extinction at the Triassic/Jurassic boundary. The zircons yield a U-Pb age of 214 ± 1 Ma. The age of the Triassic/Jurassic boundary is provided by Zircons from the North Mountain Basalt of the Newark Supergroup of Nova Scotia; the zircons yield a U-Pb age of 202 ± 1 Ma. This should be the end-of-Triassic mass extinction that paleontology and sedimentation rates suggest occurred less than 1 m.y. before extrusion of the North Mountain Basalt. Although the Manicouagan impact could thus not have triggered the mass extinction at the Triassic/Jurassic boundary (impact likely having preceded extinction by 12 ± 2 m.y.), the impact may possibly have triggered an earlier mass extinction at the Carnian/Norian boundary in the Late Triassic.

HOLSER, W.T., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): sulphur, organic carbon and microspherules. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 139-148.

All marly interbeds from the Gartnerkofel-1 core as well as numerous samples of the dominantly dolomitic limestones were analyzed for organic carbon and pyritic sulphur. A few microspherules were recovered. However, these are thought to be man-made contaminants.

HOLSER, W.T. and SCHÖNLAUB, H.P. (Eds.), 1991. The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45.

A special volume of the Abh Geol. B.-A. dedicated to the 331 m long Gartnerkofel-1 core which was drilled through the Permian-Triassic boundary interval in the Carnic Alps. The samples from this core and a nearby outcrop section were studied by a team of specialists. This volume contains the following contributions:

- ATTREP, M. Jr., ORTH, C.J. and QUINTANA, L.R.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): geochemistry of common and trace elements II - INAA and RNAA.
- BOECKELMANN, K.: The Permian-Triassic of the Gartnerkofel-1 core and the Reppwand outcrop section (Carnic Alps, Austria).
- BOECKELMANN, K. and MAGARITZ, M.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): dolomitization of the Permian-Triassic sequence.
- FENNINGER, A.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): mineralogy of the shaly and marly interbeds.
- HOLSER, W.T.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): sulphur, organic carbon and microspherules.
- HOLSER, W.T., SCHÖNLAUB, H.P., BOECKELMANN, K., MAGARITZ, M. and ORTH, C.J.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): synthesis and conclusions.
- HOLSER, W.T., SCHÖNLAUB, H.P. and KLEIN, P.: The Permian-Triassic Boundary in the Gartnerkofel Region of the Carnic Alps (Austria). Introduction.
- JENNY-DESHUSSES, C.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): foraminifera and algae of the core and the outcrop section.
- KLEIN, P.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): geochemistry of common and trace elements I - ICP, AAS and LECO.
- KRALIK, M.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): strontium isotopes and carbonate chemistry.
- MAGARITZ, M. and HOLSER, W.T.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): carbon and oxygen isotope variation.
- OBENHOLZNER, J.A.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): petrography and geochemistry of an Anisian ash-flow tuff.
- PAK, E. and HOLSER, W.T.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): sulphur isotopes.
- SCHMÖLLER, R.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): remarks on the natural gamma ray log and density log.
- SCHÖNLAUB, H.P.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): conodont biostratigraphy.
- SCHRAMM, J.-M.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): illite crystallinity in shaly sediments and its comparison with pre-Variscan sequences.
- STATTEGGER, K.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): statistical analysis of the geochemical data.
- ZEISSL, W. and MAURITSCH, H.J.: The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): magnetostratigraphy.

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. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 213-232.

Events at the P/T boundary were investigated in the 331 m core Gartnerkofel-1, Carnic Alps, Austria. 100 m of the upper Bellerophon Formation of Dzulfian/Dorashamian age are succeeded conformably by 174 m of Triassic Werfen Formation, in which conodont zonation verifies a thick Griesbachian section. The carbon isotope profile drops smoothly and with increasing steepness across the boundary to a series of minima in the lower 40 m of the Werfen Formation before returning to nominal levels in the

upper Werfen; these data reflect a very complex and extensive (≈3 Ma) shift away from the dominant organic deposition characteristic of Permo-Carboniferous time. The lower and upper minima of $\delta^{13}C$ are associated with narrow zones of early diagenetic pyrite and weak anomalies of Ir and other trace metals. Very low ratios of Ir to Co, Cr, Ni and Au in these peaks compared to chondrites and to the K/T boundary anomaly, indicate that the P/T "event" may have been spread out over several million years during which extinctions were parallelled by the deterioration of organic carbon deposition consequent on sea level regression. The traditional linkage of extinction to sea-level regression is re-examined in the context of the new geochemical data.

Holser, W.T., Schönlaub, H.P. and Klein, P., 1991. The Permian-Triassic Boundary in the Gartnerkofel Region of the Carnic Alps (Austria). Introduction. In: W.T. Holser and H.P. Schönlaub (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 5-16.

The major mass extinction event near the P/Tr boundary was investigated near Gartnerkofel in the Carnic Alps, Austria. This paper is an introduction on the other papers published by various specialists in a special issue of the Abh. Geol. B.-A. (Vol. 45).

Huang Pin, 1991. Early Triassic sporopollen and acritarchs in suburbs of Nanjing. Acta Palaeont. Sinica, 30(4): 458-479. (in Chinese with English summary)

Eighteen samples taken from the Lower Qinglong and the Upper Qinglong Formations, exposed in the suburbs of Nanjing, China, have been studied. On the basis of spores and pollen a Late Nammalian age was inferred for Member 4 of the Lower Qinglong Fm. Acritarchs indicate a shallow marine environment. The studied part of the Upper Qinglong Formation is dated as Spathian and was also deposited in a marine environment.

Hunt, A.P., 1991. The early diversification pattern of dinosaurs in the Late Triassic. Modern Geology, 16: 43-66.

Current ideas about the pattern of the early diversification of dinosaurs are based on the fossil records of Germany and South America, where there are major environmental changes at the Carnian/Norian boundary. This record suggests an explosive radiation. Recent discoveries of Late Triassic dinosaurs in North America are from "wetter" environments where there is no major change. "Prosauropods" are "dry" environment facies fossils and radiated explosively with drying conditions in Germany and South America. Carnivorous dinosaurs radiated slowly and ?ornithischians were minor components of all faunas. Dinosaurs radiated against a background of increasing provinciality of faunas and ecological stress. Dinosaurs did not fill all niches for medium-large terrestrial animals until the Middle Jurassic.

Hunt, A.P. and Lucas, S.G., 1991. The *Paleorhinus* Biochron and the correlation of the non-marine Upper Triassic of Pangea. Palaeontology, 34: 487-501.

A new skull of the phytosaur *Paleorhinus bransoni* from Palo Duro Canyon, Randall County, Texas is described. The taxonomy and the distribution of the genus *Paleorhinus* are discussed. The genus is a prominent constituent of late Carnian faunas in the western United States, Germany, Morocco, India and Austria. These faunas, together with correlative faunas which lack *Paleorhinus* in Scotland and South America, encompass a *Paleorhinus* biochron which can be recognized across much of the Late Triassic of Pangea. The age of this biochron is based on pollen, marine invertebrates, and radiometric dates.

HUNT, A.P. and LUCAS, S.G., 1991. A new Rhynchosaur from the Upper Triassic of West Texas, and the biochronology of Late Triassic Rhynchosaurs. Palaeontology, 34: 927-938.

A new rhynchosaur, *Otischalkia elderae*, from the Lower Dockum Group of West Texas is described. The new material is compared with that of other Late Triassic Rhynchosaurs from Wyoming, Madagascar, Tanzania, Brazil, Argentina, India and Scotland. Those remains which are well dated are all of early late Carnian age. Late Triassic Rhynchosaur distribution is largely controlled by the facies that are preserved at different localities. Rhynchosaurs are common in more terrestrial faunas that contain few or no phytosaurs, whereas rhynchosaurs are rare in semiaquatic faunas dominated by phytosaurs.

HUNT, A.P. and LUCAS, S.G., 1992. The first occurrence of the aetosaur *Paratypothorax andressi* (Reptilia, Aetosauria) in the western United States and its biochronological significance. Paläont. Z., 66(1/2): 147-157.

A partial skeleton of the aetosaur *Paratypothorax andressi* from Petrified Forest National Park, Arizona, is the first documentation of this species in North America. *Paratypothorax* is one of the few tetrapod taxa that occur in both the Keuper of Germany and the Chinle Group of the western United States, but it is of limited biochronological utility, because it occurs in strata that range in age from late Carnian to middle Norian.

JADOUL, F., BERRA, F. and FRISIA, S., 1992. Stratigraphic and paleogeographic evolution of a carbonate platform in an extensional tectonic regime: the example of the Dolomia Principale in Lombardy (Italy). Riv. It. Paleont. Strat., 98: 29-44.

Stratigraphic and sedimentological studies of the Norian succession of the Lombardy Basin allowed the reconstruction of the paleogeographical and structural evolution of this area. Five phases are recognized. The drowning of the platform is favoured by the lack of carbonate production, due to clay pollution and climatic changes with high subsidence rates. The Lombardy Basin is interpreted as a pull-apart basin, linked to transtension with E-W trending faults.

JADOUL, F., BERRA, F., FRISIA, S., RICCHIUTO, T. and RONCHI, P., 1992. Stratigraphy, paleogeography and genetic model of late Carnian carbonate breccias (Castro Formation, Lombardy, Italy). Riv. It. Paleont. Strat., 97: 355-392.

The stratigraphic and paleogeographic analysis of the Carnian-Norian boundary succession in central Lombardy allows the recognition of a 100-250 m thick new unit of intraformational breccias and associated limestones, the Castro Formation. Two lithozones are distinguished, the upper one is locally rich in ostracods. The Castro Formation can be differentiated geochemically from under- and overlying formations; its differences are possibly related to an early diagenesis imprint. The depositional setting can be characterized as coastal ephemeral lakes with periodic emersions and erosional, tectonically controlled phenomena in a monsoonal regime.

JADOUL, F. and GNACCOLINI, M., 1992. Sedimentazione ciclica nel Trias Lombardo: osservazioni e prospective. Riv. It. Paleont. Strat., 97: 307-328.

High-frequency cycles are widespread in the whole Triassic succession of Lombardy (Southern Alps). These cycles characterize depositional environments ranging from continental to shallow marine to basinal, with carbonate or mixed sedimentation; their thickness is from several meters to a few millimetres. They are inferred to be the result of cyclic phenomena such as eustatic and/or tectonically controlled sea level oscil-

lations and long term seasonal climatic changes. The time interval covered by each of these cycle spans from the "Milankovian band" to annual. The examined Triassic succession has been arranged in depositional sequences, tentatively correlated with third order cycles of Haq et al. (1988).

JENNY-DESHUSSES, C., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): foraminifera and algae of the core and the outcrop section. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 99-108.

The core of the Gartnerkofel-1 borehole has yielded two distinct faunal associations. One is dominated by *Globivalvulina* sp. and *Hemigordius* sp.; *Paraglobivalvulina* and *Paradigmarita* prove a Late Permian age. The second consists of a dwarf microfauna of nodosariids, *Cyclogyra* sp., *Earlandia* sp., ostracods, microgastropods and echinoderms of Triassic age.

KALANDADZE, N.N. and RAUTIAN, A.S., 1991. Late Triassic zoogeography and reconstruction of terrestrial tetrapod fauna of North Africa. Palaeontological Journal, 1991 (1): 3-14. (in Russian)

Intercontinental relations of thecodonts, dinosaurs, therapsids and mammals are considered. Small-scale paleogeographic reconstruction is proposed and compared with those based on other data. Existence of Pangea in Late Triassic is confirmed. Faunas the lived southward and northward from the Tethys contacted in North Africa. Comparatively poor fauna of the latter region is partially reconstructed.

KAPOOR, H.M., 1992. Permo-Triassic boundary of the Indian subcontinent and its intercontinental correlation. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 21-36.

Several Permo-Triassic boundary sections in India, Pakistan, Iran, Afghanistan, Tibet, Nepal and South China are discussed. The Guryul Ravine section in Kashmir, with support from the Pahalgam section is one of the best reference section for the transition beds. The Guryul section has the disadvantage of lacking Dorashamian fossils, but it has an excellent development of Lower Triassic strata. Sections in South China include a well-developed Late Permian biota, but the Permo-Triassic transition is less clear as in Kashmir. Differences are related to the independent paleogeographic development of both areas.

KELBER, K.-P., 1992. Der dreidimensionale Bau der Blattspitzen bei *Equisetites arenaceus* (Equisetopsida, Equisetales) aus dem Unteren Keuper (Trias, Ladin). In: J. KOVAR-EDER (Ed.), Palaeovegetational development in Europe, Proc. Pan-European Palaeobot. Conf. Vienna (PEPC 1991), 289-299.

Equisetites arenaceus (Jaeger) Schenk is the most frequently encountered horse-tail being represented by numerous specimens in the Lower Keuper (Triassic, Ladinian) of South Germany. Distal leaf parts of well-preserved leaf-sheaths from Schleerieth and Ochsenfurt (Franconia) are three-dimensional cup-like shaped. Raised pyramidal and thick-textured leaf-apexes terminate in spiny-like teeth which are often broken off. The multiple phenotypes of leaf tips are mainly caused by different states of fossil preservation.

KLEIN, P., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): geochemistry of common and trace elements I - ICP, AAS and LECO. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 109-122.

An analysis of common and trace elements from core Gartnerkofel-1.

KRALIK, M., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): strontium isotopes and carbonate chemistry. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 169-174.

An analysis of strontium isotopes and a study of the carbonate chemistry of 27 samples from the Gartnerkofel-1 core.

KRISTAN-TOLLMANN, E., HAAS, J. and KOVÁCS, S., Karnische Ostracoden und Condonten der Bohrung Zsámbék-14 im Transdanubischen Mittelgebirge (Ungarn). In: LOBITZER, H. and SZÁSZÁR, G. (Eds.), Jubileumsschr. 20 Jahre Geol. Zusammenarbeit Österreich-Ungarn, 1: 193-219.

In the Middle Carnian Bátyáshegy Formation and the Veszprém Marl Formation of the borehole Zsámbék-14 (W Hungary) a fairly well preserved ostracod fauna and a very poor conodont fauna have been found. The ostracode association shows close south Alpine affinity, namely to those of the Raibl Beds, characterized by the dominance of Alpine Cytheracea and Cytherellacea. The occurrence of a *"Misikella"*-type *Neospathodus* n.sp. throws a new light on the taxonomy and phylogeny of the genus *Neospathodus* Mosher, 1968.

LAI XULONG, YIN HONGFU and YANG FENGQING, 1992. The character and evolution of ecostratigraphy and paleobiogeography of Triassic Qinling basin. Earth Science-Journal of China University of Geosciences, 17(3): 345-352.

Based on an ecostratigraphic study of four sections in West Qinling, several fossil communities are established and their environmental settings reconstructed. Ecostratigraphic subdivision and correlation revealed the general pattern of basin evolution and details of eustatic vibration. According to the paleobiogeographic analysis, in the Triassic, the southern region of Qinling belonged to the tropical-subtropical zone, while the northern region of Qinling belonged to the temperate zone. The study of the similarity coefficients at species level among various regions of Qinling, Yangtze and North China shows that the Triassic sea of Qinling had considerable width and depth, but that it was not a vast ocean.

LAI XULONG, YIN HONGFU and YANG FENGQING, 1992. Reconstruction of the Triassic Qinling Sea. Exploration of Geosciences, 6: 57-64.

This paper mainly deals with the evolution of the Triassic Qinling Sea. Based on the analysis of paleobiogeography, paleomagnetism and lithofacies, three Triassic paleogeographic maps of the Qinling Sea have been drawn with the riftogenesis viewpoint. In the Early Triassic, the Yangtze Block and the North China Block came in contact with each other in the Lower Yangtze area, and the Qinling Sea shaped a loudspeaker type which opened to the west. In the western part of the Qinling Sea, the distance between Yangtze and North China was about 1000 km, and it became narrower eastward. On both sides of the Triassic depression showed difference in paleobiogeography and lithofacies. During the Anisian (Middle Triassic), both Yangtze and North China shifted northward and took the contacted Lower Yangtze area as the axis

to rotate toward each other, which caused the folding up of the Lower Yangtze and Dabie Mts. The Qinling Sea retreated to west. After the Anisian, the Yangtze Block continued to collide with the North China Block from east to west. At last, resulted in the whole Qinling area folded up and the Paleo-Tethys disappeared in this area in the Late Triassic.

Lamping, M., Overbeck, G. and Kulke, H., 1991. Sedimentologie und Diagenese obertriadischer Sandsteine im nordwestlichen Sichuan-Becken (Zentralchina). Z. dt. geol. Ges., 142: 115-129.

A sedimentological study of the about 600 m thick Xujiahe Formation (Upper Triassic) in the northwestern Sichuan Basin (Central China).

Laville, E. and Piqué, A., 1991. La distension crustale atlantique et atlasique au Maroc au début du Mésozoïque: le rejeu des structures hercyniennes. Bull. Soc. géol. France, 162: 1161-1171.

The Triassic rifting of Pangea and the formation of passive margins in the Central Atlantic Ocean were strongly controlled by the pre-existent crustal structures. This paper deals with the tectonic history of Morocco. In the Triassic old structures were reactivated, during the development of an abnormal heath flow. The presence of Triassic basins, their sedimentary filling and the thermal regime lead to distinguish two rift zones in Morocco which are separated by the meseta: (1) the Atlantic Rift, located within the continental margin and the Essaouira coastal basins, and (2) the Atlasic Rift, composed of the Central High Atlas and the Middle Atlas.

Litwin, R.J. and Ash, S.R., 1991. First early Mesozoic amber in the Western Hemisphere. Geology, 19: 273-276.

Detrital amber pebbles and granules have been discovered in Upper Triassic strata on the Colorado Plateau, U.S.A. It is the first record of Triassic amber in the Western hemisphere. The occurrences are at two localities in the lower part of the Petrified Forest Member of the Upper Triassic Chinle Formation, Arizona. Associated palynomorph assemblages indicate a late Carnian age for these deposits.

Lualdi, A., 1991. Il Trias superiore-Lias della zona Sestri-Voltaggio (Unità di M. Gazzo-Isoverde). La sezione de Lencisa - M. dei Torbi. Atti Tic. Sc. Terra, 34: 121-132.

A sedimentological study of the M. Gazzo-Isoverde Unit (Norian-Sinemurian) in the Sestri-Voltaggio Zone (Piemonte, Italy). The sequence shows indications for a general deepening. from tidal flat to basin environments. The section is compared with sequences in western Liguria.

Lucas, S.G., 1991. Triassic stratigraphy, paleontology and correlation, south-central New Mexico. New Mexico Geol. Soc. Guidebook, 42nd Field Conference, Sierra Blanca, Sacramento, Capitan Ranges, 1991. pp. 243-259.

Triassic strata in south-central New Mexico pertain to the Moenkopi, Shinarump and San Pedro Arroyo Formations. This paper deals with a detailed description of these formations. The Moenkopi Formation is dated as Anisian, the lower part of the San Pedro Arroyo Formation as late Carnian; the upper part of this latter formation is apparently Late Triassic, however, a more precise age assessment cannot be given. The paper includes a correlation scheme of the measured sections and a correlation scheme of the Triassic strata in west-central, south-central, east-central and southeastern New Mexico.

LUCAS, S.G., 1992. *Dinodontosaurus* Romer, 1943 (Reptilia, Synapsida): proposed conservation. Bull. Zool. Nomencl., 49: 52-54.

Proposal for the conservation of the name *Dinodontosaurus* Romer, 1943 against *Dinodontosaurus* Caldas, 1936.

LUCAS, S.G., 1992. Revised Upper Triassic stratigraphy in the San Rafael Swell, Utah. Utah Geol. Ass. Publ., 19: 1-8.

As much as 120 m of nonmarine Upper Triassic strata exposed in the San Rafael Swell, Utah, belong to the Carnian-Norian Chinle Group. Six formations are now recognized instead of the three members previously distinguished. These units represent three depositional sequences bounded by unconformities. Chinle strata in the Swell thus conform to the sequence stratigraphy of the Chinle Group evident throughout the western United States.

LUCAS, S.G. and HUNT, A.P., 1992. Late Triassic, not Liassic, originations. Modern Geology, 16: 389-391.

The authors comment on two papers by O. Shields (1988, 1990) in which the latter author argued for a abrupt, terminal Triassic extinction of terrestrial organisms followed by "pivotal Liassic terrestrial replacements". Shields cited an Early Jurassic age for the Chinle Formation of the American Southwest. However, this U-Pb age is nothing more than a minimum age as is shown by a wealth of palaeontological evidence. The Chinle Formation in fact has a late Carnian-early Norian age and therefore Shield's conclusions should be regarded as being wrong.

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

Dinosaurs of Late Triassic age are known from various countries. The idea has long persisted that of the Late Triassic dinosaurs, the oldest is either *Staurikosaurus* from Brazil or *Herrerasaurus* and contemporaneous forms from Argentina. A reevaluation of the ages of these dinosaurs, however, indicates that they are of the same age and that equally old dinosaurs are known from the western United States, Morocco and India. This documents an essentially simultaneous and geographically widespread first appearance of the dinosaurs in the Upper Triassic (Late Carnian, Tuvalian) fossil record.

LUKAS, V., 1991. Die Terebratel-Bänke (Unterer Muschelkalk, Trias) in Hessen - ein Abbild kurzzeitiger Faziesänderungen im westlichen Germanischen Becken. Geol. Jb. Hessen, 119: 119-175.

The carbonate-sand dominated Lower and Upper Terebratel beds are important lithostratigraphic marker horizons of the Lower Muschelkalk in the western Germanic Basin. The are intercalated with bioturbated mudstones ("Wellenkalke"). The diverse faunal composition of the Terebratel beds indicated normal salinity; the "Wellenkalk" fauna is restricted to some species of trace fossils. The facies distribution of the Terebratel beds in the western part of the Hessian depression reflects a shallow carbonate ramp environment. This ramp can be subdivided into several subenvironments, each with characteristic lithologies and/or faunas.

LUKAS, V. and WENZEL, B., 1991. Pedogenese und Diagenese der Solling-Folge (Buntsandstein, Trias) in Nordosthessen. Geol. Jb. Hessen, 119: 103-117.

Pedogenetic sequences, carbonate nodules and -crusts (calcrete) are described from the Solling Sequence in NE Hessen (Germany). Their occurrence and formations are discussed.

MADER, D., 1992. Evolution of palaeoecology and palaeoenvironment of Permian and Triassic fluvial basins in Europe. 2 Vol., 1340 pp. Gustav Fischer, Stuttgart.

In this two volume book on the palaeoecology and palaeoenvironment of the Permian and Triassic of fluvial basins in Europe most attention is given to the Buntsandstein, although the Rotliegend and Keuper are treated as well. Several of the chapters are co-authored by other specialists, i.e. D. Laming, M. Lopez and G. Čatalov. The areas treated include South Devon and the Nottingham area (England), the Lodève area (France), the Holy Cross Mountains and the Upper Silesian Basin (Poland), the Eifel (Germany/Luxembourg), the Intrasudetic Basin (Poland/Czechoslovakia), the Teteven and Belogradčik Anticlinoria, the Iskar Valley, the Vitoša Mountains, the Petrohan and Trojan Pass, the Sviti Ilja Heights, the Milanova Plateau and the Miljane Anticline (Bulgaria). Eight megafacies are recognised throughout Europe. Lithogenetical facies associations, palaeoenvironmental, palaeoecological, palaeopedological, palaeoclimatological evolution and palaeoenvironmental, palaeoclimatological and palaeotectonical cyclicity are discussed.

MADER, D., 1992. Beiträge zur Paläoökologie und Paläoenvironment des Buntsandsteins sowie ausgewählte Bibliographie von Buntsandstein un Keuper in Thüringen, Franken und Umgebung. 628 pp. Gustav Fischer, Stuttgart.

This book deals with the palaeoecology and palaeoenvironment of the Buntsandstein, especially the Middle Buntsandstein in Thuringia and adjacent areas. The deposition of aeolian, fluviatile and lacustrine sediments is discussed. Several facies zones are distinguished. A silicified stem assigned to *Pleuromeia* is described and discussed in a chapter written together with G. Roselt. In the final chapter deals on the occurrence of the solitary bee *Collenites daviesanus* in the Buntsandstein. The book includes an extensive bibliography on the Buntsandstein in Thuringia, Franconia and adjacent areas.

MAGARITZ, M. and HOLSER, W.T., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): carbon and oxygen isotope variation. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 149-164.

A detailed profile of carbon isotopes in the Gartnerkofel core indicates the complexity of changes in the marine carbon cycle near the Permian/Triassic boundary.

MANGERUD, G. and RØMULD, A., 1991. Spathian-Anisian (Triassic) palynology at the Svalis Dome, southwestern Barents Sea. Rev. Palaeobot. Palynol., 70: 199-216.

Based on palynological and faunal evidence, two shallow cores from the Svalis Dome in the Barents Sea are interpreted to represent Upper Spathian to Middle Anisian deposits. The two palynological assemblages recognized, are correlated to assemblages M and L recorded in the Spathian-Anisian deposits of the Sassendalen Group in Svalbard. The palynofacies is characterized by high amorphous content up to the middle part of the Middle Anisian, where there is an increased input of wood, charcoal and more terrestrially dominated remains. This change in palynofacies can be related to a change from marine, dysoxic or anoxic conditions to a more oxygenated environ-

ment. A moderately humid climate is interpreted from a slight dominance of hygrophytic elements.

MARTIN, M., CUNY, G. and MAZIN, J.-M., 1991. Rostres de *Saurichthys* (Saurichthyiformes, Saurichthyidae) en trois dimensions dans le Trias moyen d'Israël. Geobios, 24: 183-186.

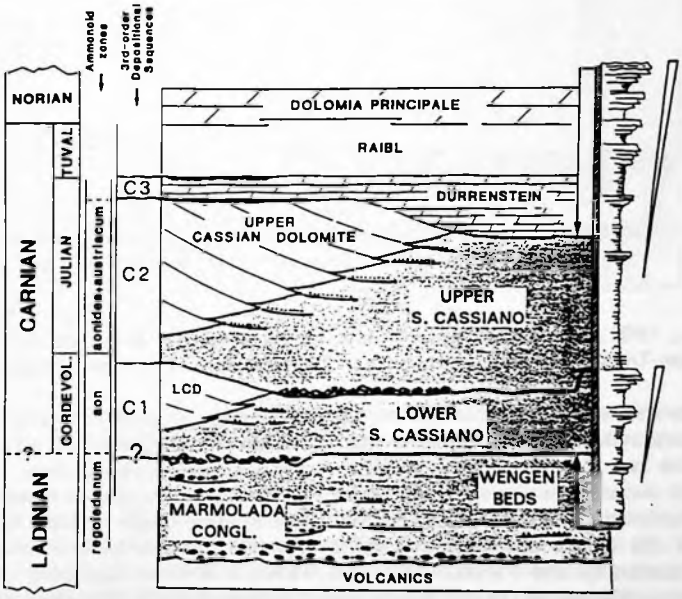
Two fragments of rostra of two very large specimens of *Saurichthys* sp. from the Middle Triassic of the Makhtech Ramon, Israel, are described.

MARTINI, R., ZANINETTI, L., ABATE, B., RENDA, P., DOUBINGER, J., RAUSCHER, R. and VRIELYNCK, B., 1991. Sédimentologie et biostratigraphie de la formation Triasique Mufara (Sicile occidentale): foraminifères, conodontes, palynomorphes. Riv. It. Paleont. Strat., 97(2): 131-152.

A sedimentological and micropalaeontological study of the Mufara Formation from NW Sicily. Conodonts and palynomorphs indicate a Carnian age (Tuvalian, excl. the top of the Tuvalian) of this series.

MASETI, D., NERI, C. and BOSELLINI, A., 1991. Deep-water asymmetric cycles and progradation of carbonate platforms governed by high-frequency eustatic oscillations (Triassic of the Dolomites, Italy). Geology, 19: 336-339.

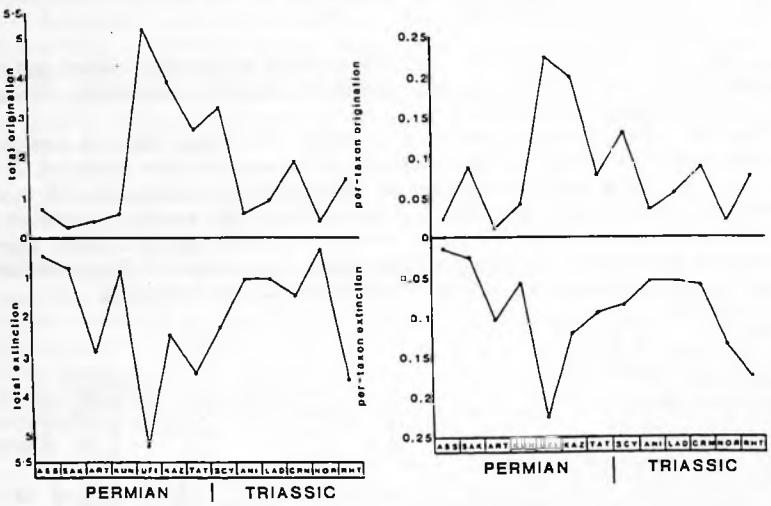
The basal San Cassiano Formation (Triassic, Dolomites, Italy) is interfingered with clinostratified megabreccia slope deposits of coeval carbonate platforms, and to a large extent is composed of metre-scale thickening coarsening-upward cycles. These asymmetrical cycles, often representing bundles of five coarsening-upward sequences, are interpreted as platform basin interactions governed by fourth- and fifth-order eustatic oscillations. According to this model, progradation of Triassic platforms of the Dolomites occurred mainly during fourth order see-level lowstands.



Carnian stratigraphy of the Dolomites (from Masetti et al., 1991)

MAXWELL, W.D., 1992. Permian and Early Triassic extinction of non-marine tetrapods. Palaeontology, 35: 571-583.

The non-marine tetrapods of the Permian and Early Triassic experienced significant episodes of extinction during a time of relatively high turnover at the family level. The Artinskian, Ufimian and Scythian extinctions appear genuine, but the Tatarian extinction is compromised by spurious data. The quality of the Tatarian data is considered in the light of the poor stratigraphical record for the Late Permian and Permian-Triassic boundary. Various extinction mechanisms are considered, bearing in mind that the radiation of the mammal-like reptiles forms a large portion of the diversity data. The most likely hypothesis is that non-marine tetrapods were subjected to environmental stress as climates fluctuated, at first in association with glaciation, and then with continental warming.

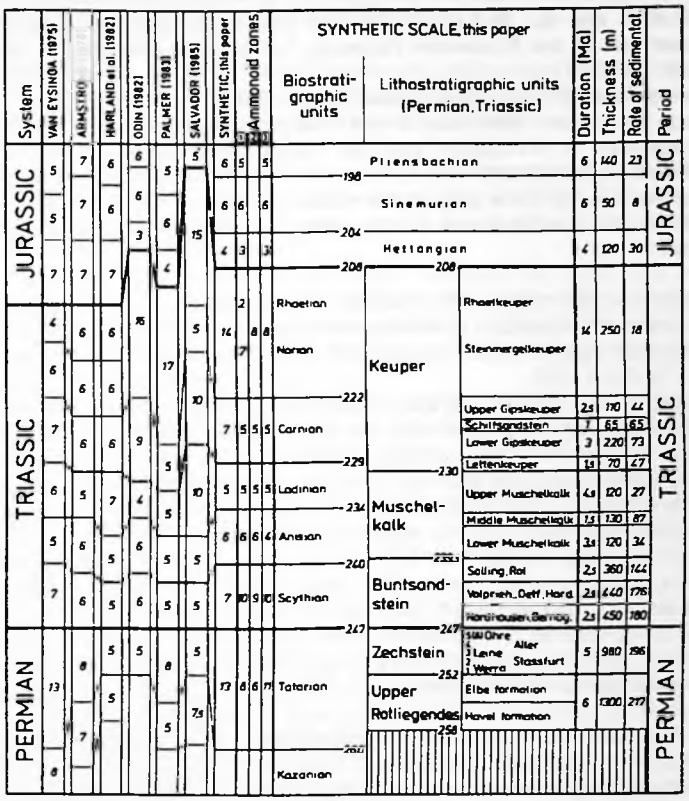


Total and per-taxon origination and extinction rate for all tetrapods during the Permian and Triassic (from Maxwell, 1992)

MENNING, M., 1991. Rapid subsidence in the Central European Basin during the initial development (Permian-Triassic boundary sequences, 258-240 Ma). Zbl. Geol. Paläont. Teil I, 4: 809-824.

With the aim to analyze the history of subsidence many authors combined relative accurate thickness with relative inaccurate time data. Therefore, a better time analysis is the key for more reliable results. A synopsis of numerical time scales shows that most uncertainties refer to the Upper Permian. The Tatarian is clearly underestimated. It includes 13-15 Ma instead of 5-8 Ma only. The Upper Triassic contains more time than the Lower and Middle Triassic together. On the base of magnetostratigraphic correlation in the Permian (MENNING, 1986) and biostratigraphic correlations in the Triassic (KOZUR, 1975) the duration of the Permotriassic lithostratigraphic units within the Central European Basin (CEB) is estimated. Upper Rotliegendes (6 Ma), Zechstein

(5 Ma), Buntsandstein (7.5 Ma) are much shorter than formerly supposed. Consequently, the rates of accumulation reach 140-220 m per million years, although they are not based on maximum thickness. During Muschelkalk, Keuper and Jurassic times the rates of subsidence decreased drastically. The time span of main subsidence sensu stricto started after a gap of about 20 Ma, caused by the Saalian tectonic movements.



① Permian KOZUR (1977), Triassic KOZUR (1975), Jurassic KÖLBEL (1968)
② ANDERSON (1981)
③ Permian NAKAZAWA et al. (1975), Triassic of North America TOZER (1984), Jurassic HARLAND et al. (1982)

The duration of uppermost Permian to lowermost Jurassic stages and Permotriassic lithostratigraphic units. Thicknesses and mean rates of sedimentation. (from Menning, 1991)

It is restricted to 258-240 Ma (Upper Rotliegendes-Buntsandstein). During this period approximately 50 % of all rocks were deposited, which are now in the CEB. In the following 240 Ma the remaining 50 % of sediments were accumulated. Perhaps, the stage of main subsidence s.s. finished already with the Hardegsen unconformity at the boundary of Middle and Upper Buntsandstein. This short and very intensive main subsi-

dence s.s. is a piece of crustal thinning and for taphrogenic or aborted riftogenic movements. Most valuable resources of the CEB (oil, natural gas, potash salt, copper shale) are concentrated in rocks deposited during a time span of not more than 10 Ma. That means rapid subsidence is one of the most important controlling factors of such resources there.

METWALLY, M.H.M. and ALI, M.S.M., 1992. The Triassic-Jurassic boundary in the Elphinstone Group, western part of the Musandam Peninsula, United Arab Emirates. N. Jb. Geol. Paläont. Mh., 1992 (5): 257-266.

The study of the macrofaunal assemblage of the Ghalilah Formation of the Elphinston Group (Musandam Peninsula, United Arab Emirates) allows to place the Triassic-Jurassic boundary at the horizon with the crinoid *Balanocrinus subteroides* Quenstedt, the echinoid *Scaptodiadema matheyi* Loriol and the ammonoid *Tragophylloceras numismale* Quenstedt in the basal part of the middle member of the formation. Within the Upper Triassic and the basal part of the Lower Jurassic, three biozones have been recognized.

MOLINA-GARZA, R.S., GEISSMAN, J.W., VAN DER VOO, R., LUCAS, S.G. and HAYDEN, S.N., 1991. Paleomagnetism of the Moenkopi and Chinle Formations in central New Mexico: implications for the North American apparent polar wander path and Triassic magnetostratigraphy. J. Geophys. Res., 96(B9): 14239-14262.

In central New Mexico, red sedimentary rocks unconformably overlying Permian carbonates have been correlated with the Early-Middle Triassic Moenkopi and Late Triassic Chinle Formations of the Colorado Plateau. This study deals on the paleomagnetism of these rocks. Paleomagnetic pole positions are given and the data from the Moenkopi and lowermost Chinle Formations plus previously published and additional results from the underlying Permian strata suggest that portions of New Mexico have experienced a small clockwise rotation (< 10°), similar to that of the Colorado Plateau with respect to the North American craton. The paleomagnetic directions of the Chinle Formation and related strata in eastern New Mexico document about 12° of rapid polar wander during mid-Carnian to late Norian times along a track which contains other cratonic poles of similar age. A preliminary magnetic polarity time scale for the Triassic, mostly from continental redbed series, is presented.

MONOSTORI, M., 1991. *Triadogigantocypris balatonica* n.g. n.sp.; a giant ostracode from the Hungarian Triassic. N. Jb. Geol. Paläont. Mh., 1991 (2): 91-96.

A 12 mm long ostracod carapace is described from the lower Ladinian (Reitzi Zone) of the Balaton Highlands, Hungary. Comparisons with extant forms suggest that this taxon was a Triassic Tethyan ancestor of recent giant ostracods.

MURPHY, N.J. and AINSWORTH, N.R., 1991. Stratigraphy of the Triassic, Lower Jurassic and Middle Jurassic (Aalenian) from the Fastnet Basin, offshore south-west Ireland. Marine and Petroleum Geol., 8: 417-429.

The stratigraphy of the Triassic, Lower Jurassic and Middle Jurassic (Aalenian) of the Fastnet Basin is described. The sequence has been divided using wireline log criteria. Six rock units are recognized in the Triassic and twelve in the Lower and Middle Jurassic. None of these major rock units shows any significant diachroneity. The ages of the Triassic units are mainly determined by correlation with dateable sequences in the North Celtic Sea Basin, whereas the Jurassic rock units yielded abundant short-ranging microfossils.

NICORA, A., 1992. Conodonts from the Lower Triassic sequence of Central Dolpo, Nepal. Riv. It. Paleont. Strat., 97(3-4): 239-268.

In the present paper, the conodont fauna from three detailed sections surveyed in the Lower Triassic sequence of Central Dolpo, Nepal (Tarap-Atali area) is illustrated. Combining faunas from the three sections, it was possible to recognize a succession of faunal events that covers most of the Scythian and the Lower Anisian. In the whole, eleven faunas have been recognized and discussed.

NIE ZETONG and LIANG DINGYI, 1991(?), Triassic ammonoids of the Ngari area. in: YANG ZUNJI and NIE ZETONG (Eds.), Paleontology of Ngari, Tibet (Xizang). Combined exploration of the Second Geological Party of Xizang. The China University Press, pp. 114-145.

OBENHOLZNER, J.A., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): petrography and geochemistry of an Anisian ash-flow tuff. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 37-52.

The drilling project Gartnerkofel-1 discovered between 30.0 and 34.5 m a layer of dacitic ash-flow tuff within a fluvial conglomerate sequence (Anisian Muschelkalk Conglomerate). The author has investigated this tuff petrographically and geochemically. The plate tectonic setting and the palaeoenvironment are discussed.

PAK, E. and HOLSER, W.T., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): sulphur isotopes. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 165-168.

A study of sulphur isotopes of the Gartnerkofel-1 core. It is concluded that the gypsum in the Werfen Formation is from oxidation of pyrite and not an evaporite sediment.

PERRI, M.C., 1991. Conodont biostratigraphy of the Werfen Formation (Lower Triassic), Southern Alps, Italy. Boll. Soc. Paleont. Ital., 30: 23-46.

Sections in the uppermost part of the Bellerophon and the lower part of the Werfen Formations near Bulla and Tesero have been investigated. *Neospathodus dieneri* is for the first time described from the Alps. Three worldwide conodont zones have been recognized: the *typicalis* Zone, the *isarca* Zone and the *Kummeli* Zone; three local zones are proposed: the *aequabilis* Zone, the *anceps* Zone and the *obliqua* Zone. On the basis of the conodont analysis the Tesero Horizon and the lower part of the Mazzin Member are lower Griesbachian, the upper part of the Mazzin Member is upper Griesbachian and the top of the Mazzin Member is post-Griesbachian, as the Triassic genus *Neospathodus* has its first occurrence at the base of the Nammalian.

PEYBERNÈS, B., MARTINI, R. and ZANINETTI, L., 1991. Les formaninifères benthiques du Trias carbonaté (Ladinien-?Carnien et Rhétien) de Corse. Geobios, 24: 683-696.

Three of the Triassic depositional sequences outcropping in Corsica, in the Balagne Autochton (Ladinian-?Carnian sequence at 228 Ma) and in the Prepiemontaise Zone (Lower Rhaetian (R1), at 225 Ma, and Upper Rhaetian Hettangian (R2) at 211 Ma, sequences) contains, particularly in their transgressive limestones, two benthic foraminifera associations which are well known on the future European margin of the Tethys. An analysis of these two associations is presented. They are compared with other north Tethyan assemblages and their palaeogeographical distribution and palaeoecology are discussed.

PIENKOWSKI, G., 1991. Facies criteria for delimitating Zechstein/Buntsandstein and Permian/Triassic boundaries in Poland. Zbl. Geol. Paläont. Teil I, 4: 893-912.

Detailed sedimentological/facies studies of cores obtained from eleven deep boreholes in the Polish Lowland have shown the stratigraphic, facies and palaeoenvironmental characteristics of the sediments from the Zechstein/Buntsandstein and the Permian/Triassic transition. The uppermost part of the Zechstein is composed of terrigenous deposits: in the central part of the basin they cover Zechstein evaporates with the depositional continuity, in the marginal part the gaps of non-sedimentation and erosion periods occur below the capping terrigenous deposits. Those terrigenous deposits show features of the continental red association. In the central part of Polish basin the playa deposits (mudstones with sulphate concretions) prevail, in the marginal parts sandy/muddy fluvial deposits of ephemeral type gradually replace the playa sediments. One may also observe some eolian sandstones. Coarse fluvial and eolian sediments tend to prograde toward the centre of the basin, which results in generally coarsening - upward megacycle. This sequence is overlain by brackish-marine/marine sediments deposited in a widespread shallow basin, where the wave processes dominated over other agents. This transgressive horizon has a great correlative significance, it may be traced even on continental areas, where fluvial regime was abruptly replaced by lacustrine regime due to the uprising of base level. This transgression may be correlated with the world-wide transgressive trend in the lowermost Triassic.

POOLE, E., 1991. Further discussion on the correlation of the Triassic-Jurassic boundary in England and Austria. J. Geol. Soc. London, 148: 943.

The author endorses Hallam's (1990, 1991) views on the position of the Triassic-Jurassic boundary. He argues for the inclusion of the Pre-*planorbis* beds of Great Britain in the Jurassic system and for rejecting the Cope committee proposals, which, in his view, would isolate Britain from the current North Sea and German classifications.

RENESTO, S., 1992. The anatomy and relationships of *Endennasaurus acutirostris* (Reptilia, Neodiapsida), from the Norian (Late Triassic) of Lombardy. Riv. It. Paleont. Strat., 97: 409-430.

A reinvestigation of the holotype and a study of and additional specimen of the skull of *Endennasaurus acutirostris* from the Norian Zorzino Limestone from the Bergamasc Alps.

ROČEK, Z., 1991. Ethmoidal endocranium in primitive Triassic amphibians. Paläont. Z., 65(3/4): 351-361.

Three-dimensionally preserved and chemically prepared skulls an natural casts of representatives of the families Benthosuchidae, Melosauridae and Capitosauridae yield data on the structure of the ethmoidal endocranium, i.e. those nosal cranial structures that consisted originally of cartilage.

ROSENFELD, U. and THIELE, I., 1992. Der Untere Muschelkalk am Nordrand der Rheinischen Masse: Fazies und Mächtigkeiten (Trias, NW-Deutschland). N. Jb. Geol. Paläont. Mh., 8: 487-512.

The Lower Muschelkalk (Middle Triassic) of the Osning hills (northern border of the Rhenish Massif) developed near the southern border of the Muschelkalk basin. It is characterized by reduced thickness and by facies variations of single parts of the succession. Paleogeographically the region is structured from southeast to northwest

by the northeastern rim of the Rhenish Massif, The Bielefeld Bay and the Hunte High, which all influence the facies and thickness of the succession in different manners in different times.

SADEDDIN, W. and KOZUR, H., 1992. Zum Alter und geographischen Verbreitung von *Theelia tubercula* Kristan-Tollman (Holothurien-Sklerit). N. Jb. Geol. Paläont. Mh., 1992 (5): 292-302.

Theelia tubercula has been regarded so far as an index species for the Cordevolian (Lower Carnian). This species was now found in Jordan in beds as old as Early Longobardian (lower part of the Late Ladinian). Its range is therefore Longobardian to Cordevolian. This enlarged stratigraphic range diminishes the stratigraphic importance of *T. tubercula*, but strengthens, in turn, its paleogeographic meaning as indicator for the Southern Tethys (and its marginal seas).

SADEDDIN, W. and KOZUR, H., 1992. *Pseudofurnishius siyalaensis* n. sp. (Conodonta) from the Lower Ladinian of Wadi Siyala (Jordan). N. Jb. Geol. Paläont. Mh., 1992 (6): 359-368.

Pseudofurnishius siyalaensis n.sp. links *Neogondolella* with *Pseudofurnishius* and is the immediate successor of *Neogondolella mostleri* (Kozur). Within *Pseudofurnishius* two phylomorphogenetic lineages are distinguished.

SADOVNIKOV, G.N., 1991. On some gymnosperms from the Late Triassic of north Iran. Palaeontological Journal, 1991 (4): 95-106. (in Russian)

Ctenophyllum, Ptilozamites and *Hsiangchiphyllum* are characterized by longitudinal folding of their leaflets. Some new species of these genera and *Pursongia* (?) are described.

SAMUEL, O., BUJNOVSKÝ, A. and SNOPKOVÁ, P., 1991. Litostratigrafické vyhodnotenie mezozoika zo štrukúrnych vrtov Závod-78, 88, 89 a Studienka-95 (Viedenská panva). Geologické práce, 93: 41-53.

A lithofacial and biostratigraphical study of the pre-Neogene from four wells in the Vienna Basin. In well Z-78 the Carnian, Ladinian and Anisian occur in a reverse succession. They are overlain by Middle and Upper Triassic. In the other wells Upper Carnian-Rhaetian, Norian, and Carnian-Norian sediments were encountered.

SANDER, P.M., 1992. The Norian *Plateosaurus* bonebeds of central Europe and their taphonomy. Palaeogeogr. Palaeoclimatol. Palaeoecol., 93: 255-299.

Plateosaurus is probably the single most common and most completely known dinosaur in the Late Triassic. This taxon is known from over 40 localities in the Norian Knollenmergel. Three localities which have yielded abundant material are compared to another in detail. The taphonomy of the skeletons is discussed.

SANDER, P.M. and MEYER, C., 1991. A labyrinthodont jaw fragment from the marine Triassic of the Alps. N. Jb. Geol. Paläont. Mh., 1991 (4): 222-232.

A fragment of a left lower jaw of a large labyrinthodont amphibian was recovered from the fully marine Partnach Formation (early Ladinian) of Austria. The specimen, which can be identified as a capitosaurid, probably pertaining to *Cyclosaurus*, is only the second labyrinthodont from clearly marine rocks of the Alps.

SCHMÖLLER, R., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): remarks on the natural gamma ray log and density log. In: W.T. HOLSER and H.P. SCHÖNLAUB

SCHMÖLLER, R., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): remarks on the natural gamma ray log and density log. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 209-212.

An interpretation of the geophysical logs from the Gartnerkofel-1 borehole.

SCHÖNLAUB, H.P., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): conodont biostratigraphy. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 79-98.

For the first time in the Permian/Triassic boundary beds of the Carnian Alps a sequence of highly significant conodonts has been recognized, in the Gartnerkofel-1 core as well as in the parallel outcrop section. More than 750 conodont elements have been found, 60% of them being identifiable at species level or assignable to as not yet fully determined multi-element apparatuses. Conodonts enable good age assessments of these dolomitic rocks in which ammonoids and other short-ranging fossils are absent.

SCHRAMM, J.-M., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): illite crystallinity in shaly sediments and its comparison with pre-Variscan sequences. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 69-78.

A study of the illite crystallinity of the core from the Gartnerkofel-1 borehole.

SCHUBERT, J.K. and BOTTJER, D.K., 1992. Early Triassic stromatolites as post-mass extinction disaster forms. Geology, 20: 883-886.

Aftermaths of mass extinctions have been thought to be characterized by relaxation of ecological constraints, accompanied by increased prominence of opportunistic generalists. Such taxa, termed "disaster forms", have been shown to increase dramatically in range and abundance after several mass extinction events. Regarding their occurrence and development in the Cambrian-Ordovician, it may be predicted that stromatolites might appear in normal-marine level-bottom sediments as disaster forms.in the aftermath of the mass extinction at the Permian-Triassic boundary. Mounded stromatolites, up to 1.5 m thick, are present in two beds of the Spathian Virgin Limestone Member of the Moenkopi Formation in Nevada. They have also been described from other Lower Triassic strata in North America, Europe and Asia. The may have developed in during the long aftermath of the Permian-Triassic mass extinction because of partial relaxation of the ecological constraints that typically restricted them from unstressed, subtidal, normal-marine, level-bottom environments.

SEIDEMANN, D.E., 1991. Comment on "U/Pb zircon and baddeleyite ages for the Palisades and Gettysburg sills of the northeastern United States: Implications for the age of Triassic/Jurassic boundary" with a reply by DUNNING, G.R. and HODYCH, J.P. Geology, 19: 766-767.

A discussion on the ages of the Palisades and Gettysburg sills in relation the age of the Triassic-Jurassic boundary. The first author argues that the ages of both sills would indicate a difference in the timing of igneous activity among the rift basins of the Newark Supergroup and that the estimates for the age of the Triassic-Jurassic boundary made in commonly used time scales are too old. The latter author reply that Palisades and Gettysburg sills are equally old and that the Triassic-Jurassic boundary would be slightly older.

SELDEN, P.A. and GALL, J.-C., 1992. A Triassic megalomorph spider from the northern Vosges, France. Palaeontology, 35: 211-235.

The oldest fossil megalomorph spider, from the Anisian Grès à Voltzia of the northern Vosges, France is described as *Rosamyale grauvogeli* gen. et sp. nov.

SESTINI, N.F., 1992. The Middle Triassic new genus *Praepinacoceras* (family Pinacoceratidae). Riv. It. Paleont. Strat., 97(3-4): 269-274.

The new genus *Praepinacoceras* (Ammonoidea) with *Pinacoceras damesi* Mojsisovics, 1882 as type species is here described. This genus is represented by Upper Anisian to Ladinian species. The new genus, because of its stratigraphic range and its morphology is herein regarded as the ancestral form of the fam. Pinacoceratidae.

SHANG YU-KE and LI YUAN-MEI, 1991. Upper Triassic sporo-pollen assemblages from Mosuohe river valley of Baoding, Sichuan. Acta Palaeont. Sinica, 30(3): 334-359. (in Chinese with English summary)

Palynomorphs from the Triassic coal series in the Baoding ares, SW Sichuan, China have been investigated. The assemblages from the Daqiaodi Formation indicate a Norian age. The lower member of the overlying Daqing Formation is dated as late Norian, whereas for a Rhaetian age is postulated for the upper member of this formation. During this time interval the climate changes from warm and humid to rather cool and dry. Twelve new species are described.

SMITH, A.B. and GALLEMÍ, J., 1991. Middle Triassic Holothurians from northern Spain. Palaeontology, 34: 49-76.

An abundant holothurian fauna is described from the Ladinian of Collbató, northern Spain. Three new genera and species are presented. Holothurians had clearly achieved considerable diversity by the Middle Triassic; at least four of the six currently recognized orders were established by this time. Holothurian were also ecologically diverse by the Middle Triassic with epibenthic deposit-feeding, infaunal, suspension-feeding species and epifaunal, attached, suspension-feeding species all represented.

SMOOT, J.P., 1991. Sedimentary facies and depositional environments of early Mesozoic Newark Supergroup basins, eastern North America. Palaeogeography, Palaeoclimatology, Palaeoecology, 84: 369-423.

The early Mesozoic Newark Supergroup consists of continental sedimentary rocks and basalt flows that occupy a NE-trending belt of elongate basins exposed in eastern North America. The basins were filled over a period of 30-40 m.y. spanning the Late Triassic to Early Jurassic, prior to the opening of the north Atlantic Ocean. The sedimentary rocks are here divided into four principal lithofacies. The different types of depositional environments are discussed. The presence of coal beds, eolian deposits and evaporites in different parts of the basin is interpreted in terms of paleoclimatology. The observed relationships suggest climatic variations across paleoaltitudes, more humid to the south where coal beds are preserved, and more arid in the north where evaporites and eolian deposits are common. Fluctuations in paleoclimate caused lake levels to rise and fall in hydrologically closed basins are preserved as lacustrine cycles of various scales, including major shifts in the Late Triassic from a wet Carnian to an arid Norian. In contrast, fluvial deposits were mainly formed in response to the tectonic evolution of the basins, but to some extent also reflect climatic changes. The Newark Supergroup illustrates the complexity of rift-basin sedimentation and the problems that may arise from using a single modern analog for sedimentary deposition

spanning millions of years. It also shows that a tremendous wealth of depositional, climatic and tectonic information is preserved in ancient rift-basin deposits which can be recovered if the depositional processes of modern rift-basin deposits are understood.

SNOW, J.K., ASMEROM, Y. and LUX, D.R., 1991. Permian-Triassic plutonism and tectonics, Death Valley region, California and Nevada. Geology, 19: 629-632.

Significant contractional structures that deform Permian rocks but predate an Early Triassic overlap sequence are recognized within the Cordilleran orogen, western United States. Thrusting in the Death Valley region of the orogen has conventionally been regarded as Middle Triassic or younger and thus kinematically distinct. The authors present new isotope age limits on two posttectonic stocks that intrude major structures of the Death Valley thrust belt. The stocks are no younger than Middle Triassic, but are likely Late Permian in age, consistent with stratigraphic and structural data suggesting that thrusting predates the overlap sequence.

SOBOLEV, E.S., 1991. Morphology, system and evolution of Clydonautilaceae (Nautiloidea). Palaeontological Journal, 1991 (4): 42-51. (in Russian)

The superfamily Clydonautilaceae is revised and raised to the rank of a suborder on the basis of the following morphological characters: highly differentiated suture, unique (within Nautilida) siphuncle with annular siphonal deposits and unusually small embryonic shell.

STATTEGGER, K., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): statistical analysis of the geochemical data. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 175-192.

A statistical analysis of the geochemical data from the Gartnerkofel-1 core which were obtained by various authors (Klein, 1991; Margaritz and Holser, 1991; Attrep et al., 1991).

STEUBER, T., 1992. Conodonten-Stratigraphie triadischer Ablagerungen am Golf von Korinth (Griechenland) und von der Halbinsel Karaburun (Türkei). N. Jb. Geol. Paläont. Mh., 1992 (3): 171-191.

In the Helikon and Kitheron Mountains (Greece), almost all Anisian substages could be recognized by means of conodont assemblages. However, index fossils for the Scythian have not yet been encountered. A volcanic event interrupted the pelagic sedimentation during the Pelsonian. Norian Lofer-type cyclothems are characteristic deposits in the Helicon Mountains. In the Kitheron Mountains, at the same time platy limestones accumulated which yielded several *Metapolygnathus* species, The oldest Triassic conodonts found in limestones from Karaburun (Turkey) are of Spathian age.

SWEET, W.C., 1992. A conodont-based high-resolution biostratigraphy for the Permo-Triassic boundary interval. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 120-133.

Strata in the Permo-Triassic boundary interval are conveniently divided into four conodont-based chronozones. The lower two of these zones (*Orientalis* and *Subcarinata*) make up the Dzhulfian Stage, whereas the upper two (*Changxingensis* and *Isarcica*) probably represent the Griesbachian Stage. The lower third of the latter, the

Changxingensis Zone, is coexistensive with the Dorashamian Stage of Transcaucasia, which is probably of too limited an extent to merit continued usage. The term Dorashamian, however, may be a better and more meaningful designation for this stratigraphic interval than "*Otoceras* beds", particularly because *Otoceras* is not known everywhere from strata in this stratigraphic position.

SWEET, W.C., YANG ZUNYI, DICKINS, J.M. and YIN HONGFU (Eds.), 1992. Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys. Cambridge University Press, 181 pp.

The final report of Project 203 of the International Geological Correlation Programme, which dealt with Permo-Triassic events of the East Tethys and their intercontinental correlation. This volume consists of sixteen contributions from forty authors:

- BROGLIO LORIGA, C. and CASSINIS, G.: The Permo-Triassic boundary in the Southern Alps (Italy) and in adjacent Periadratic regions.
- CASSINIS, G., TOUTIN-MORIN, N. and VIRGILI, C.: Permian and Triassic events in the continental domains of Mediterranean Europe.
- CHAI CHIFANG, ZHOU YAOQI, MAO XUEYING, MA SHULAN, MA JIANGUO, KONG PING and HE JINGWEN: Geochemical constraints on the Permo-Triassic boundary event in South China.
- DICKINS, J.M.: Permo-Triassic orogenic, paleoclimatic, and eustatic events and their implications for biotic alteration.
- DICKINS, J.M. and CAMPBELL, H.J.: Permo-Triassic boundary in Australia and New Zealand.
- DING MEIHUA: Conodont sequences in the Upper Permian and Lower Triassic of South China and the nature of conodont faunal changes and the systemic boundary.
- ESHET, Y.: The palynofloral succession and palynological events in the Permo-Triassic boundary interval in Israel.
- KAPOOR, H.M.: Permo-Triassic boundary of the Indian subcontinent and its intercontinental correlation.
- SWEET, W.C.: A conodont-based high-resolution biostratigraphy for the Permo-Triassic boundary interval.
- SWEET, W.C., YANG ZUNYI, DICKINS, J.M. and YIN HONGFU: Permo-Triassic events in the eastern Tethys - an overview.
- TIWARI, R.S. and VIJAYA: Permo-Triassic boundary on the Indian peninsula.
- XU GUIRONG and GRANT, R.E.: Permo-Triassic brachiopod successions and events in South China.
- YANG ZUNYI and LI ZISHUN: Permo-Triassic boundary relations in South China.
- YANG JIDUAN, QU LIFAN, ZHOU HUIQIN, CHENG ZHENGWU, ZHOU TONGSHUN, HOU JINGPENG, LI PEIXIAN, SUN SHUYING, WU SHANZU, LI DAIYUN and LONG JIARONG: Classification and correlation of nonmarine Permo-Triassic boundary in China.
- YIN HONGFU, HUANG SIJI, ZHANG KEXING, HANSEN, H.J., YANG FENGQUING, DING MEIHUA and BIE XIANMEI: The effects of volcanism on the Permo-Triassic mass extinction in South China.
- ZAKHAROV, Y.D.: The Permo-Triassic boundary in the southern and eastern USSR and its international correlation.

SWEET, W.C., YANG ZUNYI, DICKINS, J.M. and YIN HONGFU, 1992. Permo-Triassic events in the eastern Tethys - an overview. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 1-8.

The Permo-Triassic boundary interval, probably not much more than 500,000 years long, was marked in the Tethyan realm and worldwide by the culmination of a major marine regression, by widespread acid and intermediate volcanism, by a climate that was probably much warmer than now, and by the substantial reduction of biotic diversity, which was probably the result of influence on already stressed groups of organisms of a complex of climatic factors on land, chemical factors in the sea and greatly reduced areas of shallow-water-marine habitats. The work of participants of IGCP Project 203 on various aspects of the Permo-Triassic boundary interval permits the conclusion that not all animal groups were affected in the same way by the interaction of these factors. In short, the concept of a mass extinction at or near the end of the Permian may be a generalization based on a record too grossly organized to show the patterns of extinction recognized in various chapters of the book.

Taylor, P.D. and Michalík, J., 1991. Cyclostome bryozoans from the late Triassic (Rhaetian) of the West Carpathians, Czechoslovakia. N. Jb. Geol. Paläont. Abh., 182: 285-302.

Two species of tubuloporine cyclostome bryozoans are re-described using new material collected from the Rhaetian Hybe Beds of Hybe on the northern slopes of the Nízke Tatry Mountains. *Berenicia hybensis* Prantl is assigned to *Reptomultisparsa* and the second rarer bryozoan resembles *Stomatopora dichotomoides* (D'Orbigny). These two forms from Hybe are the only bryozoans thus far known from the Rhaetian.

Taylor, T.N. and Taylor, E.L. (Eds.), 1990. Antarctic paleobiology - Its role in the reconstruction of Gondwana. Springer Verlag, New York.

A volume with fifteen contributions on Antarctic paleobiology and a bibliography on Antarctic palaeobotany and palynology. The chapters dealing with Triassic paleobiology are: Depositional setting of Late Carboniferous to Triassic biota in the Antarctic Basin (J.W. Collinson), Gondwanan paleogeography and paleoclimatology (J.T. Parrish), The South Polar forest ecosystem (G.T. Creber), Triassic terrestrial vertebrate faunas of Antarctica (W.R. Hammer), Proterozoic and Paleozoic palynology of Antarctica: a review (G. Playford), Plant distribution in Gondwana during the Late Paleozoic (S. Archangelsky), Gondwana floras of India and Antarctica: a survey and appraisal (M.N. Bose, E.L. Taylor and T.N. Taylor), Structurally preserved Permian and Triassic floras from Antarctica (E.L. Taylor and T.N. Taylor), Permineralized *Glossopteris* and *Dicroidium* from Antarctica ((K.B. Pigg and T.N. Taylor), Comments on the role of Cycadophytes in Antarctic fossil floras (T. Delevoryas) and Antarctic and Gondwana conifers (R.A. Stockey).

Tintori, A., 1992. Fish taphonomy and Triassic anoxic basins from the Alps: a case history. Riv. It. Paleont. Strat., 97: 393-408.

Occurrences rich in vertebrates from the Middle and Upper Triassic of both the Northern and Southern Calcareous Alps have been studied. This study deals with classical and newly discovered localities. The high organic matter content and the preservation of fossil vertebrates have always been interpreted in terms of anoxic bottom conditions. The present study confirms this only for some cases. In other cases the isooriented and disarticulated, unimodally dispersed position of the vertebrate remains suggests light bioturbation and a disaerobic, rather than an anoxic environment.

TIWARI, R.S. and VIJAYA, 1992. Permo-Triassic boundary on the Indian peninsula. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 37-45.

A palynological study of the Gondwana sequence of peninsular India where there is no marine control for the Permo-Triassic boundary. In the Damodar Valley, Satpura, and Godavari Valley basins, the level of the Permo-Triassic boundary is definite. In other basins, however, information that permits approximation of the boundary has been recognized but further resolution is awaited.

VAN DER ZWAN, C.J. and SPAAK, P., 1992. Lower to Middle Triassic sequence stratigraphy and climatology of the Netherlands, a model. Palaeogeogr. Palaeoclimatol. Palaeoecol., 91: 277-290.

A reviewed and updated biostratigraphic framework for the Triassic of the Netherlands is presented. Five palynological zones and eight subzones are recognized. Northwest European palynological assemblages have been interpreted in terms of xerophytic and hygrophytic flora-elements, characterising dry and humid climatic conditions. The biostratigraphic zonation, the climatic fluctuations both in the Northwest European Basin and on the northwestern margin of the Tethys, and the cyclic lithostratigraphical development have been integrated. This leads to a climatological/sequence stratigraphic model for the Lower/Middle Triassic of the Netherlands. During the Late Scythian (Smithian-Early Spathian) monsoonal activity was responsible for the activation of an ephemeral drainage system on the northern side of the Central European Highland. Under the influence of sealevel highstands, the position of the monsoonal belt shifted northwards and the northward flowing drainage system was most active, leading to mass transport of erosional products from the highlands into the Germanic Basin. Based on a combination of biostratigraphic data and climatic events, the Lower Triassic sedimentary cycles in the Netherlands can be linked with the "standard" sequence stratigraphy and to "Milankovitch" orbitally forced cyclicity. For the marine Middle Triassic sediments a more direct link is envisaged.

VOLKHEIMER, W. and ZAVATTIERI, A.M., 1991. *Aratrisporites compositus* n.sp., a guide fossil from the Triassic Cuyo Basin, western Argentina. N. Jb. Geol. Paläont. Mh., 1991 (9): 564-578.

A new species of *Aratrisporites* is described from the Cuyo Basin, Argentina. The infraspecific variability and palaeoecology are discussed. The species is compared with other *Aratrisporites* species. At the present state of knowledge, the distribution of *Aratrisporites compositus* is limited to the Middle to Upper Triassic of southern South America.

WANG NAIWEN, 1991(?), Late Triassic radiolarians of the Northern Himalay subregion in the Ngari area. in: YANG ZUNJI and NIE ZETONG (Eds.), Paleontology of Ngari, Tibet (Xizang). Combined exploration of the Second Geological Party of Xizang. The China University Press, pp. 92-99.

WEINBERGER, G., 1992. A revision of the lithostratigraphic subdivision of the Triassic rock succession and its tectonic implications from the analysis of the Helez Deep Borehole, southern coastal plain, Israel. N. Jb. Geol. Paläont. Abh., 184: 141-154.

Three lithostratigraphic units of Triassic age are distinguished in the Helez Deep Borehole, viz. Unit CH (5767-5440 m), Unit BH (5440-5086 m) and Unit AH (5086-4812 m). Based upon sedimentological interpretation it is deduced that lithostrati-

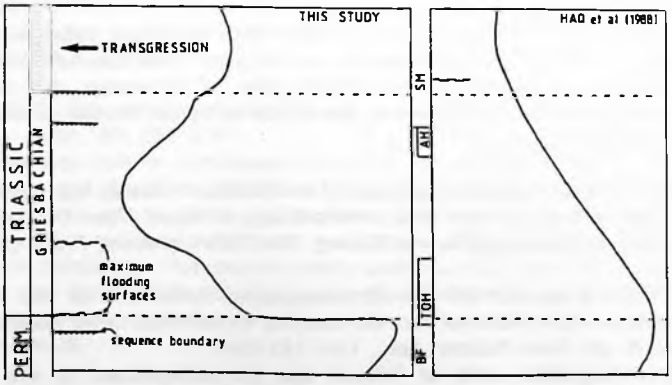
graphic unit CH was formed by a multi-stage depositional cycle. This occurred in a fault escarpment immediately after faulting of the Helez area during the late Anisian-Ladinian. Lithostratigraphic Unit BH reflects the main Triassic transgression. It was affected by oscillating periods of emergence and submergence probably induced by displacements along the postulated fault east of the Helez Deep Borehole and by slight and rare upward movements of the quartz porphyry intrusion. Lithostratigraphic Unit AH records subsidence of the Helez area during the Carnian.

Weitschat, W. and Bandel, K., 1991. Organic components in phragmacones of Boreal Triassic ammonoids: implications for ammonoid biology. Paläont. Z., 65(3/4): 269-303.

Extraordinary well-preserved ammonoids from the Boreal Triassic of Svalbard and NE Siberia are described, in which the original aragonite of the shell had been replaced by apatite during very early stages of diagenesis. Because of subsequent calcite sedimentation of the phragmacones, it is possible to dissolve the chamber contents. This allows three-dimensional observations at different ontogenetic stages. The new material leads to new conclusions concerning the functional morphology of the shell, especially related to questions of buoyancy, locomotion and mode of life.

Wiedmann, J., Kozur, H. and Kaya, O., 1992. Faunas and age significance of the pre-Jurassic turbidite-olistostrome unit in the western parts of Turkey. Newsl. Stratigr., 26(2/3): 133-144.

The pre-Jurassic turbidite-olistostrome unit of the western parts of Anatolia is characterized by large blocks of late Paleozoic platform-type limestones. In recent papers it is almost uniformly considered to be of late Paleozoic to Triassic ophiolite or tectonic melange. The turbidite-olistostrome unit (Dişkaya Fm.) consists of successions of thick sequences of shale, lithic sandstone-shale and quartzo-feldspathic sandstone, and a great variety of olistostromes containing the above rock types, reworked submarine mafic volcanics and pebbly mudstones as supporting matrix. The olistostromes contain extra- and intrabasinal blocks, sometimes of gigantic proportions, such as late Paleozoic and Triassic limestones, submarine volcanic rocks of unknown age, and *Halobia* shales. The Triassic blocks include cephalopod, ostracod and conodont faunas indicating late Scythian, middle Anisian and late Ladinian ages. The recognition of the early Norian *Halobia* shales in the lowermost as well as in the uppermost parts of the unit permits a closer age assignment to the late Triassic.



Interpreted eustatic sea level changes across the Permian-Triassic boundary bed (from Wignal and Hallam 1992)

WIGNALL, P.B. and HALLAM, A., 1992. Anoxia as a cause of the Permian/Triassic mass extinction: facies evidence from northern Italy and the western United States. Palaeogeogr. Palaeoclimatol. Palaeoecol., 93: 21-46.

Facies, faunal and geochemical evidence from the Permian/Triassic boundary sediments of the Dolomites and Idaho indicates a major anoxic event in the earliest Triassic. In both regions, the basal beds consist of finely laminated micrites with common syngenetic pyrite. The only fauna consists of occasional bedding plane assemblages of *Lingula* or *Claraia*, a typical lower dysaerobic assemblage. This is a level where previous studies have shown a major negative carbon isotope excursion and a cerium anomaly. In the Dolomites, the pyritic micrite overlies strata containing a diverse and typically Permian marine fauna of algae, foraminifers (including fusulinids) and articulate brachiopods, implying an abrupt extinction in contradiction to many previous views. Sequence stratigraphic analysis of the Dolomite boundary sediments reveals a minor sequence boundary in the Late Permian followed by an extremely rapid transgression leading to the development of the relatively deep water pyritic micrite - a maximum flooding surface at the Permian Triassic boundary. A further pulsed deepening in the lower Griesbachian, recorded in both the Dolomites and Idaho, lead to the widespread establishment of dysaerobic facies. It is clear that most of the extinctions occurred at the erathem boundary although the subsequent failure of the marine benthos to fill the empty ecospace in the ensuing Griesbachian may have been due to the widespread development of dysaerobic conditions.

WITTE, W.K., KENT, D.V. and OLSEN, P., 1991. Magnetostratigraphy and paleomagnetic poles from Late Triassic-earliest Jurassic strata of the Newark Basin. Geol. Soc. Amer. Bull., 103: 1648-1662.

A paleomagnetic study of a 7 km thick sedimentary sections from the Newark Basin (U.S.A.) which spans approximately 25 m.y. of the Late Triassic and earliest Jurassic (middle Carnian-Hettangian). This study complements earlier studies by the same authors. The Newark reversed and normal polarity characteristic magnetizations form a correlatable pattern of 12 magnetozones that are stratigraphically coherent throughout the basin with respect to independent lithostratigraphic marker units that reflect synchronous, basinwide variations in water depth. Temporal calibration of the Newark magnetostratigraphy on the basis of biostratigraphy, radiometric age determinations, and Milankovich-driven cyclostratigraphy indicates that geomagnetic polarity was reversed 70% of the time and that the mean polarity duration was 2 m.y. or less during the Late Triassic and earliest Jurassic.

WU TONG-YU, 1991. Conchostracan assemblage from bottom of Ermayin formation, Shaanxi. Acta Palaeont. Sinica, 30(5): 630-642. (in Chinese with English summary)

Some new conchostracans are described from the basal part of the Ermayin Formation near Changjiyan, Wupu County, Shaanxi, China. Similarities and differences with other faunas are discussed. The fauna is of an early Middle Triassic age.

XU GUIRONG and GRANT, R.E., 1992. Permo-Triassic brachiopod successions and events in South China. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 98-108.

A summary of the studies carried out on Permo-Triassic brachiopods collected from the boundary interval at 32 localities. A zonal scheme is proposed and correlations with others regions are discussed.

YANG JIDUAN, QU LIFAN, ZHOU HUIQIN, CHENG ZHENGWU, ZHOU TONGSHUN, HOU JINGPENG, LI PEIXIAN, SUN SHUYING, WU SHANZU, LI DAIYUN and LONG, JIARONG, 1992. Classification and correlation of nonmarine Permo-Triassic boundary in China. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 56-59.

A classification and correlation of the nonmarine boundary interval in China based on vertebrate faunas, palynomorphs, bivalves, ostracodes, plant megafossils, conchostracans and observed nonmarine changes.

YANG ZUNYI and LI ZISHUN, 1992. Permo-Triassic boundary relations in South China. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 9-20.

A study of the Permo-Triassic boundary relations in South China reveals that: (1) The great majority of Paleozoic marine invertebrates disappeared at, or somewhat below the top of the Changxingian, thus marking the end of the Paleozoic Era, (2) Among the Permo-Triassic boundaries proposed by different workers the traditional one is preferred by the authors for it is marked by mass extinction of the highest order, and (3) The ammonoid *Hyophiceras* and the conodont *Isarcicella? parva* may be used to replace *Otoceras* in defining the basal zone of the Triassic.

YIN HONGFU, 1991. Triassic Paleobiogeography of China. Saito Ho-on Kai Spec. Pub., 3: 403-421.

The paleobiogeography of the Triassic is discussed. Six realms are distinguished worldwide; the Lower-Middle Triassic of China is subdivided into four paleobiogeographic regions pertaining to three realms, viz. the Himalaya Region (Gondwana Realm, temperate), Cathaysian Tethys Region (Laurasian Tethys Realm, tropical-subtropical), Southern Mixed-biota Region (Central Laurasia Realm, warm temperate), and Northern Region (Central Laurasia Realm, temperate). They are further subdivided into ten provinces of which nine of them are subdivided in smaller units. The characteristics of each province are given. During the Triassic, owing to the widening of the tropical-subtropical climate zone and due to the geotectonic and climatic influences of the Circumpacific Belt, the Laurasian Tethys Realm was enlarged to include three regions: Himalaya, Cathaysian Tethys, and Pacific Tethys. The Himalaya Region became subtropical but retained many Gondwana features. The eastern part of the former Cathaysian Tethys was isolated, yielding warm Pacific faunas with affinities to those of Japan, and thus forming a new Pacific Tethys Region which extended northeastward to the Sino-Korean-Soviet borders. The two regions of the temperate Central Laurasia Realm remained essentially unchanged.

YIN HONGFU, 1992. Mesozoic and Cenozoic paleoclimate of China in view of paleobiogeography. Progress in Geology of China (1989-1992), Papers to 29th IGC, Geological Society of China, p. 287-290.

A brief overview of Mesozoic and Cenozoic palaeoclimates of China. Four climatic belts and three major climatic cycles are recognized.

YIN HONGFU, HUANG SIJI, ZHANG KEXING, HANSEN, H.J., YANG FENGQUING, DING MEIHUA and BIE XIANMEI, 1992. The effects of volcanism on the Permo-Triassic mass extinction in South China. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 146-157.

Clayrocks at the Permo-Triassic boundary in South China are mainly tuffaceous, blastotuffaceous, or volcanogenic rocks of other types. Mass extinctions in the boundary interval of phytoplankton, for example, may have been related to the volcanism, which may also have produced anomalies in the distribution of $\delta^{13}C$, Ir, and other elements. Frequent and widespread volcanic activity took place in China in the Late Permian and contributed to the formation of large-scale siliceous deposits. Environmental changes induced by Late Permian volcanism may have influenced the distribution and evolutionary development of fossil groups such as the ammonoids. Permo-Triassic volcanism was widespread, an intermediate to acidic volcanism was extensive in South China. Although the fact that extensive Perm-Triassic volcanism has not been reported from other parts of the world might be a major argument against extending the South China model worldwide, we suggest that because the primary effects on the biota would have been produced by dusting, overshadowing, and similar effects (rather than by the volcanism itself) intensity of volcanism would have been much more important than its ubiquity. In addition, clay beds are widespread all along the Eurasian margin of the margin of the Tethyan realm. Some might be volcanogenic, although their nature and origin needs further investigation.

YIN HONGFU and NIE ZETONG 1991(?), Triassic bivalves of the Ngari area. in: YANG ZUNJI and NIE ZETONG (Eds.), Paleontology of Ngari, Tibet (Xizang). Combined exploration of the Second Geological Party of Xizang. The China University Press, pp. 100-113.

Systematic descriptions of 27 taxa of Triassic bivalves, including one new genus and five new species. Full descriptions (including measurements) are given in Chinese with English translations of the diagnoses.

ZAKHAROV, Y.D., 1992. The Permo-Triassic boundary in the southern and eastern USSR and its international correlation. In: W.C. SWEET, YANG ZUNYI, J.M. DICKINS and YIN HONGFU, Permo-Triassic events in the eastern Tethys: stratigraphy, classification, and relations with the western Tethys, Cambridge University Press, p. 46-55.

Permian and Lower Triassic biostratigraphy of Transcaucasia, the North Caucasus, the southeastern Pamirs, the Mangyshlak peninsula and South Primorye are discussed. The author favours the traditional point of view of placing the Permo-Triassic boundary at the base of the *Otoceras* beds.

ZEISSL, W. and MAURITSCH, H.J., 1991. The Permian-Triassic of the Gartnerkofel-1 core (Carnic Alps, Austria): magnetostratigraphy. In: W.T. HOLSER and H.P. SCHÖNLAUB (Eds.), The Permian-Triassic boundary in the Carnic Alps of Austria (Gartnerkofel region). Abh. Geol. B.-A., 45: 193-208.

A paleomagnetic study of 594 samples from the Upper Permian and Lower Triassic of the Gartnerkofel-1 borehole. Due to overprinting, neither of the paleomagnetic profiles provided a believable Permian-Triassic reversal stratigraphy.

ZHANG SHUN-XIN and GUO XIAO-QUIANG, 1991. Statistical analysis on the relationship of Early Triassic conodonts with depositional environments and other fossil groups. Acta Micropal. Sinica, 8(3): 301-307. (in Chinese with English summary)

The authors present a statistical analysis of Dienerian-Spathian depositional environments, conodonts, ammonites and bivalves in order to test the independency of these fossil groups in the same environments.

ZHAO XI-WEN and ZHANG KE-XIN, 1991. Triassic conodonts from the Ngari area, Xizang (Tibet), China. Acta Micropal. Sinica, 8(4): 433-440. (in Chinese with English summary)

This paper deals on conodonts collected from the Zanda, Burang and Ngari areas of Xizang (Tibet). The formations from which the material is described have Dienerian, Smithian-Spathian, Anisian and Norian ages.

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.

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