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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: Ophiceras tibeticum *Griesbach*
(from: C. Diener, Himalayan fossils Vol. II(1): The cephalopoda of the Lower Trias, 1897)

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30th INTERNATIONAL GEOLOGICAL CONGRESS

(Beijing, China, August 4-14, 1996)

General Assembly of our Subcommission and of the Permian-Triassic Boundary Working Group: Tuesday, August 6th, 1996, 19.00-22.00, room A9, CWTC.

Colloquium on Stratigraphy: session 1.1 Progress in Stratigraphy

Symposium 1-7. The Permian/Triassic boundary and global Triassic correlations including IGCP 359) [ICS]; Convenors: Lucas, S.G. (U.S.A.); Yin Hongfu (H.F.) (China)

Symposium 1-11. Carboniferous to Permian Tethys evolution: palaeogeography, palaeoceanography and palaeogeodynamics
Convenors: Vai, G.B. (Italy); Yin Hongfu (H.F.) (China)

During-congress Workshop WB18. The Shallow Tethys
(Sunday morning, 11 August 1996)
Convenors: Yin Hongfu (H.F.): School of Geosciences, China University of Geosciences, Yujiashan, Wuhan, Hubei, 430074, P.R. China, Fax: 86 27 7801763.
McKenzie, K.Z. (Australia): 'Yugen' P.O.Box 759, Wagga Wagga, 2650, New South Wales, Australia.

Field Trip T326. Stratigraphy and palaeontology of the Nanjing Hills and its adjacent areas (Thursday, 15 August through Friday, 23 August) is related to Symposium 1-7. A one day visit to the Permian-Triassic boundary at Meishan section, Changxing, Zhejiang Province will be arranged during the trip.

The workshop WB18, The Shallow Tethys, will discuss all aspects of the shallow facies of the Tethys from Palaeozoic to Pleistocene, which comprises much of its geological record. The contents will be multidisciplinary, e.g., palaeontology, stratigraphy, sedimentology, palaeogeography, palaeoclimatology, tectonics, and energy and mineral resources. It will also include connections between the shallow and deep Tethys, as well as correlations with the Boreal and circum-Pacific, or Panthalassa. No cost for participation.

If you have not received the Second Circular containing registration forms and description of all congress events, a copy may be obtained by writing to: **30th IGC, P.O. Box 823, Beijing 100037,** P.R. China (Fax: 86-10-8328928)

REPORTS OF SHALLOW TETHYS 4

International Symposium

(Suppl. vol. 11/1995, Annali dei Musei Civici di Rovereto)

Editors: G. BRAGA, F. FINOTTI and G. PICCOLI, 1996, about 460 pp., 148 figs., 18 pls.

This special volume of the Annali dei Musei Civici di Rovereto contains most of the papers presented at the International Symposium "Shallows Tethys 4" held in Albrechtsberg, Austria, 8-11 September 1994. Sixty participants attended the Symposium, organized by the University of Vienna, Institut für Geologie und Paläontologie. The Shallow Thethys Symposia started in 1982 in Padova (Italy), followed by the sessions in Wagga Wagga (NS.W. Australia) in 1986 and Sendai (Japan) in 1990. The last one is that in Austria. Shallow Tethys Symposia are held every 4 years. They are a regular occasion in which the members of the group present the result of a larger part of the researches in paleobiogeography, oceanography, climatology, biogeography. The title of the Shallow Tethys Symposia reflects the aim of the group to establish a fruitful link between paleontological and geological research in the Tethys realm. This is supported by the assumption that the paleobiogeographic knowledge and research represent basic premises for increasing the interpretative potential of paleogeography and related tectonic causes. Analogous attention is paid to developing the interaction with sedimentological research. The present volume contains 28 contributions by scholars of many countries dealing with Tethys evolution and its faunal and floral assemblages through the geological time. The volume will be dedicated to Prof. Edith Kristan Tollmann, convenor of the Symposium who died before her time on the 25th August 1995.

papers in this volume relevant for Triassic stratigraphy

BIZZARINI, E: Stratigraphic distribution of the microfossils in St. Cassian Formation (Upper Triassic) between Badia and Ampezzo valley (Dolomites-Italy).

GIADROSSI TAMARO, L. & SARTORI, S.: Mathematical model of brachiopod and benthic mollusc spreading in the Tethyan Permo-Triassic.

HAAS, J., KOVÁCS, S. & TORÖK, A.: Early Alpine shelf evolution in the Hungarian segments of the Tethys margin.

PRONINA, G.P. & VUKS, V.J.: New data on the Triassic foraminifers of Crimea.

SUDIRO, P.: Sea-level control on carbonate platforms derived calcarenites in proximal basinal areas - examples from the Middle Triassic of Tethys (Dolomites, Northern Italy).

TAMURA, M.: Upper Triassic Tethyan bivalves from Japan and trigonian Bioprovinces.

TARUNA, M.F.: The faunal sequence of land, sea and sky predators around Tethys since the Triassic up to the Recent.

VUKS, V.J.: Late Triassic foraminifers of Caucasus and Pamir.

YIN, H.: Triassic events of East Asia.

ZAKHAROV, Y.D.: The Induan-Olenekian boundary in the Tethys and boreal realm.

This book can be ordered from:
Museo Civico di Rovereto, Borgo S. Caterina n.43, 38068 Rovereto (TN), Italia;
Price: lit. 150.000; US $ 100.
Methods of payment: - postal cheque (only for Italy)
- credit on postal account n. 315382 headed to: Comune di Rovereto - Servizio Tesoreria
- international money order or postal order headed to: Museo Civico di Rovereto (address above)

BOREAL LOWER TRIASSIC MAGNETOSTRATIGRAPHY FROM DELTADALEN, CENTRAL SVALBARD

Mark W. Hounslow, Atle Mørk, Clare Peters and Wolfgang Weitschat

Introduction

Interpreting events recorded in Triassic sedimentary sequences, in terms of their tectonic, climatic, or oceanographic significance relies upon methods which allow the widescale correlation of sedimentary horizons. Sequence stratigraphy and high resolution biostratigraphy are the standard tools for constructing a framework on which such environmental effects can be interpreted. Magnetostratigraphy also has a significant part to play in determining correlations throughout the Triassic, because it has a potential resolution of better than 0.5Ma, and is not limited by depositional environment. In recent years progress has been made in calibrating the sequence of reverse and normal polarity magnetozones against detailed conodont and ammonoid biostratigraphic zonations, both in the Boreal and Tethyan areas (Ogg and Steiner, 1991; Gallet et al., 1993; Heller et al., 1995; Muttoni et al., 1995), although much work still needs to be performed to allow inter-comparison of Boreal and Tethyan biostratigraphic dating schemes. Triassic sequences around the Arctic Ocean (Sverdrup Basin, Siberia and the Barents Sea region) potentially provide a high resolution biostratigraphy, based mainly on ammonoids (Dagys and Weitschat, 1993). The Svalbard sequences provide the outcropping reference sections for the Triassic of the Barents Sea region (Mørk et al., 1982, 1989, 1992, 1994; van Veen et al., 1992; Fig. 1). To assess the suitability of the Svalbard sequences for determining a Triassic magnetostratigraphy we collected a set of palaeomagnetic samples from central Svalbard during 1995.

The Svalbard Triassic

Countries which have signed the Svalbard Treaty have equal rights to exploration and exploitation work on the Svalbard archipelago, which has resulted in parallel multinational nomenclatures by western and Russian scientists. At present a revision of the lithostratigraphy of Svalbard, including higher rank subdivisions of the entire Barents Shelf, including Svalbard, is being undertaken by the Committee on the Stratigraphy of Svalbard, with A. Mørk responsible for the Triassic. The present committee is multinational and has members from all disciplines working in the area, and a revised lithostratigraphy will soon be presented for the whole region.

The Lower and Middle Triassic on Svalbard is essentially polarised into a western and an eastern province, with different lithostratigraphic units (Mørk et al., 1982). The western province is predominantly a sand-siltstone dominated, near-shore, delta/prodelta sequence. Within the eastern province the sequences represent mudstone dominated shelf sediments, and are divisible into the Deltadalen, Sticky Keep and Botneheia members which span the Lower and Middle Triassic (Fig. 1). Major transgressive sequences mark the base of the Deltadalen, Sticky Keep and Botneheia members, which can be correlated throughout the Boreal Triassic (Mørk et al., 1989, 1994; Mørk, 1994).

The candidate for the new stratotype for the eastern development of the Lower Triassic succession of Svalbard is the Deltadalen-Vikinghøgda sections which are described in the present study. A total of 289 palaeomagnetic samples was collected through the Deltadalen and Sticky Keep

Members, along the Deltadalen River, and adjacent sections on the flank of Vikinghøgda. We also sampled the top most few metres of the Permian, Kapp Starostin Formation, and the base of the Botneheia Member. In combination with the magnetostratigraphy, the Induan and Olenekian sequence stratigraphy and biostratigraphy of these sequences were also re-evaluated.

The Kapp Starostin Formation in Deltadalen is composed of glauconitic sandstones, with chert horizons. The Deltadalen Member is characterised by three transgressive-regressive cycles (T-R sequences, D1 to D3). Each of these is a coarsening-up sequence, which is terminated by the transgressive unit of the overlying sequence. The transgressive part of each of these T-R sequences is a shale unit, sometimes with carbonate concretionary horizons, which passes up into a shale dominated sequence with upwards-increasing abundance of laminated and wave-rippled marine siltstones. *Otoceras boreale* was found near the base of the Deltadalen D1 sequence, although Dienerian ammonoid zones *Proptychites rosenkrantzi* and *Vavilovites sverdrupi* are known from other localities in the Deltadalen Member (Weitschat and Dagys, 1989; Fig. 1).

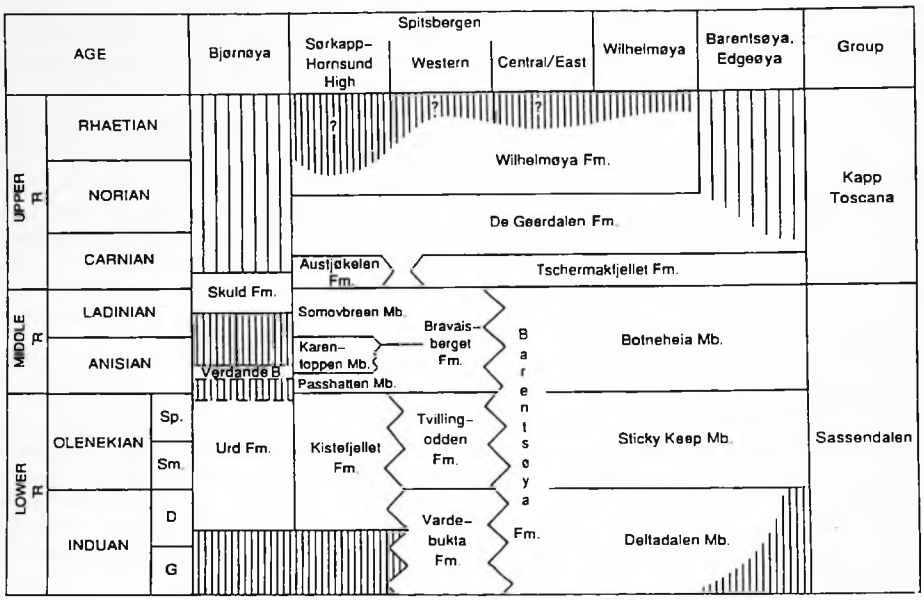

Fig. 1. Lithostratigraphic units on the Svalbard archipelago (Mørk et al. 1992).

The Sticky Keep Member is composed of three T-R sequences (S1 to S3). The lowest, S1 sequence has well developed septarian concretions in the lower part, and non-septarian concretions throughout, passing upwards into well developed carbonate cemented siltstones. The top of the S1 sequence has the first evidence of the arctoceratid fauna characteristic of the lower Smithian and typically found in the base of the Sticky Keep throughout Svalbard (Weitschat and Lehman, 1978; Weitschat and Dagys, 1989). The S2 sequence is predominantly organic-rich shales with frequent calcite concretions, capped by a thin regressive sandstone horizon. Within the base of the S2 sequence *Euflemingites romunderi* was found within carbonate concretions, and *Wasachites tardus* in the upper-most part of S2.

The S3 sequence is shale dominated with characteristic yellow weathering dolomitic concretionary horizons present throughout. The base of the S3 sequence is characterised by a distinctive transgressive black shale, which can be traced around the base of Vikinghøgda. Crushed ammonoids found 45m from the base of S3, indicate the "Grippia Niveau" horizon which is indicative of the *Keyserlingites subrobustus* Zone on Svalbard (Weitschat and Dagys, 1989). Lower Spathian ammonoid zones are not known from Svalbard, although the basinal setting of central Svalbard during the Lower Triassic probably indicates the Deltadalen sequence should be stratigraphically complete.

Svalbard Lower Triassic Magnetozones

Sampling for magnetostratigraphy was performed at an average horizon spacing of 1.7m for the Deltadalen Member and Smithian Sticky Keep member (average 5m spacing for S3 sequence), with 2 to 4 samples per horizon. The basal transgressive shale units in T-R sequences D1, D3 and S3 could not be adequately sampled at the required density due to the absence of non-fractured lithologies. The Deltadalen Member D1 sequence is dominantly normal polarity, with thin reversed polarity intervals just above and below the occurrence of *O. boreale* (Fig. 2). Sequences D2, D3 and S3 are a mix of normal and reversed polarity, with reversed polarity dominating. The S2 and S3 sequences are dominated by normal polarity.

The 4 horizons sampled from the Kapp Starostin Formation dominantly show reversed polarity, with a single normal polarity horizon. This is compatible with the mixed polarity of the uppermost (Changxingian) Permian (Heller et al., 1995) .The long normal polarity in the D1 sequence is the GN1 magnetozone of Ogg and Steiner (1991), and has been identified in sequences in China (Steiner et al., 1979; Haag and Heller, 1991), and the Siberian traps, and characterises the lowermost Griesbachian. In addition, within GN1 short reversed polarity magnetozones have been found in the Siberian traps (Gurevitch et al., 1995) and in China (Haag and Heller, 1991), which are likely to correlate to the short reversed intervals at 5-10m height in the D1 cycle.

The topmost part of D1 until the base of S2 is dominantly reversed polarity with short normal magnetozones. The overall reversed character of this interval is the same as the mid Griesbachian to lower-most Smithian polarity sequence of Ogg and Steiner (1991). This age assignment is compatible with the interval in the Deltadalen sequence which is bounded by the occurrence of *O. boreale* and *E. romunderi* (Fig. 2). The detailed correlation between Svalbard and the Sverdrup stratotype sequence is based on the magnetozones and the suggested correlative nature of sequence boundaries between Svalbard and the Sverdrup sequences (Mørk et al., 1989; Mørk, 1994). This study has more magnetozones over this interval than that of Ogg and Steiner (1991), mainly due our closer sample spacing, and the greater confidence in the magnetozones because of more than one sample per horizon. We correlate the following between the Deltadalen section and the polarity sequence of Ogg and Steiner (1991):

a) the transgressive surface of D2 with a similar event in the *O. commune* Zone from Sverdrup.
b) normal magnetozones in D2 with GN2,
c) normal magnetozone in D3 with DN1 in the Sverdrup,
d) basal transgressive surface of S1 with the transgressive surface of the Smith Creek Member in the Sverdrup,
e) thick normal polarity magnetozone in S1 with SMN1,
f) thick normal magnetozone of S2 with SMN2.

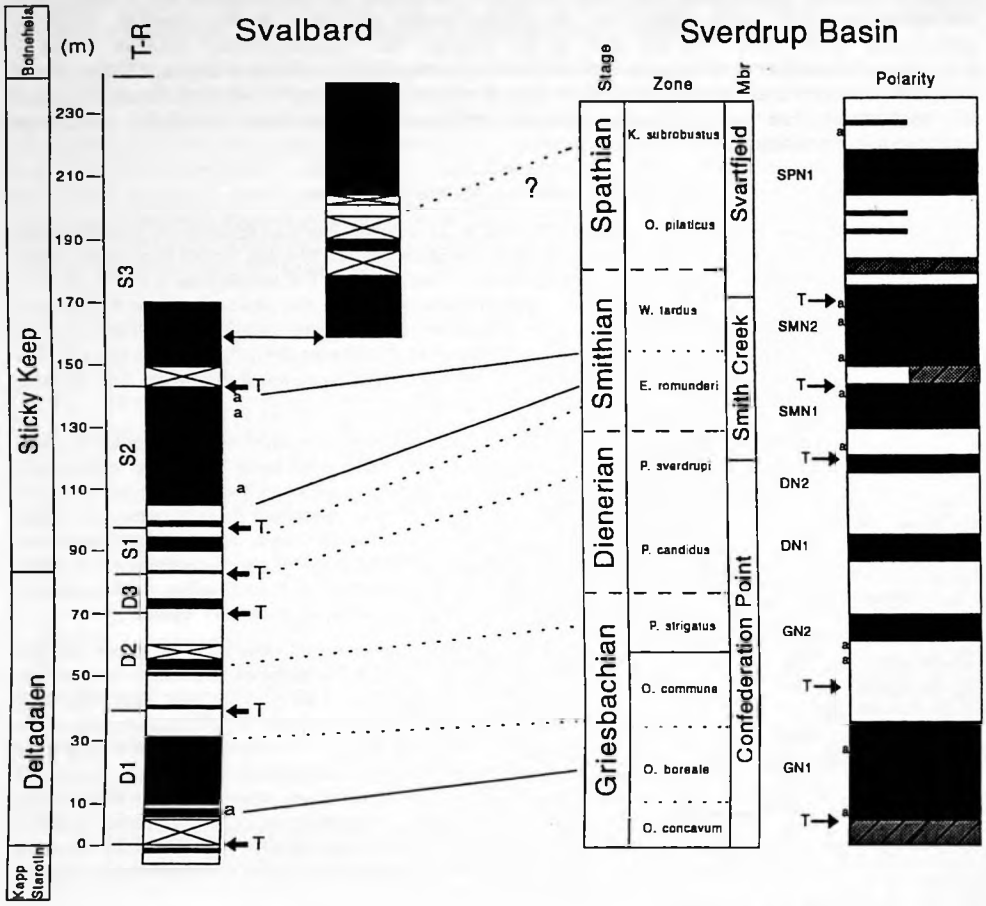

Fig. 2. Summary of the magnetostratigraphy of the Deltadalen sections, and its correlation to the sequence from the Sverdrup basin of Ogg and Steiner (1991). The transgressive-regressive sequences (T-R) are indicated in the Deltadalen sequence. T marks the beginning of transgressive shale sequences in both the Svalbard and Sverdrup sequences. Ammonoid control points in both sequences are indicated with 'a'. Normal magnetozones are black, and reverse magnetozones white. Sampling gaps are indicated by X, and unknown polarity by diagonal shading. Magnetozones derived from a single sample are indicated with a bar of half width. The ammonoid zones and normal magnetozone naming sequence is after Ogg and Steiner (1991).

The Smithian which has the best ammonoid control on Svalbard, is dominantly of normal polarity in both the Deltadalen section and in the Sverdrup Basin. However, the magnetozones in the basal parts of the Sticky Keep and Smith Creek Members are different in detail, perhaps because of our higher sampling density. The lowermost Smithian zone *Hedenstroemia hedenstroemi* (Dagys and Weitschat, 1993) was not identified in the sections examined by Ogg and Steiner (1991), neither is it found on Svalbard. Evaluation of the magnetostratigraphy of an ammonoid bearing section covering the lower Smithian late Dienerian transition would clarify the magnetozones over this interval, and their correlation to the biostratigraphic and sequence stratigraphic boundaries.

The base of the Svartfjeld Member in the Canadian Arctic, is equivalent to the transgressive sequence starting at 143m height in the Sticky Keep Member. This event has been widely recognised in the Boreal Triassic, but not before in the Sticky Keep Member (Mørk, 1994).
The dominance of normal polarity in the S3 sequence, compared to reverse polarity in the Spathian of Sverdrup is likely due to two reasons. a) The topmost part of the Spathian is probably missing from the sections studied by Ogg and Steiner (1991), as suggested by Muttoni et al. (1995). These later authors have found the uppermost Spathian in the Chios section (Greece) to be of normal polarity. b) The transgressive part of S3 is probably condensed compared to the upper transgressive part, because wells in the Barents Sea have a condensed lower Spathian (Mørk et al., 1989; van Veen et al., 1992). Samples from the base of the Botneheia Member possess normal polarity, which is consistent with other studies of the basal mid Triassic (Muttoni et al., 1995).

Lower Triassic Geomagnetic Polarity Sequence

The close similarity of the Svalbard and Sverdrup Basin magnetozones allows a composite magnetic polarity sequence to be constructed which also utilises the study of Muttoni et al. (1995) for the upper most Spathian (Fig. 3). The magnetozones have been numbered into reversed-normal polarity couplets, in much the same way as marine magnetic anomalies are referenced (Cande and Kent, 1992). Kent et al. (1995) has suggested a similar scheme for the upper Triassic. This scheme allows easy magnetozone identification, and can be further refined by later studies, which may provide better age resolution. The prefix, I, O and A refer to the dominance of Induan, Olenekian or Anisian age respectively of the couplet. Using such a scheme the magnetozone I2n in the *P. strigatus* Zone is composed of sub-magnetozones in descending order I2n.n1, I2n.r1 and I2n.n2. For completeness the lower most Anisian magnetozone (A1) is also labelled.

Whilst this and other studies have clarified the general sequence of magnetozones through the Lower Triassic, there are number of parts of Figure 3 which are poorly constrained with biostratigraphic age control.

a) What is the nature of the Permian/Triassic transition- does the base of I1n terminate at the ammonoid defined base of the Triassic. Perhaps magnetostratigraphy could help in defining this important boundary.

b) Ammonoid age control for the Dienerian and lower most Smithian magnetozones is poor, so placement of magnetozones relative to ammonoid zone boundaries is speculative, over this interval. A polarity sequence measured through horizons bearing *H. hedenstroemi*, and the Siberian upper Dienerian ammonoid zones (Dagys and Weitschat, 1993), would aid in clarifying the late Dienerian, early Smithian polarity sequence. For this reason, we have used the ammonoid zones presented by Ogg and Steiner (1991) in Fig. 3, which are similar in resolution to the Svalbard zones (Dagys and Weitschat, 1993).

c) The Spathian (and O2n.1n) magnetozones are poorly constrained by the biostratigraphy both on Svalbard and in the Sverdrup Basin. Study of the considerably superior Siberian Spathian sequences is likely to improve this part of the geomagnetic polarity sequence.

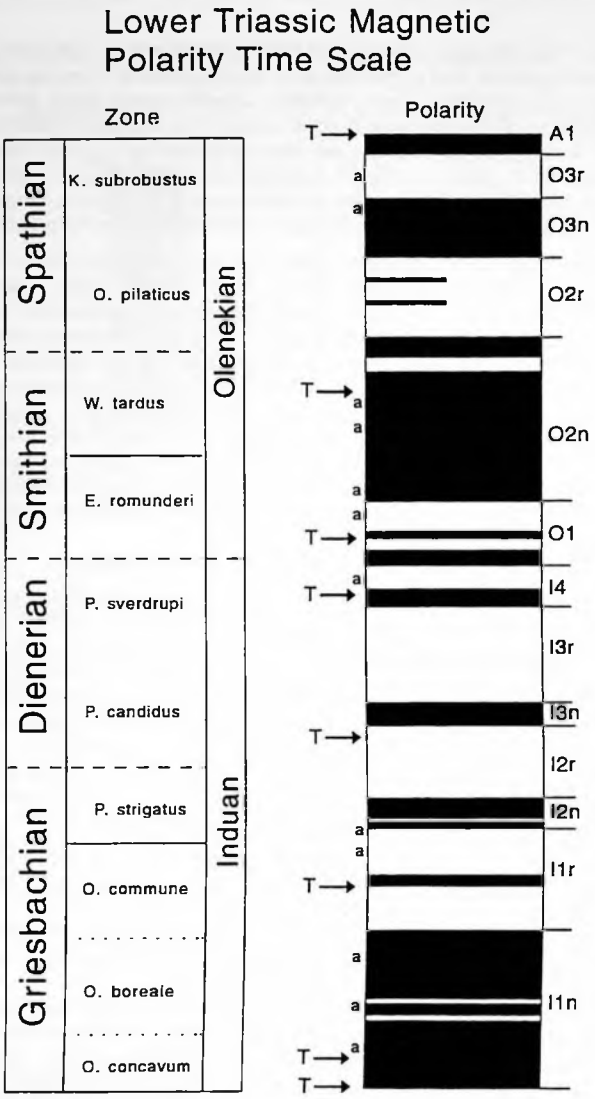

Fig. 3. Composite magnetic polarity time scale (with numbering scheme) based on this study, Ogg and Steiner (1991) and Muttoni et al. (1995). Ammonoid zones represent the biostratigraphic resolution available to the magnetostratigraphic studies. T marks the beginning of transgressive sequences on Svalbard or the Sverdrup Basin. Ammonoid control points are indicated with 'a'.

Various carbonate sequences from China and non-marine sequences in the western USA have a poorly dated magnetostratigraphy (Steiner et al., 1993; Heller et al., 1995). It is has proven difficult to correlate in detail the magnetostratigraphy in such areas with the Boreal clastic sequences (Muttoni et al., 1995). This may partly be due to undetected hiatuses in the carbonates and non-marine sequences, or large differences in sedimentation rate, due to the different nature of regressive and transgressive sequences in basinal, marginal marine and non-marine sequences. Better integration of sequence stratigraphy with magnetostratigraphy and biostratigraphy may aid high resolution stratigraphic studies in the future, and help to resolve these problems.

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LOWERMOST TRIASSIC AMMONOID AND CONODONT BIOSTRATIGRAPHY OF SPITI, INDIA

L. Krystyn and M.J. Orchard

Introduction

For more than a century the *Otoceras* beds of the Himalayas have been regarded as representing the earliest Triassic ammonoids. Their fauna has originally been described from two regions, the Shashal Cliff in Gharwal (Diener 1897) and the Pin river area (Muth, Guling, Lilang) in Spiti (Krafft & Diener 1909; Diener 1912). In the meantime additional locations have been added in Kashmir (Bando 1981), Nepal (Waterhouse 1994) and Southern Tibet (Wang & He, 1978; Orchard et al. 1994). *Otoceras* is now known to occur also outside the Himalayas from Siberia to Canada. Arctic and Himalayan *Otoceras* species are however different as are the associated ammonites. It is therefore still difficult to assess exact correlatives between the Arctic and Himalayan *Otoceras* bearing beds, an issue widely neglected in the recent P/T boundary discussion (see Dagys 1994). To contribute new data to this question we have started a survey of the *Otoceras* beds in Spiti and present the first results from four sections measured and sampled in detail for both ammonites and conodonts. These sections are Muth and Guling (also known as Kuling) in the Pin valley, Lingti (= formerly Lilang) at the confluence of Spiti and Lingti rivers and Lalung in the Lingti valley (fig. 1). All together about 200 ammonites have been collected bed by bed and about 15.000 conodont elements have been recovered from 20 conodont samples. Each sample has been split and the two sets have been dissolved separately, one in Vancouver and the other one in Vienna.

Geology (L.K.)

As in many parts of the Himalayas the Lower Triassic beds in Spiti follow unconformably above rocks of Upper Permian age. The latter are black shales with subordinate layers of brachiopod bearing siltstones named Kuling shales or Kungri Formation (Garzanti et al. 1995). They are dated as Djulfian by the rare occurrence of the ammonoid *Cyclolobus* (Bhatt et al. 1980). Youngest Permian Changshingian (Doroshamian resp.) equivalents must be completely missing because the Kuling shales are directly overlain by the brownish highly fossiliferous silty limestone band of the *Otoceras* beds. The P/T boundary is thus easily recognizable in the field by the drastic lithologic change and is marked by an undulating surface. At least local erosion and local redeposition of lithoclasts from the Kuling shales into thin pebble layers at the base of the Triassic sequence have occurred as for example recorded from Lingti by Bhatt et al. (1980).

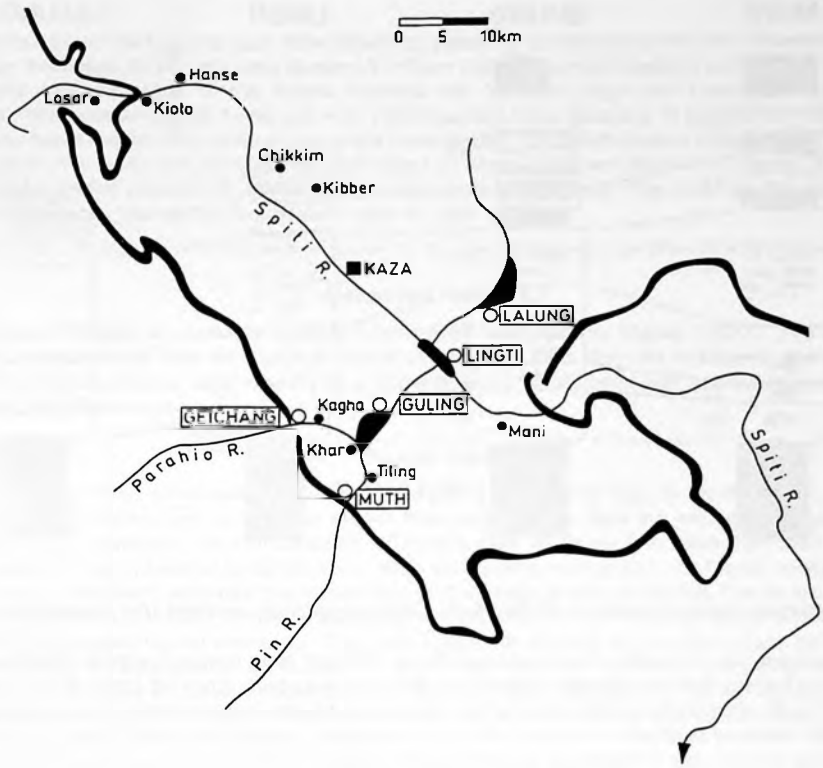

Fig. 1: Distribution of the Otoceras *beds as basal member of the Tamba Kurkur Fm. (in black) in Spiti with location of sudied sections.*

The brownish and more recessive limestone band of the *Otoceras* beds though it is commonly not thicker than half a meter, forms a distinct "mini-cliff" above the black soft weathering Kuling shales. It is therefore well visible even from a distance but it is often covered by talus from the overlying more shaly *Hedenstroemia* beds and may then be easily overlooked. This could be the reason why Garzanti et al. (1995) report a complete absence of the *Otoceras* beds in the upper Pin valley. If correct, their observation would be very important as it could be used to explain the Spiti co-occurrence of *Otoceras* and *Ophiceras* by local reworking and heterochronous redeposition of older members of the fauna of the *Otoceras* beds into younger levels. We could solve the problem by tracing the *Otoceras* beds throughout Spiti along 2 transects, one from Lhossar in the NW to Po in the SE along basin strike, the other one from Muth and Geichang in the SW to Lalung in the NE perpendicular to strike (see fig. 1). From our field evidence over an area of more than 1.500 km^2 we come to the conclusion, contrary to Garzanti et al. (1995) that the Spiti *Otoceras* beds build a very uniform and non-diachronous lithostratigraphic unit which begins in all sections in the same stratigraphic interval.

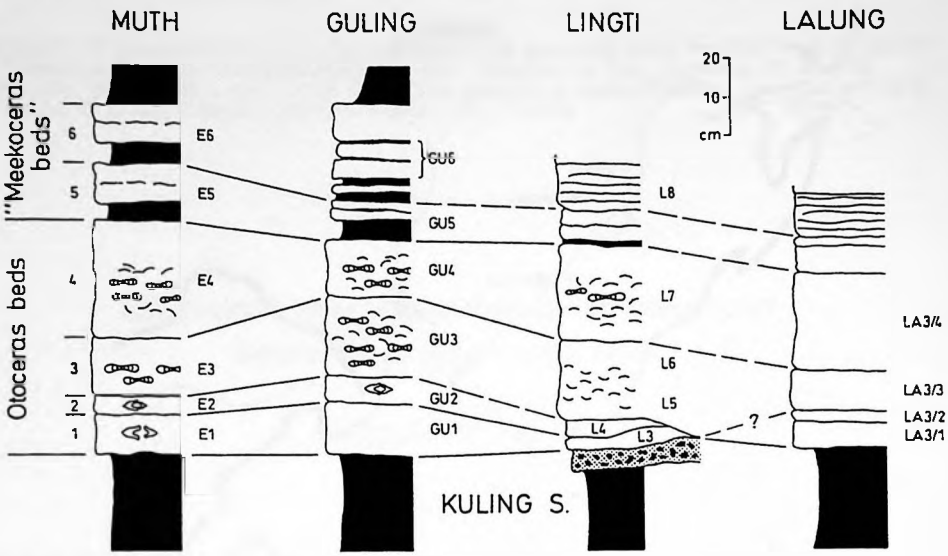

Fig. 2: Lithostratigraphic correlation of the Muth, Guling and Lingti sections (for location see fig. 1).

The documented 30 km (with tectonic correction > 45 km) long transect across the Spiti basin from Muth to Lalung shows a general thinning of the *Otoceras* beds from 60 cm in Muth to 45 cm in Lalung (fig. 2). This trend continues in other Lower and Middle Triassic lithic units. Explanations could be the reduced sediment transport and accumulation towards the inner shelf (i.e. towards NE) or a plate-tectonically (?) induced general south vergent tilting of the basin floor. Independent from its cause the trend is a useful guide for the outcrop search as the stratigraphically most complete sections should be located on the southwestern side of the Spiti-synclinorium where Muth and Geichang are the easiest accessible places.
Lithostratigraphically the four documented sections (fig. 2) can be divided into the *Otoceras* beds s.str. (part A, beds 1-4) and an overlying package B (beds 5-6) named as *Meekoceras* beds by Krafft & Diener (1909) and Diener (1912). Before the introduction of this subdivision the faunas of both parts were combined under the term *Otoceras* beds and formed together the basis for the definition of the Gangetian stage by Waagen & Diener (1895).

The lower part (A) forms a laterally very similar set of 4 limestone beds of grey, brownish weathering colour. The individual thicknesses of the beds are changing from section to section but the overall bed sequence seems to be constant leading to the adopted lithostratigraphic correlation (fig. 2). The lowermost bed is, if well weathered, indicated by its more reddish colour and a softer, less calcareous and more silty composition. It is a lithoclastic packstone with abundant semi-rounded lithoclasts of black mudstone and very frequent fragments of brachiopod shells and rare bryozoans. Though not determinable they are interpreted as reworked Permian fossils because the overlying parts of the *Otoceras* beds are devoid of both groups. Bed 1 is unfortunately very poor in ammonites and has still to be resampled. The microfacies of beds 2 to 4 is similar, forming bioclastic wacke- to packstones with thick accumulations of mostly broken ammonoid shells. Thin mudstone layers are sometimes developed at the base or top of the beds.

The lithology of part B changes from place to place. It is composed of thin limestone beds of variable thickness (3-10 cm) with distinct 5-10 cm thin shale intercalations as in Muth and Guling. With the disappearance of the shales towards the NE (i.e. Lingti and Lalung), the limestones become compact and build no longer well individualized beds because of an internal stratification. The two types exhibit also differences in the microfacies. The Muth/Guling type is made up of mud- to wackestones with thin tempestitic shell layers of ammonites and bivalves (*Claraia*) whereas the Lingti/Lalung type consists of ammonoid rich bioclastic packstones. The latter are lithologically and facially similar to the underlying beds of part A.

Field work of L. Krystyn has been financially supported by the Austrian National Committee for IGCP (Project-359).

Ammonoid data (L.K.)

Lowermost Triassic ammonoids were first described from Spiti by Diener (1897). The bulk of the fauna was published later by Krafft & Diener (1909) although they did not figure any specimens from the *Otoceras* beds. Later reports (e.g. Bhatt & Arora 1984) gave only general remarks without figuring any ammonites.

Present results

The new ammonoid subdivision as well as ammonoid sequences (fig. 3) are based on collections obtained from Guling and to a lesser extent from Muth. Rare data are added from Lingti where dolomitisation hampers the extractability of fossils and no fauna has been collected in Lalung. Correlation of the individual beds between Muth and Guling is based on the faunal content (except GU-1 which is barren) whereas the integration of the Lingti beds is tentative due to the small data set. Ammonoid subdivision in the Griesbachian is preliminary with double-named zones based on the most important faunal elements. The term Dienerian is used as no other stage definition has ever referred to equivalents of levels 5-6 (e.g. Nammalian). However, regarding the original intention of Waagen & Diener in Mojsisovics (1895), all levels together (1-6) would best represent their Gangetian stage. Numbers in parenthesis behind species names in the following paragraphs refer to the number of collected specimens.

Zone of *Otoceras woodwardi* - *Ophiceras bandoi*

The zone contains 3 levels of which the lowest certainly needs resampling as it has produced only a meagre fauna of *O. woodwardi* (2) and *O. bandoi* (1) in the Muth section. Level 2 is poor in Muth with just one specimen of *O. woodwardi* but in Guling it is much richer with *O. woodwardi* (12) and *O. bandoi* (13). The latter species has been introduced based on relatively poor material from Nepal (Waterhouse 1994) but is readily identifiable in the Spiti collections by its flat flanks and wide umbilicus. Level 3 is the richest of the zone both in Muth (bed E-3) and Guling (GU-3) where a further local subdivision may be possible. It contains *O. woodwardi* (M: 1, G: 9), *O. bandoi* (M: 6, G: 15), a single specimen of *Ophiceras* cf. *tibeticum* from Guling (which could also be an extreme variante of *O. bandoi* with a little more triangular cross-section), and *Ophiceras* n.sp. 1 (M: 1, G: 12). The last mentioned species is an evolute form with thick whorls, a well rounded venter and widely spaced blunt ribs similar to the holotype of *Ophiceras greenlandicum* Spath. There are about 30 additional specifically unidentified *Ophiceras* in the Guling collection whereas in Lingti only one *O.* cf. *bandoi* could be extracted.

All 25 *Otoceras* specimens have been studied for their suture line and show an identical sequence of single undivided umbilical (= auxiliary) lobes. This feature is seen as a distinct specific mark of *O. woodwardi* and its close allies (or subjective synonyms) *O. parbati* Diener, 1897, *O. clivei* Diener, 1897, *O. undatum* Griesbach, 1880 and *Metotoceras dieneri* Spath, 1930.

	level	SPITI zone	MUTH	GULING	LINGTI	CANADA
DIENERIAN	6	*Pleurogyronites planidorsatus*	*P.planidorsatus* *S.ellipticum* *Proptychites* n. sp.1. *Kymatites* sp. E6	*P.planidorsatus* *S.ellipticum* *A. cf.lilangensis* *Proptychites* sp. GU6	*Proptychites* sp. L8	*Proptychites candidus*
	5		*Meekophiceras* ? sp. E5	*Pleurogyronites* ? sp. *M. ?varaha* *Proptychites* ? sp. *Kymatites* sp. GU5	———	
GRIESBACHIAN	4	*Ophiceras tibeticum* + *Discophiceras* cf. *wordiei*	*D. cf.wordiei* *O.sakuntula* *O.tibeticum* E4	*Bukkenites* sp. *D. cf.wordiei* *O.sakuntula* *O.tibeticum* *O. cf.bandoi* GU4	*O. cf.tibeticum* L7	*Bukkenites strigatus* *Ophiceras commune*
	3	*Otoceras woodwardi* + *Ophiceras bandoi*	*O. cf.tibeticum* *O.bandoi* *Ophiceras* n. sp. 1 *O.woodwardi* E3	*O.bandoi* *Ophiceras* n. sp. 1 *O.woodwardi* GU3	*O. cf.bandoi* L5-L6	
	2		*O.woodwardi* E2	*O.bandoi* *O.woodwardi* GU2	——— L4	?
	1		*O.bandoi* *O.woodwardi* E1	——— GU1	——— L3	

Fig. 3: Griesbachian to Lower Dienerian ammonoid zonation and faunas of the Muth, Guling and Lingti sections.

Zone of *Ophiceras tibeticum* - *Discophiceras* cf. *wordiei*

The zone corresponds to level 4 which is restricted to one bed (Muth: E-4, Guling: GU-4) but has produced the richest fauna of the whole succession. Guling especially has produced more than 100 partly well preserved ophiceratid ammonites of at least 3 different *Ophiceras* species beside one more ophiceratid of the genus *Discophiceras* until now unknown from the Himalayas. The fauna consists of rare *O.* cf. *bandoi* (G: 4) together with common *O. tibeticum* (M: 2, G: 12), *O. sakuntula* (M: 4, G: 23) and *D.* cf. *wordiei* (N: 1, G: 21). In addition, there are rare new forms of which one has a *Placites*-like cross section with an open narrow umbilicus and an *Ophiceras*- like suture line (M: 2, G: 6). From the top of bed GU-4 a single *Bukkenites* sp. has been collected with only one side preserved. It looks like a "subsolutionsrelikt" and is close to *B. strigatus* but less evolute, the suture line is identical. The preservation of this ammonite as well as phyletic considerations (*D.* cf. *wordiei* as stratigraphic successor of *O. sakuntula*, see also Tozer 1994) could indicate stratigraphic condensation in level 4.

Pleurogyronites planidorsatus Zone

Presently two levels are distinguished within this newly introduced interval - a lower, level 5 where *Pleurogyronites* seems to be rare and an upper level where the species is common. As the fauna of level 5 is to date meagre this differentiation may not be important. Additional faunal elements in level 5 are at Guling *Meekophiceras*? *varaha* (Diener), *Proptychites*? sp., and *Kymatites* sp. in GU-5 and at Muth, *Meekophiceras*? sp. in E-5. Level 6 is much richer in ammonites both in Muth and Guling and contains *P. planidorsatus* (Diener) (E-6, GU-6) *Shevyrevoceras ellipticum* (Diener) (E-6, GU-6), *Ambites* cf. *lilangensis* (Krafft) (GU-6), *Proptychites* n. sp. 1 (E-6, GU-6), *Proptychites* sp. (L-8), and *Kymatites* sp. (E-6, GU-6). A larger part of Krafft & Diener's *Meekoceras* beds fauna from Lilang and Ensa could have been derived from level 6 as it is the richest fossil horizon in this particular region.

The fauna of the interval lacks true *Ophiceras* completely. It is dominated by forms with a fastigiate venter typical for gyronitids and is therefore placed above the Griesbachian into the basal Dienerian stage. First true representatives of *Gyronites* occur 2 m higher up in bed E-10 of the Muth section. Further collecting is therefore needed to establish the full range of the new zone in Spiti.

Correlations

Detailed correlations without a careful review and description of the fauna seem premature. As a consequence, the following discussion is centred on literature data which either strengthen, complete or contradict the Spiti data.

Salt Range: Two *Ophiceras* horizons are known in the basal Triassic Kathwai member (Kummel 1970) - 1) a lower one in the dolomite unit with *O. connectens* Schindewolf (see Kummel 1970, pl. 1, fig. 2) which is close to *O. bandoi* and is thought to represent zone 1 of the Spiti succession and 2) an upper one in the limestone unit with ophiceratids very close to *O. sakuntula* (op. cit., pl. 1, fig. 3, 5) as well as *Discophiceras* (op. cit., pl. 1, fig. 4, 6-9) indicating a correlation with zone 2 of Spiti. Guex (1978) reports a third questionable Griesbachian level at the base of the "Lower Ceratite Limestone" with *Hypophiceras plicosum* and *Lytophiceras* sp. ind. Judging from the illustrations in Guex (1978), *H. plicosum* could be a *Pleurogyronites* and *Lytophiceras* sp. ind. a questionable *Meekophiceras* sp. In this case they would indicate a *planidorsatus* age and therefore the lower Dienerian.

Kashmir: Bando (1981) describes from member E2 of the Khunamuh formation of the Guryul Ravine section the co-occurrence of *Otoceras woodwardi* and *Ophiceras* (*Lytophiceras*) *sakuntula*. Some of the latter (op. cit., pl. 17, fig 1, pl. 18. fig. 2) are clearly different because of their more evolute whorls, another (op. cit., pl. 16, fig. 5) comes relatively close to *O. sakuntula* but has been identified with the new species *Ophiceras nakazawai* by Waterhouse (1994). Their emendations avoid a faunal overlap of the two species in Kashmir.

Shashal: *O. woodwardi*, *O. sakuntula* and *O. tibeticum* co-occur in a single 20 cm thick bed which most probably is stratigraphically strongly condensed. Another report of the combined occurrence of the fore-mentioned species 1 m higher in the section (Diener 1912) is not confirmed in the original documentation (Diener 1895).

Nepal: In the Manang area Waterhouse (1994) has subdivided a 130 cm thick equivalent of our Spiti sequence into 5 horizons. His data look very interesting but are difficult to interpret. Compared with Spiti, the horizons would represent an mixing of zones 1 to 3 because distinct members of zone 3 (*Bernhardites*, *Shevyrevoceras*, *Pseudoprotychites*) appear right at the base together with *O. woodwardi*. Similarly, *Ophiceras* coexists still in the topmost level with *Gyronites*, *Ambites* and *Kymatites*. Condensation (or inappropriate sampling ?) renders these records unreliable.

Tibet: The Selong section is very important because it documents the successive appearance of 1) *O. latilobatum*, 2) *O. woodwardi* and 3) *O. tibeticum* (cf. ORCHARD et al. 1994, fig. 4). *Otoceras latilobatum* is described by WANG & HE (1976, fig. 5) to have a suture line with well intended auxiliary lobes and is interpreted here as a junior subjective synonym of *O. fissisellatum* Diener. Horizon 2 should correlate with levels 1-3 and horizon 3 with level 4 of the Spiti succession.

Canada (Arctic): In his latest account, Tozer (1994) distinguishes from the base of the Triassic to the lower Dienerian 5 zones, in ascending order the *concavum, boreale, commune, strigatus* (all Griesbachian) and the *candidus* Zone. Of these, the *concavum* Zone is missing in Spiti and probably elsewhere in the Tethys. The *boreale* Zone might be coeval to the *latilobatum* Zone based on the overall sutural and shell similarity of the corresponding *Otoceras* species. It is seemingly also missing in Spiti but should be present in Selong (see above). Within the *commune* Zone, Tozer (1994: 22) describes a successive sequence of ophiceratid ammonites with *O. greenlandicum* at the base and *Discophiceras wordiei* near the top of the zone. Because of the close morphological relationship of *O. greenlandicum* with *Ophiceras* n. sp. 1 from level 3 and the presence of *Discophiceras* cf. *wordiei* in level 4 these 2 Spiti horizons are interpreted as distinct correlatives of the *commune* Zone. By the presence of *Bukkenites*, level 4 could however also include equivalents of the *strigatus* Zone, a situation explained by stratigraphic condensation. Identification of the *planidorsatus* Zone (levels 5 + 6) with the *candidus* Zone is tentative but has firm grounds in the simultaneous appearance of *Pleurogyronites* and other gyronitid genera in both regions.

Conodont data (M.O.)

Changshingian conodonts have been reported from Griesbachian strata of Spiti (Bhatt et al., 1981; Bhatt & Arora, 1984) and Selong, Tibet (Yao & Li, 1987; Wang et al., 1989). These reports have contributed to the view that the Changshingian and Griesbachian stages are in part correlative. A different interpretation of Griesbachian conodont fauna has been presented by Orchard (in Orchard et al., 1994), who described the conodonts of the *Otoceras latilobatum* bed at Selong and contrasted them with those from the Changshing Limestone at Meishan, China. In the current study, conodonts from the *Otoceras*-bearing beds of Spiti are re-assessed.

Conodonts from *Otoceras*-bearing strata in the Kumuan, Spiti River, and Zanskar sections of the Himalayan region were previously identified as *Neogondolella subcarinata, N. changxingensis, N. carinata, N. orientalis, N. planata, N. deflecta* subspp., *N. behnkeni* and *N.* sp. A (Bhatt & Arora, 1984, p. 724), apparently a mixture of typical Permian elements and others originally described from the Griesbachian. Recently, Garzanti et al. (1995) have also illustrated Griesbachian conodonts from Spiti. They recognize several of the species regarded as typical Griesbachian forms by Orchard et al. (1994), namely *Neogondolella carinata, N. taylorae*, and *N. tulongensis*.

Present results

A total of 12,000 conodont elements were recovered from Griesbachian strata at four Spiti sections: Muth, Guling, Lingti, and Lalung. All collections are dominated by *Neogondolella* pectiniform elements [85%], with fewer *Hindeodus-Isarcicella* [<4%] and ramiform [<12%] elements. In common with the *Otoceras latilobatum* bed in Selong (comparable numbers: [68%], [19%], [13%]), the conodont faunas represent a relatively deep-water, more offshore biofacies compared with the shallow-water *Hindeodus* (+*Isarcicella*) biofacies (see Orchard, in press), examples of which characterize the Tesero Oolite and Werfen Formation of the European Alps (Schonlaub, 1991). As is the case at Selong (Orchard et al., 1994), the zonal indices of *Isarcicella* (including *I. parva*) constitute only 0.5% of the pelagic fauna of the Spiti Griesbachian.

Level	MUTH	GULING	LINGTI	LALUNG
6	*N. kummeli* E6	*N. kummeli* GU6	*N. kummeli* L8	———
5	——— E5	*H. typicalis* *N.* aff. *taylorae* *N.* aff. *taylorae* *N. carinata* *N.* n. sp. D *N.* n. sp. E GU5	———	———
4	*N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* *N. planata* *N. nevadensis* *N.* n. sp. D E4	*N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* *N. planata* *N.* n. sp. D GU4	*N.* n. sp. A *N. meishanensis* *N. carinata* *N.* n. sp. D L7	*N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* *N. planata* *N.* n. sp. D LA3-4
3	——— E3	*H. typicalis* *N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* *N. planata* *N. nevadensis* *N.* n. sp. C *N.* n. sp. D GU3	*N. planata* *N. nevadensis* L6 *N.* n. sp. C *H. typicalis* *N. taylorae* *N.* aff. *taylorae* L6 *N. tulongensis* + *N.* n. sp. A L5 *N. meishanensis* *N.* n. sp. D *N. carinata* *N.* aff. *changxingensis* *I.? parva* ? *I. isarcica* L5	*H. typicalis* *I. isarcica* *N.* aff. *carinata* *N.* aff. *changxingensis* *N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* *N. nevadensis* *N.* n. sp. D LA3-3
2	*H. typicalis* ?*N.* aff. *carinata* *N.* aff.*changxingensis* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* *N. planata* *N. nevadensis* *N.* n. sp. D E2	*H. typicalis* *H.* sp. *I. parva* *I. isarcica* *N.* aff. *carinata* *N.*aff. *changxingensis* *N. taylorae* *N.* aff. *taylorae* *N. tulongensis,* *N.* n. sp. A *N. meishanensis* *N. carinata* *N.* n. sp. C *N.* n. sp. D GU2	*H. typicalis* *H.* sp. *I. parva* *I. isarcica* ? *N.* aff. *carinata* *N.* aff. *changxingensis* *N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* *N. planata* *N.* n. sp. D L4	*H. typicalis* *N.* aff. *carinata* *N.* aff. *changxingensis* *N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* LA3-2
1	*H. typicalis* *N.* aff.*changxingensis* *N.*aff.*taylorae*, $\alpha+/-\beta$ *N.* aff. *taylorae* *N. tulongensis*, $\alpha+/-\beta$ *N.* n. sp. A, $\alpha+/-\beta$ *N. meishanensis* *N. carinata* E1	*H. typicalis* *I. parva* *N.*aff. *changxingensis* *N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* GU1	*H. typicalis* *I. parva* *I. isarcica* *N.* aff. *carinata* *N.* aff. *changxingensis* *N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* L3	*H. typicalis* ? *I. parva* *I. isarcica* *N.* aff. *carinata* *N.*aff. *changxingensis* *N. taylorae* *N.* aff. *taylorae* *N. tulongensis* *N.* n. sp. A *N. meishanensis* *N. carinata* *N. planata* LA3-1

Fig. 4: Griesbachian to Lower Dienerian conodont faunas of the Muth, Guling, Lingti and Lalung sections.

Most Griesbachian conodont faunas described to date are dominated by the *Hindeodus* biofacies or have only meagre representation of the *Neogondolella* biofacies. Selong and Spiti are exceptions. Conodont fauna from these latter areas have facilitated a fuller understanding of the morphological characteristics of Griesbachian *Neogondolella* form-species. The presence of *Isarcicella* species in both localities, although in relatively small numbers, is very important because it demonstrates that the described Griesbachian *Neogondolella* fauna postdates the *Neogondolella*-dominated fauna of the Changshing Limestone. The results from Spiti further demonstrate that these two *Neogondolella* faunas differ.

Neogondolella distribution

In Spiti, the *Neogondolella* conodont faunas from throughout the Griesbachian and immediately overlying strata have many form-species in common: *Neogondolella taylorae*, *N.* aff. *taylorae*, *N. tulongensis*, the recently named *N. meishanensis*, and the newly differentiated *N.* n. sp. A. These species range throughout the studied sections, as they do also in the *Otoceras latilobatum* bed at Selong. Some of these species can also be identified in the collections from the Guryul Ravine, Kashmir illustrated by Matsuda (1984). With the exception of the basal sample at Guling (Gu-1), *Neogondolella carinata*, *N. planata*, and rare *N. nevadensis* also occur throughout the four Spiti sections. The range interval of *N. taylorae*, here termed the *taylorae* Zone (new), can be subdivided into three parts based on successive first appearances of *Neogondolella* n. sp. D and *Neogondolella* n. sp. E.

Neogondolella pectiniform elements from the Griesbachian have a variety of platform shapes, as do those from the Changshingian. In fact, there is little to suggest that a major reduction in conodont diversity occurred either at the base of, or within the Griesbachian. Combining data from Meishan and Spiti, a progressive morphological change (cline) in the configuration of the axial part (blade-carina-cusp) of the pectiniform elements is recognized. On this basis, three *Neogondolella* datums (alpha, beta, gamma) and four successive *Neogondolella* faunas are recognized from the late Changshingian through Griesbachian:

1. *Neogondolella* species from the Changshing Limestone typically have high blades and carinas composed of partially fused denticles; in some species the posterior carina and cusp is suppressed. Cusps are indistinct (*N. orientalis*), small (*N. changxingensis*) or moderately large, terminally located and posteriorly directed (*N. subcarinata*, *N. wangi*), or upright (*N. xiangxiensis*). Some large morphotypes are posteriorly deflected ("*N. deflecta*") or postero-laterally expanded ("*Dicerogondolella*" spp.), but these features alone are not regarded as diagnostic because they can be found in many *Neogondolella* species. The fauna of the upper Changshing Limestone was originally referred to the *Neogondolella changxingensis-deflecta* Zone, but it has recently been further divided into zones of *N. postwangi* followed by *N. xiangxiensis* (Tian, 1993a,b; Wang, 1995b).

-----alpha datum: diminution of blade-carina, vertical growth of cusp-----

2. The oldest Griesbachian *Neogondolella* species often have relatively low, discrete blade-carina denticles, and a distinctive, upright cusp surrounded by a platform brim (*N.* ex gr. *taylorae*, *N. tulongensis*, *N.* ex gr. *carinata*). Some elements have subquadrate platforms with an "hour-glass" outline (*N. tulongensis*). Other forms have a terminal cusp (*N.* aff. *changxingensis*, *N. meishanensis*). These species occur in collections from Muth (E1), Guling (Gu-1), Lingti (L3, L4), and Lalung (LA-1, -2, -3). The *Neogondolella* fauna is assigned to the Lower *taylorae* Zone (new), which is also represented in the *Otoceras latilobatum* bed at Selong (Orchard et al., 1994).

-----beta datum: accelerated posterior growth, fusion of axial region-----

3. The *Neogondolella* populations show a significant shift in axial morphology within the Griesbachian of Spiti. In general, platform outline does not change as significantly. At Lingti (sample L4), Guling (Gu-2), Muth (E2), and Lalung (LA-4), *Neogondolella* n. sp. D appears, as do new morphotypes of *N. taylorae*, *N. tulongensis* (e.g. *N.* aff. *tulongensis* sensu Garzanti et al., 1995), and *N.* n. sp. A, as well as occasional *N.* n. sp. C. Most of these species share a common carinal morphology, with an elevated carina, notably in the posterior part. The interval dominated by these forms is here termed the Middle *taylorae* Zone (new). It is represented in samples from Muth (E2, 4), Guling (Gu-2, 3, 4), Lingti (L4, 5, 6, 7), and Lalung (LA3-3, 4). Some characteristic Lower *taylorae* Zone species - *N.* aff. *changxingensis*, *N.* aff. *carinata*, and *Isarcicella* spp.- occur only in the lower part of the Middle *taylorae* Zone.

-----gamma datum: strong elevation of axial region, separation of denticles-----

4. A further morphological shift is recognized in the Guling section (Gu-5). In this collection, *Neogondolella* n. sp. E appears amongst several long-ranging form species of the *taylorae* Zone. The new species shows a further evolution of the carina in which all the denticles are long and relatively discrete. *Neogondolella* n. sp. E is diagnostic for the Upper *taylorae* Zone (new). The species is the probable precursor of *Neospathodus kummeli* which arose through further evolution of the axial/carinal region and reduction of the platform. *Neospathodus kummeli* occurs in the next higher bed at Guling and elsewhere.

Isarcicella distribution

Although relatively uncommon, *Isarcicella* species occur at the base of each of the Spiti sections except that at Muth, where *Hindeodus* is rare. At the base of the Guling section (Gu-1), *I. parva* occurs alone but in the next higher bed (Gu-2), and at the base of the Lingti (L3) and Lalung (LA-1) sections, it is associated with *I. isarcica*. Strictly, the basal bed of the Guling section is referrable to the *parva* Zone, whereas the basal beds of other Spiti sections are referrable to the younger *isarcica* Zone. There is some support for this because of the absence of *Neogondolella carinata* and *N. planata* in Gu-1, which are also missing in the *Otoceras latilobatum* bed at Selong. The latter also contains (for the most part) a *parva* Zone fauna.

Isarcicella isarcica appears within the Lower *taylorae* Zone and disappears, with all *Isarcicella* spp., within the Middle *taylorae* Zone. Neither level corresponds to a particular *Neogondolella* datum. Apart from the long ranging *Hindeodus typicalis*, which occurs throughout the Griesbachian of Spiti, several other uncommon *Hindeodus* elements occur in the Spiti faunas. One of these, from Lingti (sample L4), corresponds to *H. latidentatus* emmend. sensu Kozur (e.g. Kozur, 1995). These forms have been regarded as directly ancestral to *Isarcicella parva*, although they clearly co-occur with that species too. *Hindeodus latidentatus* emmend. is here called *Hindeodus* n. sp. X. Although the latter species resembles *H. latidentatus* sensu stricto in possessing broad posterior denticles, it differs in lacking the wide separation of those denticles by concave arcs. *Hindeodus* n. sp. X occurs also in the upper transition bed at Meishan (both lower and upper bed 27, Wang, 1995a), in Nepal (Garzanti et al., 1994a), in the Tesero Oolite (Schonlaub, 1991; Kozur, 1995), and in Greenland (Sweet, 1976; Kozur, 1989).

Conclusions

The Spiti *Otoceras* beds represent two zones named in ascending order the *Otoceras woodwardi* - *Ophiceras bandoi* zone (levels 1-3) and the *Ophiceras tibeticum* - *Discophiceras* cf. *wordiei* zone (level 4). Additional results are:

1) the complete time overlap of *Otoceras woodwardi* with certain *Ophiceras* species and thus a main time overlap of the original scope of the *woodwardi* and *tibeticum* zones.
2) the exclusive presence of *Otoceras* specimens with undivided auxiliary saddles (= *Otoceras woodwardi*) in levels 1-3.
3) A single *Otoceras* - free *Ophiceras* horizon (level 4) above, characterized by *Ophiceras tibeticum* and several other more involute ophiceratids.
4) the representation of the genus *Bukkenites* point to a condensed nature of level 4.
5) level 4 is overlain by a gyronitid dominated fauna without ophiceratids.
   This interval includes levels 5+6 and is proposed as a new zone named for *Pleurogyronites planidorsatus*, defined as basal Dienerian.

Any attempt to establish correlations with other *Otoceras* bearing sequences seems premature. If we, however, assume that otoceratids with intended auxiliary saddles are older than those without, a hypothetical three-fold division of the *Otoceras* faunas could emerge - an upper zone with *O. woodwardi* known only from the Himalayas (and Kashmir), a middle one with *O. boreale* missing in Spiti and Nepal but represented in Shashal and Selong by *O. fissisellatum/latilobatum*, and a lower one with *O. concavum* known only from Canada.

Based on a progressive morphological change in the configuration of the axial part (blade-carina-cusp) of the pectiniform conodont elements, three *Neogondolella* datums (alpha, beta gamma) and four successive *Neogondolella* faunas are recognized from the late Changshingian through early Dienerian (sensu this paper). A newly differentiated *taylorae* Zone, with three subdivisions into Lower, Middle (both Griesbachian), and Upper (Dienerian) parts are recognized.

The available evidence suggests that, within a mixed biofacies (see Orchard, in press), the appearance of *Isarcicella parva* and *Neogondolella taylorae* may be coincident. The base of the Lower *taylorae* Zone and of the *parva* Zone coincides with the appearance of *Otoceras latilobatum* at Selong (Orchard et al., 1994). The conodont indices also co-occur with *O. woodwardi* in Spiti, but most sections begin slightly higher in the *taylorae* Zone, within the range of *Ophiceras* and *I. isarcica*.

In all Spiti sections, the base of the Middle *taylorae* Zone (appearance of *Neogondolella* n. sp. D) and the subsequent disappearance of *Isarcicella* spp., *N.* aff. *changxingensis*, and *N.* aff. *carinata*, occur within the range of *Otoceras woodwardi* plus *Ophiceras bandoi*. That part of the Middle *taylorae* Zone above the disappearance of the aforementioned conodont taxa corresponds to the *Ophiceras tibeticum* plus *Discophiceras* cf. *wordiei* ammonoid zone.

Conodonts from the Upper *taylorae* Zone occur within the lower part of the *Pleurogyronites planidorsatus* Zone. The upper part of that ammonoid faunal interval is associated with *Neospathodus kummeli*.

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CRINOIDS IN LOWER TRIASSIC IN SLOVENIA

Anton Ramovš

Although in general crinoids were relatively rare in the Lower Triassic, in Slovenia localities of trochitic limestones with rock-forming remains of these crinoids are numerous. They were established in the Karavanke Mountains, the Julian Alps, the Loka and Polhov gradec hills, the Idrija region, the surroundings of Ljubljana, Lower Carniola and in the Slovenian Styria. They occur in a single or in several beds, but only in the Upper Scythian (Cencenighe Member). Their remains are principally the pentahedral columnalia.

(1) **Karavanke.** In southern Karavanke in several localities the Cencenighe Member with the typical crinoid horizon was established, often with the foraminifer *Meandrospira pusilla*, and less frequently also with the pelecypod *Costatoria costata*. In the western Karavanke west of Podkoren in the Podkoren-Ravne area the horizon of crinoid limestone with prevailing columnalia outcrops within the dark grey Upper Scythian limestone.

West of Srednji vrh and east of the Vošča hamlet dark grey crinoid limestone occurs, only a few tens of centimetres thick, and east of there another horizon of grey trochitic limestone.

The crinoid limestone appears in very dark grey limestone also at the upper Dobrišnik waterfalls in the Dobrišnik riverbed above Hrušica near Jesenice. Next to it also the pelecypod *Costatoria costata* (Ramovš, 1983, 134) is frequent.

In Tržič the crinoid limestone outcrops at the foot of the Trziška Bistrica waterfall step near the Slap hamlet. Dark grey and pale rosy limestone contains in several beds numerous pentagonal columnalia around half a centimetre in size that protrude from the brownish weathered rock. In other beds no crinoid remains occur (Ramovš, 1983, 146).

In the upper part of the Scythian series T. Dolenec, B. Ogorelec and J. Pezdič (1981, 225) recorded crinoid limestone in the studied profile from Slap along the road towards Lom below Storžič. Crinoid plates form the entire skeleton of the rock.

Crinoid limestone occurs in the Upper Scythian beds also in the wider area of Jezersko. At the road near Reka west of Kanonir inn small crinoid remains appear in the upper part of the Upper Scythian beds in dark grey micritic limestone. The other stratigraphically somewhat lower horizon appears at the reddish limestone oolite that is mainly grey in the trochitic horizon.

Julian Alps. In the Podalenk bed south of Rateče (northern Julian Alps) appears a 60 cm thick limestone bed with numerous columnalia, and in the sparitic limestone also *Meandrospira pusilla* is abundant. Crinoid and sparitic limestone with meandrospiras are characteristic rocks of the upper part of the Lower Triassic beds (Cencenighe Member) in the northern Julian Alps (Ramovš, 1989, 625, 636).

South of Podkoren in the Lower Triassic complex between Mavrinec and the saddle west of Špica in Sedelce a 0.5 m thick horizon of sparitic limestone with numerous pentahedral columnalia and the foraminifer *Meandrospira pusilla* (Cencenighe Member) occurs several metres above the *Tirolites* level (*Tirolites cassianus*). In the western margin of Mavrinec a 4 cm thick sheet of dark grey trochitic limestone is situated that consists of mere pentahedral columnalia (Ramovš, 1989, 630).

Above the Kovinar path in Dolgi plazovi (about 1830 m, in the northern part of the eastern Julian Alps) rock-building members of stems of sea lilies, in part with *Meandrospira pusilla* appear in platy limestone (Ramovš, 1989, 633, 636).

The trochitic horizon also appears at the Studor saddle below the Veliki Draški peak and in the northern part of Mežakla where abundant pentahedral members of crinoid stems are present in variously grey limestones (Ramovš, 1989, 634, 636).

Surroundings of Ljubljana. The crinoid horizon is known from Mt. Šmarna gora north of Ljubljana, in the Ločnica valley near Medvode, and above Studenčice near Medvode. The crinoid horizon is everywhere in the upper part of the Scythian series (Cencenighe Member).

Surroundings of Skofja Loka. At the Blegoš road in the large curve in front of the Breznica village I found in dark grey limestone numerous columnalia. There also occurs *Meandrospira pusilla* (= Cencenighe Member).

Surroundings of Idrija. At Idrija grey grainy bedded dolomite outcrops in the upper part of the Lower Triassic. In its upper sheets the rock contains numerous crinoid remains (Mlakar, 1954, 165). Later Mlakar (1969, 9) reported a dolomitic bed with crinoids in the upper level of the Upper Scythian. In the dolomite no other fossils occur. This is the only locality of crinoid remains in the Upper Scythian dolomite known to me.

Surroundings of Žiri. In the uppermost Scythian Grad and Ogorelec (1980) stated about 140 m of dark grey marly limestone, in part with dolomite sheets and lenses. The limestone is mainly recrystallized microsparite, and in part bio- and pelmicrite. In the limestone remains of echinoderms (= crinoids) and the foraminifer *Meandrospira pusilla* appear.

East Slovenia. The crinoid horizon with rock-building columnalia outcrops in the Mišnica valley east of Rimske Toplice. In black limestone with columnalia frequent tests of the foraminifer *Meandrospira pusilla* appear. The locality is situated about 20 m below the Scythian/Anisian boundary. The horizon with crinoid remains and the foraminifer *Meandrospira pusilla* belongs to the Cencenighe Member (Ramovš & Aničič, 1995).

Conclusion

All hitherto established localities with crinoid remains belong to the narrow horizon in the upper part of the Scythian series, Spathian stage. Except for Idrija almost all localities occur in dark grey crystallized limestone. In the crinoid horizon in most localities also *Meandrospira pusilla* was found that is typical next to the crinoid horizon for the Cencenighe Member in Slovenia. The found columnalia are pentahedral, and they most certainly belong to a single species.

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"IMPACT CRATERING AND EVOLUTION OF PLANET EARTH"

A workshop related to the former Scientific Network of European Science Foundation (E.S.F.)

INTERNATIONAL WORKSHOP

The Role of Impact Processes in the Geological and Biological Evolution of Planet Earth

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The meeting will include a one-day excursion to the Karst area to see Upper Cretaceous and the K/T boundary at the Dolenja Vas and Padriciano sections. An additional optional post-conference excursion will be organized. We will show a Jurassic-Cretaceous basinal succession, with emphasis on mid-Cretaceous deposits in the NW part of Slovenia.

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THE FELSŐÖRS SECTION: A POSSIBLE STRATOTYPE FOR THE BASE OF THE LADINIAN STAGE

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Introduction

The Middle Triassic sequence at Felsőörs (Balaton Highland) is one of the most famous geological localities of Hungary. The fossiliferous strata at the hillside (also known as Forráshegy or Malomvölgy) aroused the interest of the international scientific community as early as the seventies of the last century when bed-by-bed collections were made and some strange ammonoids were described from the "yellow, siliceous limestones of Forráshegy" by Roth (1871), Böckh (1873) and Stürzenbaum (1875). The results were included to the monograph of Mojsisovics (1882) where it was clearly stated that the Felsőörs section straddles the stratigraphic interval passing from the Anisian to the Ladinian ("Norische Stufe" at that time).

In the last years a remarkable scientific resurgence was invoked by the activity of the Working Group on the Anisian/Ladinian Boundary lead by M. Gaetani. By now, the Working Group is approaching, seemingly irreversibly, to a formal voting about the GSSP of the Ladinian base. According to the last Circular by Gaetani (11 January, 1996) the Felsőörs section deserved the honour of being one of the two GSSP candidates. This circumstance obliges us to summarize the most important new stratigraphic data of the section.

In fact, neither the Felsőörs, nor the other candidate (Bagolino) provides really perfect documentation of the faunal changes and other stratigraphic criteria throughout the discussed interval (from the top of the Trinodosus Zone to the base of the Curionii Zone). Therefore, if the complex stratigraphic approach (which is highly requested because of the practical usefulness) is concerned, none of them would be a perfect GSSP. However, there are further sections in both areas (Balaton and Giudicarie, respectively) which provide important additional information largely filling the gap of knowledge deriving from the candidate sections. Similarly to Bagolino, complemented with the Pertica and Prezzo sections (Brack et al., 1995), a joint evaluation of ammonoid and conodont evolutionary events is mostly possible in the Balaton area, as well, the Felsőörs section being completed with the Vászoly P-11/a and Mencshely sections. In case of the Felsőörs section, valuable additional information have been yielded by the Vászoly section for the lower and by the Mencshely section for the upper part of the Reitzi Zone. In this contribution the stratigraphic data from these three sections will be presented together.

Felsőörs

After a long silence, following the classical works mentioned in the introduction, modern descriptions of the section were given in Szabó et al. (1980), Kovács et al. (1990) and Vörös (1993). For the occasion of the Anisian/Ladinian Boundary Field Workshop (1993) the (micro)biostratigraphical data were summarized (Góczán and Oravecz-Scheffer 1993, Dosztály 1993) and papers focused on conodonts (Kovács 1993a, 1994) and ammonoids (Vörös 1993) also appeared.

Some drawbacks of the Felsőörs section have been pointed out at the Workshop (e. g. the apparent absence of "*Ticinites* horizon", "*Nevadites* Zone" and "*chiesense* horizon", only indirect evidence for the *curionii* Zone; see a summary by Gaetani 1993). Therefore in the last two years we made

serious efforts to collect data (i.e. fossils) from the interval between the uppermost part of the *reitzi* Zone and the "conodont-proved" *curionii* Zone (i.e. between the bed No. 111/H and the lowermost banks of the reddish, cherty limestone: bed No. 1-3/86 in Kovács 1993, 1994). Due to the new excavations, we found several new, or previously not sampled layers with scarce and poorly preserved ammonoids belonging to *Ticinites, Stoppaniceras* and *Chieseiceras*. Regrettably, *Nevadites* and *Eoprotrachyceras* are still wanted. Sampling for radiolarians gave also important new results. The complemented and redrawn stratigraphical column of the Felsőörs section with the ranges of the diagnostic taxa of ammonoids, conodonts and radiolarians is presented in Fig. 1.

Ammonoids

Although new data (fossils) came only from a few beds (100/F, and 111/I - 118), in the light of the new paleontological data (Balini 1992a, 1992b, Brack and Rieber 1993) and new stratigraphical schemes advocated by some authors (Brack and Rieber 1994, Brack et al. 1995, Kozur and Mostler 1994, Kozur 1995a, Kozur et al. 1995, Manfrin and Mietto 1995, Mietto and Manfrin 1995) the biostratigraphic subdivision and nomenclature of the Felsőörs section needs some reevaluation.

The lower part of the section (Felsőörs Limestone, beds No. 87-99/C) was not collected again but its ammonoid fauna was partly revised on the basis of the works by Balini (1992a, 1992b) and Mietto and Manfrin (1995). The fauna contains some characteristic elements of the Trinodosus Zone (*Paraceratites, Semiornites aviticus*). *Lardaroceras krystyni* (which was called "*Parakellnerites* sp., aff. *meriani* B" in Vörös 1993) appears in bed No. 88-89 and its range shows almost total overlap with that of *Asseretoceras camunum*, up to the bed No. 99. *Lardaroceras pseudohungaricum* occurs in the topmost beds of the Felsőörs Limestone. This species (called previously "*Parakellnerites* sp., aff. *meriani* A" by Vörös) is restricted to the highest part of the Prezzo Limestone sequence in Lombardy (Balini 1992a). "*Hungarites*" *inconstans* appears in bed No. 99/C. This is a characteristic element of the "*Lardaroceras* fauna" in the Southern Alps (Mietto and Manfrin 1995).

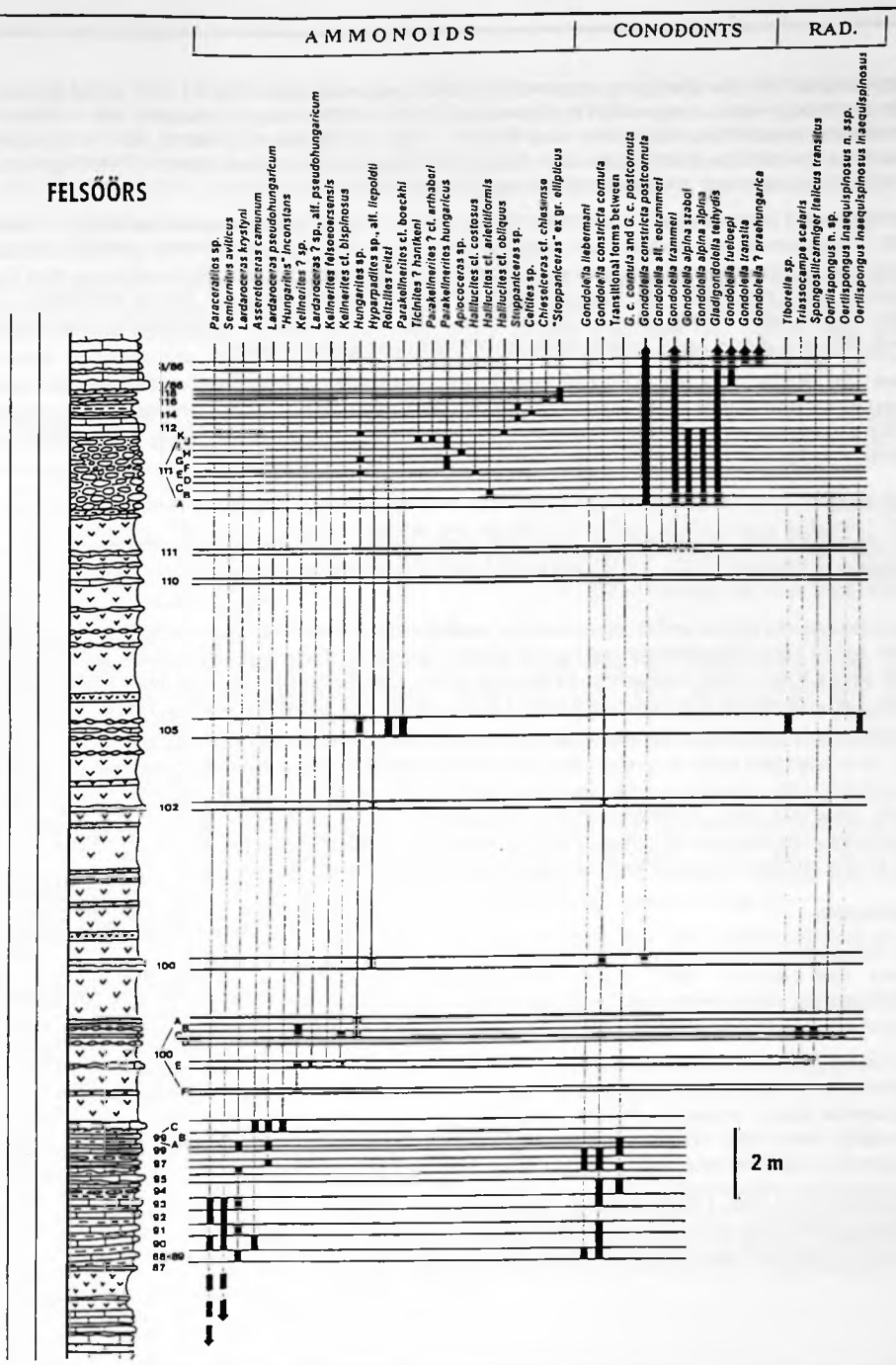
The first *Kellnerites* was found in the lowermost solid tuff layer (bed No. 100/F) of the "*reitzi*-tuff". The first limestone intercalation (bed No. 100/E) contains a rather rich *Kellnerites*-fauna ("*felsoeoersensis* horizon" in Vörös 1993) and *Lardaroceras* ? sp., aff. *pseudohungaricum*. This form was called "*Parakellnerites* sp., aff. *hungaricus* A" by Vörös (1993) but in the light of the new paleontological and stratigraphical information (Balini 1992a, Brack and Rieber 1993) it seems more reasonable to regard it as the possible last representative of *Lardaroceras*.

Higher up, within the "*reitzi*-tuff", the ammonoids and their distribution ("*liepoldti*" and "*reitzi*" horizons) remained the same as in Vörös (1993).

The next unit, numbered as 111/A-111/K, is the most problematic part of the Felsőörs section. This 2.5 m thick, tuffitic, nodular, siliceous limestone sequence was regarded as a product of normal, more or less continuous sedimentation, therefore we made a detailed sampling in 1989 (No. 111/A-H) and in 1994 (No. 111/I-K). In the lower part we have found some representatives of *Halilucites*: partly on this ground Vörös (1993) introduced the "*costosus* horizon".

The data from the new collections and the reevaluation of the fauna lead to contradictory results. The pattern of distribution (Fig. 1) shows a picture of a mixed fauna. *Halilucites arietitiformis* which occurs high in the "*Nevadites*" or *secedensis* Zone in the Southern Alps (Mietto and Manfrin 1995, Brack and Rieber 1993) appears here first, in the lower part of this unit (No. 111/B). On the other hand, *Ticinites* ? *hantkeni* and *Parakellnerites* ? *arthaberi* which were frequently found in the deeper

Fig. 1. Stratigraphic ranges of the most diagnostic ammonoid, conodont and radiolarian taxa in the Felsőörs section


AMMONOIDS
CONODONTS
RAD.
FELSŐÖRS
Paracoralites sp.
Semiornites avilicus
Lardaroceras krystyni
Asseretoceras camurum
Lardaroceras pseudohungaricum
"Hungaritis" inconstans
Keilnerites ? sp.
Lardaroceras ? sp., aff. pseudohungaricum
Keilnerites felsoeoerszensis
Keilnerites cf. bispinosus
Hungarites sp.
Hyparpadites sp., aff. liepoldti
Roitzites reitzi
Parakeilnerites cf. boeckhi
Ticinites ? hanifkeni
Paakeilnerites ? cf. arthabari
Paakeilnerites hungaricus
Apiococeras sp.
Hallucites cf. costosus
Hallucites cf. arietitiformis
Hallucites cf. obliquus
Stoppaniceras sp.
Celtites sp.
Chieseiceras cf. chiesense
"Stoppaniceras" ex gr. ellipticus
Gondolella liebermani
Gondolella constricta comuta
Transitional forms between
G. c. comuta and G. c. postcornuta
Gondolella constricta postcornuta
Gondolella aff. wolcommesi
Gondolella trammeri
Gondolella alpina szabol
Gondolella alpina alpina
Gladigondolella tethydis
Gondolella fuetoepi
Gondolella transita
Gondolella ? praehungarica
Tiborella sp.
Triassocampe scalaris
Spongosilicarniger italicus transitus
Oertlispongus n. sp.
Oertlispongus inaequispinosus n. ssp.
Oertlispongus inaequispinosus inaequispinosus
2 m

"*reitzi* horizon" in other sections, occurred here in the topmost beds (No. 111/J). After all, we have to accept the previous suggestion by one of us (Kovács 1993) and to interpret this whole unit as "pyroclastic debris flow with limestone clasts". This means that the debris flow was deposited sometimes in the *secedensis* Zone and contains a reworked and mixed fauna of the higher part of the *reitzi* Zone and the lower part of the *secedensis* Zone.

From the next interval (beds No. 112-118) we made a new, bed-by-bed collection in 1994 and 1995. This part is well bedded and, beyond doubt, normally deposited. The ammonoid fauna is scarce and poorly preserved, nevertheless, it provided important results. *Stoppaniceras* and *Celtites* occurs in beds No. 113-115; this may hint at the *secedensis* Zone (cf. Brack and Rieber 1993, Mietto and Manfrin 1995). In the bed No. 116 a single specimen of *Chieseiceras chiesense* was found: this is a direct proof of the highest part of the *secedensis* Zone.

Higher up, in the beds No. 117-118 only a few specimens of "*Stoppaniceras*" ex. gr. *ellipticus* (sensu Brack and Rieber 1993) occurred. On the basis of the South Alpine analogies the occurrence of *Eoprotrachyceras curionii* was expected in the directly overlying beds (No. 1/86-3/86) but our extensive digging and hammering remained unsuccessful.

Conodonts

New sampling and investigations have not been made in the last years, therefore the results published in Kovács (1993, 1994) are used here; only a few remarks seem necessary. The ranges of conodont taxa are shown in Fig. 1.

Gondolella alpina alpina and *G. alpina szaboi* were found in the limestone nodule horizon (numbered herein as 111/K), immediately below the cherty limestone bank numbered here as bed No. 112 (0/86 according to the numbering in Kovács 1993, 1994) and in the bed No. 113 immediately above that. However they were not found in the bank 112 (0/86 in Kovács 1993, 1994) itself.

On the other hand, the form indicated as "*G.* aff. *transita*" from here in Kovács et al. (1990, fig. 9/d), is recognized now as a transitional form between *G. trammeri* and *G.*? *praehungarica*. The FAD of the latter was known till now from bed No. 3/86 (cf. fig. 3 in Kovács 1993), whereas the newly exposed part, numbered herein as No. 114-118, has not yet been investigated for conodonts. To clear up LAD, resp. FAD of these three taxa, it is necessary to investigate also this part of the section for conodonts, as well as to re-investigate the above mentioned three beds.

Radiolarians

The Felsőörs section is well known and famous for its extremely rich Illyrian radiolarian fauna (Kozur and Mostler 1981, Kozur 1984, Budai and Dosztály 1990, Dosztály 1993). The investigations made in the last few years have proved that the Ladinian sequence also contains radiolarians which have great importance in drawing the Anisian/Ladinian boundary.

The limestone layers intercalating the "*reitzi*-tuff" are strongly silicified therefore the extraction of radiolarians is rather difficult and their preservation is usually poor. Due to these circumstances, only seven layers yielded radiolarians determinable on species level. Even at the first glance it is clear that this Ladinian fauna is resulted by a considerable turnover of the Anisian fauna. The ranges of radiolarian taxa are shown in Fig. 1.

In the first layer (No. 100/E) yielding radiolarians, the representatives of *Triassocampe scalaris* and *Spongosilicarmiger italicus* have been found. The fauna, dominated by Ladinian forms, contained a poorly preserved specimen belonging to the genus *Tiborella*.

In the next layer (No. 100/D) *Oertlispongus* specimens appear; namely *Oertlispongus inaequispinosus* n. ssp. (also known from Mencshely: cf. Dosztály 1993), and a single specimen of a probably new species (marked as *Oertlispongus* n. sp. in Fig. 1). The representatives of the genus *Triassocampe* are frequent, just as the *Spongosilicarmiger italicus transitus* which, according to Kozur and Mostler (1994), marks the lowermost radiolarian subzone of the lowermost Ladinian.

The bed No. 100/C yielded poorly preserved specimens of *Eptingium*, along with *Triassocampe scalaris* and *S. italicus transitus.*

The next valuable information came from the bed No. 105 where the previously known forms are accompanied by *Eptingium manfredi* and *Oertlispongus inaequispinosus inaequispinosus.* The specimens of this subspecies are different from those known from bed No. 100/D (and from Mencshely): at these, the straight part of the primary spine is much shorter and the bent part is massive and longer than the straight part.

The higher beds of the sequence provided very few evaluable material. The scarce radiolarians belong to the taxa known from the lower part of the section with the single exception of *Baumgartneria* in bed No. 116.

To sum it up, the fauna of the bed No. 100/E represents the oldest subzone of the Ladinian. The fauna of the beds No. 100/E, D, and C is similar and seems to belong to the same subzone. The radiolarians of the bed No. 105 (with *Oertlispongus inaequispinosus inaequispinosus* represent an other subzone. No further subzones seem to be distinguished higher up in the Felsőörs section.

Vászoly

This important section (labelled as P-11/a) was found and excavated by I. Szabó in the fifties. The sequence and its biostratigraphy was described in Vörös and Pálfy (1989) and (accompanied with a review of the wider geological surrounding) in Kovács et al. (1990). The ammonoid and conodont biostratigraphy of the section was revised and presented on the occasion of the Anisian/Ladinian Boundary Field Workshop (Vörös 1993, Kovács 1993).

Since then, new, systematic collections have not been made, but some occasional findings enriched the ammonoid fauna. Moreover, on the basis of the newest taxonomical and biostratigraphical data published e.g. by Balini (1992a, 1992b), Brack and Rieber (1993) and Mietto and Manfrin (1995) the ammonoid taxonomy and biostratigraphy of the Vászoly section has been reevaluated. The ranges of the most important ammonoid taxa are shown in Fig. 2.

The lowermost layer yielding evaluable ammonoids was the bed No. 3/A, where several small specimens of *Asseretoceras camunum* have been found.

In the rich fauna of the bed No. 5, *Megaceratites* ? *subnodosus* and *Lardaroceras krystyni* also appears. (The latter was called "*Parakellnerites* sp., aff. *meriani* B" in Vörös 1993).

Higher up, the biostratigraphy of the section is more or less the same as in Vörös (1993) i.e.: *Kellnerites* appears in bed No.6, *Hyparpadites* in bed No. 9, *Hungarites* a little higher and *Reitziites* (together with *Ticinites* ? *hantkeni)* in bed No. 14. This bed yielded a strange small ammonoid specimen which was figured under the name *Nevadites* ? *ecarinatus* in Vörös and Pálfy (1989, Pl. III., Fig. 1) and was called *Reitziites ecarinatus* in Vörös (1993). Now, in the light of the preliminary taxonomical results published by Mietto and Manfrin (1995), this form is determined as *Nevadites* ? cf. *symmetricus* (Salomon, 1895). According to Mietto and Manfrin (1995) this species belongs to the group of the "early" *Nevadites* ("*Nevadites* s.s.") appearing earlier than e.g. *Nevadites secedensis*, still, its occurrence together with *Reitziites* implies some degree of condensation.

The rich fauna of the bed No. 16/A was presented by Vörös and Pálfy (1989) and Vörös (1993). As it was described in Vörös and Pálfy (1989), this bed is a "reconstructed bed" and does not form a coherent layer in the outcrop. In the last years, some new findings (though unfortunately from the scree) enriched the ammonite assemblage of this layer. On the basis of the data published by Brack and Rieber (1993) and Mietto and Manfrin (1995) the fauna of this layer can be interpreted as a condensed fauna containing some characteristic elements of the highest part of the *reitzi* Zone (*Hungarites mojsisovicsi, H. lenis*) and of the "*Nevadites*" or *secedensis* Zone (*Halilucites rusticus, Ticinites crassus*, "*Stoppaniceras*" ex gr. *ellipticus*).

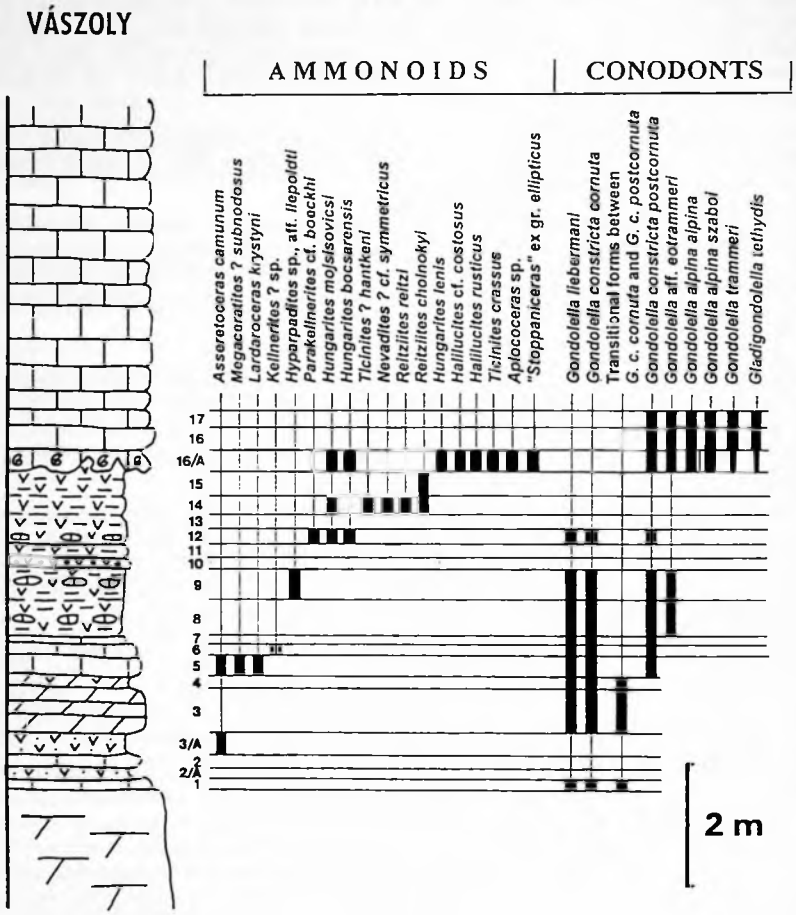


Fig. 2. Stratigraphic ranges of the most diagnostic ammonoid and conodont taxa in the Vászoly section

The conodont data presented by Kovács (1993, 1994) from Vászoly are still valid but in the present paper only a part of the conodont distribution (restricted to the section P-11/a) is shown (Fig. 2). The appearance of *Gondolella constricta postcornuta* in bed No. 5 and *Gondolella trammeri* in bed No. 16/A is remarkable. However S. Kovács (as expressed in Kovács et al. 1994, p.62) maintains his uncertainty about this reconstructed part of the section (beds No. 16/A, 16, 17) and does not recommend to use this interval as a reference section in conodont biostratigraphic literature.

Mencshely

The Mencshely section was excavated in 1990 and provided very valuable data to the ammonoid, conodont and radiolarian faunal content and biostratigraphical subdivision of the *reitzi* Zone. No new collections have been made but a reevaluation of previous data seemed to be necessary. The ranges of ammonoid, conodont and radiolarian taxa are shown in Fig. 3.

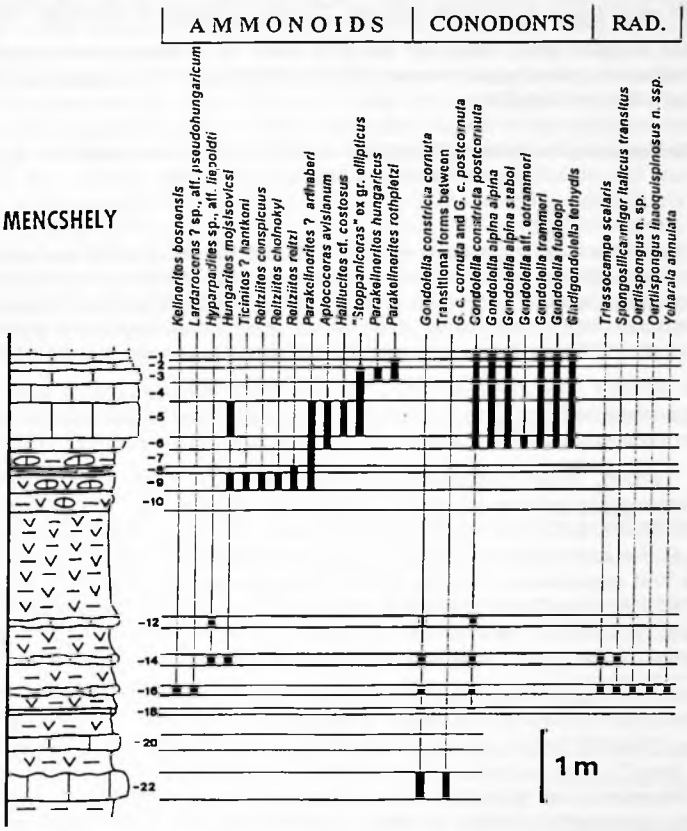


Fig. 3. Stratigraphic ranges of the most diagnostic ammonoid, conodont and radiolarian taxa in the Mencshely section

The bed No. -16 contained *Kellnerites bosnensis* and *Lardaroceras* sp., aff. *pseudohungaricum* (which was called "*Parakellnerites* sp., aff. *hungaricus* A" by Vörös 1993). This association fits well to the fauna of bed No. 100/E of Felsőörs.

Higher up, the faunal content and biostratigraphy is the same as in Vörös (1993), i.e.: *Hyparpadites* appears in bed No. -14 and *Reitziites* (together with *Ticinites* ? *hantkeni*) in bed No. -9.

The highest part of the section (from the bed No. -6 upwards) contains *Aplococeras avisianum*, *Parakellnerites hungaricus* and *P. rothpletzi* and represents the uppermost part of the *reitzi* Zone, though "*Stoppaniceras*" ex gr. *ellipticus* seems to point to the higher, *secedensis* Zone.

Radiolarians have been found in two layers of the Mencshely section. Their fauna shows strong similarity to that from the beds No. 100/C and 100/D of the Felsőörs section.

Triassocampe scalaris, *Spongosilicarmiger italicus transitus* and *Yeharaia annulata* appears in bed No. -16. The same bed yielded specimens of *Oertlispongus* n. sp. and *Oe. inaequispinosus* n. ssp. which have been recorded also from the bed No. 1 00/D at Felsőörs (Dosztály 1993).

In the somewhat impoverished fauna of the bed No. -14, *Triassocampe scalaris* and *Spongosilicarmiger italicus transitus* is still present. This assemblage is very similar to the fauna known from the bed No. 100/C at Felsőörs.

Remarks on the biostratigraphical subdivision and correlation in the Anisian/Ladinian boundary interval

Ammonoids

The lively activity of the Working Group on the Anisian/Ladinian Boundary, lead by M. Gaetani, brought about a fruitful period in the research of the stratigraphical interval in question. In the last years, a plenty of new paleontological data (Balini 1992a, 1992b, Brack and Rieber 1993) and new stratigraphical schemes (Brack and Rieber 1994, Brack et al. 1995, Kozur and Mostler 1994, Kozur 1995a, Kozur et al. 1995, Manfrin and Mietto 1995, Mietto and Manfrin 1995) have been published.

In the following, these contributions will shortly be commented; a subzonal scheme around the Anisian/Ladinian boundary will be proposed and the possibilities of correlation will be discussed.

Balini (1992a, 1992b), when describing the new genera *Asseretoceras*, *Megaceratites* and *Lardaroceras*, presented important stratigraphical data which permit to delineate two new subzones at the top of the *trinodosus* Zone. In the Prezzo Limestone sequence at Stabol Fresco, the lower subzone starts at the appearance of *Asseretoceras camunum* (bed No. SF 105A), the higher one begins with the first appearance of *Lardaroceras pseudohungaricum* (bed No. SF 111A). The use of these subzones is proposed here labelled as *camunum* Subzone and *pseudohungaricum* Subzone. In fact, these subzonal names were applied in Kozur and Mostler (1994) and Kozur (1995a) but as substituting names for the same stratigraphical interval and not as successive subzones.

Brack and Rieber (1994) and Brack et al. (1995) made only a few amendments on the ammonoid zonation developed previously for the Bagolino sequence (Brack and Rieber 1993). They used the terms *reitzi* Zone (instead of the previous "*reitzi/Kellnerites* Zone") and *secedensis* Zone (instead of "*Nevadites* Zone"). The substitute names fulfil the criteria of the International Guide for Stratigraphical Nomenclature, therefore they are justified, and accepted here also. Considering the opinion by Mietto and Manfrin (1995, p. 554), it seems to be reasonable to extend the faunal and stratigraphical content of the *secedensis* Zone downwards and include the "*Ticinites* beds". This would mean the revival of the original concept of Brack and Rieber (1993) and drawing the lower boundary of the *secedensis* Zone slightly below 60.0 m in the Bagolino section.

Kozur and Mostler (1994), Kozur (1995a) and Kozur et al. (1995) produced two different, almost completely rearranged ammonoid zonal/subzonal scheme of the discussed interval. These subzonal schemes are rather arbitrary compilations evidently based on the reinterpretation of the biostratigraphical data published by Vörös (1993). The conclusion in the latest version (Kozur 1995a, Kozur et al. 1995) is shocking: it offers a "fourth possible position" of the base of the Ladinian (for those who would not be fed up with the other three). This position (i.e. at the base of the "*reitzi* horizon", within the *reitzi* Zone) is unacceptable for us, but Kozur's subzonal schemes are worth keeping in mind because some useful subzonal names (e.g. *Lardaroceras pseudohungaricum* Sbz., *Kellnerites felsoeoersensis* Sbz. *Reitziites reitzi* Sbz.) were first introduced in these papers.

Manfrin and Mietto (1995) and Mietto and Manfrin (1995) published very important and interesting contributions on Middle Triassic ammonoid biostratigraphy. They seem to proceed on a rather private way among the other South Alpine workers and an enormous collecting and paleontological work appears to be at the background of their papers. They proposed a new zonal/subzonal scheme for the Anisian to Lower Carnian interval, which cannot be discussed in detail in the absence of a biostratigraphical documentation (e.g. stratigraphical columns with ranges). However, their "stratigraphical philosophy" and the resulted practice can be questioned, at least at the points, where they (1) disregard priority and (2) intentionally choose generic names for zonal names, because this is simply against the rules of the International Guide for Stratigraphical Nomenclature. On the other hand, their subzonal names may be applied if the biostratigraphical content justifies that. Focusing to the critical interval, the *reitzi* Subzone (sensu Mietto and Manfrin 1995) is unacceptable for us because it is too wide: embraces the *felsoeoersensis* horizon and extends down to the "*Lardaroceras* beds". The *avisianum* Subzone is accepted here as the highest subzone of the *reitzi* Zone, substituting the "*costosus* horizon" of Vörös (1993). This latter cannot be maintained after considering the sound and right criticism by Mietto and Manfrin (1995). In the lack of proper data set in the Balaton Highland, we cannot comment on the *crassus, serpianensis* and *chiesense* Subzones of Mietto and Manfrin (1995), though we agree that the lower boundary of the *secedensis* (="*Nevadites*") Zone should be shifted down to include the "*Ticinites* beds".

After all, on the basis of the detailed biostratigraphic data from Felsőörs, Vászoly and Mencshely and considering the above discussed South Alpine results, we propose the following zonal/subzonal scheme:

STAGES	ZONES	SUBZONES
LADINIAN	*CURIONII*	
	SECEDENSIS	
	REITZI	*avisianum*
		reitzi
		liepoldti
		felsoeoersensis
ANISIAN	*TRINODOSUS*	*pseudohungaricum*
		camunum

The extent and possible correlation of the above subzones is shown in Fig. 4. The reference line is the proposed Anisian/Ladinian boundary: between the *pseudohungaricum* and *felsoeoersensis* Subzones.

The uppermost two subzones of the ***trinodosus*** **Zone** can well be defined and documented both in eastern Lombardy and in the Balaton area.

The ***camunum*** **Subzone** comprises the lower part of the "*Lardaroceras* beds" in Lombardy (e.g. between the beds No. 105A and 111A in Stabol Fresco: cf. Balini 1992a) and roughly corresponds to the "*camunum* horizon" used by Vörös (1983) in the Balaton area (e.g. between the beds No. 90 and 97 in Felsőörs). The fauna consists of, besides the subzonal index, late representatives of *Paraceratites* (e.g. *P. elegans*) and *Lardaroceras krystyni*; sometimes *Beyrichites beneckei, Semiornites aviticus* and *Longobardites zsigmondyi.*

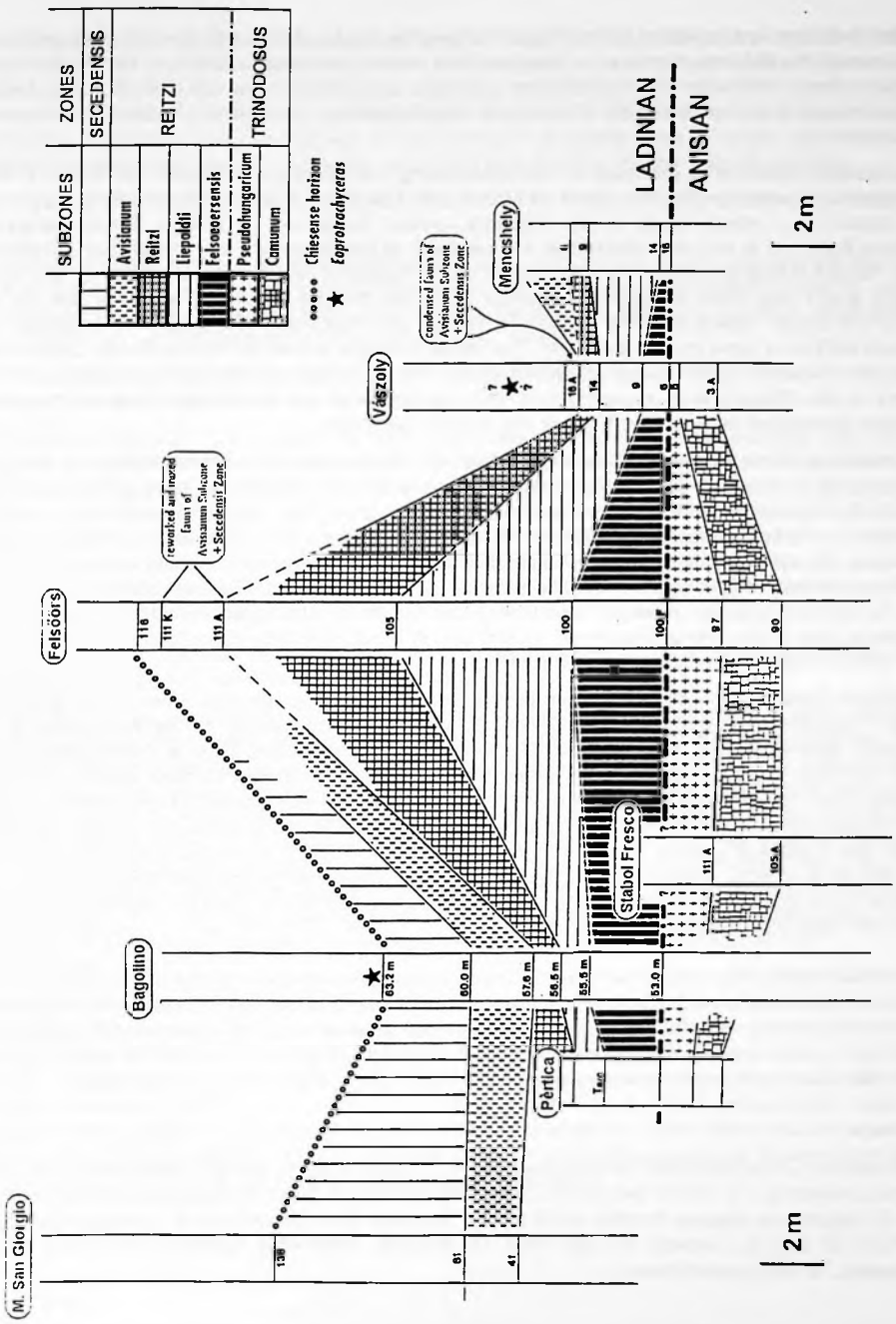
The ***pseudohungaricum*** **Subzone** is confined to the uppermost part of the Prezzo Limestone at Stabol Fresco and the Felsőörs Limestone (including the bed No. 99/C) at Felsőörs and more or less corresponds to the "*meriani* B horizon" of Vörös (1993). Its fauna is characterized by *Lardaroceras pseudohungaricum,* associated occasionally with *Norites gondola, Megaceratites* ? *subnodosus, Longobardites breguzzanus* and "*Hungarites*" inconstans. It is worth mentioning, that, at least in the Balaton area, *Asseretoceras camunum* and *Lardaroceras krystyni* persists throughout this Subzone. [Mietto and Manfrin (1995) ranged this biostratigraphical unit into the "*reitzi* Subzone" of their "*hungarites* Zone"; this opinion is not accepted here.]

The *reitzi* Zone is proposed to be divided into four Subzones which are well developed in and can be excellently correlated between the sections of eastern Lombardy and the Balaton area.

The ***felsoeoersensis*** **Subzone** is equivalent to the "*felsoeoersensis* horizon" of Vörös (1993). It is well defined in Felsőörs (between the beds No. 100/F and 100) and in Bagolino (from 53.0 to 55.5 m). Its lower boundary (which is at the same time the suggested base of the Ladinian) is marked by the appearance of the representatives of the genus *Kellnerites.* The fauna is characterized by various (perhaps partly synonymous) species of *Kellnerites,* along with *Hungarites, Norites* and a "*Parakellnerites*-like" form called in this paper *Lardaroceras*? sp., aff *pseudohungaricum.*

The ***liepoldti*** **Subzone** is equivalent to the "*liepoldti* horizon" of Vörös (1993). It is defined between the beds No. 100 and 105 in Felsőörs and No. 9 and 14 in Vászoly and can be correlated with the interval 55.5 - 56.5 m in the Bagolino section. Its fauna is rather poor; the only characteristic element is the genus *Hyparpadites,* .with several species e.g *H. liepoldti, H.* sp., aff. *liepoldti,* and *H. bagolinensis* (*Kellnerites bagolinensis* in Brack and Rieber 1993, 1994). In one section in the Balaton area (Szentkirályszabadja: cf. Vörös 1993) the range of *H. liepoldti* shows large overlap with that of *Kellnerites felsoeoersensis.* For this reason Manfrin and Mietto (1995) and Kozur (1995a) cast serious doubt on the validity of a separate "*liepoldti* horizon". In fact, however, there is always, in almost all sections, an interval between the "LAD" of *Kellnerites* (s.s.) and the appearance of *Reitziites,* where almost nothing else than these strange forms, ornamented with four rows of nodes, can be found. Furthermore, this interval can well be correlated between Felsőörs and Bagolino. Therefore, for practical reasons, the use of *liepoldti* Subzone is maintained here, even if the index name is perhaps not fortunate.

Fig. 4. Diagrammatic presentation of the proposed ammonoid subzones and their correlation between some important sections of the Southern Alps and the Balaton area. The proposed Anisian/Ladinian boundary is used as the line of reference. Note that the correlation is perfect below and above the proposed stage boundary (base of the reitzi *Zone), whereas it is poor or impossible (at least for the Balaton area) at the* secedensis *base.* Chieseiceras chiesense *seems to be good guide fossil in contrast to* Eoprotrachyceras curionii.


SUBZONES
ZONES
SECEDENSIS
Avisianum
Reitzi
Liepoldi
REITZI
Felsoeoersensis
Pseudohungaricum
TRINODOSUS
Curnunum
Chiesense horizon
Eoprotrachyceras
LADINIAN
ANISIAN
2 m
Mencshely
condensed fauna of Avisianum Subzone + Secedensis Zone
Vászoly
reworked and mixed fauna of Avisianum Subzone + Secedensis Zone
Felsöörs
Stabol Fresco
Bagolino
Perica
M. San Giorgio
2 m

The ***reitzi*** **Subzone** is equivalent to the "*reitzi* horizon" in Vörös (1993). Its base is well defined in all sections of the Balaton area (e.g. at bed No. 105 in Felsőörs) and in Bagolino (at 56.5 m) with the appearance of *Reitziites reitzi* (and other, perhaps synonymous species of *Reitziites*). Among the accompanying faunal elements *Hungarites, Parakellnerites* ? *arthaberi, P. boeckhi* are worth mentioning.

The ***avisianum*** **Subzone** is intended to be substituting the "*costosus* horizon" of Vörös (1993) which latter is disqualified by the critics of Mietto and Manfrin (1995) and by the fact that it was partly based on a mixed fauna in the Felsőörs section (beds No. 111/A-H). The base of the *avisianum* Subzone is not well marked in the sections of the Balaton area, except the Mencshely section, where it was drawn by the appearance of the subzonal index at the bed No. -6. The lower boundary is not very clear in Bagolino, whereas in M. San Giorgio it can be put to the bed No. 41. Some of the South Alpine sections studied by Mietto and Manfrin (1995) (e.g. Punta Zonia) may give more definitive base for this Subzone. The fauna is characterized by *Aplococeras, Latemarites* and by the "acme" of the genus *Parakellnerites.* The presence of *Halilucites costosus* in this Subzone in the Balaton area suggests that this species is an early representative of the genus *Halilucites* diversified later, in the time of the *secedensis* Zone.

The ***secedensis*** Zone is not well represented in the Balaton area therefore neither its faunistic definition, nor its possible subdivision can be commented here. As for the base of the Zone, we accepted the opinion of Mietto and Manfrin (1995) i.e. to include the "*Ticinites* beds" (with *T. dolomiticus* + *T. brescianus* as possible synonyms of *T. crassus*) where the early, "*Nevadites* s.s." (*N. fedaiae, N. symmetricus*) appear. As for the name, we suggest to use the *secedensis* Zone (Brack and Rieber 1994) instead of "*Nevadites*" Zone (Mietto and Manfrin 1995) because the former is conform with the rules of the International Guide for Stratigraphical Nomenclature. (it is remarkable that, if the "*Nevadites* base" would win in a poll, one would have to organize another poll to decide that which *Nevadites* is the true.)

The *curionii* Zone is also not well known in the Balaton area. Though this Zone seems to have a definite "sequence stratigraphical" importance, its correlation seems to be not easy as the ammonoid biostratigraphy is concerned. The ammonoid fauna of this Zone is rather poor and its base is defined, in fact, solely by the index species *Eoprotrachyceras curionii* which is easy to recognize but sometimes difficult to find. In the Balaton area it was (rarely) found in the scree and never "in sequence" and even in the Southern Alps it was not found in some key sections (e.g. M. San Giorgio, Contrada Gobbia, Seceda: cf. Brack and Rieber 1993). Even Brack and Rieber (1994) and Brack et al. (1995) suggest to use the *Chieseiceras chiesense* horizon (immediately predating *E. curionii*) as a practical tool for defining the base of the *curionii* Zone. This procedure is, however, clearly not valid from theoretical point of view.

In conclusion, after discussing the three "official" alternatives of drawing the base of the Ladinian (1: base of the *reitzi* Zone, 2: base of the "*Nevadites*" Zone, 3: base of the *curionii* Zone) we have serious reservations concerning the second and third alternatives. *We maintain that both from theoretical (= priority) and from practical (= fossil content, correlation) points of view, the base of the* reitzi *Zone is the most suitable alternative for drawing the base of the Ladinian.*

Conodonts

The *trinodosus* Zone and the "*Lardaroceras* beds" in the Felsőörs section (below the top of the Felsőörs Limestone, i.e. below the bed No. 99/C) are characterized by *Gondolella constricta cornuta* of the *G. constricta* lineage (mostly adult forms, formerly discriminated as *G. cornuta*) and by *G. liebermani* of the *G. excelsa* lineage (true *G. excelsa,* otherwise common in coeval pelagic successions, is not present here).

The first appearance of primitive representatives of *G. constricta postcornuta* could be recorded in bed No. 5 in the Vászoly section (with *Lardaroceras,* one bed below the appearance of *Kellnerites*). Although the *constricta* lineage shows a low evolutionary rate, this datum seems to be close to the record by Nicora and Brack (1995) from the Bagolino section, apart from the uncertainty caused by the low number of specimens in the latter case. Typical specimens of *G. constricta postcornuta* appear, however, only from bed No.8 on in the Vászoly section.

The last record of *G. liebermani* was found in bed No. 12 in the Vászoly section, still below the "*reitzi* horizon".

The record of the *G. szabói* -- *G. trammeri* lineage begins with that of *G.* aff. *eotrammeri* also in bed No. 8 in the Vászoly section. However, the appearance of this lineage, including the *G. alpina* – *G. szabói* group, was evidently facies controlled in the Balaton area (this explains their different FAD at Bagolino, as recognized by Nicora and Brack, 1995).

The "*reitzi* horizon", for sedimentary reasons, cannot be satisfactorily evaluated for conodonts in the Balaton area (cf. Kovács et al., 1994).

The "*costosus* horizon" (*avisianum* Subzone), best represented by the six purplish red, crinoidal limestone beds (No. -6 to -1) in the Mencshely section, shows some important changes in conodont content, as compared to the above described lower part of the sequence. *G. constricta cornuta* and *G. liebermani* no longer occur. The LAD of *G.* aff. *eotrammeri* was found together with the FAD of *G. trammeri* in the lowermost bed (N. -6) of this part of the section. From here upward, *G. trammeri* of the *G. szabói* -- *G. trammeri* lineage and *G. fueloepi* of the *G. excelsa* lineage are quite characteristic of the whole succession, up into the *archelaus* Zone. Appearance of *Gladigondolella* from the base of this horizon indicates the establishment of full pelagic connections.

The newly exposed part of the Felsőörs section, between beds N. 112 (=0/86 in Kovács, 1993) and 1/86 should be still investigated for conodonts.

The clarification of the FAD of "*Metapolygnathus*" *hungaricus,* representing a very significant conodont evolutionary event, needs still further, more detailed conodont investigations of the relevant ammonoid-bearing horizons at Bagolino. It was found by Krystyn (1983) at the base of the *curionii* Zone at Epidauros. Kovács (1993) presumed, that this apparent coincidence was caused by a hiatus and proposed, that the true first occurrence could be higher up in the *curionii* Zone, and, in the lack of ammonoid control in this part of the Felsőörs section, indicated the lower part of the range of this species tentatively as "*recubariense* Horizon(?)" on the range chart. Nicora and Brack (1995), on the other hand, found it still higher in the Bagolino section, already in the *gredleri* Zone; however, this part of the section has been found particularly poor in conodonts. So, the position of this important conodont evolutionary event has remained unclear, so far.

Provided that the differences between the Balaton sections and Bagolino concerning the ammonoid and conodont distribution above the "*reitzi* horizon" may derive from differences in biofacies and depositional rates, it casts doubts on the so far proposed correlation between them (cf. Nicora and Brack, 1995, p. 61, 63). This difficulty, at present, does not permit a reliable choose one of them as GSSP, Bagolino having a better ammonoid control and the Balaton sections a generally better conodont control in this higher interval. It underlines, that their detailed comparative study and evaluation before voting is indispensable. Furthermore, according to these latest results, a possible definition of the A/L boundary either at the base of the (*Nevadites*) *secedensis* Zone or at the base of the *curionii* Zone would not be well supported by conodonts.

Radiolarians

The radiolarian faunas changed considerably at around the Anisian/Ladinian boundary. Great number of "Anisian" forms disappeared and a lot of new, "Ladinian" forms appeared. This boundary is marked by the appearance of such forms of worldwide distribution as the genera *Oertlispongus* and *Yeharaia,* furthermore the species *Triassocampe scalaris* and *T. deweveri.* In our knowledge, this turnover is the most conspicuous change in the history of Triassic Radiolaria and it is recognizable worldwide in the pelagic realm (cf. Kozur 1995).

The appearance of the above mentioned taxa coincides with the appearance of *Kellnerites* (i.e. with the base of the *felsoeoersensis* Subzone) (Dosztály 1993, Kozur and Mostler 1994). Within a short time, prior to the *"reitzi* datum" (i.e. the base of the Reitzi Subzone), the representatives of the family Oertlispongidae show a wide differentiation (the genera *Falcispongus and Baumgartneria* appear). In the Felsőörs section the appearance of the subspecies *Oertlispongus inaequispinosus inaequispinosus* coincides with the base of the *reitzi* Subzone.

Based on the new investigations, the *Oe. inaequispinosus* Zone can be divided into two subzones. The base of the lower subzone coincides with the base of the *felsoeoersensis* Subzone, whereas the base of the upper subzone agrees with the base of the *reitzi* Subzone.

	ZONES	SUBZONES
LADINIAN	*Oertlispongus inaequispinosus*	*Oertlispongus inaequispinosus inaequispinosus*
		Spongosilicarmiger italicus transitus
ANISIAN	*Archaeospongoprunum mesotriassicum*	

From the point of view of radiolarian stratigraphy, the bases of the *secedensis* and the *curionii* Zones cannot be recognized, therefore none of them can practically be used as the base of the Ladinian. Any deviation from using the base of the *reitzi* Zone as the base of the Ladinian would arise the old problem of the radiolarian stratigraphy, namely that it would be impossible to distinguish the latest Anisian and earliest Ladinian faunas (cf. Ramovš and Goričan 1995).

Conclusions

Recent collections and investigations made in the last years in the Middle Triassic sections of the Balaton area, first of all at Felsőörs, filled some gaps of knowledge in the Ladinian ammonoid succession. The uppermost part of the *secedensis* Zone has been proved by finding *Chieseiceras chiesense* and "*Stoppaniceras*" ex gr. *ellipticus.* On the other hand, the uppermost part of the *reitzi* Zone (*avisianum* Subzone) and the large part of the *secedensis* Zone, though the diagnostic faunal elements (*Aplococeras avisianum, Parakellnerites* spp., *Ticinites* ? *hantkeni, T. crassus, Halilucites* spp.) do occur, is represented by condensed and/or mixed faunas. *Eoprotrachyceras curionii* has nowhere been found in sequence.

The results of the previously made conodont investigations have been reevaluated, taking into consideration the latest results from the Southern Alps, and a joint interpretation of ammonoid and conodont evolutionary events has been done in the Felsőörs section being completed with the Vászoly P-11/a and Mencshely sections.

Radiolarian investigations lead to important new results in the Felsőörs and Mencshely sections. A very remarkable turnover of the radiolarian faunas can be recorded near the base of the *reitzi* Zone: an extremely rich and characteristic assemblage appears in the *felsoeoersensis* Subzone.

A short analysis and discussion of the recent results, opinions and proposals published in the last years in the matter of the Anisian/Ladinian boundary lead to the conclusion that:

(1) From the point of view of ammonoid biostratigraphy we have serious reservation sconcerning the second and third alternatives from among the three "official" alternatives of drawing the base of the Ladinian (1: base of the *reitzi* Zone, 2: base of the "*Nevadites*" Zone, 3: base of the *curionii* Zone). We maintain that both from theoretical (= priority) and from practical (= fossil content, correlation) points of view, the base of the *reitzi* Zone is the most suitable alternative for drawing the base of the Ladinian.

(2) A possible definition of the base of the Ladinian either at the base of the *secedensis* Zone or at the base of the *curionii* Zone would not be well supported by conodonts. On the other hand, the base of the *G. constricta postcornuta* lineage zone nearly coincides with the base of the *felsoeoersensis* Subzone and can be correlated between the Balaton Highland and Bagolino.

(3) The radiolarian faunas show a distinct change near the base of the *reitzi* Zone (*felsoeoersensis* Subzone). This turnover is the most conspicuous change in the history of Triassic Radiolaria and it is recognizable worldwide in the pelagic realm, consequently it is an excellent tool for correlation. On the other hand, the bases of the *secedensis* and the *curionii* Zones cannot be recognized by radiolarians, therefore none of them is suggested to be used as the base of the Ladinian.

(4) According to the present knowledge, the second and third alternative (bases of the *secedensis* and *curionii* Zones, respectively) would remain largely unrecognizable in continental deposits (no palynomorph control) and in the widespread Tethyan platform carbonate successions (being most probably well above the major change in dasycladacean associations).

Therefore, if the complex biostratigraphical approach is requested, the base of the *reitzi* Zone (*felsoeoersensis* Subzone) is the most suitable candidate for being the base of the Ladinian. In this case, the Felsőörs section is an excellent candidate for being a GSSP because it is easily accessible and the necessary complex biostratigraphical study of the critical interval has been made which can be complemented by any further investigations (e. g. paleomagnetism).

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IN MEMORIAM

KÁLMÁN BALOGH (1915-1995)

On 6th April 1995, Professor Kálmán Balogh, former member of the IUGS Triassic Subcommission, died in the 80th year of his life. The outstanding specialist of the Late Palaeozoic and Triassic of Hungary was the master of numerous younger geologists, several of whom having been specialized to different aspects of the Triassic research.

He graduated at the University of Debrecen. As a student, then the assistant of Professor Károly Telegdi-Róth, he gained an excellent geological knowledge. He received his doctorate on the study of the Triassic of the South Gemer area in 1940. Subsequently, he continued his researches at the Hungarian Geological Institute. At this time, the main field of his activity was the geological mapping of the mountains in NE Hungary, made up to a great extent of Triassic rocks: first, in the Aggtelek-Rudabánya Mountains, then - together with his younger colleagues - in the Bükk Mountains. In this area, his work culminated in 1961, in a D.Sc. thesis on the geology of the Bükk Mountains, published in 1964. This - internationally known - book with the detailed description of the Upper Carboniferous, Permian and Triassic formations of the mountains served as a sound basis for subsequent researches. Besides mapping, he carried out palaeontological studies on Triassic brachiopods, bivalves and - after a training of Professor Julius Pia (Vienna) - also on dasycladaceans. In addition to his scientific work, he was the Director of the Geological Institute for a short time and, subsequently, the Editor-in-Chief of a lot of geological maps.

In 1966, he left the Geological Institute and became a professor of geology and palaeontology at the University of Szeged. Besides his continuous research activity on the Triassic formations, Professor Balogh became the founder of modern sedimentology in Hungary and published important contributions on the tectonics of the country. Also, he initiated the studies on dasycladacean algae, sphinctozoan sponges and conodonts in Hungary, a work continued by his students.
Although he retired from his job at the University of Szeged in 1977, he never retired as a geologist. He returned to the Hungarian Geological Institute as a scientific advisor, helping the new geological mapping project in NE Hungary, teaching his young colleagues and supervising their work with great care.

Professor Kálmán Balogh acted as a corresponding, then ordinary member of the IUGS Subcommission on Triassic stratigraphy from 1972 to 1982 and, contemporaneously, the Chairman of the Triassic Subcommission of the Hungarian Stratigraphic Committee from its establishment till 1983. Mainly for his initiation, as a leader of the Hungarian group, the workshop of IGCP Project No. 4 ("Triassic of the Tethys realm") was organized in Hungary in 1978, attended by most members of the STS (although a formal meeting of the Subcommission was not held). The field trip of the workshop was devoted to the classical Triassic sections of the Balaton Highland. In fact, this meeting was the resurgence of the activity of Hungarian researchers in this area, which resulted 15 years later in the joint Italian-Hungarian field trip focused on the Anisian/Ladinian boundary problem in the Southern Alps and on the Balaton Highland, and the "fruits of which are just now ripening" in the voting of the STS about the A/L boundary.

Professor Balogh made a lot of efforts to introduce the Triassic of Hungary for the international scientific community. The results of his work were presented in a comprehensive review "Correlation of the Triassic of Hungary", published in 1981.

He worked very actively up to the last moment of his life. Though he himself published no more contributions on the Triassic, he participated in the discussions of the Hungarian Triassic workers with full enthusiasm, lending a helping hand wherever he could. In the middle of his 70's, his scientific activity was crowned by three voluminous, well-illustrated text-books on sedimentology, edited - and most chapters also written - by him.

For the outstanding scientific work and achievements, he was awarded with the highest scientific prize of Hungary, "the Széchenyi Prize", in 1995, presented at the occasion of the national day in the Parliament. On 15 March, in the TW News, the whole country witnessed the tragedy of an old, greatly honoured scientist: during the awarding ceremony, his "golden heart" refused to act any more and he was not able to take over the prize.

With the death of Kálmán Balogh the Hungarian and international earth sciences have lost an outstanding scientist. Besides his family, friends, colleagues, and students, his memory will be kept also by the Hungarian and international scholars of the Triassic.

Sándor Kovács and János Haas

THE NEW *"HIGH RESOLUTION MIDDLE TRIASSIC AMMONOID STANDARD SCALE"* PROPOSED BY TRIASSIC RESEARCHERS FROM PADOVA - A DISCUSSION OF THE ANISIAN / LADINIAN BOUNDARY INTERVAL

P. Brack and H. Rieber

Introduction

Following a recent I.U.G.S. workshop on the Anisian/Ladinian boundary (for results on ammonoid biostratigraphy see Gaetani [Ed.], 1993; Brack and Rieber, 1993; Vörös, 1993) several Trias researchers of the University of Padova (hereafter referred to as the Padova Group, PG) have published a number of articles (De Zanche et al., 1993, 1995; De Zanche and Gianolla, 1995; Manfrin and Mietto, 1995; Mietto and Manfrin, 1995) introducing a new *"high resolution Middle Triassic ammonoid standard scale in the Tethys Realm"*. In a recent letter Mietto and Manfrin (1996) further explained their view on the Anisian/Ladinian boundary. The new scale was anticipated several years earlier (see Mietto and Manfrin, 1995, p. 559 for its history), but only since issue n.15 of ALBERTIANA (1995) has information been made available on its biostratigraphic basis. Nevertheless for reasons unknown to the present writers, the "Padova standard" has been adopted for a recent Mesozoic time scale by Gradstein et al. (1994).

Unfortunately no member of the PG participated in the above mentioned 1993 field-workshop on the Anisian/Ladinian boundary. The purpose of this meeting was to discuss the boundary problem by visiting and comparing some of the most important boundary sections in the Southern Alps and

Hungary. The main result of this field-meeting was the recognition of a relatively detailed and coherent ammonoid succession throughout the Anisian/Ladinian boundary interval. For the first time a precise positioning, within the wider reaching South Alpine ammonoid record, was made possible for the so-called "*reitzi* fauna", known from Hungary for more than a century. In ALBERTIANA, 12, Gaetani (1993) gave a brief account of the field-workshop. The correlation of fossils between the two areas was schematically illustrated in a figure which was by no means meant to represent the range of ammonoids. Detailed logs and fossil data with their real distribution were provided in the field-guide booklet (Gaetani [Ed.], 1993) and further discussions and updates (e.g., Brack and Rieber, 1993, 1994; Brack et al., 1995; Vörös, 1993).

Subsequently a number of conclusions regarding the ammonoid biostratigraphy of the Anisian/ Ladinian boundary interval (i.e., the time between the *trinodosus* Zone below and the *curionii* Zone above) and, in particular, the summary figure by Gaetani (1993) have been challenged by statements in Manfrin and Mietto (1995). Moreover, the PG made critical comments on several of our fossil determinations and interpretations, which we feel are unjustified or incorrect. Because the boundary discussion has reached a critical phase, in this discussion we shall focus on some of the most relevant points made in recent publications by the PG. After some indications on the original definition of the 'Buchenstein Beds' we will briefly comment on stratigraphic sections and correlations, on illustrated fossils and determinations of ammonoids, and finally on the biostratigraphic subdivision provided by the PG.

We fear that the introduction of a great number of new zone/subzone labels, without full discussion of the biostratigraphic basis, has unnecessarily brought confusion in an already delicate matter. Furthermore, we think that the new data collected by the PG largely support our previous conclusions. While we refrained from formal subdivision of our *reitzi* and *secedensis* ammonoid zones, the PG supports a subdivision of an equivalent biostratigraphic record into zones and subzones (instead of horizons).

'Buchenstein Beds'

In their contribution to *"a clear stratigraphic setting"* De Zanche and Gianolla (1995, p. 75) state, that *"the Buchensteiner Schichten were defined by von Richthofen (1860, p. 65) in the Southern Alps, in the Livinallongo area ... and not near Pufels ... as suggested in Brack and Rieber (1993, p. 425) ...."*. On the basis of the original indications by Richthofen (1860) as summarised below we disagree with De Zanche and Gianolla.
In his chapter *"Gliederung der Sedimentärgebilde"* Richthofen (1860, p. 45ff.) first says: *"Schichtentblössungen und deutliche Profile sind in Süd-Tyrol häufig, doch übertrifft keines an Vollständigkeit und Klarheit das der Seisser Alpe, das wir daher als Ausgangspunkt wählen"*. He then mentions that *"am geeignetsten zur Untersuchung ist die Pufler Schlucht..."* and subsequently describes in detail the *"Sedimentären Schichten der Seisser Alp"* subdividing the succession along the Pufels creek into lithological units n. 1-19. Following this description he continues on p. 43 *"Da das Schichtsystem der Seisser Alp den grössten Teil der südtyrolischen Sedimentgebilde in sich vereinigt, so können wir die* ***Gliederung derselben*** *unmittelbar an das eben analysirte Profil anknüpfen. Die verschiedenen* ***Abtheilungen ergeben sich gerade hier sehr deutlich,*** *sowol vom paläontologischen, als vom petrographischen und stratigraphischen Gesichtspunkt"*. On p. 45 he indicates the previously described strata *"No. 12-13"* from the Pufels gorge as the ***"Buchensteiner Kalke*** *(12,13), so genannt nach ihrem Vorkommen unter dem Schloss Andraz oder Buchenstein am Cordevole-Bach"*. In a later chapter on the ***"Schichten von Buchenstein"*** (p. 64-66) he again first refers to the stratigraphic succession of the *"Seisser Alpe"* and only then mentions that *"in typischer Entwicklung treten sie* (i.e., the 'Buchenstein Beds') *in der Nähe des alten Castells Buchenstein auf"*.

From these statements it is sufficiently clear, that Richthofen (1860) defined his formal subdivision of the *"südtirolischen Sedimentgebilde"* on the basis of the succession around *"Seisser Alpe"*. The term **'Buchenstein'** was thus introduced for a distinct stratigraphic interval of the Pufels section although the name was clearly derived from elsewhere *("Castell Buchenstein")*. However, for the latter locality Richthofen merely mentions the typical development *("typische Entwicklung")* without providing any further lithological characterisation, a section or fossil data. Therefore, we still consider the Pufels gorge as the locus of the first definition of the 'Buchenstein Beds'.

Sections and correlations

Of the numerous sections studied by the PG (Mietto and Manfrin, 1995, Fig. 4) in the Anisian/ Ladinian boundary interval only a few non-condensed sections span more than two subzones. A small number of these sections have been illustrated to date in some detail by De Zanche et al. (1993, Figs. 10,13; 1995, Fig. 3). In contrast to the high resolution claimed by these authors the graphs, unfortunately, allow neither the identification of layers on a bed-scale nor a precise correlation with our previously published logs from partly identical sections (Val Gola, Seceda, see Brack and Rieber, 1986, 1993).

Bagolino - Punta di Zonia (Cernera)

For the ammonoid faunal succession at the Anisian/Ladinian boundary Mietto and Manfrin (1996) believe *"the critical interval to be the* avisianum *Subzone - basal* crassus *Subzone, which ... is not well documented in Bagolino"* and they *"wish ... to demonstrate that the real succession of ammonoids in the interval between the* Reitziites *LAD and the* Nevadites *FAD is not documented there, as supposed until now"*. We do not understand why the PG supposed a better record for Bagolino. Brack et al. (1995, p. 50) wrote explicitly that *"only few macrofossils (*Hungarites zalaensis, Parakellnerites *sp.) could be extracted from the lowermost two metres of typical siliceous 'Knollenkalke' (58-60m-interval at Bagolino)"*. The same few fossils were indicated also in earlier graphs from this section.

The approximately 2.5 m thick interval between the *Reitziites* layers and the *Ticinites* horizon at Bagolino which may largely correspond to the *avisianum* Subzone of the PG is indeed poor in fossils. However, correlative sections at Monte San Giorgio and Seceda (see Brack and Rieber, 1993) provide a reasonable record of ammonoids and Daonellas, for a large part of this time interval. In our opinion this record and its close ties to pelagic successions is far better than the data indicated to date by Mietto and Manfrin (1996) for Punta di Zonia on the northern slope of the Cernera platform (central Dolomites). The latter section suggested by these authors as a *"comparative section"* has several serious drawbacks such as the poor and unclear exposure of its lower portion, the limited stratigraphic range and the condensation of its upper portion. Mietto and Manfrin (1996) call it *"a complicated stratigraphical situation"*. Indeed Punta di Zonia corresponds to a particular setting on the slope of a carbonate platform with relatively little accumulation of platform debris but far from being a truly pelagic section reflecting continuous quiet sediment accumulation. Regarding the ammonoids mentioned from this locality for the time being doubts arise about the occurrence of unambiguous *Kellnerites*. Contrary to Manfrin and Mietto (1995, p. 28) we do not think that these fossils question the distribution of *Kellnerites* and *Reitziites* at Bagolino. Moreover, from our experience in the Southern Alps, Aplococeratidae preferentially occur in close proximity of carbonate platforms. Also because of their poor and sometimes variable ornamentation different forms of the genus *Aplococeras* are not well suited for detailed correlation. Nevertheless it would be of great interest to study the presumably rich fauna that must have been recovered from the upper part of the actually exploited Punta di Zonia locality.

Bagolino - Seceda - Ru Sec (Dont)
We disagree with De Zanche and Gianolla (1995, p. 79) according to which the 'Plattenkalke' at Seceda may not correspond partly to the 'transitional beds' at Bagolino. Contrary to what is mentioned by these authors their correlation lacks any direct biostratigraphic support because to our knowledge not a single age-diagnostic macrofossil has been reported from the lower two thirds of the 'Lower Plattenkalke' in the Dolomites. However, palynomorphs from this interval at Frötschbach in the northwestern Dolomites (Brugman pers. comm., in Brack and Rieber, 1993) match those of the '*reitzi* tuffs' at Balaton whose equivalents are indeed found in the 'transitional beds' at Bagolino.

De Zanche and Gianolla (1995, p. 79) further suggest that *"the uppermost centimetres of the 'transitional beds' at Bagolino ... correspond to tens of metres of a succession (Bivera Fm. p.p. and Ambata Formation) rich in ammonoids in the Dolomites"* testifying *"... in eastern Lombardy if not a hiatus, at least an extremely low sedimentation rate"*. On the basis of their illustration of the Ru Sec section near Dont (De Zanche et al., 1995, Fig. 3) and according to our own observations made at this locality, the abundance and spectrum of ammonoids is not such as to allow a sufficiently precise correlation with eastern Lombardy and Giudicarie. This is also hampered because the uppermost 'transitional beds' in the latter areas have as yet yielded only a few ammonoids (*Parakellnerites arthaberi* at Bagolino, *Aplococeras avisianum* at Prezzo; Brack et al., 1995, Fig. 3). Thus for Bagolino we have no clear indication for a hiatus within the uppermost 'transitional beds' although the rate of sediment accumulation was certainly low. On the basis of the recent illustrations as indicated below we have serious doubts as to whether *Reitziites* is unambiguously proven for Ru Sec. Nevertheless the transition between the Bivera Fm. to the Ambata Fm. in this section does presumably represent a time interval corresponding to a part of the *reitzi* Zone.

Cima di Valsorda (Latemar)
Doubts arise about the precise stratigraphic collocation of some ammonoid localities at Cima di Valsorda within the platform carbonates at Latemar (De Zanche et al., 1995, Fig. 5). As outlined below we do not think that the reported ammonoids (and our own material from presumably the same spots discovered by A. Peterhänsel and S. Egenhoff from Heidelberg) are as yet clearly age-diagnostic. Moreover, the Torre di Pisa and adjacent tower (with fauna TP9) belong to a narrow slab of 'Tepee facies' (sensu Goldhammer et al., 1993) in a position between igneous dykes that has been lowered by some 10's of metres with respect to the coherent Cima di Valsorda unit. The effective stratigraphic interval represented by faunas TP9 to L3 in De Zanche et al. (1995) is therefore presumably smaller than the hundred metres suggested by these authors.

Ammonoids and their determinations

On several occasions the PG has emphasised the *"great number of data"* and *"the very large quantity of ammonoids"* providing the basis for their conclusions. Nothing was stated, however, about the quality, the distribution and occurrence of this wealth of fossils. To date the material can be judged only by the illustrations given in Mietto and Manfrin (1995) and in a paper on the Latemar stratigraphy by De Zanche et al. (1995). Several specimens are illustrated in both papers. With some surprise we noticed that a significant number of ammonoids in De Zanche et al. (1995, Pl. 1-3) are from old collections, from blocks not found in situ (e.g., Forno, Margreid, Penon) or from localities with vague stratigraphic position (e.g., Viezzena, Pian dei Fiacconi, La Grea).
The explanation for the striking differences in the stratigraphic ranges of key-genera shown in Fig. 1 of Manfrin and Mietto (1995) when compared with Fig. 13 in Brack and Rieber (1993) lies, in our opinion, mainly in divergent determinations rather than effectively different stratigraphic occurrences in the Southern Alps. However, several ammonoids illustrated in Mietto and Manfrin

(1995) and De Zanche et al. (1995) are difficult to verify. This is mainly because essential taxonomic and diagnostic features such as the external sides of specimens are not shown. In the following we shall therefore comment briefly on the most important fossils, in roughly ascending order of their stratigraphic appearance within the Anisian/Ladinian boundary interval:

- A clear and objective subdivision of the genera ***Lardaroceras, Hungarites*** and ***Parakellnerites*** is in many cases difficult. With few exceptions, precise correlations based on representatives of these genera are hampered. A comprehensive description of the Ceratitidae and Hungaritidae of the *reitzi* and *secedensis* Zones is still required to get a better idea of similar species but with different stratigraphic ranges.
  Our material from Cima di Valsorda at Latemar suggests that *Parakellnerites* and/or *Hungarites* from this locality are subtly different from those of the stratigraphically older 'Lastei di Valsorda' outcrop mentioned in Brack and Rieber (1993). Unfortunately ammonoids such as *Halilucites* cf. *rusticus* indicated for Cima di Valsorda by De Zanche et al. (1995, p. 144-145) and which might provide a better assessment of the age of these faunas at Latemar were not illustrated. We can only regret that De Zanche et al. (1995, p. 144) have never contacted us for obtaining more precise information on the location of the Lastei outcrop (Brack and Rieber, 1993, p. 444: footnote n.17).

- On the basis of detailed logs from Balaton (Vörös, 1993; Gaetani [Ed.], 1993) we are not aware of any overlap of ***Kellnerites*** (*felsoeoersensis* gr. of Vörös, 1993) and ***Reitziites*** with the exception of a *"curious* Kellnerites *with* Reitziites-*like ornamentation but still with ventral keel"* (Vörös, 1993, p. 27). This is in perfect agreement with our observations at Bagolino, but contrary to what was stated by Manfrin and Mietto (1995, p. 28). At Bagolino only *Kellnerites bagolinensis* and a single unpublished *Reitziites*-like *Kellnerites* were found in the lower *Reitziites* horizon (56.60m-level). The affiliation of the former species to *Kellnerites* instead of *Hyparpadites* is unquestioned for reasons given in Brack and Rieber (1993, p. 471).
  Specimens such as their *Reitziites reitzi* (De Zanche et al., 1995, Pi. 2/Fig. 4; Mietto and Manfrin, 1995, Pi. 2/Fig. 7) are difficult to evaluate and provide, in our view, no unambiguous proof of the occurrence of this species at Ru Sec.

- ***"Megaceratites" friccensis*** is a key ammonoid for the PG, although it is unclear why Mietto and Manfrin (1995, p. 550) consider this ammonoid group as *"more representative"* than *Reitziites reitzi. "Megaceratites" friccensis* does certainly not belong to *Megaceratites* BALINI (1992). Outsides the Valsugana area it is indicated to occur at Fosso Sercolo in the Chiese Valley of eastern Lombardy (De Zanche and Gianolla, 1995, p. 79; Mietto and Manfrin, 1995, p. 552). We suppose that Fosso Sercolo corresponds to a creek south of the village Nozza. At this locality rather untypical nodular limestones, equivalent to the Prezzo Limestone and possibly including parts of the 'transitional beds', are only poorly exposed. Interestingly along the northern flank of the Monte Colmo anticline (including Fosso Sercolo), turbiditic 'Wengen Beds' follow directly on top of the former succession. The entire stack of 'Buchenstein Beds' is missing, but for as yet unknown reasons. Provided Fosso Sercolo as indicated above corresponds to the locality mentioned by the PG, the precise level of *"Megaceratites" friccensis* at Fosso Sercolo remains unclear.
  The stratigraphic position of *Stoppaniceras golanum* at Val Gola (Brack and Rieber, 1986, 1993), and its co-occurrence with *"Megaceratites" friccensis* at Passo della Fricca (Mietto and Manfrin, 1995, p. 552), might indicate a slightly younger stratigraphic position of the latter ammonoid species, i.e., close to the base of the *secedensis* Zone.

- Various species of Aplococeratidae are considered to be of crucial importance for correlation by De Zanche et al. (1995), Manfrin and Mietto (1995), Mietto and Manfrin (1995). Due to the variable ornamentation of our specimens of different sizes and from different locations and

stratigraphic levels, we consider these forms as indicative at best. In their correlation of the South Alpine ammonoid record with Nevada, Manfrin and Mietto (1995, p. 32) largely rely on the comparison of Aplococeratidae.

- The concept of Manfrin and Mietto (1995) and Mietto and Manfrin (1995) regarding the taxonomy of the genus *Ticinites* is unclear. We maintain that what we referred to as *Ticinites* occupies a rather restricted time interval. We do not believe that *"Ticinites hantkeni"* from the *Reitziites* layers at Balaton (= *Nevadites ? hantkeni* in Vörös, 1993) belongs to the genus *Ticinites* from the Southern Alps. Moreover, the inclusion of our *Ticinites* from the Brescian Prealps and Seceda (*T. brescianus, T. dolomiticus*) into *Ticinites crassus* is certainly incorrect. The type of *Ceratites crassus* HAUER, actually kept at the Natural History Museum of Vienna, is from Han Bulog limestones near Sarajevo (Hauer, 1896) and shows a significantly different ornamentation. Its exact stratigraphic position is unknown.

- The generic affiliation of the *Nevadites* sp. specimen from Prezzo (Brack and Rieber, 1986, Pi. 4/Fig. 1-2) is justified. Its inclusion into the genus *Ticinites* as suggested by Manfrin and Mietto (1995, p. 29) would significantly enlarge the frame of this genus. In any case this ammonoid is different from the type of *Ceratites crassus* HAUER, contrary to what we thought initially (Brack and Rieber, 1986, p. 201). We maintain that this is the oldest *Nevadites* known to date from the Southern Alps.
  In an earlier publication (Brack and Rieber, 1994, p. 34) we indicated that specimens of *Nevadites* from the Southern Alps might be slightly different from *Nevadites* in Nevada. In our recently collected material from Nevada more forms appear to be present than what is evident from the illustrations by Silberling and Nichols (1982). The stratigraphic ranges of the genus *Nevadites* and *Paranevadites* probably need supplementary studies. First steps in this direction have been made by Bucher and Orchard (1995).
  In view of these problems, and taking into account the unconstrained stratigraphic position of ammonoid horizons in platform carbonates at Plan dei Fiacconi (Marmolada) where small specimens occur of what Manfrin and Mietto (1995) and Mietto and Manfrin (1995) consider *Nevadites* s.s., the subdivision of South Alpine *Nevadites* suggested by these authors appears to be premature.

- The recognition of ***Chieseiceras chiesense*** being not confined exclusively to a thin biohorizon (Manfrin and Mietto, 1995, p. 30) is not new. Its distribution at Biogno and Marcheno (see Fig. 7 in Brack and Rieber, 1986) clearly shows that this ammonoid was found in a stratigraphic interval up to at least 0.5 m thick.
  The specimen of *Chieseiceras chiesense* illustrated in De Zanche et al. (1995, Pl. 3/Fig. 7) and in Mietto and Manfrin (1995, Pl. 3/Fig. 8) is identical with the ammonoid from the De Toni collection at Padova we referred to some time ago (Brack and Rieber, 1986, p. 197). The new label DT.VDP obviously stands for "De Toni, Valdepena".
  The specimen of *"Protrachyceras recubariense"* reported by Urlichs (1978) from the *spinosus* Zone in the 'Oberer Muschelkalk' of southwest Germany is by no means a *Chieseiceras chiesense* as suggested by Mietto and Manfrin (1995, p. 556), but rather comparable with *Nevadites*.

Biostratigraphic subdivision of the Anisian/Ladinian boundary interval

We suspect, that for the Anisian/Ladinian boundary interval the higher resolution suggested by the "Padova standard" is illusory. The main difference with our own scheme is a more detailed subdivision into ammonoid subzones, which we considered inappropriate based on currently available fossil material. Nevertheless the biostratigraphic data in both cases are probably compatible.

Because two zone boundaries of the "Padova standard" obviously differ from definitions of previously used zones a few comments shall be made in this paragraph on the appropriateness of the boundary collocations and labels used for zones and subzones.

Mietto and Manfrin (1995) prefer generic names for ammonoid zones and names of species for subzones. In view of the uncertainties with some generic affiliations (e.g., South Alpine *Nevadites*) this practise is at best questionable (Brack and Rieber, 1994, p. 30). The *Hungarites* Zone of Mietto and Manfrin (1995) approximates our *reitzi* Zone and their *Nevadites* Zone corresponds roughly to our *secedensis* Zone. However, in each case the lower zone boundaries do not coincide precisely.

Ammonoid Zones

Mietto and Manfrin (1995, p. 550) define the base of their *Hungarites* Zone with the *"first appearance of a new genus (n. gen.* B.*), related to* Hungarites*"*. This would split the *'Lardaroceras* beds' of Balini et al. (in Gaetani [Ed.], 1993) into a lower portion, to be included in the *Paraceratites* Zone, and an upper portion, to be merged with the subsequent *Hungarites* Zone. Moreover, this boundary position lies stratigraphically deeper than the first appearance of true *Kellnerites*. Representatives of *Kellnerites* are much easier to identify, however, and were therefore chosen to mark the base of the *reitzi* Zone (Brack and Rieber, 1993, 1994; Brack et al., 1995) in agreement with the corresponding boundary at Balaton (Vörös, 1993)!

The base of the *Nevadites* Zone in Manfrin and Mietto (1995) and Mietto and Manfrin (1995) is somewhat ambiguous. The lower boundary is defined by the appearance of the index genus (i.e., *Nevadites*), but in no section illustrated to date by the PG is this event clearly pinpointed. Pian dei Fiacconi, which is indicated as the type locality of the *crassus* Subzone, is an isolated locality within platform interior carbonates whose upward and downward extensions are not visible. Other sections such as La Grea (south of Col Mer on the Marmolada north slope) are unclear (tectonised thin red nodular and possibly condensed limestones between platform carbonates) and the co-occurrence of *Ticinites* and *Halilucites* (De Zanche et al., 1995, p. 148) may not be representative. *Halilucites* was not found by us at this locality (see also Blendinger, 1994, p. 1152). This could explain the awkward collocation by Manfrin and Mietto (1995) and Mietto and Manfrin (1995) of *Ticinites* from Monte San Giorgio to the older *Hungarites* Zone and of the *Ticinites* of eastern Lombardy and the Dolomites to the younger *Nevadites* Zone. The *Ticinites* horizons at Monte San Giorgio (bed 58) and at Seceda both follow immediately on top of the occurrence of *Daonella elongata*. Supported further by our correlation of volcaniclastic layers, we see absolutely no indication for a substantial time difference between the *Ticinites* horizons at these two localities (see Fig. 11 in Brack and Rieber, 1993).
We maintain, that the base of the (*Nevadites*) *secedensis* Zone is identified by the first occurrence of a *Nevadites* sp. which is at Prezzo, in a level immediately below the Tc-tuffs and corresponding to the 60.7 m-level at Bagolino.

The base of the *curionii* Zone with the first occurrence of *Eoprotrachyceras* still remains uncritical.

Subzones

As mentioned above, we have previously refrained from giving a more detailed formal subdivision of the *reitzi* and *secedensis* Zones into subzones. The "Padova standard" (Mietto and Manfrin, 1995) instead provides two subzones for each of the roughly equivalent intervals. Of these we consider terms such as *avisianum* Subzone, *crassus* Subzone, *serpianensis* Subzone, and their respective type-localities (Punta di Zonia, Plan dei Fiacconi, Monte San Giorgio) as inadequate. Not only are the index fossils *Aplococeras avisianum* (MOJSISOVICS), *Ticinites crassus* (HAUER) and *Serpianites serpianensis* (AIRAGHI) uncommon in pelagic records (*Aplococeras, Serpianites*) or of unclear position (*Ceratites crassus* from Han Bulog limestones in Bosnia), but also the designated

type-localities do not correspond to truly pelagic successions (platform flanks and tops and platform interior depressions). The '*avisianum* Zone' was reestablished by Assereto (1969) but in a position below the *reitzi* Zone. This has created much confusion in past and the term is therefore better abandoned.

For the Ladinian portion of the "Padova standard" we only indicate that the *gredleri* and *longobardicum* Subzones are largely based on data from condensed red nodular limestones (Clapsavon Lst.) in the easternmost Dolomites and western Carnia. In eastern Lombardy and Giudicarie *Frankites regoledanus* (i.e., the index species of the *regoledanus* Subzone of the "Padova standard") first appears only slightly above the top of the 'Buchenstein Beds'. This might suggest that the time span between the *margaritosum*-level and the *regoledanus* Zone could be relatively short.

Conclusions

In spite of the critical comments made by the PG we are still convinced that correlations based on ammonoids between the Balaton sections and successions in eastern Lombardy and Giudicarie are acceptable up to and including the *Reitziites* horizons as outlined in Gaetani (1993). Recently Vörös (1995) indicated new ammonoid finds (*'Ticinites', Chieseiceras*) in layers above the *costosus* horizon at Felsoörs.

Based on the available illustrations, the fossil record of the PG appears to be largely compatible with our own data. It is mainly their biostratigraphic subdivision, and its present state of documentation, which are disputable. We hope that the announced final monograph by Mietto and Manfrin will soon become available and contribute to further clarification of the determination of quoted ammonoids and of the biostratigraphic subdivision.

In the Southern Alps the range of the ammonoid record in the fully pelagic section at Bagolino is still unchallenged. Indeed Mietto and Manfrin (1996) do not indicate alternative sections. It is evident that certain intervals are clearly better represented at Bagolino, whereas other localities have yielded additional ammonoids to corresponding layers at Bagolino. Because of the apparent facies dependence of certain fossils it is unrealistic, however, to expect a complete record of all age-equivalent ammonoids in just one section.

For reasons given in our previous publications (Brack and Rieber, 1993, 1994; Brack et al., 1995) we continue to support the Anisian/Ladinian boundary position at the base of the *curionii* Zone. In all recent discussions of the boundary problem, this is the most stable, and only, marker whose identity and definition has neither been questioned nor changed.

We do not understand why Manfrin and Mietto (1995, p. 28) consider the "Parakellnerites + Hungarites *s.s. beds ... to be the most important interval for the definition of the Anisian/Ladinian boundary"* if this is *"at the same time the least well defined"*. Although Manfrin and Mietto (1995, p. 34) and Mietto and Manfrin (1996) clearly support the base of the *Nevadites* Zone for the boundary collocation they suggest at least one new potential position, i.e., the base of their *avisianum* Subzone. Yet another recent proposal for the stage boundary by Kozur (1995) propagates the base of *Reitziites reitzi* Zone, s.str. with the first occurrence of *Reitziites*.

Rather than being simplified the complexity of the discussion of the Anisian/Ladinian boundary is still increasing although the ammonoid record fortunately seems to stabilise.

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MAGNETO-BIOSTRATIGRAPHY OF THE 'BUCHENSTEIN BEDS' AT FRÖTSCHBACH (WESTERN DOLOMITES, ITALY)

G.Muttoni, D.V. Kent, A. Nicora, H. Rieber and P. Brack

Introduction

In this short contribution we present preliminary results on the magneto-biostratigraphy of the Anisian/Ladinian boundary interval at Frötschbach in the Dolomites of northern Italy. The interdisciplinary research carried out at this and on other coeval sections such as Aghia Triada and Vlichos on Hydra island, Greece (Muttoni et al., in prep.) is aimed at correlating in detail the well-known Tethyan biozonation to a geomagnetic polarity sequence of reversals for the construction of a standard Triassic time scale.

Location of Frötschbach section and lithologies

The Frötschbach section near Seis in the western Dolomites (Fig. 1) was recorded in outcrops close to trail n.1a between Bad Ratzes and Prossliner Schwaige on the way to Seiser Aim. Its trace follows the exposure along the trail (lower part, 0-23 m) and a nearby southern tributary of the Frötschbach creek (upper part, 24 m ff.); both portions are separated by a small fault with a vertical displacement of less than eight metres. As a result of a recent heavy storm water the basal section ('Lower Plattenkalke') is now fully exposed along the Frötschbach creek in the bottom of the main valley.

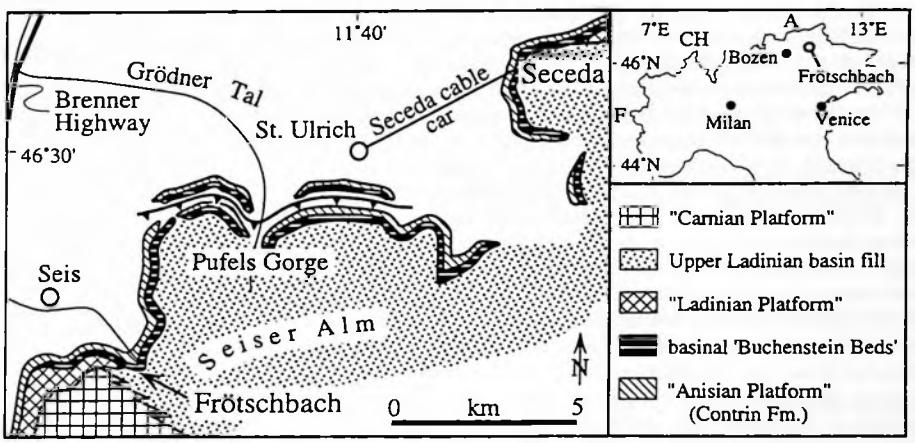


Fig. 1. Simplified geological sketch of Middle Triassic units in the St. Ulrich (Ortisei) area (Dolomites, northern Italy). The Frötschbach section is located to the southeast of the village Seis am Schlern (Siusi allo Sciliar). Other well known and coeval sections in the area are found at Seceda and in the Pufels gorge between these two localities.

The section comprises the 'Buchenstein Beds' (= Livinallongo Fm. in the Italian terminology; for an alternative illustration of the section see Abb. 2 of Brandner, 1982) consisting of two stratigraphically superposed units (Fig. 2): (i) the 'Lower Plattenkalke', which is a 8 to 9 m-thick succession of evenly bedded black siliceous and calcareous mudstones, and (ii) the 'Knollenkalke', consisting of 30 to 35 m of calcareous mudstones arranged in dm-thick wavy to nodular beds with abundant chert. Higher up (i.e., above the 42 m-level in Fig. 2), the 'Knollenkalke' are replaced by more evenly-bedded light dolomitic limestones and dolomites which are in part of a turbiditic origin. Acidic volcaniclastic layers ("Pietra verde") occur throughout the 'Buchenstein Beds' as silty to sandy horizons (e.g., Tc, Td, Te in Fig. 2) between a few centimetres and several decimetres thick.

Correlation with other sections and biostratigraphic constraints

On the basis of the vertical distribution of volcaniclastic layers, distinct lithological marker beds and few macrofossils, the Frötschbach section (Fig. 2) is closely tied to the nearby succession of 'Buchenstein Beds' at Seceda, around 13 km to the northeast (Fig. 1).
Correlation of the lower portions of both sections on a bed-scale is based on the unambiguous recognition of the volcaniclastic markers Tc-e and of distinct nodular limestone beds n.1-6 (corresponding to the 14.7-16.5 m-interval at Seceda). This has been illustrated in Fig. 6 of Brack and Rieber (1993). Probably as a result of closer proximity to coeval carbonate platforms, intervals of 'Knollenkalke' are on the average between 10-20% thicker at Frötschbach than at Seceda. The tuffite-bearing interval above the 34 m-level at Frötschbach most likely corresponds to the lower part of the interval rich in volcaniclastic layers between the 30 m and 40 m-levels at Seceda (see Brack and Rieber, 1993, Fig. 7).
The Seceda section has been correlated in detail with other well-known Anisian/Ladinian boundary sections further afield in the Southern Alps (e.g., Bagolino, Monte San Giorgio; see Brack and Rieber, 1993, 1994).

At Frötschbach the 'Lower Plattenkalke' yielded palynomorphs of the "*vicentinense-scheuringii* Phase" (Brugman pers. comm., in Brack and Rieber, 1993, p.435; see also p. 63 in Gaetani [Ed.], 1993), as well as few ammonoids (*Aplococeras* sp., *Parakellnerites* sp.) and thin-shelled 'pelagic' bivalves of the *Daonella elongata* group (*Daonella angulata*, Fig. 2). The conodont species *Gondolella trammeri, G. fueloepi fueloepi* and *Gladigondolella tethydis* occur from the upper part of the 'Lower Plattenkalke' upwards. *Gondolella trammeri* is considered as a good proxy for the base of the (*Nevadites*) *secedensis* Zone (e.g., Krystyn, 1983; Kovács, 1994; Nicora and Brack, 1995) although at Frötschbach it does occur already somewhat earlier. Other conodont species in this section show an as yet discontinuous distribution and do not provide further biostratigraphic detail. Several specimens of the ammonoid *Chieseiceras chiesense* were collected from a rock slab found at the base of a cliff of the lowermost 15 metres of 'Knollenkalke' (Fig. 2). This non *in-situ* finding is in agreement with data from Seceda where *Chieseiceras chiesense* occurs around three metres above the volcaniclastic Te-level (Brack and Rieber, 1993). According to data from eastern Lombardy and Giudicarie, this ammonoid species marks the very top of the (*Nevadites*) *secedensis* Zone (Brack and Rieber, 1993; Brack et al., 1995). Slightly higher up at Seceda *Eoprotrachyceras* cf. *recubariense* was found around 7.5 metres above the volcaniclastic Te-level; this ammonoid species is attributed to the *curionii* Zone (Brack and Rieber, 1993). Finally, at Frötschbach a specimen of *Arpadites* was collected close to the top of the recorded section. In the Bagolino section ammonoids of the genus *Arpadites* occur in an interval with a few conodonts of the genus *Budurovignathus* (*B. truempyi* slightly below, *B. hungaricus* somewhat higher up; Nicora and Brack, 1995). This association may be referred to the *gredleri* Zone.

Based on these fossil data and correlations, the bottom of the Frötschbach section (i.e., the 'Lower Plattenkalke') is ascribed to the *reitzi* Zone, whereas its top, although less well constrained, presumably represents part of the *gredleri* Zone (Fig. 2). The Frötschbach section therefore straddles two out of the three chief candidates for the ultimate collocation of the Anisian/Ladinian boundary, namely the base of the *secedensis* Zone and the base of the *curionii* Zone. In analogy with Bagolino (Brack et al., 1995), the base of the *secedensis* Zone is drawn immediately below volcaniclastic layer Tc. The base of the *curionii* Zone is constrained by the occurrence of *Chieseiceras chiesense* and *Eoprotrachyceras* at Seceda. At Frötschbach this boundary most probably falls in an interval between four to eight metres above the volcaniclastic Te-layer.

Radiometric age data

High resolution U-Pb ages were obtained by single grain analysis of zircons from selected volcaniclastic layers at Seceda, Bagolino and Monte San Giorgio (Mundil et al., in press; Brack et al., in press). Zircons from a thin crystal-tuff at the base of the volcaniclastic Tc-layer at Seceda have an average radiometric age of 241.2 +0.8/-0.6 Ma (errors given at 95% confidence level). The same layer is also identified at Frötschbach. Zircons from a tuff layer at the 72.5 m-level of the Bagolino section have yielded an age of 238.0 +0.4/-0.8 Ma. This level can be approximately correlated via Seceda to the upper part of the Frötschbach section (35-40 m interval in Fig. 2). These data allow an estimate of the duration of the Frötschbach interval shown in Fig. 2 at about three millions of years.

Magnetostratigraphy

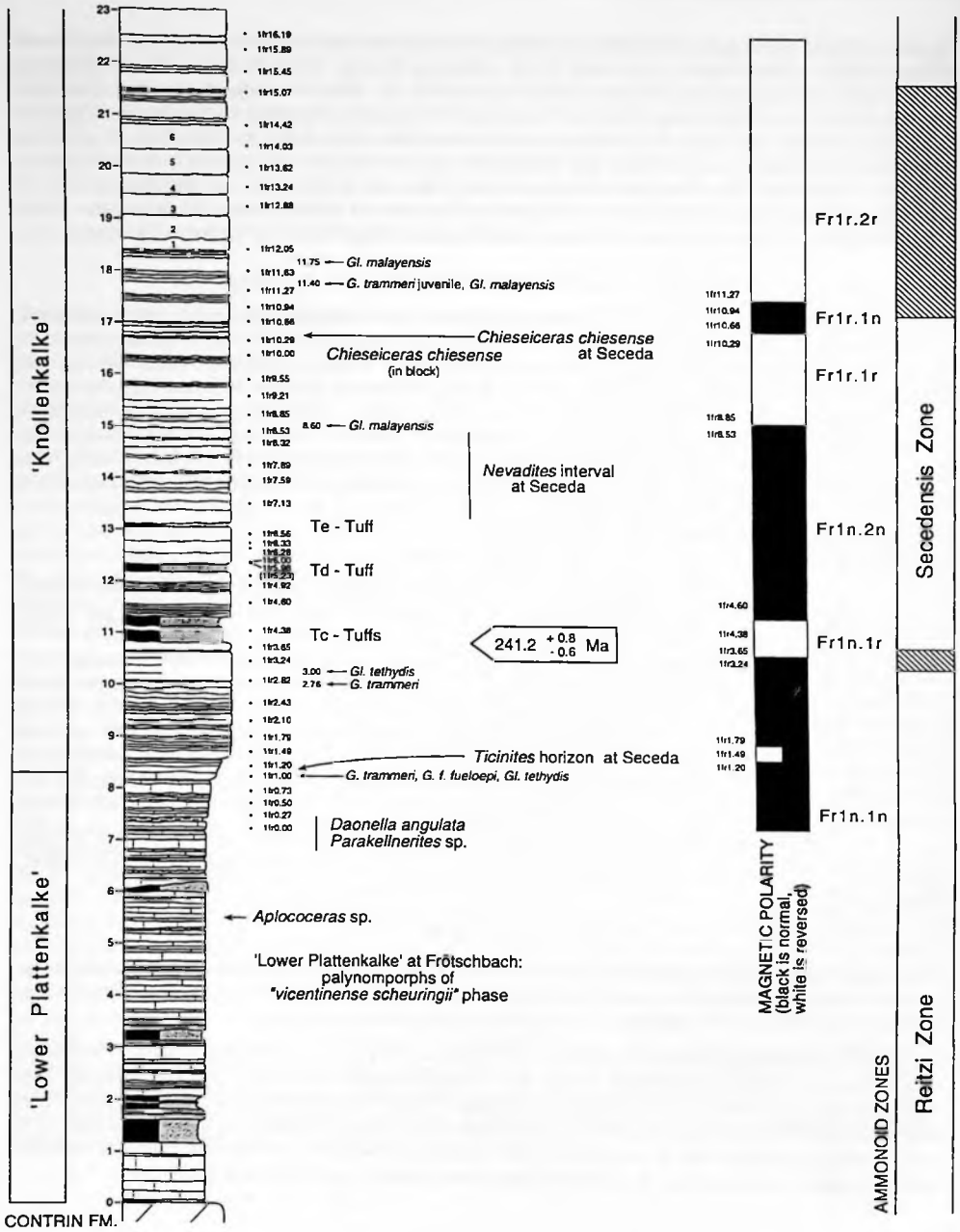
Samples for palaeomagnetic analysis were taken over a stratigraphic interval of 31.6 metres equally subdivided in two complementary sections (Fig. 2). A sampling interval of 2-4 samples per metre was adopted, yielding a total of 101 samples for thermal demagnetization. Samples typically show an initial steeply inclined component which in geographic (i.e., in situ) coordinates is consistent with the present-day field. A bipolar northwest-and-down (southeast-and-up) characteristic component was successively unblocked in 92 samples between about 200°C and 500°C, with a maximum upper limit of 575°C. Magnetic susceptibility is typically low and stable over the heating procedure. We interpret the characteristic directions as carried by a magnetite phase, and assign normal (reversed) polarity to the positive (negative) inclinations after correction for bedding tilt. For each of the characteristic component directions a virtual geomagnetic pole (VGP) was calculated.

The latitudes of the VGPs plotted with respect to stratigraphic thickness define a pattern of four main polarity intervals, i.e., Fr1n to Fr2r, with two short polarity intervals within Fr1n and Fr1r (Fig. 2).

Final remarks

The magnetostratigraphic record established so far at Frötschbach indicates the existence of at least one main reversal in the Anisian/Ladinian boundary interval (i.e., between Fr1n and Fr1r in Fig. 2). This event falls in the upper part of the (*Nevadites*) *secedensis* Zone.

Based on its magnetostratigraphic pattern, the Frötschbach section can be successfully correlated to a similar record from the Aghia Triada and Vlichos sections on Hydra island in Greece. The sampling rate and, therefore, the resolution at Aghia Triada has been improved compared to what was reported in Muttoni et al. (1994). These new data and correlations shall be presented in a forthcoming publication by the authors. The main result will be a composite magneto-chrono-biostratigraphic record across a boundary interval of around five million years duration.


'Knollenkalke'
'Lower Plattenkalke'
CONTRIN FM.
11.75 Gl. malayensis
11.40 G. trammeri juvenile, Gl. malayensis
Chieseiceras chiesense at Seceda
Chieseiceras chiesense (in block)
8.60 Gl. malayensis
Nevadites interval at Seceda
Te - Tuff
Td - Tuff
Tc - Tuffs
241.2 +0.8 -0.6 Ma
3.00 Gl. tethydis
2.76 G. trammeri
Ticinites horizon at Seceda
G. trammeri, G. f. fueloepi, Gl. tethydis
Daonella angulata
Parakellnerites sp.
Aplococeras sp.
'Lower Plattenkalke' at Frötschbach: palynomporphs of "vicentinense scheuringii" phase
Fr1r.2r
Fr1r.1n
Fr1r.1r
Fr1n.2n
Fr1n.1r
Fr1n.1n
MAGNETIC POLARITY (black is normal, white is reversed)
AMMONOID ZONES
Secedensis Zone
Reitzi Zone

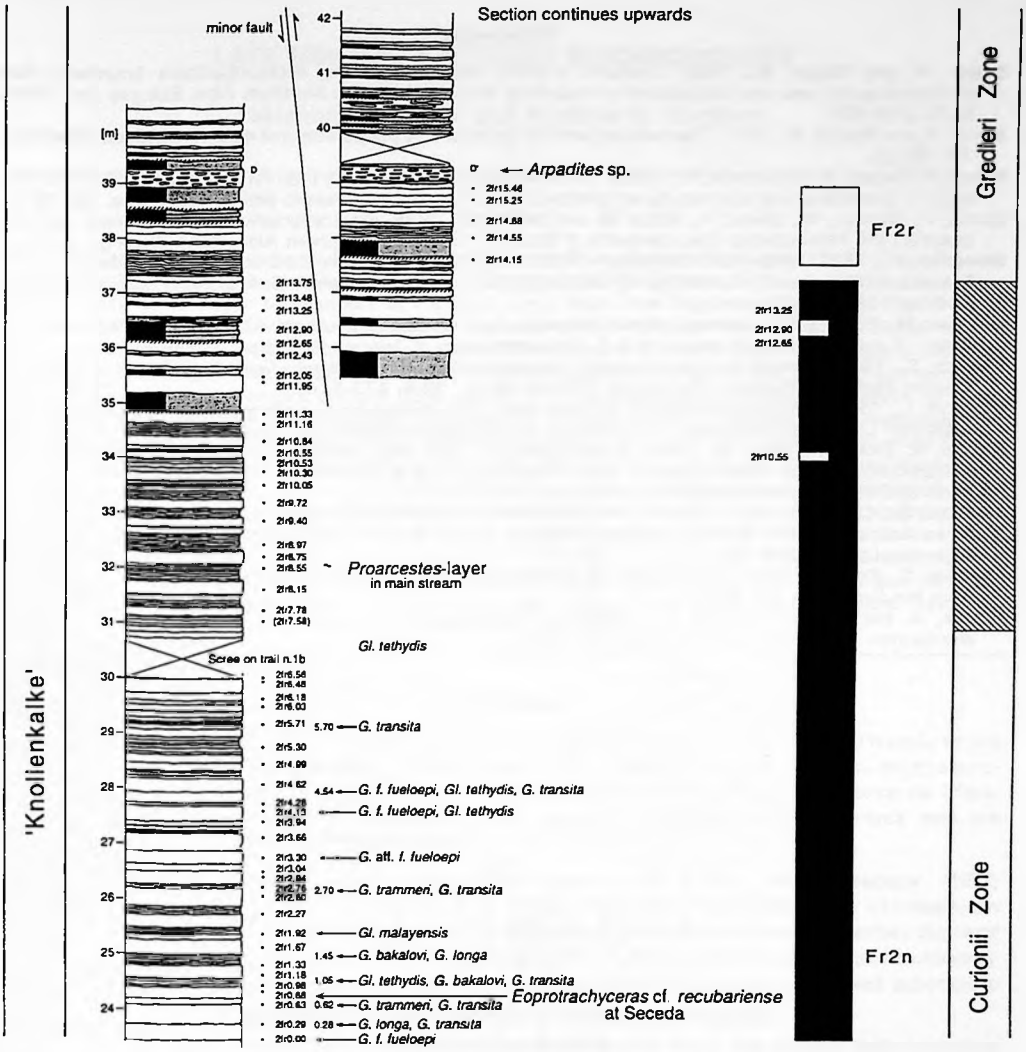


Fig. 2. Section of 'Buchenstein Beds' at Frötschbach: lower part (0-23 m), upper part (24 m ff.) with the position of samples for paleomagnetism (black dots to the right of stratigraphic column labelled 1fr0.00 to 2fr15.46) and the derived magnetic polarity stratigraphy. Volcaniclastic layers are indicated by black bars. Zones are based on ammonoid distribution at Seceda, Bagolino and few fossils from Frötschbach (see text). Conodonts indicated with sample positions are from Frötschbach. See Brack and Rieber (1993) for further information on macrofossils and correlation with other Anisian/Ladinian boundary sections.

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LATE TRIASSIC AETOSAUR BIOCHRONOLOGY

Spencer G. Lucas and Andrew B. Heckert

Abstract

Aetosaurs are extensively-armored, herbivorous archosaurs with an abundant fossil record from Upper Triassic strata in North America, Western Europe, India, North Africa and South America. Highly distinctive body armor allows ready identification of aetosaurs at the genus level, even from fragmentary material. This ease of identification, wide distribution and abundance make aetosaurs excellent index fossils. Based on the stratigraphic succession of aetosaurs in the upper Carnian-Rhaetian Chinle Group of the western USA five aetosaur biochrons can be identified: (1) *Longosuchus* (=*Lucasuchus*) biochron of late Tuvalian age correlates oldest Chinle and some Newark (eastern USA) strata; (2) *Stagonolepis-Desmatosuchus* biochron of latest Tuvalian age correlates lower Chinle to Elgin (Scotland) and to Ischigualasto if *Stagonolepis* = *Aetosauroides*; (3) *Paratypothorax* biochron straddling the Carnian-Norian boundary correlates mid-Chinle to part of the Keuper (Germany), Fleming Fjord Formation (Greenland) and Zarzaïtine Series (Algeria); (4) *Typothorax* biochron of Norian age restricted to the Chinle; and (5) *Redondasuchus* biochron of Rhaetian age also restricted to the Chinle. In the Newark Supergroup, a *Stegomus* biochron is of Norian age and restricted to the Newark. In the Keuper, an *Aetosaurus* biochron of middle Norian age can be tied directly to the SGCS by the marine middle Norian occurrence of *Aetosaurus* in northern Italy and correlates to *Aetosaurus* records in Greenland. The South American *Chilenosuchus* from the El Bordo Formation of the Chilean Andes is not an aetosaur. Aetosaur genera were relatively cosmopolitan during the late Carnian and became increasingly provincial during the Norian-Rhaetian.

Introduction

Tetrapod fossils provide one of the principal bases for the correlation of nonmarine Triassic strata across Pangea (Ochev and Shishkin, 1989; Lucas, 1990). During the Late Triassic, archosauromorph reptiles dominated tetrapod faunas. Two archosauromorph groups - phytosaurs (Parasuchidae) and aetosaurs (Stagonolepidae) - were broadly distributed across Pangea and are abundant in Upper Triassic nonmarine strata.

Phytosaurs have long been used for correlation of these strata (Camp, 1930; Gregory, 1957; Westphal, 1976; Ballew, 1989). However, they are not ideal index fossils because: (1) nearly an entire phytosaur skull is needed to make a genus- or species- level identification, whereas the vast majority of phytosaur fossils are isolated bones and skull fragments; and (2) phytosaur taxonomy is not well agreed on and generally oversplit, with three different, recently published taxonomic schemes (Ballew, 1989; Long and Murry, 1995; Hunt, 1996).

In contrast, aetosaurs make ideal index fossils for Late Triassic time. We exploit their excellent record to propose a Late Triassic aetosaur biochronology.

Aetosaurs as Index Fossils

Aetosaurs (Fig. 1) were herbivorous, as is indicated by their small leaf-shaped cheek teeth. Their heads are extremely small relative to their bodies, and their snouts lack teeth. The heavily armored body has quadrangular plates that run from the back of the skull to the tip of the tail and encase much of the abdomen as well as the entire tail. The tarsus is crocodile normal, and the ichnogenus *Brachychirotherium* probably represents aetosaur footprints.

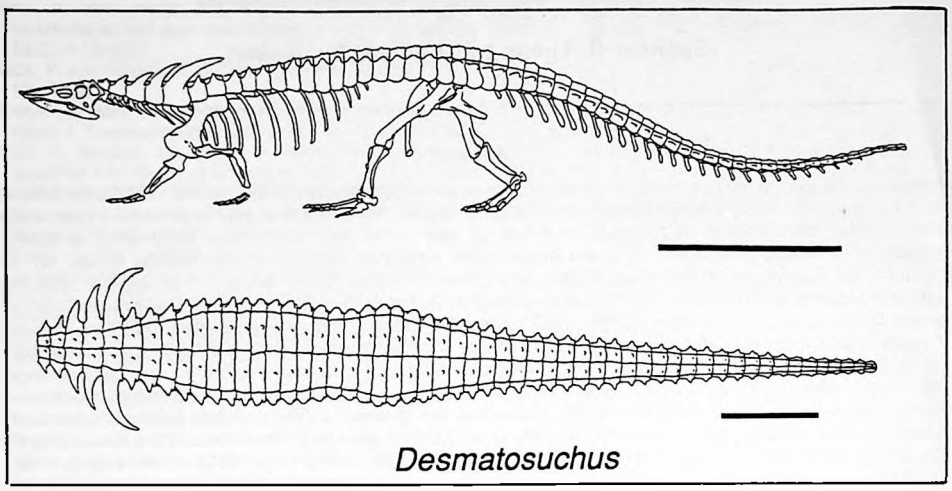

Fig. 1. Skeleton of a typical aetosaur, Desmatosuchus, *in lateral (above) and dorsal (below) views. Scales = 1 m. After Long and Murry (1995).*

An ideal index fossil should be widely distributed geographically, abundant, have a short temporal range, and easily identifiable. Aetosaurs meet all four criteria:

(1) Aetosaur fossils are found throughout most of Late Triassic Pangea (Fig. 2). Indeed, they have a broader distribution than phytosaurs, most notably being known from Argentina, where phytosaurs do not occur.

(2) Aetosaurs are the most abundant tetrapod fossils in the Chinle Group (western U.S.A.) and the Ischigualasto Formation of Argentina (Lucas, 1993; Rogers et al., 1993). They are common in many other Upper Triassic deposits.

(3) Stratigraphic/temporal ranges of aetosaur genera are usually relatively short - much less than a stage/age (Fig. 3).

(4) Aetosaurs are easy to identify because their body armor is highly distinctive at the genus level (Fig. 4). A single piece or fragment of aetosaur armor, sometimes even as small as a postage stamp, can be very precisely identified.

Aetosaur biochrons

The Chinle Group in the western United States is critical to establishing an aetosaur biochronology of the Late Triassic. This is because the Chinle has a prolific aetosaur record that includes many of the known aetosaur genera, and the fossils can be arranged in an unambiguous stratigraphic succession that spans the late Carnian, Norian, and Rhaetian. Six aetosaur genera are found in the Chinle and establish six biochrons (Fig. 2). Three other biochrons can be recognized based on non-Chinle genera.

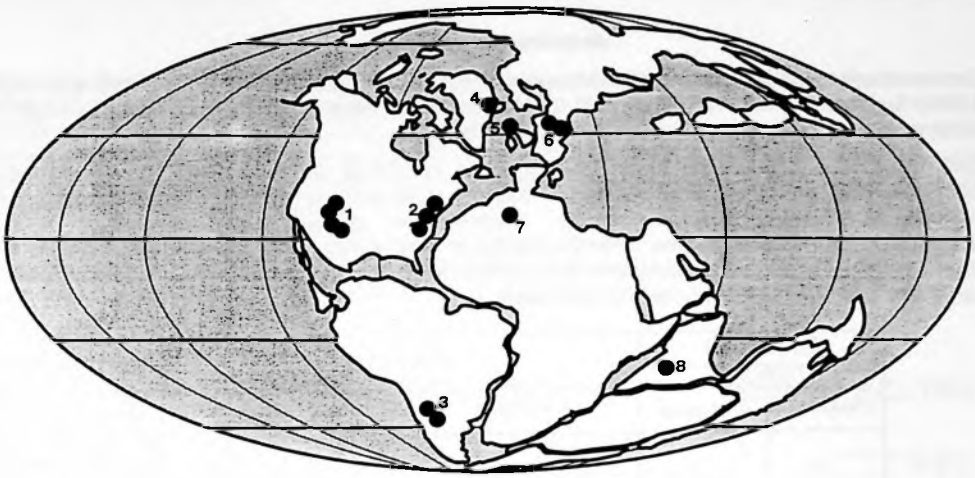

Fig. 2. Distribution of aetosaur fossils across Late Triassic Pangea. 1 = Chinle Group, western United States; 2 = Newark Supergroup, eastern United States; 3 = Ischigualasto and Los Colorados Formations, Argentina; 4 = Fleming Formation, Greenland; 5 = Elgin Sandstone, Scotland; 6 = Keuper and Alpine marine Triassic, Germany and Italy; 7 = Zarzaïtine Series, Algeria; 8 = Maleri Formation, India.

Longosuchus biochron

Longosuchus Hunt and Lucas, 1990 (long called *Typothorax meadei* Sawin, 1947) is the oldest Chinle aetosaur, found in strata of Otischalkian age (Hunt and Lucas, 1990; Lucas and Hunt, 1993). Its occurrence in the Pekin Formation of the Newark Supergroup in North Carolina provides a direct Chinle-Newark aetosaur-based correlation (Huber et al., 1993b).

Long and Murry (1995) split *Longosuchus* into two genera: *Longosuchus* from Texas and their new genus *Lucasuchus*. Their diagnosis of *Lucasuchus* is based on minor differences in scute morphology, some so subjective that they cannot be replicated. Therefore, we regard *Lucasuchus* as a junior subjective synonym of *Longosuchus*. Long and Murry (1995, p. 203) claimed that their taxonomy, which restricted *Longosuchus* to West Texas and identified *Lucasuchus* from West Texas, New Mexico and North Carolina, "negates the utility of *L[ongosuchus] meadei* as a biochron fossil." Ironically, all Long and Murry (1995) did was redefine the *Longosuchus* biochron of Hunt and Lucas (1990) as a *Lucasuchus* biochron. *Longosuchus* (=*Lucasuchus*) thus remains a robust biochronologic indicator.

Chatterjee and Roy-Chowdhury (1974) published an annotated faunal list of the Triassic of India, in which they indicated the presence of an aetosaur in the Maleri Formation. This fossil consists of a series of both paramedian and lateral scutes that have not been illustrated. The paramedians are described as rectangular, and the lateral plates "show horn-like spine(sic), very similar to those of *Typothorax* of North America" (Chatterjee and Roy-Chowdhury (1974, p. 107). In this description they fit closely the diagnosis of *Longosuchus* (=*Typothorax meadei*) as described by Hunt and Lucas (1990). The Maleri fauna also includes phytosaurs, metoposaurs, and rhynchosaurs of late Carnian age, including *Paleorhinus* (=*Parasuchus*) (Long and Murry, 1995) and *Metoposaurus* (Hunt, 1993). Thus, we suggest that the *Longosuchus* biochron can be tentatively extended to India.

Desmatosuchus biochron

Desmatosuchus co-occurs with *Longosuchus* in the Otischalkian (Case, 1922; Hunt and Lucas, 1990; Lucas and Hunt, 1993; Lucas, 1994) and has a temporal range extending through the Adamanian into Revueltian A (Fig. 3).

Desmatosuchus is abundant in the Adamanian of the Chinle Group, so this can be termed its abundance biochron ("acme zone"). *Desmatosuchus* is also known from the Pekin Formation of the Newark Supergroup, providing another Chinle-Newark aetosaur-based correlation. A *Desmatosuchus*-like scute from the Zarzaïtine Series of Algeria is the only other possible record (Jalil et al., 1995). *Acaenasuchus* Long and Murry (1995) is based on juvenile scutes of *Desmatosuchus*, as Murry and Long (1989) originally concluded.

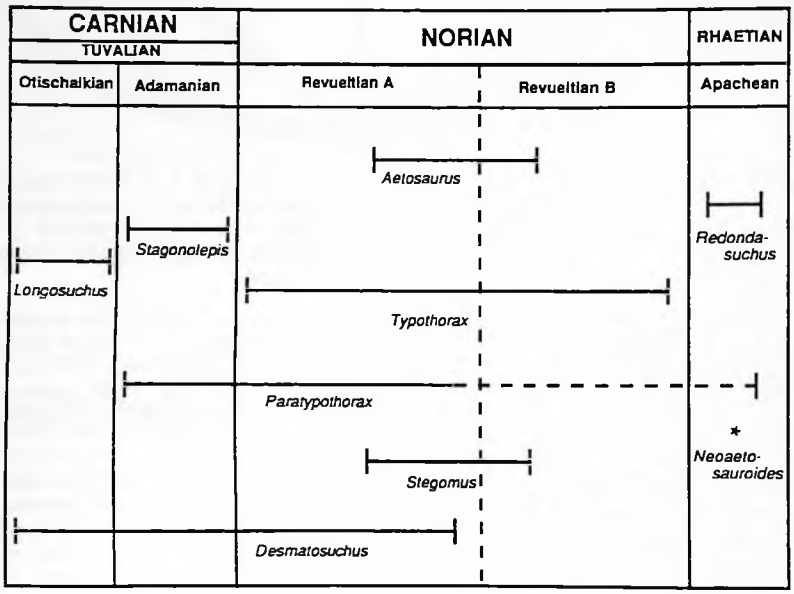

Fig. 3. Aetosaur biochronology of the Late Triassic.

Stagonolepis biochron

Stagonolepis (= *Calyptosuchus* Long and Ballew, 1985) occurrences in North America are restricted to Adamanian strata of the Chinle Group, where it has been referred to as both *S. robertsoni* and *S. wellesi* (Long and Murry, 1995). *Stagonolepis robertsoni* is well known from its type locality, the Elgin Sandstone of Scotland (Walker, 1961), which supports an Adamanian age for the Elgin tetrapod fauna.

Aetosauroides from the Ischigualasto Formation of Argentina may be a synonym of *Stagonolepis*. If so, this provides strong evidence of a late Carnian age of the Ischigualasto tetrapods supported by other evidence presented by Hunt and Lucas (1991a,b), Lucas et al. (1992), and Lucas and Hunt (1993), not the older "middle Carnian" or Ladinian age advocated by some other workers (e.g., Cox, 1991; Rogers et al., 1993; Battail, 1993).

Paratypothorax biochron

Recent collecting by Heckert (1996) has extended the stratigraphic range of *Paratypothorax* in the Chinle Group to the early Adamanian (Bluewater Creek Formation in west-central New Mexico). Small and Sedlmayr (1995) reported scutes of *Paratypothorax* from the Apachean of the Chinle Group (Bell Springs Formation, northwestern Colorado). Thus, the late Adamanian-early Revueltian age of *Paratypothorax* in the Chinle Group reported by Hunt and Lucas (1992) has been greatly extended by recent collecting (Fig. 3).

In the German Keuper, *Paratypothorax* has a temporal range of late Carnian-early Norian. The genus has also been reported from the Norian Fleming Fjord Formation of Greenland (Jenkins et al., 1994) and may also be present in the Zarzaïtine Series of Algeria (Jalil et al., 1994).

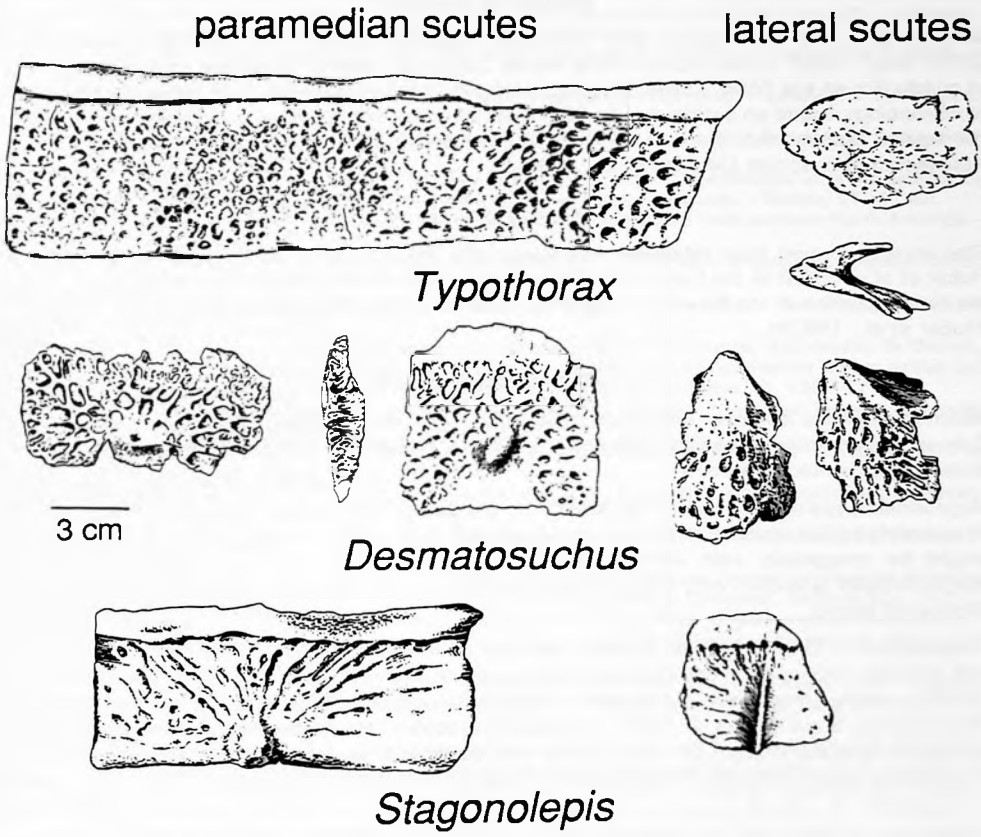

Fig. 4. Paramedian and lateral scutes of selected aetosaurs to illustrate differences in scute morphology used in genus-level identification (After Long and Ballew, 1985).

Typothorax biochron

Typothorax is known only from the Chinle Group and is the most common tetrapod fossil in strata of Revueltian age (Hunt et al., 1993; Hunt, 1994; Long and Murry, 1995). It thus provides a robust basis for correlating Chinle Group strata with each other.

Redondasuchus biochron

Redondasuchus Hunt and Lucas, 1991c, is known only from Apachean strata of the Chinle Group. Its restriction to the Redonda Formation of eastern New Mexico limits its broad biochronologic utility. Long and Murry (1995) synonymized *Redondasuchus* with *Typothorax*, but Heckert et al. (1996) demonstrate that the two genera are distinct.

Aetosaurus biochron

Aetosaurus is well documented from the Lower Stubensandstein of the German Keuper (Fraas, 1877; Wild, 1989). It also occurs in the marine Calcare di Zorzino Formation near Bergamo, Italy of middle Norian age (Wild, 1989). This is the only direct cross-correlation of nonmarine and marine biochronology based on aetosaurs. As Wild (1989) concluded, it suggests a middle Norian age for the Lower Stubensandstein and for part of the Fleming Fjord Formation in Greenland, where *Aetosaurus* also occurs (Jenkins et al., 1994).

Stegomus biochron

Stegomus is known from relatively few specimens (Marsh, 1896; Jepsen, 1948; Baird, 1986; Huber et al., 1993a) in the Newark Supergroup of eastern North America. All specimens are from the Norian portion of the Newark and provide some basis for correlation among the Newark basins (Huber et al., 1993b).

Other aetosaur records

Neoaetosauroides is known only from its holotype specimen collected in the upper part of the Los Colorados Formation in La Rioja Province, Argentina (Bonaparte, 1967, 1970). Therefore, it is of limited biochronological utility.

Argentinasuchus was named for postcrania co-occurring with the type material of *Aetosauroides* in an article by Casamiquela (1960). Casamiquela's (1960, 1961) suggestion that *Argentinasuchus* might be congeneric with *Aetosauroides* has been followed by most subsequent workers. *Aetosauroides* is known only from the Ischigualasto Formation, which is late Carnian in age, as discussed above.

Casamiquela (1980) named the putative aetosaur *Chilenosuchus forttae* for a partial skeleton from the El Bordo Formation of the Chilean Andes. Judging from the poor illustrations in Casamiquela's (1980) article, there is no compelling reason to assign *Chilenosuchus* to the Aetosauria. Furthermore, Breitkreuz et al. (1992) indicated a probable Late Carboniferous-Permian age for the El Bordo Formation based on fossil plants and ostracods, so retention of *Chilenosuchus* in the Aetosauria would represent a monumental range extension for the group.

Paleobiogeography

A precise biochronology of the Aetosauria (Fig. 3) indicates increasing provincialization of aetosaurs during the Late Triassic. The most cosmopolitan genera of aetosaurs (*Stagonolepis, Longosuchus, Paratypothorax, Desmatosuchus*) are primarily late Carnian, whereas characteristically Norian genera (*Aetosaurus, Typothorax, Stegomus*) are more provincial. Highly provincial are the Rhaetian genera (*Redondasuchus, Neoaetosauroides*). Increasing provincialization of the aetosaurs during the Late Triassic parallels the initial breakup of Pangea.

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BRITISH TRIASSIC PALAEONTOLOGY: SUPPLEMENT 20

G. Warrington

Since the completion of the writer's previous supplement (No.19; ALBERTIANA, 15: 81-82) 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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TRESISE, G. 1996. Sex in the footprint bed. Geology Today, 12: 22-26.

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

PERMIAN-TRIASSIC BOUNDARY WORKING GROUP

NEWSLETTER NO. 5 MARCH 8, 1996

1. Advances since the issue of PTBWG Newsletter no. 4

Remarkable advancement has been achieved in Arctic Canada (Baud, Henderson). Based on six P/T boundary sections the following fossil succession has been established:

- Latest Permian *Neogondolella* cf. *subcarinata* and *N.* cf. *changxingensis* (basal part of the Confederation Point Member, Blind Fiord Formation).
- *? Otoceras concavum* in concretions of the Confederation Point Member, a Permian type brachiopod in concretion (NE Axel Heiberg) and *Claraia* sp. a little above. These are found below the maximum flooding surface -a thin interval of fissile black shale.
- *Otoceras boreale*, at Greesbach Creek coexisting with *Otoceras concavum.*
- *Neogondolella carinata, N.* cf. *planata, N.* cf. *taylorae, Hindeodus* cf. *parvus* (2 specimen) at the upper part of the *boreale* Zone.
- *Ophiceras, Tompophiceras* (according to Kozur, *H. parvus* also occurs at this level).

These achievements are in accordance with fossil successions found elsewhere in the world and have the advantage that the PTB strata is far thicker than that of the Tethys, e.g. Meishan. The authors have not suggested a GSSP candidate, probably because the succession is assembled from sections far apart from each other with none of them containing the whole succession. By the way, the existence of *Otoceras concavum* in NE Siberia seems now in question (Dagys, 1995, ALBERTIANA 14; Zakharov, 1995, ALBERTIANA 16), leaving only the Arctic Canadian occurrence for certain.

With the discovery of *Isarcicella isarcica* at Bed 28 (Lai, 1995), the *H. latidentatus - H. parvus - I. tugida - I. isarcica* lineage has been established at the Meishan section with a table of PTB conodont occurrences there (Zhang et at., 1995).

Renne et al.(1995) averaged $^{40}Ar/^{39}Ar$ data from the two boundary tuffs from Meishan and Shangsi respectively, and settled on an age of 250.0 ± 0.2 Ma, which is comparable to the inception of the main stage eruption of the Tunguss Traps at 250.0 ± 0.3 Ma.

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BAUD A. et al., 1996, The Blind Fiord transgression (Canadian Arctic Islands), a key to the Permian-Triassic boundary. Abstract to the 30th IGC.

HENDERSON C.M. et al., 1996, Correlation of the Permian-Triassic boundary in Arctic Canada on the basis of molluscan and conodont distribution. Abstract to the 30th IGC.

LAI et at 1995, The significance of the discovery of *Isarcicella isarcica* at the Meishan Permian-Triassic boundary stratotype section in Zhejiang Province. Exploration of Geosciences, 11: 7-12 (in Chinese with English abstract).

RENNE, P.R. et al., 1995, Synchrony and causal relations between Permian-Triassic boundary crises and Siberian flood volcanism. Science, 269: 1413-1416.

ZHANG et al., 1995. Conodont sequence and its global correlation of Permian-Triassic boundary in Meishan section Changxing, Zhejiang Province. Earth Science, 20(6): 65-668 (in Chinese with English abstract).

2. Echoes to the comments by members

The requirements expressed by members concerning the GSSP (see PTBWG Newsletter no. 4) have more or less been fulfilled as follows:

a. There is now a consensus on the level of the PTB in Meishan, that is the base of Bed 27c of section D or its equivalent level at section Z (Yin et al., 1995; Wang, 1995)
b. Advancements in Arctic Canada confirm the fossil succession established in the Tethys. *Hindeodus* cf. *parvus* coexists with *Otoceras boreale*, which should be coeval with *O. latilabotum* and *woodwardi* in the Tethys. *Otoceras concavum* has been proved unsuitable as PTB marker. The reported occurrence of *parvus* with *Ophiceras commune* (Greenland) is not due to diachronism, but simply its range into the *Ophiceras* zone, as repetitiously shown in Tethyan regions.
c. After the report from Kozur (in press), leading conodont specialists in the world seem now agreeable upon, though still tentatively, the generic assignment of *parvus* to *Hindeodus*, as shown in the joint recommendation paper.
d. No essential proposal came out from Spiti and Kashmir regions.

Considering that in replies to the last questionnaire only one candidate section obtained support, that there is no prospect of a competitive candidate in near future, and that the requirements for further study have now been more or less fulfilled, a formal recommendation of the Meishan section as the GSSP of PTB, prepared by 9 members of the PTBWG, has been submitted for publication. As asked in the comment no. 1 expressed in Newsletter no. 4, this and other documents will be distributed to members.

3. Membership

The PTBWG now has 25 voting members and 4 corresponding members. Four specialists have been recommended by members to join the PTBWG. They are:

- Professor B.F. Glenister (already corresponding member of PTBWG), Geology Department, University of Iowa, Iowa City, Iowa 52242, USA.
- Dr. Yugan Jin, Nanjing Institute of Geology and Palaeontology, Nanjing, Jiangsu Province, 210008, China.

- Dr. M. J. Orchard, Geological Survey of Canada, 100 West Pender Street Vancouver, British Columbia V6B 1R8, Canada.
- Dr. R. K. Paull, Department of Geosciences, College of Letters and Science, University of Wisconsin, Milwaukee, WI 53201, USA.

Members are asked to express their opinions to involvement of all or anyone of them and to whether we should postpone the decision till after the vote for the GSSP. Please write to Yin Hongfu.

Comments on: Permian-Triassic Boundary Working Group Newsletter No. 5 (first issued March 8, 1996; reproduced here on p. 66-68)

Aymon Baud

In his Newsletter No. 5, Prof. Yin wrote, based on my not yet published abstract for 30th IGC, that *Otoceras concavum* coexists with *Otoceras boreale* at Griesbach Creek (Arctic Canada). It has to be understood as "virtually coexisting", because until now, *O. boreale* has never been found together with *O. concavum*. However, according to Tozer (1994) *O. boreale* occurs in different sections of NW Axel Heiberg Island at the same level (5-20m above the base of Blind Fjord Formation) as *O. concavum* appears in Griesbach section.

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CORRELATION OF TETHYAN, CIRCUM-PACIFIC AND MARGINAL GONDWANAN PERMO-TRIASSIC

IGCP PROJECT 359 (1993-1997)

Yin Hongfu, J.M. Dickins, Yang Zunyi, A.Baud

Description of the project

The project aims to provide a more accurate stratigraphical correlation and a more comprehensive synthesis of the geological events of the Permo-Triassic in the concerned regions. It embraces 184 members from 25 countries and develops relations with IGCP Projects 306, 321, 335 and GSSP Project (Pangea). During 1993 and 1994 noteworthy progress has been achieved on two main tasks of this project. Concerning the intersystem and intrasystem boundaries of the Permian and Triassic, candidates of the Permian-Triassic boundary stratotype have been focused on the Meishan section of South China; a candidate for the Triassic-Jurassic boundary has been proposed; researches on the subdivision of the Permian series and boundaries of the Triassic stages have obtained important results. Compilation of the regional stratigraphic charts, the second task, is smoothly going on, and a few of them have been reported and discussed in workshop meetings. The project attained 'excellent' evaluations from the assessments of the IGCP Scientific Board in the past two years.

Achievements in 1995

1. General Scientific Achievements

1.1. Intersystem and intrasystem boundaries

The Permian-Triassic boundary: The P/T Boundary Working Group, chaired by the leader of this project and involving many project members, suggested four candidates in 1993 (Calgary). During the two workshops held in Guiyang and Albrechtsberg, 1994, two informal votings were taken. Meishan obtained 23 and 4 approvals respectively, Guryul Ravine 1 and 3 approvals, and Selong and Shangsi none, so the candidates focused on two sections. Yin et al. (1994) proposed that the boundary stratotype for the P/T boundary be defined at the base of the *Hindeodus parvus* (*Isarcicella parva*): Zone between beds 27b and 27c of the Meishan section. A questionnaire was distributed to voting members of the P/T BWG in June 1995 asking whether it is time to take a formal vote and which section and point they would prefer. The result was: 14 agreed to take a vote and they chose Meishan; 5 disagreed to take a vote. Among those who favoured Meishan, 12 chose the base of the *Hindeodus parvus* (*Isarcicella parva*) Zone while two chose *Otoceras*. A number of books and papers concerning this subject have been or are being published. It is now generally agreed upon that the Meishan section together with its FAD of *Hindeodus parvus* is suitable for the candidate of GSSP of Permo-Triassic boundary. Global correlation of the boundary strata, establishments of *latidentatus-parvus-tugida-isarcica* lineage and Ir anomaly-δ^{13} C-FAD of the *parvus* succession prove the synchroneity of *H. parvus*. Following sections are also discussed in workshops held this year: The P/T boundary section at Selong of Xizang (Tibet), China, the Permian-Triassic transitional strata in central Iran (Abadeh Area); the continental Permian-Triassic

boundary stratotype and correlation with the marine boundary stratotype. The terrestrial stratotype of the P/T boundary has been discussed by Rozovsky and Lucas.

The Triassic-Jurassic boundary: Reports on T/J boundary researches have been made by the leader and secretary of the working group in meetings held in Toulouse (France), Albrechtsburg (Austria) and Mendosa (Argentina). The West Somerset section of England was suggested as a candidate for the T/J boundary stratotype (Warrington; 1994); a strontium isotope profile of the T/J boundary has been made (Hallam, 1994). However, project members involved in this group are few.

The Permian series and stages: an operational scheme of Permian chronostratigraphy and a revised version of it have been proposed by Jin et al. (1994, 1995), which evoked considerable echoes and further discussions. Opinions were given on the middle part of the Permian, on the evaluation of the traditional Russian sequence, which is of brackish water facies, the Guadeloupian sequence, which is of reef facies, and the correlation between stage names originated from North America, Ural and South China (Kotlyar, 1995; Taraz, 1995). Stages of the lower part (Asselian, Sakmarian, Artinskian) and upper part (Wuchiapingian or Dzhulfian, Changhsingian) seems satisfactory to a majority of the Permian workers.

The Induan-Olonekian boundary of the Lower Triassic: Ussuri Gulf in Primorye and Delinya River in Siberia have been suggested by Zakharov (1994, 1995) and Dagys (1995) respectively as stratotype of this boundary. Tozer (1994) stongly opposed the bipartite subdivision of the Lower Triassic and advocated quadrapartite subdivision instead.

The Anisian-Ladinian boundary of the Middle Triassic: This working group of STS led by Professor M. Gaetani has been very active. After bed by bed field work and subsequent discussions on the boundary strata from the *Lardaroceras* Zone to the *curionii* Zone, the Bagolina section in the southern Alps and Felsőörs section in Hungary have been prefered by the majority as stratotype candidates. A questionnaire has been circulated to the members asking their opinions on this boundary.

Numerical dating: of special interest is the dating of the Permo-Triassic (Rose et al., Menning) and of the P/T boundary (Renne et al.).

1.2. Regional Stratigraphic Achievements on the Permian and Triassic:

A large volume on Pangea (Klein, 1994) contains 5 papers from project members dealing with Permian and Triassic palaeoenvironments. Exhaustive works and publications on the Permian and Triassic of the Alps, central and western Europe have been accomplished by project members, among which are conodonts and radiolarians (Ramovs, Kozur); sedimentology (Cassinis et al., 1995); Olenekian-Anisian, Anisian-Ladinian boundaries (papers in Albertiana, vols. 14-15). The journal Rivista Italiana Palaeontologia e Stratigrafia vols. 99 & 100 published a number of Permian and Triassic works of project members concentrating on the Alps and adjacent areas.

East and SE Asia: Summaries on the Permian of Vietnam and the Permo-Triassic of Malaysia have been published. Several papers dealt with Carboniferous-Triassic fossil sucessions, esp. conodonts, fusulinids, radiolarians in South China, Thailand, Malaysia and sequence stratigraphy in South China. The Permo-Triassic sequence of Son La in the western part of the Song Da palaeorift region shows close affinity between the Song Da region and the Yangtze Block and a good potential to establish a continuous P-T sequence at the resolution of stage level. A number of monographs focusing on the P-T of South China are published (Feng et al., Jiang et al.). Compilation of the biota and palaeomagnetism on the hopeful candidate for the continental stratotype of the P/T boundary, the Dalongkou section in Xinjiang, is nearly finished, with a special excursion being prepared by the 30th IGC. Work on the P-T strata of Tarim basin is now ongoing.

Russia: Active works have been published on the Permian subdivision, esp. Murgabian and Midian (Kotlyar, Leven) and on Permo-Triassic foraminifers (Pronina). Many papers concern with Sikhote Alin: discovery of late Changxingian ammonoids in the Lyudyanza horizon (Zakharov et al., 1994); finding of eight radiolarian assemblages from Upper Sakmarian to Dorashaniam (Rudenko et al.); six coral successions from Ladinian to Rhaetian (Punina); Triassic sedimentary events (Buryi, Satoru et al.).

Terrestrial Permian and Triassic biotas: Carnian and Norian tetrapods from southwestern US (Long and Murry, 1995); continental Triassic in western US (Lucas et al., 1994-1995); Palynostratigraphy of the Permian and Lower Triassic of the Svendrup Basin (Utting, 1994).

Permo-Triassic affinities of Australasian blocks with Gondwana, South China and with each other: An overview of Gondwana dispersion and Asian accretion shows that the Permo-Triassic is a critical period. The Gondwana-type strata including diamicrites and Permian brachiopod successions in the West Yunnan blocks contribute to relocate these peripheral blocks in the Gondwanan system. P-T stratigraphy in New Zealand and Timor casts new light on their affinity with either a tropical area, SE Asia or with Australia. Identification of the Upper Permian *Dicynodon* in Luang Prabang of Laos clarified a long-existing mystery of the so-called *Lystrosaurus* in Indochina. Stratigraphic and sedimentologic studies of terranes and tectonic belts in Japan and Sikhote Alin yield important achievements.

Permo-Triassic events: A few papers emphasized that in Australia and in the world as well as the Hunter-Bowen or Indosinian movement from the Late Permian to the end of the Triassic constitutes an independent tectonic cycle beginning with riftogenesis and ending up with orogeny, and partitioned by volcanic, tectonic, eustatic and biotic events. Events at the P/T boundary have attracted much attention, among of which of special interest are the geochemical anomalies and eustatic changes as shown along the North Indian margin, as well as a world wide event of the flourishing fungi.

2. Meetings

Workshop of the Chinese Group of IGCP Proj. 359 (13-14 May, Beijing), 12 participants from 7 institutions. Topics on Permian and Triassic stratigraphy and especially the P/T boundary, and preparation of the symposium in 30th IGC (Beijing).

Workshop meetings of IGCP Project 359 during the XIII. International Congress on the Carboniferous-Permian (28 August - 2 September, Krakow, Poland), more than 15 participants from 8 countries.

International Meeting on the Geology of Southeast Asia and Adjacent Areas (4-6 November 1995, Hanoi, Vietnam) - a joint meeting of IGCP Projects 306, 321 and 359.
Pre-excursion 1: Permo-Triassic of Son La; Pre-excursion 2: Triassic and carst topography of Ha Long; Post-excursion 1: Song Ma suture of Ta Khoa. Among 100 participants from 20 countries, 35 are members of IGCP Project 359, including three co-leaders of this project - Yin Hongfu, M. Dickins and A. Baud. Of the 92 presentations 42 concerned the Permo-Triassic stratigraphy, tectonics and metallogenesis. 10 members attended the workshop meeting of IGCP 359.

Participating countries

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

3. Activities planned

International Congress on Triassic Biostratigraphy - Jointly organized by Queensland University of Technology, IGCP Project 359 and the Gondwana Subcommission (April 8-12, 1996; Brisbane, Australia), with excursions: New Zealand Triassic; Triassic of the Brisbane area. Organizing committee: John Rigby (Dept. Geol., QUT), J.M. Dickins, Yin Hongfu.

International field excursion on Permian-Triassic sections of the North Caucasus - jointly sponsored by IGCP Projects nos. 343 (Peri-Tethys Basins) and 359 (July 20-28, 1996), venue-Mineralny Vody. Organizing committee: V. Kotlyar (VSEGEI, St. Petersburg), G.P. Pronina, G.I. Baranov.

Symposia, workshops and excursions during the 30th IGC associated with Project 359 (August 4-14, 1996, Beijing, China):

Symposium 1-7. The P/T boundary and global Triassic correlations. Convenors: Lucas and Yin.
Symposium 1-11. Carboniferous and Permian Tethys evolution. Convenors: Vai and Yin.
Workshop WB18: The shallow Tethys. Convenor: Yin.
Workshop of the IGCP Project 359. Convenor: Yin, Dickins, Yang, Baud.
Excursion T326. Stratigraphy and palaeontology of the Nanjing Hills and adjacent areas. Ld.: Chen.
Excursion T394. Permian and Triassic sequences of continental facies in the Dalongkou area, Jimsar and the Turpan Basin of Xinjiang. Leader: Chen.

FROM THE EDITOR

ALBERTIANA has developed into a very flourishing newsletter. Since it is published twice a year the number of pages has doubled. This means of course that the production of ALBERTIANA has become much more time-consuming. Therefore, authors are urged to submit the contributions on a floppy disc. Only discs in MS-DOS format can be accepted, preferably in WordPerfect 5.1 or any other kind of word-processing program that can be converted into WordPerfect 5.1 (e.g. Word, WordStar or as a plain ASCII file) together with a printed hard copy. This will considerably facilitate the production of ALBERTIANA. Moreover, this will reduce the risk of typing errors. Authors are kindly requested to submit texts that are ready for printing; special attention should be paid to grammar and syntax. References should be in the format used in the 'Annotated Triassic Literature'. Those who do not have the possibility to submit a manuscript in electronic format are kindly requested to send smooth and clearly typed manuscripts in a 12-point typeface with single line spacing. Tables and schemes should be in camera-ready format, clearly drawn or printed; only originals can be accepted, xerox copies can no longer be accepted. Due to time restrictions it is no longer possible to redraw tables and schemes as has been done previously. For the same reason it is impossible to send proofs. Although the editor can now also be reached by e-mail, discs are preferred. Triassic workers are kindly requested to send reprints or xerox copies of the titles and abstracts (including journal, volume and page numbers) of their recently published papers to the editor for the 'Annotated Triassic Literature'.

Hans Kerp (editor of ALBERTIANA)

ANNOTATED TRIASSIC LITERATURE

Hans Kerp and Henk Visscher[1]

ACKERMANN, R.V., SCHLISCHE, P.W. and OLSEN, P.E., 1995. Synsedimentary collapse of portions of the lower Blomidon Formation (Late Triassic), Fundy rift basin, Nova Scotia. Canadian J. Earth Sci., 32: 1965-1976.

A chaotic mudstone unit within the lower Blomidon Formation (Late Triassic) has been traced for 35 km in the Mesozoic Fundy rift basin of Nova Scotia. This unit is characterized by highly disrupted bedding that is commonly cut by small (<0.5 m) domino style synsedimentary normal faults, downward movement of material, geopetal structures, variable thickness, and an irregular, partially faulted contact with the overlying unit. The chaotic unit is locally overlain by a fluvial sandstone, which is overlain conformably by mudstone. Although the thickness of the sandstone is highly variable, the overlying mudstone unit exhibits only gentle regional dip. The sandstone unit exhibits numerous soft sediment deformation features, including dewatering structures, convoluted bedding, kink bands, and convergent fault fans. The frequency and intensity of these features increase dramatically above low points at the base of the sandstone unit. These stratigraphic relations suggest buried interstratal karst, the subsurface dissolution of evaporites bounded by insoluble sediments. We infer that the chaotic unit was formed by subsidence and collapse resulting from the dissolution of an evaporite bed or evaporite rich unit by groundwater, producing dewatering and synsedimentary deformation structures in the overlying sandstone unit, which infilled surface depressions resulting from collapse. In coeval Moroccan rift basins, facies similar to the Blomidon Formation are associated with halite and gypsum beds. The regional extent of the chaotic unit indicates a marked period of desiccation of a playa lake of the appropriate water chemistry. The sedimentary features described here may be useful for inferring the former existence of evaporites or evaporite rich units in predominantly elastic terrestrial environments.

AIGNER, T., SCHAUER M., JUNGHANS, W.D. and REINHARDT, L., 1995. Outcrop gamma-ray logging and its applications: examples from the German Triassic. Sedimentary Geology, 100: 47-61.

Gamma-ray logging of outcrops is a quick and simple, yet powerful technique to better correlate well data with surface geology. It is particularly useful for integrated sequence stratigraphic analysis and for reservoir and aquifer characterisation using outcrop analogues. Three examples from the Triassic of the cratonic German Basin are discussed: (1) shallowing-upward cycles in the Upper Muschelkalk carbonate ramp with retrogradational and progradational stacking patterns; (2) evaporite-to-red bed cycles of the Gipskeuper; (3) fluvial architecture across the terminal alluvial plain system of the Stubensandstein. Such outcrop analog studies help: (1) to calibrate subsurface well log data; (2) to evaluate the heterogeneity of subsurface reservoirs (and aquifers); and (3) to provide improved data for quantitative reservoir modelling.

[1] The help of Sabine Gibas and Gaby Swenzien (Münster) and Dr. Zwier Smeenk (Utrecht) in tracing relevant literature and compiling this bibliography is gratefully acknowledged. Of some papers which contain no (English) abstract only the title is listed. Some references have been obtained from secondary sources. Therefore, diacritical signs may sometimes be missing.

ALAFONT, L.S. and SANZ, J.L., 1996. Un nuevo Sauropterigio (Reptilia) en el Triásico de la Sierra de Prades (Tarragona). Cuad. Geol. Ibérica, 20: 313-330.

ALAVI, M., 1996. Tectonostratigraphic synthesis and structural style of the Alborz Mountain system in Northern Iran. J. Geodynam., 21: 1-33.

Based on lithologic, structural and stratigraphic analyses of the rocks exposed in the Alborz poly-orogenic system of northern Iran, seven tectonostratigraphic and a number of metamorphic rock assemblages, including remnants of the Paleo-Tethys oceanic realm, are distinguished. The tectonostratigraphic units are: (1) an uppermost Precambrian to lower Ordovician epicontinental sequence; (2) an Ordovician to Devonian mafic magmatic assemblage; (3) a Devonian to upper Triassic continental shelf sequence; (4) an upper Triassic and lower Jurassic foreland siliciclastics succession; (5) a middle Jurassic to upper Cretaceous discontinuous epicontinental/continental shelf succession; (6) an upper Cretaceous and Cenozoic are type magmatic assemblage; and (7) the Tertiary and Quaternary synorogenic mostly siliciclastic molasse deposits. The metamorphic assemblages include the upper Paleozoic metamorphosed carbonates, volcanics, and siliciclastics of the Masuleh region, the upper Triassic-lower Jurassic slates and metagraywackes of the Binalood region, and the Paleozoic metavolcanics and metacarbonates of the Gorgan area ('the Gorgan schists'), which are all correlatives of the above tectonostratigraphic units, as well as the Paleo-Tethys remnants of the Mashhad Torbat Jam region in eastern Alborz, the Shanderman complex in western Alborz, and the Gasht complex in the vicinity of Masuleh. These rocks, structurally, form either single thrust sheets or complex duplex systems which are transported generally from NNE to SSW by numerous thrust faults. The thrust faults, which collectively constitute a composite antiformal stack, formed during the Cimmeride and Alpide orogenies.

ÁLVAREZ RAMIS, C. and PÉREZ-LÓPEZ, A., 1996. Megaflora hallada en el Trías de Facies Germánica del sector central de la Cordillera Bética. Cuad. Geol. Ibérica, 20: 215-228.

ANDJELKOVIĆ, M., PEŠIĆ, L. and ANDJELKOVIĆ, D., 1993. The Permian/Triassic boundary in the Dinarides. Ann. Géol. Penins. Balk., 57: 1-20.

Permian and Triassic rocks have a large distribution in the Dinarides. The Permian/Triassic boundary is considered in terms of stratigraphy and paleogeography, vertical occurrence of diverse faunal and floral associations, and geodynamic processes. Columns of the Upper Permian and Lower Triassic developments in the Dinarides and vertical occurrences of various faunal and floral associations for all sea basins of these two periods are given in tables.

ARCHANGELSKY, S., 1996. Aspects of Gondwana paleobotany: gymnosperms of the Paleozoic-Mesozoic transition. Rev. Palaeobot. Palynol., 90: 287-302.

During the late Paleozoic and early Mesozoic the Gondwana Supercontinent underwent dramatic geographic and climatic changes. Geologic and biologic factors concurrently played an important role modelling the vegetation of that time. The gymnospermic component of plant assemblages shows significant variations in composition and in the distribution of different taxa. Analysis of the assemblages shows that some plant groups dominated the scenario, such as the pteridosperms, glossopterids, corystosperms and, to a lesser degree, cordaites and conifers. Ginkgophytes, bennettites or cycads were less important in the Paleozoic but their numbers increased in the Triassic. Paleozoic assemblages were extensively dominated by glossopterids that became extinct in the earliest Mesozoic. Pteridosperms crossed the P-M barrier and became dominant during the Triassic, at a time when corystosperms evolved and radiated. Other groups became extinct in the Paleozoic, namely dicranophylls and cordaites. Conifers were represented by different families, restricted either

to the Paleozoic or the Mesozoic. They were not conspicuous in the analysed assemblages. In some areas of Gondwana, taxa of the Euramerican alliance are present through a migrational mechanism that occurred during continental displacements which produced global climatic changes. Recent studies have shown that there are far more common elements between Euramerica and Gondwana than suspected up to now. These elements find their distribution especially in the western part of Gondwana (Africa-South America).

Baker, J.C., Kassan, J. and **Hamilton, P.J.**, 1996. Early diagenetic siderite as an indicator of depositional environment in the Triassic Rewan Group, southern Bowen Basin, eastern Australia. Sedimentology, 43: 77-88.

Early concretionary and non-concretionary siderites are common in subsurface Triassic sandstones and mudrocks of the Rewan Group, southern Bowen Basin. A detailed petrological and stable isotopic study was carried out on these siderites in order to provide information on the depositional environment of the host rocks. The siderites are extremely pure, containing 85-97 mol% $FeCO_3$, and are commonly enriched in manganese. $\delta^{13}C$ (PDB) values are highly variable, ranging from -18.4 to +2.9 ‰, whereas $\delta^{18}O$ (PDB) values are very consistent, ranging from -14.0 to -10.2 ‰ (mean = -11.9 ± 1.0 ‰). The elemental and oxygen isotopic composition of the siderites indicates that only meteoric porewaters were involved in siderite formation, implying that host rocks accumulated in totally non-marine environments. The carbon isotopic composition of the siderites is interpreted to reflect mixing of bicarbonate/carbon dioxide generated by methane oxidation and methanogenesis. Very low $\delta^{13}C$ values demonstrate that, contrary to current views, highly ^{13}C-depleted siderite can be produced at shallow burial depths in anoxic non-marine sediments.

Bandel, K., 1995. Mathildoidea (Gastropoda, Heterostropha) from the Late Triassic St. Cassian Formation. Scripta Geol., 111: 1-83.

In the St. Cassian fauna of Late Triassic (Early Carnian) age gastropods with protoconch coiled in opposite direction to the teleoconch are common and belong to a number of quite different taxa. Twenty-nine of these are here described, 11 of them for the first time: *Promathilda misurinensis* sp.nov., *Turrithilda cassiana* sp.nov., *T. dockeryi* sp.nov., *Tirolthilda seelandica* gen. et sp.nov., *T. nuetzeli* sp.nov., *Tofanella cancellata* sp.nov., *Cristalloella cassiana* gen. et sp.nov., *C. sinuata* sp.nov., *C. delicata* sp.nov., *Stuorilda cassiana* gen. et sp.nov., and *S. tichyi* sp.nov. All are newly defined and placed in the Mathildoidea. This connects the Triassic species of that superfamily with the modern Heterostropha (= Heterobranchia). In the family Mathildidae the genera *Mathilda* and *Promathilda* are differentiated, two species of *Turrithilda* described, and *Tirolthilda* and *Schroederilda* are included as new genera, with the type species *T. seelandica* gen. et sp.nov. and *Pseudotritonium millierense* Zardini, 1978, respectively. The new family Anoptychiidae holds the genera *Anoptychia, Turristylus* and *Camponella* gen.nov. (type species *Coelostylina pianozensis* Zardini, 1985). Here the juvenile ornament resembles that of the Mathildidae but differs from the later smooth teleoconch. Protoconch morphology differentiates the new families Tofanellidae, Trachoecidae and Ampezzanildidae. In contrast to the Mathildidae, Dolomitellidae and Anoptychiidae, the sinistral shell of the protoconch changes its direction of coiling within the larval part of the shell and not at the transition from larval shell to teleoconch. The Trachoecidae with the genera *Trachoecus* and *Vallandroella* gen.nov. (type species *Tyrsoecus antorni* Zardini, 1985) have a fusiniform shell. The Tofanellidae, with the genera *Tofanella* gen.nov. (type species *Turritella decussata* von Münster, 1841), *Cristalloella* gen.nov. (type species *C. cassiana* gen. et sp.nov.) and *Camponaxis* gen.nov. (type species *Cerithium* (?) *lateplicatum* Klipstein, 1843), differ from the Ampezzanildidae, with the genera *Ampezzanilda* gen.ov. (type species *Promathildia aialensis* Zardini, 1980), *Cassianilda* gen.nov. (type species *Turritella margaritifera* von Münster, 1841)

and *Stuorilda* gen.nov. (type species *S. cassiana* gen. et sp.nov.), by the ornament of their protoconch. A key differentiates all described species, and the evolutionary history of the group is discussed.

BATTAIL, B, 1995. Continental Permo-Triassic biostratigraphic scales based on tetrapod vertebrates: a few problems. Bull. Soc. Géol. France, 166: 527-535.

In many Permo-Triassic continental sedimentary basins, tetrapod vertebrates (amphibians and reptiles) are well represented, and better known than any other group of organisms. Consequently they play a major role in the establishment of regional biostratigraphic scales (South African Karoo, Russian Platform, etc.). Many difficulties are met, however, when attempts are made to establish correlations between the various regional scales, or to locate the continental tetrapod biozones on the universal stratigraphic scale. Some of the problems which are encountered are illustrated with the well known example of the biozones of the Beaufort Group, South African Karoo.

BARABÁSNÉ STUHL, Á., BERCZINÉ MAKK, A., BUDAI, T., CSILLAG, G., DOSZTÁLY, L., HAAS, J., HÍVESNÉ VELLEDITS, F., KOLOSZÁR, L., KOVÁCS, S., LESS, G., PELIKÁN, P., PIROS, O., RÁLISCHNÉ FELGENHAUER, E., RÉTI, Z., RÓTH, L., SZABÓ, I., SZOLDÁN, Z., TÓTHNÉ MAKK, Á. and TÖRÖK, Á., 1993. Lithostratigraphic units of Hungary: Triassic. Kiadja a Magyar Államy Földtani Intézet, Budapest, 278 pp.

BAUDIN, T., MARQUER, D., BARFETY, J.C., KERCKHOVE, C. and PERSOZ, F., 1995. A new stratigraphical interpretation of the Mesozoic cover of the Tambo and Suretta nappes: evidence for early thin skinned tectonics (Swiss Central Alps). C.R. Acad, Sci. Sér. II, Fasc. A, 321: 401-408.

The sedimentary cover of the Tambo and Suretta crystalline nappes (Mid Penninic, Eastern Switzerland), hitherto regarded as only Triassic, is similar to the reduced Mesozoic series of the internal Brianconnais (Acceglio zone) of the French Italian Alps. This series, which includes an unconformable thick member of polygenic breccias considered to be mainly late Cretaceous, must be divided into (1) a reduced autochthonous cover overlain by (2) a more complete allochthonous cover, the 'Starlera Nappe'. An early phase of thin skinned thrusting accounts for the emplacement of this new unit of more internal origin.

BEAUCHAMP, J., BENAOUISS, N. and COUREL, L., 1995. Where was the marine realm in the African Morocco in the Upper Triassic? C.R. Acad. Sci. Sér. II, Fasc. A, 321: 1033-1040.

In the High Atlas realm, early in the Upper Triassic, marine advances are suggested by sedimentary structures, fossils and boron content of illite. Sea water could have invaded parts of the incipient High Atlas rift system until block tilting caused generalized regression and non-marine deposition. The Tethyan domain might be closer than previously inferred with marine pathways located to the North of the Moroccan Meseta.

BELKA, Z. and WIEDMANN, J., 1996. Conodont stratigraphy of the Lower Triassic in the Thakkhola region (eastern Himalaya, Nepal). Newsl. Stratigr., 33: 11-14.

Conodont faunas present in the Lower Triassic rocks of the Thakkhola region (eastern Himalaya, central Nepal) are summarized and analysed with respect to stratigraphy. The sequence exposed near Thini and Jomoson, assigned to the Tamba Kurkur Formation, consists of pelagic limestone bands alternating with dark shale units. It ranges from the early Griesbachian up to late Spathian in age. The conodont fauna documents well in particular the Spathian portion of this condensed sequence. Conodont-based correlation of the Lower Triassic rocks in the Nepal Himalayas reveals that the alternation of carbonate units with shales resulted primarily from the global third-order sea-level fluctuations during Griesbachian to Smithian times, while later, during the Spathian, local tectonics had a stronger influence on the sedimentary regime.

BÉRCZI-MAKK, A., HAAS, J., RÁLISCH-FELGENHAUER, E. and ORAVECZ-SCHEFFER, A., 1993. Upper Paleozoic-Mesozoic formations of the Mid-Transdanubian Unit and their relationships. Acta Geol. Hungaria, 36: 263-269.

The Central Transdanubian (Igal) unit has been a key issue in the pre-Neogene basement of the Pannonian Basin, the elucidation of its setting is indispensable from the geodynamic aspect. In the narrow, strongly tectonized unit lying between the Central Hungarian and Balaton lines Late Paleozoic and Triassic formations do not occur on the surface but are known only from structural key boreholes, hydrocarbon and water exploratory wells. In the northern strip of the tectonic unit Lower Pennian clastic Trogkofel strata and Upper Permian dolomites similar to the *Bellerophon*-bearing dolomite of the Carnian Alps are known in spots. Triassic sequences of different formations of the northwestern, eastern and southwestern parts relate to different tectonic-paleogeographic relations. In the theoretical sequence of the northwestern area nearly the complete period is represented. The Lower Triassic shallow marine and the Anisian platform carbonates are common. The Ladinian radiolarian tuffitic clastic sequences are known in tectonically strongly disturbed areas. The Upper Triassic platform-marginal back-reef lagoon formations are similar to the corresponding formations of the Southern Caravanca. The Triassic sequence of the eastern part known only from sporadic data differs both in structure and in fossil assemblage from the corresponding formations of the Transdanubian Central Range, of the Bükk Mountains. Only a few data are available on the Lower Triassic shallow marine carbonate formations. The Anisian intertidal lagoon facies formations are rich in fossils. The Ladinian-Carnian Wetterstein-type platform formations are represented by near-reef and fore-reef slope sediments. These Wetterstein-type reef formations can be found both in the Northern Calcareous Alps, in the Northern Caravanca, in the Dinarides and in the Internal Western Carpathians. The *Turrispirillina*-bearing formations of Igal indicate the environment of formation close to the outer platform margin and support the relationship with the Dinarides. The complex of the southwestern part containing carbonatic, pelitic sediments, acid to intermediate metavolcanics that underwent partly anchizonal metamorphism, as well as serpentinites, displays similarities also to the Dinarides and belongs probably to a lower-situated nappe unit. Its belonging, however, to the Repno complex cannot be excluded where the ophiolitic melange is found beneath the Tara-nappe. At the level of recent knowledge it is obvious that the pre-Tertiary basement of the Central Transdanubian Unit is foreign to its recent geological setting and is of non-uniform built-up. Part-units got probably close to each other along parallel displacement planes but it is also probable that nappe formation during the Earth's history complicates the tectonic conditions.

BERRA, F., 1995. Stratigraphic evolution of a Norian intraplatform basin recorded in the Quattervals Nappe (Austroalpine, northern Italy) and paleogeographic implications. Eclogae geol. Helv., 88: 501-528.

The Quattervals Nappe (Central Austroalpine) consists of a thick Norian succession which records a stratigraphic evolution from inner carbonate platform to intraplatform basin facies (Quattervals Basin). This evolution is recorded by three partly coeval formations (from bottom to top): 1-Hauptdolomit or Dolomia Principale (up to 400-500 m thick), mainly represented by dolomitized inner platform facies; 2-Pra Grata Formation (thickness from 200 m southward to 20-30 m northward), characterized by alternations of dark thin bedded limestones and dolomitic breccias and dolarenites; 3-Quattervals Limestone (more than 600 meters thick, the top being not preserved in the study area), mainly consisting of dark calcarenites and fine grained limestones. Facies association and distribution allowed the reconstruction of the geometry and paleogeography of the basin with a width in N-S direction of at least 8 km. The preserved E-W length is about 30 km. Facies distribution and sedimentologic features, such as orientations of slump overfolds and submarine erosional surfaces, clearly document the

asymmetry of the basin. The existence of two different margins can be inferred: a flexural type northern margin with a low angle slope and a fault controlled southern one with a steeper slope. The orientation of the synsedimentary faults of the southern margin was probably W-E or WNW-ESE: the Norian faults are likely to have been reactivated during the alpine orogenic phases. The development of the Quattervals Basin is related to extensional/transtensional tectonics. A Norian tectonic phase is documented almost all over the alpine realm and is usually related to the first stages of the extension responsible for the Jurassic opening of the Penninic Ocean. The characteristics of the Quattervals Basin suggest that its origin could be related not directly to the opening of the Penninic Ocean (Neotethys), but to the evolution of the Hallstatt basin (Paleotethys).

Blau, J., Wenzel, B., Senff, M. and Lukas, V., 1995. Die Foraminiferen des oberen Buntsandsteins (Röt) und des unteren Muschelkalks (germanische Trias: Skyth, Anis) in Nordhessen. Geol. Paläont. Mitt. Innsbruck, 20: 13-33.

The authors describe the first foraminifera from the Röt and the Lower Muschelkalk of Northern Hessen. In the Röt three lithologic horizons yielded foraminifers: (1) 'Untere Bunte Schichten', (2) 'Obere Bunte Schichten', and (3) 'Myophorien-Schichten'. In the Lower Muschelkalk the 'Gelbe Grenzbank', the 'Oolith-Bänke', the 'Untere Terebratel-Bänke' and the 'Schaumkalk-Bänke' yielded foraminifers. The Röt as well as the Muschelkalk faunas are dominated by agglutinated forms and primitive representatives of the Miliolaceae. Calcareous-walled forms are rare. Sessile forms are restricted to the crinoid-rich limestones of the 'Terebratel-Bänke'.

Blendinger, W., 1995. Lower Triassic to Lower Jurassic cephalopod limestones of the Oman Mountains. N. Jb. Geol. Paläont. Mh., 10: 577-593.

Mesozoic cephalopod limestones occur as megabreccia blocks in Jurassic to Lower Cretaceous deep water sedimentary rocks in the Oman Mountains. The blocks contain ammonoids of Smithian to Early Jurassic age. The Smithian to Lower Carnian interval rests stratigraphically on Upper Permian shallow water limestone, is about 75 m thick and composed of bedded, typically red limestone. Upper Norian to Hettangian rocks are about 18 m thick and consist of red, argillaceous nodular limestone. The limestone blocks are locally associated with channelized gravity flows derived from the Arabian platform. This indicates that the seamount, on which the cephalopod limestones were deposited, was located close to the edge of the Arabian platform rather than in a distal, oceanic environment.

Bourquin, S., Friedenberg, R. and Guillocheau, F., 1995. Depositional sequences in the Triassic series of the Paris Basin: Geodynamic implications. Geol. Ibérica, 19: 337-?

Bourquin, S., Poli, E., Durand, M. and Courel, L., 1995. Evaporite stratigraphy of the French Triassic basins: example of Carnian series, depositional sequences and their morpho-structural evolution. Bull. Soc. Géol. France, 166: 493-505.

A review of current dating information on French Triassic basins indicates that major evaporitic episods occurred at remarkably similar times throughout Peritethyan basins. More recent studies based on sequence stratigraphy analysis allow to establish the depositional sequence geometry of evaporitic series and their clastic and carbonate equivalents. From examples taken on the evaporitic Carnian series of French basins, it is possible to point out local tectonical events. These events control evaporitic sedimentation and may have a more extended origin at the scale of the West European craton.

BUFFETAUT, E., MARTIN, V., SATTAYARAK, N. and SUTEETHORN, V., 1995. The oldest known dinosaur from Southeast Asia: a prosauropod from the Nam Phong Formation (Late Triassic) of northeastern Thailand. Geol. Mag., 132: 739-742.

The distal part of the fused ischia of a prosauropod from the Nam Phong Formation (Late Triassic) of Phetchabun Province, in northeastern Thailand, is described. Comparisons with various prosauropods, as well as with an early sauropod, show that the Thai specimen is especially robust. However, the available material is too incomplete to warrant a precise identification. It is the first vertebrate fossil found in the Nam Phong Formation, the oldest known dinosaur from southeast Asia, and the first prosauropod to be reported from that region.

BÜRGIN, T., 1995. Actinopterygian fishes (Osteichthyes: Actinopterygii) from the Kalkschiefer-Zone (uppermost Ladinian) near Meride (Canton Ticino, southern Switzerland). Eclogae geol. Helv., 88: 803-826.

During three small-scale excavations in the Kalkschiefer-Zone (Uppermost Ladinian) near the village of Meride, Canton Ticino, some fish fossils were found alongside remains of plants, invertebrates and reptiles. The fishes are exclusively actinopterygians, with the neopterygian *Prohalecites porroi* being the predominant species with 60 found specimens. Five specimens of *Perleidus altolepis* allow a more derailed reconstruction of this species. Among the other taxa found are a fragment of *Gyrolepis* sp., two, presumably new species of *Peltopleurus,* a few specimens of *Archaeosemionotus* sp. and three specimens of *Ophiopsis* cf. *lepturus.* A preliminary comparison is made between the fossil fishes found near the village of Meride and those already described from the contemporaneous locality Ca' del Frate, (Viggiù, Northern Italy).

CARULLI, G.B., LONGO SALVADOR, G. and PONTUN, M., 1995. Le unitá ladino-carniche nella Carnia centro-occidentale. Ann. Univ. Ferrara, Sci. Terra, 5(Suppl.): 75-84.

In central-western Carnia, the Ladinian-Carnian sequence consists of a number of terrigenous units (Livinallongo, Wengen, S. Cassiano Formations) located between two carbonate platforms (the dolomitic limestones of Mount Tiarfin and of the Cassian Dolomite). The former is covered with red Ammonite limestones which unquestionably belong to the upper Ladinian, while the latter is surmounted by dark limestones, which undoubtedly belong to the middle Carnian age. Therefore, the Ladinian-Carnian boundary actually occurs in the higher basinal units, and perhaps, more to the east, at the bottom of the Cassian platform. For this purpose, three stratigraphic sections between Ampezzo (Val Lumiei) and Forni di Sopra (M. Lagna and Forcella Torondon) have been suggested for analysis as, owing to the sequences' continuity and their favourable exposures, they are well suited to biostratigraphic studies aiming to define their boundary. For each of the three sections, a schematic geological section is shown, along with a stratigraphic log which has been re-interpreted in view of the most recent proposals. A comparative analysis of these three sections has clearly revealed a prograding of the Cassian platform from the central Carnia, where it is thicker, towards NW namely towards the regions of greatest development of the terrigenous basinal sequences. These are formed in the upper part by the Acquatona, Fernazza, La Valle, and S. Cassiano Formations.

CARULLI, G.B., LONGO SALVADOR, G., PODDA, F. and PONTON, M., 1994. Platform-Basins relationships in the norian of the Carnia region (NE Italy). Géol. Mediterr., 21(3-4): 27-30.

CASTAÑO, S. and CARBÓ, A., 1995. Los afloramientos triásicos de la zona de confluencia de las Cordilleras Ibérica y Bética. Aportes de la gravimetría a su interpretación. Cuad. Geol. Ibérica, 19: 235-248.

CHUNG, S.L. and JAHN, B.M., 1995. Plume lithosphere interaction in generation of the Emeishan flood basalts at the Permian-Triassic boundary. Geology, 23: 889-892.

The Emeishan flood volcanism that erupted at the Permian-Triassic boundary time produced a large igneous province of at least 2.5 x 10^5 km^2 in the western margin of the Yangtze craton, southwestern China. The volcanic successions, suggested to have resulted from a starting mantle plume, comprise thick piles of basaltic flows and subordinate picrites and pyroclastics. The picrites, which have high magnesian contents (MgO = 20-16 wt%), variable degrees of light rare earth element enrichment [$(Ce/Yb)_N$ = 4-25] and heterogeneous isotope ratios ($\epsilon_{Nd}(T)$ = +4 to -4], are proposed to have been generated by mixing between the dominant plume derived magmas and small amounts of lamproitic liquids from the continental lithospheric mantle.

CIRILLI, S., 1995. Le associazioni palinologiche al limite Ladinico-Carnico. Ann. Univ. Ferrara, Sci. Terra, 5(Suppl.): 91-99.

The Triassic was a period of reconstruction in the plant kingdom after the Permian/Triassic biologic crisis. There are many evidences that in the Mediterranean region a domain of mixed Laurasia and Gondwana floras (Onslow microflora) developed during Middle-Late Triassic. It is testified by a lot of findings of mixed northern and southern elements such as *Camerosporites secatus, Ovalipollis pseudoalatus, Samaropollenites speciosus*. In a very general view, the Ladinian is dominated by bisaccate pollen grains (*Triadispora* group, *Striatoabietites aytugii, Lunatisporites acutus, L. noviaulensis, Ovalipollis pseudoalatus, Staurosaccites quadrifidus, Illinites chitonoides* associated with *Echinitosporites iliacoides, Cannanoropollis scheuringii, Costatisulcites ovatus, Moslterina globosa, Podosporites amicus, Kuglerina meieri, Sellaspora rugoverrucata, Uvaesporites gadensis, Porcellispora longdonensis, Krauselisporites dentatus*. The Carnian record is characterized by the blooming of the Circumpolles group such as *Paracirculina scurrilis, Praecirculina granifer, Camerosporites secatus, Duplicisporites granulatus* and *Patinasporites densus*, while bisaccate pollen grains are scarce. Previous studies palynologically defined the Carnian, including the Ladinian/Carnian boundary, in term of phase 1, characterized by the occurrence of *Ovalipollis pseudoalatus* in combination with numerous distinctive species such as *Camerosporites secatus, Ellipsovelatisporites plicatus, Enzonalasporites vigens, Duplicisporites granulatus, Triadispora* spp., *Infernopollenites* spp.. Within this long-ranging phase, all the authors agreed to distinguish a progressive diversification of additional taxa for discerning younger assemblages. The most indicative are: *Patinasporites densus, Paracirculina quadruplicis* and *Vallasporites ignacii*. Assemblages corresponding to phase 1 are well known in the Germanic and Alpine Triassic areas. Several authors expressed the Ladinian-Carnian event also in terms of the *Camerosporites secatus* phase. This phase, based by Visscher & Krystyn (1978) on Schuurman's (1977; 1979) Phase I, was first considered as an exclusively Carnian event and then was extended into the Ladinian, too (Visscher & Brugmann, 1981; Van der Eem, 1983). According to other authors, *C. secatus* is unsuitable to characterize a well defined palynological subdivision as it is a long-ranging element. Therefore, more detailed palynostratigraphic subdivisions of the *Camerosporites secatus* phase were introduced in several parts of the Tethys realm (Besems, 1981a,b; 1982; 1983; Besems & Simon, 1982; Van der Eem, 1983). As suggested by Visscher & Krystyn (1978), a late Ladinian trend may well be represented by the occurence of *C. secatus* in combination with *E. iliacoides, Retisulcites perforatus* and, at least in the Alpine-Mediterranean part of Europe, the 'northern' element *Staurosaccites quadrifidus*. An exclusively Carnian development is suggested on the basis of a gradual diversification of species of circumsulcate form genera other than *Camerosporites*, and of vesicate forms belonging to the *Enzonalasporites-Pseudoenzonalasporites-Patinasporites-Vallasporites* group. Upwards younger Carnian assemblages are marked by the combined presence of *Paracirculina*

quadruplicis, Patinasporites densus, Vallasporites ignacii and *Pseudoenzonalasporites summus.* Recently Brugman et al. (1994) reported a well defined palynological assemblage from the Germanic Triassic recognizing two distinct phases referred to the Longobardian: the *perforatus-dimorphus* phase (lower Longobardian) and the *dimorphus-iliacoides* phase (upper Longobardian). Van der Eem (1983) from a palynostratigraphic investigation in the Middle-Upper Triassic of the western Dolomites, palynologically characterized this interval with seven phases. Across the Ladinian/Carnian boundary the author recognized three phases: *secatus-dimorphus* and *secatus-vigens* phases (late Ladinian, Longobardian) and the *vigens-densus* phase (early Carnian, Cordevolian). Waiting for a more detailed correlation between palynomorph assemblages and ammonoid and conodont zonations, the Ladinian-Carnian boundary could be reasonably characterized by the occurrence of two distinct palynological assemblages: Assemblage A (late Ladinian, Longobardian), corresponding to the *perforatus-dimorphus* and *dimorphus-iliacoides* phases (sensu Brugmann et al., 1994 for the Germanic Triassic) and *secatus-dimorphus* and *secatus-vigens* phases (sensu Van der Eem, 1983, for the Triassic of the southern Alps); this assemblage results to be composed by the presence and last occurence of *Retisulcites perforatus, Heliosaccus dimorphus, Keuperisporites baculatus,* by the appearance of *Echinitosporites iliacoides* and *Infernopollenites* spp. and, locally, by a progressive diversification of important taxa: *Foveosporites vischeri, Ischyosporites* cf. *variegatus, Porcellispora longdonensis* and *Neoraistrikia taylorii.* In the southern Alps this assemblage is characterized upwards (*secatus-vigens* phase sensu Van der Eem) by the appareance of *E. vigens* and *W. magmus* (which disappears at toe top of this phase). The top of this phase is marked by the disappearance of *Heliosaccus dimorphus* and *Echinitosporites iliacoides. Camerosporites secatus* can locally appear at the upper Ladinian. Assemblage B (Early Carnian, Cordevolian), which corresponds to the *vigens-densus* phase (sensu Van der Eem, 1983), is characterized by the presence of *E. vigens* and first occurrence of *Patinasporites densus, Vallasporites ignacii* and *Lagenella martinii.*

CUNY, G., 1996. French vertebrate faunas and the Triassic-Jurassic boundary. Palaeogeography, Palaeoclimatology, Palaeoecology, 119: 343-358.

The study of vertebrate fossils, mainly microremains, between the Norian and the Hettangian in 13 outcrops in France and Luxembourg shows no catastrophic extinction at the Triassic-Jurassic boundary in this area. This study suggests an ecological re organization following the great Rhaetian trangression which reduced the distribution area of large terrestrial assemblages and favoured the development of new lineages of fishes. Such a result is of limited geographic and stratigraphic value and has to be extended to all Europe and to the Carnian to confirm the proposed scheme.

DAGYS A.S. and ERMAKOVA S.P., 1995. A new genus of Olenekian (early Triassic) boreal ammonoids. Paleont. Z., 3: 120-123.

Procarnitoides, a new monotypical genus with the type species *P. sobolevi* sp. nov. is described from Olenekian deposits of East Taimyr.

DALLA VECCHIA, F.M., 1994. Reptile remains from the Middle-Upper Triassic of the Carnic and Julian Alps (Friuli-Venezia Giulia, northeastern Italy). Gortania - Atti Mus. Friul. Storia Nat., 15: 49-66.

Reptilian remains from Upper Ladinian (Middle Triassic) and Lower Carnian (Late Triassic) of the Carnic and Julian Alps (Friuli-Venezia Giulia region, Northeastern Italy) stored at the Museo Friulano di Storia Naturale (Udine) are described. A large nothosaur similar to *Paronothosaurus* is identified for the first time in the Carnian. The placodont *Cyamodus* is reported for the first time from the Upper Ladinian.

DALLA VECCHIA, F.M., 1995. A new pterosaur (Reptilia, Pterosauria) from the Norian (Late Triassic) of Friuli (northeastern Italy). Preliminary note. Gortania, Atti Mus. Friul. Storia Nat., 16: 59-66.

Eudimorphodon rosenfeldi n.sp. a pterosaur from the Norian (Late Triassic) of northern Friuli (Northeastern Italy) is described. The features which distinguish *E. rosenfeldi* from *E. ranzii* are: hind-limbs proportionally longer (tibia is as long as ulna and much longer than humerus), different shape of the posterior part of the lower jaw, of the humerus, coracoid and pteroid; pterygoid without teeth; teeth surface smooth.

DALLA VECCHIA, F.M., 1996. Archosaurian trackways in the upper Carnian of Dogna valley (Udine, Friuli, NE Italy). Natura Nascosta, 12: 5-17.

Archosaurian trackways from the Upper Carnian ('Unità Dogna'/Forimazione di Monticello) of Dogna valley (Udine) are here preliminarly described. They are tracks left by quadrupedal reptiles with a pentadactyl elongated pes, clawed and with apparently narrow, short digits, and manus smaller with at least 4 digits of which only 3 are usually well marked. In the pes digit III is the longest, digit V is short and placed rather posteriorly. The trackways are wide, with a low (~100°) pace angulation. No drag marks of body or tail are visible. The trackmaker was an archosaur, possibly a phytosaur or, less probably, a primitive crocodylomorph still retaining a functionally pentadactyl pes, an aetosaur or a rauisuchian.

DALLA VECCHIA, F.M., 1996. Ipotesi stratigrafiche sulle unità bacinali noriche della Carnia. Natura Nascosta, 12: 18-21.

Stratigraphical data about Norian basinal units of Carnia and other Alpine regions are reported. A possible Late Norian (Sevatian) age is hypotesized for the lower part of the 'calcari di Chiampomano' Fm. of Carnia.

DE RENZI, M., BUDOROV, K. and SUDAR, M., 1996. The extinction of conodonts -in terms of discrete elements- at the Triassic-Jurassic boundary. Cuad. Geol. Ibérica, 20: 347-366.

DE ZANCHE, V. and GIANOLLA, P., 1995. Litostratigrafia al limite Ladinico-Carnico (Sudalpino orientale). Annali Univ. Ferrara, Sci. Terra, 5 (Suppl.): 41-48.

The stratotype of the Ladinian/Carnian boundary must be proposed inside a unambiguous lithostratigraphic setting. A redefinition of some uppermost Ladinian-lower Carnian lithostratigraphic units in the eastern Southern Alps is suggested. As during latest Ladinian and early Carnian in dependence of paleogeography volcaniclastics were more or less common throughout the basinal sediments, their presence seems not to be a discriminant lithological feature. Therefore the boundary between La Valle Formation and S. Cassiano Fm., close to the Ladinian/Carnian boundary, is placed at the base of the first carbonate beds which record in the basin the progradation of the Cassian Dolomite 1. Thus the original idea by Richthofen 1860 could be reinstated. As a consequence the La Valle Fm./S. Cassiano Fm. boundary is rightly diachronic. As two Cassian carbonate platforms exist, the S. Cassiano Fm. should include the products of two carbonate progradational events.

DE ZANCHE, V., GIANOLLA, P., MANFRIN, S., MIETTO, P. and ROGHI, G., 1995. A Middle Triassic backstepping carbonate platform in the Dolomites (Italy): sequence stratigraphy and biochronostratigraphy. Mem. Sci. Geol., Padova, 47: 135-155

In the Dolomites, the latest Anisian to early Ladinian Lower Edifice is formed by isolated carbonate platforms up to 400 m thick. It developed throughout the western Dolomites but it also extends elsewhere in the Southern Alps. It overlies upper Anisian carbonate platform deposits (Contrin Formation) and is in turn overlain by a lower Ladinian prograding carbonate platform (Sciliar Dolomite 1); where it is drowned, it is covered by pelagic limestones early

Ladinian in age. The Lower Edifice consists of hundreds of stacked shallowing upward carbonate parasequences, mainly subtidal and commonly bearing ammonoids. In the areas where margins are preserved, the platforms show back-stepping geometries. The adjacent equivalent basin deposits consist of few metres of "Plattenkalke", made up of thinly bedded dark calcareous dolomitic mudstones and distal microturbidites, and of few metres of "Knollenkalke", consisting of nodular cherty limestones. From the sequence stratigraphic point of view the Contrin Fm. may be interpreted as the HST of an upper Anisian 3rd order depositional sequence. The Lower Edifice and the coeval basinal interval correspond to the TST, and the Sciliar Dm. 1 to the HST of the overlying depositional sequence. The sequence stratigraphic framework was correlated throughout the Southern Alps on the basis of ammonoids and conodonts. Due to their spectacular exposition, the upper Anisian-Ladinian carbonate bodies in the Latemar area (western Dolomites) have been considered by many authors as a significant example of platforms controlled by short- and long-term sea level fluctuations. However, the latest Anisian-early Ladinian behaviour of the Latemar area was anomalous in comparison to the situation throughout the Southern Alps. The sedimentary cover probably reflects the first effects of the emplacement of the Predazzo-Monzoni intrusive bodies. As a consequence, the features of Latemar cyclic succession suggests decreasing accommodation in a context of regional increasing accommodation space. The sequence stratigraphic framework and the high resolution ammonoid chronostratigraphy rise problems when attempting to calculate time duration only on the basis of high-frequency cyclicity.

DEGALDEANO, C.S., DELGADO, F., LOPEZ-GARRIDO, A.C. and ALGARRA, A.M., 1995. Alpujarride attribution suggested for the La Mora Unit, NE of Granada (Betic Cordillera, Spain). C.R. Acad. Sci., Ser. II, Fasc. A, 321: 893-900.

NE of Granada, the La Mora Unit appears in tectonic windows under two Alpujarride units. Besides the series already known (Lias to Tertiary), the authors describe thick carbonates of Middle and Late Triassic age (Norian dated previously and probable Ladinian/Carnian), These are similar to those of the overthrusting Alpujarride units, although without metamorphism. Consequently, we ascribe the La Mora Unit to the Alpujarride Complex. At least in this unit, Jurassic and younger sediments belong stratigraphically to the Alpujarrides.

DEL FUEYO, G.M., TAYLOR, E.L., TAYLOR, T.N. and CÚNEO, N.R., 1995. Triassic wood from the Gordon Valley, central Transantarctic Mountains, Antarctica. IAWA Journal, 16: 111-126.

Wood from an in situ permineralized forest from the Middle Triassic of Gordon Valley (Queen Alexandra Range, central Transantarctic Mountains) in Antarctica is described as a new taxon. Approximately 100 trunks in growth position are present at the site; they range from 13-61 cm in diameter and suggest that some of the trees were up to 20 m tall. Pits in the radial walls of the tracheids are of the abietinean type. Rays are uniseriate and 1-9 cells high; cross fields include one to two pits that appear to be simple. Axial parenchyma is absent. Pith and cortex are not preserved. The Antarctic wood is compared with existing fossil wood types from Antarctica and other parts of Gondwana. Although the fossil wood shares a number of characteristics with the Podocarpaceae, it differs from any existing genera and is described as a new taxon, *Jeffersonioxylon gordonense*.

Triassic workers are kindly requested to send reprints or xerox copies of the titles and abstracts (including journal, volume and page numbers) of their recently published papers to the editor for the 'Annotated Triassic Literature'

DIEZ, J.B., BROUTIN, J., FERRER, J., GISBERT, J.and LIÑÁN, E., 1996. Estudio paleobotánico de los afloramientos triásicos de la localidad de Rodanas (Epila, Zaragoza), rama aragonesa de la Cordillera Ibérica. Cuad. Geol. Ibérica, 20: 205-214.

DILKES, D.W., 1995. The rhynchosaur *Howesia browni* from the Lower Triassic of South Africa. Palaeontology, 38: 665-685.

Howesia browni is a rhynchosaur (Reptilia: Archosauromorpha) known from a single locality in the *Cynognathus* Assemblage Zone (Beaufort Group: Burgersdorp Formation) near the town of Aliwal North, Eastern Cape Province, South Africa. *Howesia* is diagnosed by the following autopomorphies: (1) multiple rows of small, conical teeth on medially expanded maxillaries that lack longitudinal, occlusal grooves; (2) multiple rows of small, conical teeth on dentaries; (3) a broad ventral process of the squamosal that does not extend below the middle of the lower temporal fenestra; (4) a medial shelf on the quadrate ramus of the pterygoid; (5) contact between the ectopterygoid and jugal reduced to less than half of the distal expansion of the ectopterygoid; (6) deep pockets on the neural arches of the posterior dorsals and sacrals; and (7) posteriorly inclined and tall proximal caudal neural spines. A preliminary phylogenetic analysis demonstrates that Rhynchosauria can be rediagnosed by seven synapomorphies: (1) a beak shaped premaxilla; (2) a single, median external naris; (3) contact between the premaxilla and prefrontal; (4) depression on the dorsal surface of the frontal; (5) depression on the dorsal surface of the postfrontal; (6) fused parietals; and (7) flat occlusion. *Howesia* is the probable sister taxon to the clade of *Rhynchosaurus*, *Stenaulorhynchus*, *Scaphonyx* and *Hyperodapedon*.

DINARÉS-TURREL, J. and PARÉS, J.M., 1996. El Triásico de la Península Ibérica: nuevos datos paleomagnéticos. Cuad. Geol. Ibérica, 20: 367-384.

DRONOV, V.I. and POLUBOTKO, I.V., 1995. The stratigraphy of Triassic deposits in the south-eastern part of the Central Pamirs (Kalaktash Zone). Dokl. Akad. Nauk., 343: 361-363.

DRONOV, V.I., DAGYS, A.A. and POLUBOTKO, I.V., 1995. The stratigraphy of Triassic deposits of the intermediate zone in the south-east Pamirs. Dokl. Akad. Nauk., 343: 500-502.

ELLESS, M.P., RABENHORST, M.C. and JAMES, B.R., 1996. Redoximorphic features in soils of the Triassic Culpeper Basin. Soil Science, 161: 58-69.

Conflicting observations have been reported about redoximorphic features in soils derived from red Triassic sediments. Previous laboratory research has shown that development of redoximorphic features is sometimes inhibited in these sediments. Soil morphological descriptions made under the auspices of The National Cooperative Soil Survey, however, include redoximorphic features consistent with their drainage status. The objective of this study was to examine the relationship between soil characteristics and development of redoximorphic features in these soils. Eleven pedons located along two topohydrosequences in the Triassic Culpeper Basin of Maryland were described and characterized. In addition, water table depths were measured biweekly over a 2 year period at each pedon during the wet season. Similarly drained, yet morphologically different pedons were observed occupying the lower backslope, footslope, and toeslope positions of both topohydrosequences. Differences in organic carbon content and soil temperature did not explain the observed morphological differences among these similarly drained soils. The nature of the parent material, however, appears to control the development of redoximorphic features in the soils of the Triassic Culpeper Basin of Maryland. Lithological discontinuities were observed at the boundary between horizons with yellow and red hues (i.e., 5YR) in soils that occupy the

footslope and toeslope positions. These discontinuities are believed to represent the incorporation of alluvial debris in these soils. Within pedons whose upper sola were influenced by alluvial additions and a persistent seasonally high water table, substantial development of redoximorphic features was observed. Within hydrologically similar pedons derived mainly from Triassic residuum, redoximorphic features were weakly expressed. Hydromorphological features are formed by redox processes, but the particular expression may be affected by the nature of the parent materials. These results may be useful to field soil scientists for their assessment of the correct drainage class of these soils.

ENGESER, T., 1995. Berippte Nautiliden (Cephalopoda) aus der Mitteltrias von Epidauros (Peloponnes, Griechenland). Mitt. Geol.-Paläont. Inst. Univ. Hamburg, 78: 95-127.

From the Late Anisian/Early Ladinian boundary to the Late Ladinian of the Epidauros section (Peloponnes, Greece) six new genera with seven species of ribbed nautilids are described: *Cornatinautilus fiedieri* n.gen. n.sp., *Cornalinautilus* sp., *Renzinautilus scholzi* n.gen. n.sp., *Veitinatitilus banholzerae* n.gen. n.sp., *Veitinautilus boettcherae* n.sp., *Epidauronautilus tselepidisi* n.gen. n.sp., *Graeconautilus buechseli* n.gen. n.sp., *Weitschatinautilus mediterraneus* n.gen. n.sp.. *Cornalinautilus* n.gen. and *Renzinautilus* n.gen. are attributed to the Pleuronautilidae. The new family Epidauronautilidae contains the two genera *Epidauronautilus* n.gen. and *Graeconautilus* n.gen. The generic affiliation of *Veitinautilus* n. gen. is left open. *Weitschatinautilus* is attributed to the Syringonautilidae. The specific variability and the phylogeny of the genera (and families) is briefly discussed.

ESHET, Y., RAMPINO, M.R. and VISSCHER, H., 1995. Fungal event and palynological record of ecological crisis and recovery across the Permian-Triassic boundary. Geology, 23(11): 967-970.

The end of the Permian Period was marked by the most severe mass extinction in the geologic record. Detailed quantitative study of pollen and spores from shallow marine deposits spanning the Permian-Triassic (P-Tr) boundary in Israel reveals a sequence of palynological ecological stages reflecting a major crisis among land plants. The disappearance of the gymnosperm dominated palynoflora of the Late Permian *Lueckisporites virkkiae* Zone is recorded at a claystone horizon containing almost exclusively abundant fungal remains and carbonized terrestrial plant debris. This "fungal spike" is followed by a zone dominated by marine acritarchs and a succession showing ecological recovery with abundant lycopod spores and eventual reappearance of bisaccate gymnosperm pollen in the Early Triassic. The latest Permian proliferation of fungi is recognizable worldwide and can be correlated with other paleontological and geochemical markers of a global ecological disaster.

FAERSETH, R.B., GABRIELSEN, R.H. and HURICH, C.A., 1995. Influence of basement in structuring of the North Sea Basin, offshore southwest Norway. Norsk Geol. Tidsskr., 75: 105-119.

The coast parallel deep reflection profile ILP 10, located ca. 50 km west of the Norwegian coastline, suggests that major geological Precambrian and Caledonian units well known from the west Norway mainland can be correlated to similar basement units in the shelf area. The offshore continuation of the Nordfjord Sogn detachment and the Hardangerfjord shear zone related to Devonian extension, bound two N- and NW-facing half grabens containing lower Palaeozoic rocks of the Caledonian Ailochthon. The basement units constitute the substrate for Permo-Triassic sediments within the bulk of the study area. following Mid Permian-Early Triassic (ca. 260-240 Ma) stretching, crystalline basement thickness on the Horda Platform was, in places, reduced to some 12-13 km, and the basement rocks are now covered by 8-10 km sediments. The block bounding and extensional basement involved master faults of this generation have a spacing of 15-20 km. Permo-Triassic faulting resulted in throws of up to 4-5 km, whereas throws related to the Jurassic-Early Cretaceous reactivation are negligible

(< 300 m). The Permo-Triassic master faults in the area are discordant to structural trends in the coastal area which result from Caledonian compression and Devonian extension. It is suggested that both the orientation and spacing of the master faults were influenced by a Precambrian N-S structural grain, whereas changes in fault polarity and associated accommodation zones are related to basement grains represented by the Bergen Arcs of Caledonian origin and the Nordfjord Sogn detachment representing a Devonian shear zone. While the Jurassic extension in the northern North Sea was fairly localized and concentrated to the Viking Graben, the Permo-Triassic extension was distributed across the total width of the basin. However, the most pronounced Permo-Triassic fault activity was concentrated to the eastern part of the northern North Sea basin and it is proposed that the Permo-Triassic rift axis was situated on the present Horda Platform.

FLINCH, J.F., BALLY, A.W. and WU, S.G., 1996. Emplacement of a passive margin evaporitic allochthon in the Betic Cordillera of Spain. Geology, 24: 67-70.

The Triassic section of the External domain of the Betic Cordillera is rootless and thus allochthonous. The frontal accretionary wedge of the Guadalquivir allochthon consists dominantly of Triassic evaporites and red beds forming a melange with Upper Cretaceous-Paleogene deep water sedimentary rocks. Throughout the unit, Jurassic rocks are absent. It is here proposed that the widespread Triassic evaporites of the Guadalquivir allochthon were originally emplaced as gravitational allochthonous masses in a passive margin setting much like the widespread allochthonous salt of the Texas Louisiana Gulf of Mexico. Thus, on the Betic passive margin, allochthonous evaporites were first emplaced during the Late Cretaceous-Paleogene. Later, during Neogene time, these evaporites were overthrusted as an accretionary wedge to form the Guadalquivir allochthon. A schematic reconstructed position of the Guadalquivir allochthon places the original passive margin allochthon in its continental slope setting.

FLÜGEL, E. and KOCH, R., 1995. Controls on the diagenesis of Upper Triassic carbonate ramp sediments: Steinplatte, Northern Alps (Austria). Geol. Paläont. Mitt. Innsbruck, 20: 283-311.

The Steinplatte near the Austrian-German boundary was long regarded to be a classical model for Upper Triassic reefs formed at carbonate platform margins. This model was replaced by a distally-steepened ramp model (Stanton & Flügel (1989, 1995). Our paper discusses the early diagenetic criteria of the 'mound facies' of the Oberrhätkalk exposed in three sections in the western and southern cliff walls. The mound facies consists of three aggradational depositional cycles separated by regressive phases. Primary facies differences within these cycles resulted in the formation of complex hydrological systems acting as flow pathways for marine and/or meteoric or altered pore waters and producing different carbonate cement types. The flow pathways were intensified by repeated early meteoric influx causing dissolution of mineralogically unstable bioclasts (predominantly molluscs). Increasing access of pore waters resulted in the formation of molds and vugs and recrystallization of great parts of the rocks above and below the beds which acted as pore water conduits. Marine pore waters resulted in the abundant formation of radiaxial-fibrous calcite cements whose growth was strongly substratecontrolled. Interruptions of cement growth by reddish silt and vadose silt point to subaerial exposure and karstification of adjacent platform areas. The 'mound facies' of the Steinplatte is an example of a complex cementation pattern controlled by (1) the spatial distribution of primary facies criteria (matrix, grains, porosity types), (2) deposition on a ramp, causing variations of the hydrological systems in time, and (3) local substrate control favouring the precipitation of radiaxial-fibrous calcite cement within a marine diagenetic environment.

FONTAINE, H., IBRAHIM, B.A. and KHUC, D.V., 1995. Triassic limestone of southwest Kelantan (east and south of Pos Blau) and north Pahang (Merapoh area), peninsular Malaysia. J. Geol. (Vietnam), Ser. B, 5-6: 16-30.

FRANCES, C.P. and METCALFE, I., 1995. Paleozoic and Mesozoic radiolarian biostratigraphy of peninsular Malaysia. J. Geol. (Vietnam), Ser. B, 5-6: 75-93.

FURRER, H., 1995. The Kalkschieferzone (Upper Meride Limestone: Ladinian) near Meride (Canton Ticino, southern Switzerland) and the evolution of a Middle Triassic intraplatform basin. Eclogae geol. Helv., 88: 827-852.

The Kalkschieferzone (uppermost Meride Limestone; Late Ladinian) in the area of Monte San Giorgio near Meride (Canton Ticino Switzerland) and Ca' del Frate (Varese, Italy) is known for its excellent preservation of numerous small actinopterygian fishes and rare aquatic reptiles. During small scale excavations in the Gaggiolo valley near Meride, some actinopterygians, crustaceans and plants have been recovered in the middle Kalkschieferzone. Preliminary studies suggest a seasonally controlled sedimentation in a shallow basin or lagoon with freshwater influence in the wet season. A high productivity in the surface water and stable density stratification resulted in anoxic bottom water with accumulation of organic matter. Carbonate laminae were deposited under increased salinity in the dry season. Mud-cracked stromatolites and halite crystal casts indicate the presence of evaporitic conditions. The Kalkschieferzone represents a late stage evolution of an intraplatform basin, beginning with open marine influence in Late Anisian lime (Grenzbitumenzone) and increasing restriction by growing carbonate platforms during Early Ladinian (Lower Meride Limestone). In Late Ladinian time, the basin was filled progressively by carbonate and siliciclastic mud (Upper Meride Limestone). The shallow lagoon of the Kalkschieferzone with strong seasonal variation of salinity and water level finely was buried by an increasing input of fine siliciclastic material, reaching its maximum with the locally evaporitic Pizzella Marls (Raibl Beds) in the Carnian.

FURRER, H., 1995. The Prosanto Formation, a marine Middle Triassic Fossil-Lagerstätte near Davos (Canton Graubünden, eastern Swiss Alps). Eclogae geol. Helv., 88: 681-683.

GAETANI, M., 1995. Criteri per la definizione della base del Piano Carnico. Ann. Univ. Ferrara, Sci. Terra, 5(Supl.): 9-12.

The choice of a GSSP (Global Stratotype Section and Point) is presently a must, according to the International Commission on Stratigraphy. Their main characters are shortly listed and discussed. Since several historical and classical sections and localities quoted by Mojsisovics, 1869, when establishing the Carnian Stage are in Italy, Italian stratigraphers and paleontologists should try to re-illustrate these classical sections. The ultimate goal is to propose a candidate GSSP. The "state of the art" for the three more useful fossil groups to define the base of the Carnian stage, ammonoids, conodonts, palynomorphs, is shortly summarized.

GAETE, R., GALOBART, A., PALOMAR, J. and MARZO, M., 1996. Primeros resultados sistemáticos y bioestratigráficos del yacimiento de tetrápodos fósiles de la facies Buntsandstein de La Mora (Pla de la Calma, Barcelona). Cuad. Geol. Ibérica, 20: 331-346.

GARCÍA-BARTUAL, M., RINCÓN, R. and HERNANDO, S., 1996. Propuesta de una nueva técnica de estudio mediante análisis digital de imagen en huellas quiroteroides encontradas en el Triásico de Nuévalos (provincia de Zaragoza). Cuad. Geol. Ibérica, 20: 301-312.

GARCÍA-GIL, S., 1995. Evolución sedimentarla en la zona de enlace Cordillera Ibérica-Sistema Central, margen occidental de la cuenca del Tethys durante el Triásico Medio. Cuad. Geol. Ibérica, 19: 99-128.

GARETSKY, R.G., AIZBERG, R.Y., ZINOVENKO, G.V. and MONKEVICH, K.N., 1995. Evolution of Mezozoic basins in the East European platform west. Dokl. Akad. Nauk. Belarusi, 39: 92-95.

The evolution of the Mesozoic basins of the East European platform west is due to global geological processes which took place within the European continent and neighbouring regions. A close correlation is established between global and regional geological events. Global transgressions and regressions caused by the sea-floor spreading and Triassic, Jurassic, Cretaceous rifting involved the territory of the East European platform west and contributed to the formation of different basins of sea and continental types.

GE CHUN-PEI, 1995. Middle Triassic charophytes from Shimen, Hunan. Acta Micropal. Sinica, 12: 31-37.

The rich fossil charophytes descripted here were found from the Badong Formation in Shimen, Hunan. They belong to the *Stellatochara sellingii-S. maedleriformis-Cuneatochara mira* Assemblage, consisting of four genera, eight species (including three new species) and two indeterminate species. This assemblage indicates a Middle Triassic age of the Badong Formation.

GIANOLLA, P., 1995. Stratigrafia sequenziale al limite Ladinico-Carnico (Sudalpino orientale). Ann. Univ. Ferrara, Sci. Terra, 5(Suppl.): 49-57.

The main features of the 3rd order depositional sequences (La 3 and Car 1) close to the Ladinian-Carnian boundary have been considered. Particularly the features of the Car 1 sequence boundary in different areas, its relationships with the underlying sequences and its ammonoid calibration (upper *neumayri* Subzone) have been discussed. Due to different sedimentary sources and the paleogeographic setting, the stratal patterns and the evolution of the LST facies can be different. The Passo Gardena and the Sciliar/Schlern carbonate megabreccias are interpreted as a part of the lpc. The TST deposits belong to the *regoledanus* Subzone. The Car 1 mfs lies in the uppermost part of the same subzone and it is very close to the proposed Ladinian-Carnian boundary (base of the *Daxatina* Subzone).

GONZALEZ-LEON, C., TAYLOR, D.G. and STANLEY JR., G.D., 1996. The Antimonio Formation in Sonora, Mexico and the Triassic/Jurassic boundary. Canad. J. Earth Sci., 33(3), (in press).

The Antimonio Formation furnishes a record of more-or-less continuous sedimentation across the Triassic-Jurassic System boundary and is one of a few stratigraphic sections globally that preserves latest Triassic to Hettangian ammonoids in stratigraphic succession. The boundary falls near the middle of the formation, within a 155 m thick stratigraphic section which is divided into five distinct sedimentary packages. The laminated shales and siltstones in the middle of package 4 represent deposition in an anoxic or disaerobic setting. While shales of package 4 themselves are poorly fossiliferous, they are bounded below and above by Triassic and Jurassic biotas respectively. The Triassic-Jurassic System boundary should fall within or stratigraphically close to the laminated beds. The transgressive-regressive signature from the Antimonio Formation corresponds closely to that of the Gabbs and Sunrise formations in Nevada and jointly show eustatic regressive events at or near the beginning of the *Crickmayi* Zone and another near the top of the Hettangian. The beds from package 4 indicate a transgression closely associated with the Triassic-Jurassic system boundary.

GÖTZ, A.E., 1995. Neue Conodonten aus dem unteren Muschelkalk (Trias, Anis) des Germanischen Beckens. Geol. Paläont. Mitt. Innsbruck, 20: 51-59.

Four new conodont species are described from the Bithynian/Pelsonian boundary (Middle Triassic, Anisian) of the Germanic Basin (Germany): *Diplododella lanceata* n.sp., *Metalonchodina magnidentata* n.sp., *Neohindeodella excurvata* n.sp. and *Neohindeodella germanica* n.sp. These conodonts are characteristic faunal elements of the examined stratigraphical horizon with biostratigraphical importance for the Germanic Middle Triassic.

GOY, A., 1995. Ammonoideos del Triásico Medio de España: Bioestratigrafía y correlaciones. Cuad. Geol. Ibérica, 19: 21-60.

GOY, A. and MARTÍNEZ, G., 1996. Nautiloideos del Triásico Medio en la Cordillera Ibérica y en la parte oriental de las Cordilleras Béticas. Cuad. Geol. Ibérica, 20: 271-300.

GRAMM M.N., 1995. Remains of the ostracode suborder Kirkbyocopina in the Middle Triassic of southern Primorye. Paleont. Z., 3: 123-124.

Poorly preserved ostracodes belonging to Kirkbyocopina are reported from the Anisian of southern Primorye (Russian Far East), the fact suggesting that some representatives of this suborder survived the end of the Early Triassic.

GRAUVOGEL-STAMM, L and ÁLVAREZ RAMIS, C., 1996. Conifères et pollen in situ du Buntsandstein de l'île de Majorque (Baléares, Espagne). Cuad. Geol. Ibérica, 20: 229-244.

GUREVITCH, E., WESTPHAL, M., DARAGANSUCHOV, J., FEINBERG, H., POZZI, J.P. and KHRAMOV, A.N., 1995. Paleomagnetism and magnetostratigraphy of the traps from western Taimyr (northern Siberia) and the Permo-Triassic crisis. Earth and Planet. Sci. Let., 136: 461-473.

The Siberian traps were emplaced near the Permo-Triassic boundary and are among the largest continental igneous provinces. A 1750 m thick section of traps from the western Taimyr (72.9° N, 84° E) has been sampled. This section is equivalent to the lower and middle part of the total Siberian traps section. Thirty-one oriented hand samples were studied and demagnetised by alternating fields and heating cycles. A stable characteristic component passes the fold test and is thought to be primary. The mean direction is D = 84°, I = 75° with α_{95} = 10° (N = 29) and the corresponding pole is 59° N, 150° E. The bottom part (660 m) is of reversed polarity, the middle part (900 m) is normal and the uppermost level (150 m) is mixed. Correlations with reference Permo-Triassic magnetostratigraphic timescales are discussed. The most probable correlation indicates an age quite close to the Permian/Triassic boundary and a duration for the volcanism of less than 1 m.y. The data are therefore consistent with the hypothesis that this volcanism triggered the Permian/Triassic crisis.

HAAS, J. (Ed.), BARABÁS-STUHL, A., BÉRCZI-MAKK, A.. BUDAI, T., CSILLAG, G., DOSZTÁLY, L., HAAS, J., HÍVES-VELLEDITS, F., KOLESZÁR, L., KOVÁCS, S., LESS, Gy., PELIKÁN, P., PIROS, O., RÁLISCH-FELGENHAUER, E., RÉTI, Zs., RÓTH, L., SZABÓ, I., SZOLDÁN, Zs., TÓTH-MAKK, Á. and TÖRÖK, Á., 1993 (1994). Lithostratigraphic units of Hungary: Triassic. Hungar. Geol. Inst., Budapest, pp. 3-278.

The Hungarian Stratigraphical Commission decided to publish a series of booklets containing brief descriptions of the Hungarian formations. In the first volume of this series, the Triassic formations have been presented by a working group of the Triassic Subcommission. The volume contains descriptions of 82 formations in a uniform structure. In addition to the definition of the units, synonyms, lithologic features, extension, thickness, facies characters, key sections and age as well as the relevant literature are also indicated. Separate chapters discuss the formations of the different structural (regional) units: the Transdanubian Range,

the Bükk, the Aggteiek-Rudabánya, the Mecsek-Villány and the Békés Units, respectively, and brief chapters are devoted to the characterization of the informal lithostratigraphic subdivision of the Tokaj-Zemplén region and the Mid-Transdanubian Unit. The volume is also supplemented by a reviewed version of the lithostratigraphic chart of Hungary.

HAAS, J. and BUDAI, T., 1995. Upper Permian-Triassic facies zones in the Transdanubian Range. Riv. Ital. Paleont. Strat., 101: 249-266.

Facies patterns of the Upper Permian and Triassic formations within the Transdanubian Range are presented. Based on surface and subsurface data, facies maps were compiled for six time slices which served as a basis of the paleogeographic reconstructions. Considering the entire Late Permian - Triassic interval, the Transdanubian Range unit shows a definite polarity: its northeastern part represents the seaward (internal) side, whereas its southwestern part represents the landward (external) side. A remarkable part of facies units of the Transdanubian Range could be correlated with time equivalent facies in the Southern Alps and the Upper Austroalpine nappes, providing an effective tool for the reconstruction of the original position of the displaced Transdanubian Range Unit.

HAGDORN, H., 1995. Die Seeigel des Oberen Muschelkalks. Fossilien, 6: 351-356.

HE YAN and WANG LI-JUN, 1995. Late Triassic foraminifera and holothurian sclerites from western Sichuan and eastern Xizang (Tibet). Acta Micropal. Sinica, 12: 133-144.

21 species belonging to 18 genera of foraminifera and eight species in five genera of holothurian sclerites have been discovered from the Late Triassic (Norian) sediments in Baiyu County of western Sichuan Province and Gonjo and Jomda Counties of eastern Xizang along the upper reaches of the Jinshajiang River in western China. It is the first discovery of Triassic holothurian sclerites in China and of abundant Triassic foraminiferal fauna in western Sichuan and eastern Xizang. The foraminifera are closely related to the Late Triassic ones from Yunnan and northwestern Sichuan. Many of them are common in Triassic strata in India and Tethys areas of Europe. The holthurian sclerites are mostly Middle and Late Triassic species of Europe.

JADOUL, F., NICORA, A. and ORTENZI, A., 1995. Il Ladinico superiore- Carnico in Val D'Aupa e Alpi Giulie: prospettive di studio per il limite Ladinico-Carnico. Ann. Univ. Ferrara, Sci. Terra, 5(Suppl.): 85-90.

The name 'Raibl Group' is discussed as it appears unsuitable because of synonymy problems, misunderstanding, usage in areas that show different paleogeographic evolution. Three lower Carnian paleogeographic domains have been distinguished: a) the Val d'Aupa, mainly basinal western sector; b) the Val d'Ogna central carbonate platform high; c) the Tarvisiano eastern trough. Simplification of the Carnian lithostratigraphy in Eastern Carnia-Julian Alps is proposed. The upper portion of the Schlern Dolomite in Val Bruna-Val d'Ogna (high carbonate platform areas of the Central Sector) may correspond to the lower Cassian (or Cassian Dolomite 1 of Assereto et al., 1977). The Predil Limestone is confined to the Tarvisian area (intraplatform trough). The basinal Rio del Lago Fm. lithologically may correspond to the S. Cassian Fm. of Val d'Aupa (Carnia) but its age seems to be younger. The Conzen Fm. is correlatable with the uppermost Cassian Dolomite of Val d'Aupa. The Tor Fm. is related to a mixed shallow water mixed carbonate-terrigenous sequence (Dürrenstein Fm. or Infraraibl Group = Du) locally subdivided in several informal units: Rio Pontuz Member (Po), Loveana Limestone (Lo), Mestri/Dordolla, Lunze (Me) dolomitic platform horizons. The Carnizza Fm. strictly corresponds to the Monticello Fm. (Mo) of Val d'Aupa. The most suitable areas where the Ladinian/Carnian boundary may be present are: - the classical Cave del Predil succession; - the S. Cassian Formation of upper Val d'Aupa (Rio Colan).

Jasin, B., Ali, C.A. and **Mohamed, K.R.**, 1995. Late Triassic radiolaria from the Kodiang limestone, northwest peninsular Malaysia. J. Southeast Asian Earth Sci., 12: 31-39.

Two different cherty packstone wackestone facies are exposed at an abandoned limestone quarry at Bukit Kodiang, Kedah. Chert occurs as discontinuous layers and nodules in the cherty packstone wackestone. The thickness of individual chert layers varies from 2 to 10 cm. The facies exhibit slump folds. 18 species of Radiolaria were identified: *Capnuchosphaera triassica* De Wever, *Triassocampe sulovensis* Kozur and Mock, *Tetraporobrachia asymmetrica* Kozur and Mostler, *Xenorum flexum* Blome, *Canoptum laxum* Blome, *Palaeosaturnalis triassicus* Kozur and Mostler, *Canoptum* cf. *farawayensis* Blome, *Pseudostylosphaera* cf. *spinulosa* Nakaseko and Nishimura, *Hagiastrum* cf. *augustum* Pessagno, *Perispongidium* sp., *Capnuchosphaera* sp., *Sarla* sp., *Kahlerosphaera* sp., *Canoptum* sp., *Latium* sp., *Paronaella* sp., *Sontonaella* sp., and *Spongostylus* sp. The assemblage indicates that the age of the chert bearing strata ranges from late Carnian to middle Norian, Late Triassic.

Klein, G.D., 1994. Pangea: paleoclimate, tectonics, and sedimentation during accretion, zenith and breakup of a supercontinent. Geol. Soc. Amer., Spec. Paper 288, 301 pp. (with several papers contributed by members of IGCP 359).

Knaust, D. and **Langbein, R.**, 1995. Pot casts in the Upper Muschelkalk (Middle Triassic) of Weimar/Thuringia: composition, microfabrics and diagenesis. Facies, 33: 151-165.

A horizon with pot casts (potholes) is described from shallow marine limestones of the *spinosus* zone ('Discitesschichten', Upper Muschelkalk) near Weimar/Thuringia. The erosional structures are not developed as sole marks but occur as isolated structures. They differ distinctly in size and composition from pot casts described from the Muschelkalk of Southern Germany. Vertical sedimentary zonation and varying sediment infill in the structures suggest continuous erosion and deposition contemporaneous with the background sedimentation. Deposition may have been caused by oscillatory and unidirectional flows as well as a long period of micrite deposition. Early diagenetic deformations (e.g. dewatering, brecciation, pressure solution) have been controlled by a higher continuous water flux inside the pot casts and higher intergranular dispersal pressure.

Kolar-Jurkovšek, T. and **Jurkovšek, B.**, 1995. Lower Triassic conodont fauna from Tržič (Karavanke Mts., Slovenia). Eclogae geol. Helv., 88: 789-801.

The results of micropaleontological examinations of Upper Permian and Lower Triassic beds in the Tržiška Bistrica valley northeast of Tržič, Slovenia, are described. The rocks of the studied section form part of the Southern Karavanke nappe situated between the Košuta nappe and the Sava fault. The section starts with Gröden beds which pass upwards into the Upper Permian dolomite followed by the Lower Triassic variegated sequence which is overlain by the Anisian bedded dolomite. The Lower Triassic oolitic limestone contains the conodont elements: *Foliella gardenae* (Staesche), *Hadrodontina anceps* Staesche, *Pachycladina obliqua* Staesche and *Parachirognathus ethingtoni* Clark which are of Smithian age.

Konstantinov, A.G., 1995. *Arctophyllites,* a new genus of Ammonoidea from Karnian deposits of north-eastern Asia. Paleont. Zh., 3: 18-25.

Ussuritids from Carnian deposits of North-Eastern Asia have been revised. A new genus, *Arctophyllites,* is defined on the basis of the type species *Discophyllites taimyrensis* Popow, 1961. Phylogenetic relationships and systematic position of this genus are discussed. Three species - *Arctophyllites taimyrensis* Popow, *A. popovi* (Archipov) and *A. ochotensis* sp. nov.- are described.

KOZUR, H., 1995. First evidence of Middle Permian ammonitico rosso and further new stratigtaphic results in the Permian and Triassic of the Sosio Valley area, western Sicily. Proc. 1st Croatian Geol. Cong., 1: 307-310.

KOZUR, H., 1995. The position of the Anisian-Ladinian boundary and the development of the radiolarian faunas in this level. Proc. 1st Croatian Geol. Cong., 1: 311-314.

KRAHN, L. and BAUMANN, A., 1996. Lead isotope systematics of epigenetic lead-zinc mineralization in the western part of the Rheinisches Schiefergebirge, Germany. Miner. Depos. 31: 225-237.

In the western part of the Rheinisches Schiefergebirge three different types of epigenetic lead-zinc-vein mineralization in Paleozoic rocks can be distinguished: 1. Syntectonic Variscan veins, 2. post-Variscan (Saxonian) veins mainly in Paleozoic siliceous elastic rocks, 3. post-Variscan carbonate hosted mineralization in the Aachen-Stolberg area. Ore impregnations occur in the Triassic Buntsandstein (Bunter sandstone) and Muschelkalk of the Maubach-Mechernich triangular depression covering the Paleozoic rocks. Data points define two distinct populations in both lead isotope diagrams and thus indicate two major Variscan and post-Variscan mineralization events. The lead isotope pattern of the Paleozoic sedimentary rocks bears good evidence that this thick rock sequence may be the main source of metals for the mineralization. The metals were mobilized at deeper levels by saline fluids at different times. There are no direct indications for remobilization of the older Variscan vein ore deposits. The sandstone and carbonate hosted ore impregnations of Maubach-Mechernich have a similar lead isotope pattern to the post-Variscan mineralization in the Paleozoic sedimentary basement.

KRAINER, K. and LUTZ, D., 1995. Middle Triassic basin evolution and stratigraphy in the Carnic Alps (Austria). Facies, 33: 167-184.

A local intraplatform basin developed in the Gartnerkofel Zielkofel area of the Carnic Alps (southern Carinthia, Austria) during the Middle Triassic (Ladinian). This basin was filled with a transgressive basinal sequence composed of the Uggowitz Formation and overlying Buchenstein Formation. At the northwestern slope of the Gartnerkofel, the platform carbonates of the Schlern Dolomite interfinger with the Buchenstein Formation, causing the formation of two depositional sequences. The Uggowitz Formation consists of the Uggowitz Breccia and the Kuhweg Member. Sediments of the Uggowitz Breccia were formed by different types of gravity-induced processes. The Kuhweg Member is a thin sequence of silt and fine-grained sandstones which were deposited in a slope to basin margin environment by turbidity currents. The overlying Buchenstein Formation consists of hemipelagic to pelagic limestones of Fassanian age with intercalated pyroclastic rocks (Pietra verde). Nodular limestones were deposited under slow rates of accumulation during a relative sea-level highstand. The uppermost Buchenstein Formation is composed of hemipelagic limestone beds with intercalated graded calcarenites and breccias of platform-derived debris, showing characteristic features of a fore-reef slope of the prograding Schlern Dolomite. The Uggowitz Formation and basal Buchenstein Formation are interpreted as a transgressive systems tract, nodular limestones from the middle part of the Buchenstein Formation mark an early highstand systems tract, fore-reef slope sediments of the upper Buchenstein Formation formed during the beginning regression of a late highstand systems tract, the basal part of the overlying Schlern Dolomite probably reflects a lowstand systems tract. The intercalated bedded limestone facies within the Schlern Dolomite is characterized by large, platform-derived blocks, slump structures, breccia beds, graded calcarenites and hemipelagic limestones indicating a fore-reef slope environment. This intercalated facies belongs to the Buchenstein Formation and interfingers with the Schlern Dolomite. Conodonts from this intercalated slope facies point to Late Fassanian age. Therefore, the two Middle Triassic depositional sequences of the

Gartnerkofel area can be correlated with the depositional sequences 'Ladinian 1' and 'Ladinian 2' of the Dolomites, proposed by De Zanche et al. (1993). A brief comparison with the basinal sequences of similar age of the Karawanken Mountains and the Carnia is presented.

KRISTAN-TOLLMANN, E., 1995. Weitere Beobachtungen an Rhätischen Nannofossilien der Tethys. Geol. Paläont. Mitt. Innsbruck, 20: 1-11.

Eoconusphaera zlambachensis and *Prinsiosphaera triassica,* surely the most common nannofossils of the uppermost Triassic, are presented in variable stages of preservation from new sites of Rhaetian Zlambach marls of the Northern Calcareous Alps. *Eoconusphaera jansae,* hitherto known only since the lower Sinemurian, has now been found in the Rhaetian Zlambach marls of the Eastern Alps. They also occur in the Rhaetian marls of the Wombat plateau NW of Australia. Thus their occurrence throughout the whole of the Tethys, beginning in the Upper Triassic, is demonstrated.

KRS, M., KRSOVA, H. and PRUNER, P., 1995. Palaeomagnetism and palaeogeography of Variscan formations of the Bohemian Massif: a comparison with other regions in Europe. Stud. Geophys. Geodaet., 39: 309-319.

Statistical evaluation of palaeomagnetic data from the Early Carboniferous to the Middle Triassic rock in Europe, north of the Alpine tectonic belt, confirmed previously defined palaeotectonic stability of the whole European Plate since the Early Permian. The Trans-European Suture Zone represents a plate boundary, SW of which the Early Variscan and pre-Variscan formations show different degrees of palaeotectonic rotations, predominantly rotations of clockwise sense. A theoretical model simulating the translation and rotation movements was proposed showing that the West European Variscides underwent Hercynian palaeotectonic rotations comparable with the rotations derived for the Alpine tectonic belt.

KULL, J. and HERBIG, A., 1995. Leaf venation of angiosperms: form and evolution. Naturwissenschaften, 82: 441-451.

Leaf venation patterns are caused by the interaction of genetically determined processes, environmental effects and chance. The 'rules' of geometry are explained as a means of using energy economically. The major contribution of self-organizational processes can be deduced from a topological description. The similarity of the venation system for some orders of magnitude can be measured as fractality, using a scaling exponent. Observations of the physiological ana-tomy also show connections with transport activity. Vein systems of the angiosperm type de-veloped for the first time during the Permian/Triassic periods, in connection with major climatic changes on Earth. The important contribution of selforganization to the development of the pattern of small veins resulted in a higher adaptability and was a key advance in angiosperm evolution.

LEPERCQ, J.Y. and GAULIER, J.M., 1996. Two-stage rifting in the North Viking Graben area (North Sea): inferences from a new three dimensional subsidence analysis. Marine and Petroleum Geology, 13: 129-148.

Backstripping software from the IFP (SUBTEC) was used to realize a three dimensional subsidence analysis of the Norwegian part of the North Viking Graben. For each considered epoch the software produces restored depth maps of the selected stratigraphic horizons, as well as tectonic subsidence maps. That allows, in addition to classical subsidence curve analysis, an overview of the spatial evolution of the studied basin. The three dimensional data set consists of maps representing the present day geometry of the graben. For this study, these maps have been established on the basis of a new interpretation of available seismic lines, taking into account new information on the time-depth-conversion and on the age of the

different seismic markers. Data from wells give detailed information on lateral lithological variations. Sedimentological information and analysis of the geometry of the seismic markers have allowed palaeobathymetry and eroded thickness maps to be established and discussed with a reasonable confidence. Computed tectonic subsidence maps define three major events and allow discussion of their origin: the lower Jurassic thermal subsidence in relation to the previous Triassic rifting event, the Jurassic rifting phase and the subsequent Cretaceous post-rift thermal subsidence, and, finally, a rapid subsidence event at the beginning of the Palaeocene. Thermal modelling provides theoretical subsidence curves. The comparison with the observed curves allows testing of and discrimination between several hypotheses about two parameters: the age of the first rifting event (Permo-Triassic) and its relative amplitude with regard to the Jurassic event. The corresponding stretching factors were compared with the crustal stretching values observed along the NSDP1 seismic profile. It appears that the first extensional phase is clearly Triassic (beginning about 240 Ma) and that it is characterized by higher stretching factors than the following Jurassic phase. The ability of different geological processes to produce both the Palaeocene subsidence observed in the graben and the contemporaneous uplift of the basin margins is discussed. The preferred interpretation involves buckling of the lithosphere in response to the onset of a compressional stress regime at the end of the Cretaceous. A simple method (assuming uniform stretching) is proposed for computing maps of stretching factors for both the Jurassic and Triassic events.

LÓPEZ-GÓMEZ, J. and ARCHE, A., 1995. El Pérmico y el Triásico del Levante español Características principales y consideraciones paleogeográficas. Cuad. Geol. Ibérica, 19: 201-234.

LORIGA BROGLIO, C. and NERI, C. (Eds.), 1995. Verso una definitione del limite Ladino-Carnico nel Sudalpino orientale [Towards a definition of the Ladinian-Carnian boundary in the eastern Southalpine, Italy]. IUGS, Subcomm. Triassic Strat., IGCP 359, Ann. Univ. Ferrara, Sci. Terra, 5(Suppl.), 111 pp.

LOZOVSKY, V.R., 1995. The cyclicity of the Lower Triassic shelf deposits of Laurasia and reasons of their formation. Sbornic statey po stratigraphii i regionalnoy geologii. (in Russian)

MARTIN, E.E. and MACDOUGALL, J.D., 1995. Sr and Nd isotopes at the Permian-Triassic boundary: a record of climate change. Chem. Geol., 125: 73-99.

We present a detailed curve of seawater Sr^{87}/Sr^{86} for the Middle Permian to Triassic based on analyses of conodonts from overlapping sections in the U.S.A, and Pakistan, correlated using conodont biostratigraphy. The isotope ratio decreased in the Middle Permian at an average rate of 0.000062 Ma^{-1}, reached a minimum in the Capitanian (257-258 Ma), and increased in the Late Permian at an average rate of 0.000097 Ma^{-1}. The Late Permian rate of increase was roughly two and a half times greater than the average increase over the past 40 Ma, and approxi-mately equal to the highest Cenozoic rates, which occurred over much shorter time intervals. Modeling results suggest that decreasing Middle Permian Sr^{87}/Sr^{86} ratios were driven by changes in the riverine Sr-flux to the oceans, while increasing ratios in the Late Permian/Triassic are attributed to both increased riverine Sr^{87}/Sr^{86} and flux. The reduced Middle Permian riverine flux coincides with extreme continental aridity associated with the formation of Pangea and recorded by massive evaporite deposits. In addition, mountains in the equatorial region of Pangea may have created a rain shadow, thereby minimizing precipitation in regions that currently contribute the bulk of chemical weathering products to the ocean. Increasing riverine Sr^{87}/Sr^{86} in the Late Permian is suggested by the observation that Nd^{143}/Nd^{144} values decrease at the same time; however, the source of radiogenic Sr is not known. Frequently cited mechanisms for increasing Sr^{87}/Sr^{86} in runoff, such as glaciations and

continent to continent collisions, coincide instead with decreasing seawater Sr^{87}/Sr^{86} in the Middle Permian. One possible source may have been deep erosion into older orogens, associated with a dramatic increase in chemical weathering in the Late Permian. The cause of enhanced weathering appears to have been increased levels of atmospheric CO_2 with associated global warming and increased humidity. Proposed sources of CO_2 include dissociation of gas hydrates and oxidation of organic matter during extreme sea level regression, as well as volcanic emissions from Siberian Traps eruptions. Continental floral and faunal distributions are consistent with this interpretation, as are oceanic $\delta^{13}C$ patterns and variations in shallow water sediment lithologies.

MARTÍN ALGARRA, A., SOLÉ DE PORTA, N. and MAATE, A., 1995. El Triásico del Maláguide-Gomáride (Formación Saladilla, Cordillera Bética Occidental y Rif Septentrional). Nuevos datos sobre su estratigrafía y significado paleogeográfico. Cuad. Geol. Ibérica, 19: 249-278.

MARTÍN ALGARRA, A., SOLÉ DE PORTA, N. and MÁRQUEZ-ALIAGA, A., 1995. Nuevos datos sobre la estratigrafía, paleontología y procedencia paleogeográfica del Triásico de las escamas del Corredor del Boyar (Cordillera Bética Occidental). Cuad. Geol. Ibérica, 19: 279-308.

MCCUNE, A.R., 1996. Biogeographic and stratigraphic evidence for rapid speciation in semionotid fishes. Paleobiology, 22: 34-48.

In this study advantage is taken of an unusual system of fossil lakes in eastern North America to estimate the time for speciation of endemic semionotid fishes. Twenty one species are all found in sedimentary cycle P4, the deposits of a single Early Jurassic lake, in the Towaco Formation of the Newark Basin in New Jersey. To determine the degree of endemism in the fauna from this fossil lake and estimate time for speciation, the author surveyed more than 2000 museum specimens from 45 named localities in the Newark Basin and related basins of the Late Triassic to Early Jurassic Newark Supergroup. Six species not found in deposits equal in age to P4 or older are considered to be endemics, eight species occurring in older deposits presumably colonized Lake P4, and evidence for whether the remaining seven species were endemics or colonists is equivocal. The time for the formation, decline, and evaporation of Lake P4, in which P4 sediments were deposited, has been estimated at 21,000-24,000 years. Because all endemic *Semionotus* first occur in the first third of lake history, the estimated time for speciation of endemics is six species in 5000-8000 years. This rate is remarkably similar to that estimated for the five cichlids in Lake Nabugabo that diverged from Lake Victoria cichlids in about 4000 years.

MCGOWAN, C., 1996. A new and typically Jurassic ichthyosaur from the Upper Triassic of British Columbia. Can. J. Earth. Sci., 33: 24-32.

A new ichthyosaur species is described from the Upper Triassic (middle Norian) of Williston Lake, northeastern British Columbia. Aside from the foramen enclosed between the radius and ulna a characteristic of Triassic ichthyosaurs the new specimen is typical of Lower Jurassic forms. Indeed, if the specimen had been collected from the English lower Liassic, there would have been no hesitation in referring it to the common English genus *Ichthyosaurus,* a taxonomic course the author follows here. Referring the new species to Ichthyosaurus extends the geological range of the genus by approximately 9 Ma, to the middle Norian. *Ichthyosaurus janiceps* sp. nov. has an abbreviated snout, like that of *Ichthyosaurus breviceps,* but it is a much larger species, and has a distinctly different forefin.

MEDINA, F., 1995. Syn- and postrift evolution of the El Jadida-Agadir Basin (Morocco): constraints for the rifting models of the Central Atlantic. Can. J. Earth Sci., 32: 1273-1291.

The El Jadida-Agadir basin shows an evolution related to that of the central Atlantic rifting history. The synrift period (late Early Triassic to earliest Jurassic) is dominated by deposition of red clastic sediments and evaporites, which are overlain by or intercalated with basalt flows. Two intense extensional phases are recognized. The first, probably in Middle Triassic times, is oriented NNW-SSE and resulted in the formation of ENE-WSW oriented grabens and half-grabens. The second, a widespread NW-SE trending extension, is Ladinian to earliest Liassic, and induced the formation of westward dipping half-grabens. Extensional tectonics initiated in the southern part of the basin and migrated northwards, contrary to classical ideas proposing rifting from north to south. The postrift evolution is characterized by Jurassic to Eocene subsidence. Tectonism appears to have been restricted to a narrow area close to the present day coast. Subsidence history shows four stages of rapid subsidence disrupting the thermal relaxation period. The values of extension are moderate, ranging from 1.1 to 1.34. The best model that accounts for this evolution is the one combining simple shear at the onset of rifting and pure shear at its end.

MELÉNDEZ, A., AURELL, M., BÁDENAS, B. and SORIA, A.R., 1995. Las rampas carbonatadas del Triásico Medio en el sector central de la Cordillera Ibérica. Cuad. Geol. Ibérica, 19: 173-200.

MIETTO, P. and MANFRIN, S., 1995. A high resolution Middle Triassic ammonoid standard scale in the Tethys Realm: a preliminary report. Bull. Soc. Géol. France, 166: 539-563.

Over the past few years research on Triassic in the southern Alps has made it possible to collect a great number of ammonoids bed by bed from both known and new sections. A comparison of these data and their integration with known data throughout the Tethys has made it possible to elaborate a well documented frame of the ammonoid fauna in Middle Triassic. By applying the principle of major events, faunal turnovers not controlled by local factors were defined. The integration between the hierarchy of biological events and the hierarchy of chronostratigraphic units suggests a detailed and, as far as possible, not conjectural, biochronostratigraphic setting of ammonoids. A synthesis of the new standard scale, which will be discussed both comprehensively and in detail in the monograph by the authors, due to be published soon, is presented. The scale is arranged in zones (zonal index = genus) and subzones (subzonal index = species). Its high resolution has been essential to the sequence stratigraphic analysis of the Triassic in the southern Alps.

MIETTO, P. and MANFRIN, S., 1995. La successione delle faune ad ammonoidi al limite Ladinico-Carnico (Sudalpino, Italia). Annali Univ. Ferrara, Sci. Terra, 5 (Suppl.): 13-35.

The succession of ammonoid faunas gathered in many sections and places in the Southern Alps is illustrated. The biozonal scheme, concerning the interval on which the Ladinian-Carnian boundary rests, includes both the Longobardian *neumayri* and *regoledanus* Subzones and the Julian ones *Daxatina* cf. *canadensis* and *aon*. In some subzonal units, more widely documented, it was possible to identify and to illustrate some characteristic biostratigraphic horizons. The Stuores Wiesen section, which is the most significant section in the Southern Alps also from an historical point of view, is widely dealt, with reference to the many bibliographic data as well. The *Daxatina* cf. *canadensis* Subzone in particular is defined in the mentioned section; in this critical Subzone the appearance of the marker - of which the sutural line of ceratitic type is illustrated - is also associated with *Trachyceras* although with species different from *T. aon* -, *Clionitites* and *Badiotites*. These taxa are well-known as characteristic of the Carnian and some of them mark the appearance of the important Clydonitaceae and Choristocerataceae superfamilies. A correlation between the zonal scale achivied in the Southern

Alps and the ones used in Canada (British Columbia) and in the Arctic Ocean (Svalbard) is suggested. Among the emerged elements, the acknowledged cosmopolitism of *Daxatina* makes it advisable to set the Ladinian-Carnian boundary at the appearance of this genus.

MILLER, J.S., GLAZNER, A.F., WALKER, J.D. and MARTIN, M.W., 1995. Geochronologic and isotopic evidence for Triassic-Jurassic emplacement of the eugeoclinal allochthon in the Mojave Desert region, California. Geol. Soc. Amer. Bull., 107: 1441-1457.

The geologic history of the outer continental margin (eugeoclinal) rocks in the El Paso Mountains and northern Mojave Desert has long been important in models for the development of the active continental margin in the western Cordillera. Current interpretations call for either strike-slip or thrust-juxtaposition of eugeoclinal rocks against miogeoclinal/cratonal (platformal) rocks, or some combination of both strike-slip faulting and thrusting. Two broad and interrelated aspects of the history of the eugeoclinal rocks are at issue: (1) How much primary displacement is necessary to account for the present position of the eugeoclinal rocks and (2) When were the eugeoclinal rocks thrust against platformal rocks? This study primarily addresses the second issue. The outcrop belt of eugeoclinal rocks coincides with the only known Permian and Triassic plutons in the El Paso Mountains and northern Mojave Desert, which are dated at 260 to 240 Ma by U-Pb zircon in this report. Initial Sr and $\varepsilon_{Nd}(T)$ isotopic values from these plutons are distinct ($\leq$ -0.704 and $\geq +2$, respectively) from continental lithosphere isotopic signatures ($\geq$ -0.705 and $\leq$ -2) of both Middle Jurassic plutons in the same area and Triassic plutons in the southern and eastern Mojave Desert. Feldspar common lead data for the Permian and Triassic plutons within the eugeoclinal outcrop belt also indicate limited crustal involvement and do not overlap previously reported values for common lead data from Mesozoic plutons in the eastern Mojave Desert region where Proterozoic basement is widespread. The observations and data reported here indicate that Late Permian-Early Triassic plutons in the northern Mojave Desert and El Paso Mountains were generated within or passed primarily through oceanic lithosphere, but later Jurassic plutons were derived from and/or interacted extensively with continental lithosphere. The authors hypothesize that the eugeoclinal rocks were deposited on oceanic crust that was thrust eastward over Precambrian cratonal basement and overlying strata between approximately 240 Ma and 175 Ma, a time of little documented tectonic activity in the Mojave Desert region.

MOLDOWAN, J.M., DAHL, J., JACOBSON, S.R., HUIZINGA, B.J., FAGO, F.J., SHETTY, R., WATT, D.S. and PETERS, K.E., 1996. Chemostratigraphic reconstruction of biofacies: molecular evidence linking cyst-forming dinoflagellates with pre-Triassic ancestors. Geology, 24: 159-162.

New data from numerous detailed mass spectrometric studies have detected triaromatic dinosteroids in Precambrian to Cenozoic rock samples. Triaromatic dinosteroids are organic geochemicals derived from dinosterols, compounds known in modern organisms to be the nearly exclusive widely occurring products of dinoflagellates. The authors observed the ubiquitous occurrence of these dinosteroids in 49 Late Triassic through Cretaceous marine source rocks and the absence of them in 13 Permian-Carboniferous source rocks synergistic with the dinoflagellate cyst record. However, finding dinosteroids in lower Paleozoic and Precambrian strata presents challenging results for molecular paleontologists, evolutionary biologists, palynologists, and especially for those concerned with the food web at various times of biological crisis. Other than the few species known as parasites and symbionts, many other dinoflagellate species are important as primary producers. The presence of Precambrian to Devonian triaromatic dinosteroids gives chemostratigraphic evidence of dinoflagellates (or other organisms with similar chemosynthetic capabilities) in rocks significantly older than the oldest undisputed dinoflagellate fossils (dinoflagellate cysts from the Middle Triassic, similar to 240 Ma), and older than the putative Silurian (similar to 420 Ma) dinocyst, *Arpylorus*

antiquus (Calandra) Sargent, from Tunisia. This systematic chemostratigraphic approach can shed light not only on lineages of dinoflagellates and their precursors, but potentially on many other lineages, especially bacteria, algae, plants, and possibly some metazoans.

MOLINA-GARZA, R.S., GEISSMAN, J.W., LUCAS, S.G. and VAN DER ROO, R., 1996. Palaeomagnetism and magnetostratigraphy of Triassic strata in the Sangre de Cristo Mountains and Tucumcari Basin, New Mexico, USA. Geophys. J. Int., 124: 935-953.

The authors report palaeomagnetic data and a composite magnetic polarity sequence for Middle and Upper Triassic rocks assigned to the Anton Chico Member of the Moenkopi Formation and Chinle Group, respectively, exposed along the eastern flank of the Sangre de Cristo Mountains and in the Tucumcari Basin of eastern and northeastern New Mexico. Thermal demagnetization isolates a well defined, dual polarity, characteristic magnetization, carried in most cases by haematite and interpreted as an early acquired chemical remanent magnetization (CRM). Characteristic magnetizations from 74 palaeomagnetic sites (one site = one bed) are used to define a magnetic polarity sequence, which the authors correlate with previously published Triassic data obtained from both marine and non-marine rocks. Preliminary correlation suggests that the resolution of magnetostratigraphic data derived from continental strata is not necessarily of lesser quality than that from marine rocks. On the basis of the magnetostratigraphic data, a profound unconformity is believed to separate lower-middle Norian and upper Norian-Rhaetian strata of the Chinle Group. Palaeomagnetic poles derived from selected sites in steeply dipping (> 85°) strata for the Middle Triassic (Anisian, similar to 240 Ma: 50° N 121° E; N = 8), late Carnian-early Norian (similar to 225 Ma: 53° N 104° E; N = 16), and late Norian-Rhaetian (similar to 208 Ma: 59° N 77° E; N = 8) are in relatively good agreement with previously published data for the Moenkopi Formation and Chinle Group and related strata in southwest North America. None the less, comparison with palaeomagnetic poles obtained from gently dipping or flat lying Triassic strata from this study (Anisian, 46° N 112° E; N = 13; late Carnian, 54° N 87° E; N = 12) and previously published Triassic poles in southwest North America suggest that a modest 'apparent rotation' not greater than about 5° affects declinations from steeply dipping rocks. The distribution of palaeomagnetic poles indicates similar to 25° (angular distance) of apparent polar wander between about 240 and 208 Ma.

MORAD, S., ALAASM, I.S., LONGSTAFFE, F.J., MARFIL, R., DEROS, L.F., JOHANSEN, H. and MARZO, M., 1995. Diagenesis of a mixed siliciclastic/evaporitic sequence of the Middle Muschelkalk (Middle Triassic), the Catalan Coastal Range, NE-Spain. Sedimentology, 42: 749-768.

The Middle Muschelkalk (Middle Triassic) of the Catalan Coastal Range (north east Spain) comprises sandstone, mudstone, anhydrite and minor carbonate layers. Interbedded sandstones and mudstones which are dominant in the north eastern parts of the basin are terminal alluvial fan deposits. South westward in the basin, the rocks become dominated by interbedded evaporites and mudstones deposited in sabkha/mudflat environments. The diagenetic and pore water evolution patterns of the Middle Muschelkalk suggest a strong facies control. During eodiagenesis, formation of microdolomite, anhydrite, baryte, magnesite, K-feldspar and mixed layer chlorite/smectite was favoured within and adjacent to the sabkha/mudflat facies, whereas calcite, haematite, mixed layer illite/smectite and quartz formed mainly in the alluvial facies. Low $\delta^{18}O_{SMOW}$ values for microdolomite (+23.7 to +28.4 and K-feldspar overgrowths (+17.3 to +17.7 ‰) suggest either low temperature, isotopic disequilibrium or precipitation from low ^{18}O porewaters. Low ^{18}O waters might have developed, at least in part, during low temperature alteration of volcanic rock fragments. During mesodiagenesis, precipitation of quartz overgrowths and coarse dolomite occurred in the alluvial sandstones, whereas recrystallization of microdolomite was dominant in the sabkha/mudflat facies. The isotopic compositions of these mesogenetic phases reflect

increasing temperature during burial. Upon uplift and erosion, telogenetic calcite and trace haematite precipitated in fractures and replaced dolomite. The isotopic composition of the calcite ($\delta^{18}O_{SMOW}$ = +21.5 to = +25.6 ‰; $\delta^{13}C$ = -7.7 to -5.6 ‰) and presence of haematite indicate infiltration of meteoric waters.

MORITZ, R, FONTBOTE, L., SPANGENBERG, J., ROSAS, S., SHARP, Z. and FONTIGNIE, D., 1996. Sr, C and O isotope systematics in the Pucara Basin, central Peru: comparison between Mississippi valley type deposits and barren areas. Miner. Depos., 31: 147-162.

A combined Sr, O and C isotope study has been carried out in the Pucara basin, central Peru, to compare local isotopic trends of the San Vicente and Shalipayco Zn-Pb Mississippi Valley type (MVT) deposits with regional geochemical patterns of the sedimentary host basin. Gypsum, limestone and regional replacement dolomite yield $^{87}Sr/^{86}Sr$ ratios that fall within or slightly below the published range of seawater $^{87}Sr/^{86}Sr$ values for the Lower Jurassic and the Upper Triassic. The data indicate that the Sr isotopic composition of seawater between the Hettangian and the Toarcian may extend to lower $^{87}Sr/^{86}Sr$ ratios than previously published values. An ^{87}Sr enrichment is noted in (1) carbonate rocks from the lowermost part of the Pucara basin, and (2) different carbonate generations at the MVT deposits. This indicates that host rocks at MVT deposits and in the lowermost part of the carbonate sequence interacted with ^{87}Sr enriched fluids. The fluids acquired their radiogenic nature by interaction with lithologies underlying the carbonate rocks of the Pucara basin. The San Ramon granite, similar Permo-Triassic intrusions and their elastic derivatives in the Mitu Group are likely sources of radiogenic ^{87}Sr. The Brazilian shield and its erosion products are an additional potential source of radiogenic ^{87}Sr. Volcanic rocks of the Mitu Group are not a significant source for radiogenic ^{87}Sr; however, molasse type sedimentary rocks and volcaniclastic rocks cannot be ruled out as a possible source of radiogenic ^{87}Sr. The marked enrichment in ^{87}Sr of carbonates toward the lower part of the Pucara Group is accompanied by only a slight decrease in $\delta^{18}O$ values and essentially no change in $\delta^{13}C$ values, whereas replacement dolomite and sparry carbonates at the MVT deposits display a coherent trend of progressive ^{87}Sr enrichment, and ^{18}O and ^{13}C depletion. The depletion in ^{18}O in carbonates from the MVT deposits are likely related to a temperature increase, possibly coupled with a ^{18}O enrichment of the ore forming fluids. Progressively lower $\delta^{13}C$ values throughout the paragenetic sequence at the MVT deposits are interpreted as a gradually more important contribution from organically derived carbon. Quantitative calculations show that a single fluid rock interaction model satisfactorily reproduces the marked ^{87}Sr enrichment and the slight decrease in $\delta^{18}O$ values in carbonate rocks from the lower part of the Pucara Group. By contrast, the isotopic covariation trends of the MVT deposits are better reproduced by a model combining fluid mixing and fluid rock interaction. The modelled ore bearing fluids have a range of compositions between a hot, saline, radiogenic brine that had interacted with lithologies underlying the Pucara sequence and cooler, dilute brines possibly representing local fluids within the Pucara sequence. The composition of the local fluids varies according to the nature of the lithologies present in the neighborhood of the different MVT deposits. The proportion of the radiogenic fluid in the modelled fluid mixtures interacting with the carbonate host rocks at the MVT deposits decreases as one moves up in the stratigraphic sequence of the Pucara Group.

MOSTLER, H. and KRAINER, K., 1994. Saturnalide Radiolarien aus dem Longobard der südalpinen Karawanken (Kärnten, Österreich. Geol. Paläont. Mitt. Insbruck, 19: 93-131.

MUÑOZ, A., RAMOS, A., SOPEÑA, A. and SÁNCHEZ-MOYA, Y., 1995. Caracterización de las unidades litoestratigráficas del Triásico en el subsuelo del tercio noroccidental de la Cordillera Ibérica y áreas adyacentes. Cuad. Geol. Ibérica, 19: 129-172.

MUTTONI, G., KENT, D.V. and GAETANI, M., 1995. Magnetostratigraphy of a lower Middle Triassic boundary section from Chios (Greece). Phys. Earth Planet. Int., 92: 245-260.

The Marmarotrapeza Formation at Chios Island (northern Aegean Sea, Greece) is renowned for its Lower Middle Triassic boundary sections in a marine Tethyan setting. Two sections have been sampled bed by bed to develop a magnetostratigraphic framework for the ammonoid and conodont biostratigraphy. The boundary sections occur within a lower normal (A+) reverse (B-) upper normal (C+) polarity sequence. The Lower Middle Triassic boundary, placed at the first occurrence of the ammonoid taxa *Aegeiceras ugra* Diener, *Parncrochordiceras* spp., *Paradanubites depressus* Fantini Sestini and *Japonites* sp., and close to the first ap-pearance of the conodont species *Gondolella timorensis* Nogami, occurs in normal polarity zone Chios C+. The overall mean direction of the reversal bearing characteristic component, whose early acquisition is suggested by a tilt test, is D = 271.2°, 1 = 33.2° (α_{95} = 11.7°, k = 112.5, N = 3). The inferred paleolatitude of the sampling sites is about 18° N, consistent with either an African or stable European affinity, although the declinations suggest large scale counter clockwise rotations with respect to Africa or stable Europe since the Early Middle Triassic.

NERI, C., RUSSO, F., MASTANDREA, A. and BARACCA, A., 1995. Litostratigrafia, ammonoidi e conodonti della Formazione di S. Cassiano: la sezione dei Prati di Stuores (Stuores-Wiesen, Dolomiti). Ann. Univ. Ferrara, Sci. Terra, 5(Suppl.): 59-74.

The S. Cassiano (St. Cassian) Formation outcropping in the type-area (Prati di Stuores -Stuores Wiesen-) is described from a sedimentological, lithostratigraphical and biostratigraphical point of view. In order to define the position of the Ladinian-Carnian (L/C) boundary, the authors have studied the vertical distribution of ammonoid faunas and conodont assemblages in the stratigraphic interval lying below the *aon* Zone, studied in detail by Urlichs (1974; 1994).

- Lithostratigraphy: Five stratigraphic sections have been investigated. The succession mainly consists of pelites and marls with intercalated turbiditic sandstones (mainly deriving from the erosion of the mid-Ladinian volcanics), micritic limestones and calciturbidites (mainly consisting of oolitic and bioclastic calcarenite). The vertical evolution of the succession is characterized by the gradual increase in carbonate lithologies and the consequent decrease in siliciclastic input. The whole succession (about 400 m thick) has been referred to the S. Cassian Formation; due to the graduality of the lithological changes, it is not possible to subdivide the formation into well-defined members. Four of the sampled sections are representative of the lower part of the succession and have been carefully correlated by means of significant key-beds; the fifth, documenting the upper part of the outcropping succession, corresponds to the section 'Stuores-Wiesen' of Urlichs (1974), Early Carnian (= 'Cordevolian') in age. Due to the occurrence of a fault between the sections, their physical correlation has not been defined in detail. - Biostratigraphy: The taxonomic composition and the vertical distribution of the ammonoid and conodont assemblages are shown. The lower sections are characterized by ammonoid faunas poor in number of taxa and specimens; moreover, they lack in good index fossils, with the exception of the isolated occurrence of *Frankites apertus* (indicating the Late Ladinian *regoledanus* Zone). The conodont assemblage is characterized by taxa typical of the *diebeli* Assemblage Zone of Krystyn (1983). (*Budurovignathus mungoensis, B. diebeli, B. mostleri*), correlated to the *regoledanus* Zone. The fifth section yielded a rich ammonoid fauna, with *Trachyceras aon*. The conodont *Metapolygnathus polygnathiformis* first occurs about 30 m above this sample. Generally speaking, the fossil association is characterized by Carnian markers. Above the (inferred) Late Ladinian assemblages with *F. apertus* and the conodonts of the *diebeli* A.Z., and below the Early Carnian beds with *T. aon* and *M. polygnathiformis,* there is a stratigraphic interval some tens of metres thick with long-range conodont taxa and poor ammonoid faunas. Within this interval the LIC boundary occurs. This stratigraphic interval will be the target of further research. Moreover, Urlichs (1994) reports the first occurrence of

T. aon just above the last bed with the *diebeli* conodont assemblage. If this occurrence will be confirmed, the interval in which the L/C boundary occurs will be further restricted; moreover, it should be located within a continuous, well-exposed and not-tectonized section. If the next research will improve the available fossil documentation, this section may be proposed as a candidate-stratotype for the L/C boundary.

NEWELL, D.D. and BOYD, D.W., 1995. Pectinoid bivalves of the Permian-Triassic crisis. Bull. Amer. Mus. Nat. Hist., 227: 5-95.

This contribution concludes a general revision of genera of pectiniform bivalves (pectinoids) of the world's marine rocks near the Permo-Triassic boundary. The study includes the morphology, taxonomy, and distribution of some 20 families and 30 genera, several of them new. It is based on the best material available anywhere, mainly from the western United States. The known diversity of these early pectinoids declined gradually from about 23 genera in the Guadalupian (M. Permian) to a minimum of 5 in the Griesbachian (L. Triassic). After the biological decline, they did not recover substantial diversity until Late Triassic (Norian) time. So they shared the great mass extinction with most other groups of marine invertebrates. The crisis extended over some tens of millions of years and was slow, rather than catastrophic. This diversity pattern agrees well with carbon isotope ratios that seem to reflect a depressed oceanic productivity in Early Triassic time.

OLSEN, P.E., KENT, D.V., CORNET, B., WITTE, W.K. and SCHLISCHE, R.W., 1996. High resolution stratigraphy of the Newark rift basin (Early Mesozoic, eastern North America). Geol. Soc. Amer. Bull., 108: 40-77.

Virtually the entire Late Triassic and earliest Jurassic age section of the early Mesozoic Newark continental rift basin has been recovered in over 6770 m of continuous core as part of the Newark Basin Goring Project (NBCP). Core was collected using an offset drilling method at seven sites in the central part of the basin. The cores span most of the fluvial Stockton Formation, all of the lacustrine Lockatong and Passaic formations, the Orange Mountain Basalt, and nearly all of the lacustrine Feltville Formation. The cores allow for the first time the full Triassic age part of the Newark basin stratigraphic sequence to be described in detail. This includes the gray, purple, and red, mostly fluvial Stockton Formation as well as the 53 members that make up the lacustrine Lockatong (mostly gray and black) and Passaic (mostly red) formations. The nearly 25% overlap zones between each of the stratigraphically adjacent cores are used to test lateral correlations in detail, scale the cores to one another, and combine them in a 4660 m thick composite section. This composite shows that the entire post-Stockton sedimentary section consists of a hierarchy of sedimentary cycles, thought to be of Milankovitch climate cycle origin. Lithostratigraphic and magnetostratigraphic correlations between core overlap zones and outcrops demonstrate that the individual sedimentary cycles can be traced essentially basinwide. The agreement between the cyclostratigraphy and magnetostratigraphy shows both the cycles and the polarity boundaries to be isochronous horizons. Detailed analysis of the Newark basin shows that high resolution cyclostratigraphy is possible in lacustrine, primarily red-bed rift sequences and provides a fine scale framework for global correlations and an understanding of continental tropical climate change.

OPDYKE, N.D., 1995. Paleomagnetism, polar wandering, and the rejuvenation of crustal mobility. J. Geophys. Res. Sol. Earth, B 12, 100: 24361-24366.

The decade from 1951 to 1961 witnessed the birth of a new geophysical subdicipline, paleomagnetism. Early studies in Europe, North America, and Australia led to the following conclusions: (1) rocks could preserve directions of magnetiziation for hundreds of millions of years in red beds, (2) late Cenozoic lavas had directions of magnetiziation that led to the conclusion

that the mean geomagnetic field was a geocentric dipole aligned along the axis of rotation, (3) rocks of Triassic age and older yield directions which depart widely from the present axis of rotation, (4) if these directions are used to calculate pole positions, then poles for older and older rocks fall farther and farther from the present pole of rotation, (5) these data may be used to construct polar wander curves, (6) polar wander curves from different continents do not coincide with one another, (7) they may be reconciled if the continents move with respect to each other, and (8) the distribution of climatic indicators show that the pole of rotation of Earth and the paleomagnetic pole for the same periods coincide for Phanerozoic time. These observations changed the perspectives of many Earth scientists and paved the way for seafloor spreading and plate tectonics.

Otto, S.C. and Bailey, R.J., 1995. Tectonic evolution of the northern Ural Orogen. J. Geol. Soc., 152: 903-906.

The closure of the Uralian Ocean occurred in Early Permian-Early Triassic time. In the northern Ural fold belt, overthrusting to the west produced a major foreland basin to the west of the mountain chain. In contrast, in the northern extension of the Ural Orogen, the Taymyr fold belt, thrusting was directed to the SE. It is proposed that Novaya Zemlya, at the interface of these two zones, acted as a thin skinned allochthonous nappe emplaced by gravity tectonics into a basin produced by rapid Permo-Triassic rifting in the eastern Barents Sea.

Pant, D.D., 1996. The biogeography of the late Paleozoic floras of India. Rev. Palaeobot. Palynol., 90: 79-98.

This paper reviews the biogeography of Paleozoic floras in India and addresses some of the important biogeographic questions that have been raised regarding the distribution of floras and faunas on the subcontinent. Little is known about the Silurian and Devonian Boras. Plants of this age have been reported sparingly from the extra-peninsular Panjab-Kashmir Himalaya region. On the basis of the available evidence, land plants comprised a cosmopolitan world flora until the end of the Early Carboniferous. The beds above the Lower Carboniferous strata of Gondwanaland record a sudden large-scale extinction of plants due to widespread glaciation. The Gondwana glaciation is believed to have ranged from the Upper Carboniferous to the Upper Permian in different parts of the supercontinent. The earliest post-glacial fossiliferous strata of Upper Carboniferous/Lower Permian age in India are found in the Talchir Series which has been divided into two stages, the Talchir and the Karharbari. Talchir floras are depauperate and appear to have lived under unfavorably cold conditions. Approximately 20 Talchir taxa are reported. The floras are dominated by *Gangamopteris*. Conditions during the Karharbari in peninsular India favoured the development of diverse floras and extensive, thick peat accumulations. On the basis of floral evidence, climatic conditions are interpreted to have been milder and warmer than during the Talchir Stage. *Gangamopteris* still dominated but other glossopterids were becoming abundant and the pre-conifers first emerged. The Talchir series is overlain by the Damuda Series. The time during which the Damuda strata were being deposited is divided into three stages, the Barakar, Barren Measures (Kulti or Ironstone Shales), and the Raniganj. These stages are characterized by the increased diversification of *Glossopteris* and the waning of *Gangamopteris*. The tectonic movement of Gondwanaland northward away from its southern polar position resulted in gradually ameliorating temperatures during the Permian period. By the beginning of the Triassic, northward plate movement had positioned the subcontinent within an arid realm. Except for some rare occurrences of *Glossopteris* and *Sphenophyllum*, the glossopterids became extinct by the Triassic and were replaced by the *Dicroidium* floras. Some of the important biogeographic problems relating to the distribution of the late Paleozoic floras of India are concerned with the location of the northern, northeastern, and northwestern boundaries of

Gondwanaland. The occurrence of non-Gondwanan forms at these localities could be interpreted as an indication that paleoecotones developed in the border areas between biogeographic provinces. However, an alternative hypothesis suggests that the areas of mixed floras constitute evidence that a microcontinent lay between the Eurasian plate and Gondwanaland. The occurrence of marine strata in the middle peri-Tethys region in the Salt Range and the Himalayan localities in Kashmir has long been established. However, the discovery of shelled faunas and smooth walled acritarchs interpreted to be of marine origin throughout peninsular India indicates that the possibility of widespread marine transgressions into Lower Gondwana strata situated far from the Tethys will have to be considered.

PANTIĆ-PRODANOVIĆ, S., 1994. The micropaleontologic and biostratigraphic characters of Upper Permian and Lower Triassic sediments in northwestern Serbia. Ann. Géol. Penins. Balk., 58: 129-168.

Upper Permian and Lower Triassic sediments are considered for the localities Petovica and Nečaje river-bed on Cer Mt. northwestern slopes, northwestern Serbia. The presentation includes micropaleontological, lithological, and biostratigraphic analyses of surveyed geologic columns and their correlation.

PÉREZ-LÓPEZ, A., 1996. Sequence model for coastal-plain depositional systems of the Upper Triassic (Betic Cordillera, southern Spain). Sedimentary Geology, 101: 99-117.

The deposits of the Upper Triassic of the Subbetic Zone (Betic Cordillera) offer an example of semi-arid fluvial deposits passing into shallow-water facies through a mud-flat environment. From the study of the vertical changes in facies, a sequence model is proposed for the Upper Triassic succession, relating, for each systems tract, the changes in sea-level, the accommodation space and the evolution of the facies within a coastal-plain depositional system. The lowstand depositional system is made up of a package of thick, amalgamated sandstone strata limited below by an erosive surface with little incision. These are sheet-flood deposits and channel fills which form part of an extensive alluvial system in which wide but shallow water courses appear, with the development of extensive sand bars. These sandbodies from the lowstand phase often contain mudrock intraclasts, plant remains and erosive surfaces. The accommodation space being extremely limited, the preservation of the floodplain or mud-flat deposits and palaeosols is practically nil. The result is an amalgamation of extensive sand-bodies with fine intercalated claystone levels. The transgressive depositional systems consist mainly of a red claystone series, although the first sediments of these systems are composed of sandstone with major claystone intercalations. These lower sandy levels of the transgressive phase do not exceed 50 cm in thickness and usually contain burrows and small-scale sedimentary structures. In the intermediate part of the red claystone series of this transgressive episode of saline mud-flat facies, there are sandstone levels of a little-developed fluvial system with channels which migrate laterally due to rise of the base level. In addition, the predominance and the great development of the red claystone facies reflect the increase in the accommodation space, which permitted a greater accumulation of sediments during a transgressive phase than during the lowstand phase. In the upper part of the transgressive depositional systems, beds of calcrete and carniolar limestone are common, indicating a decreased sedimentation rate. The generation of accommodation space begins to slow down, leading to the enlargement of sandbodies corresponding to terminal fan deposits. These developed over a flat topography where the flow scattered and expanded laterally. In the highstand phase, the accommodation space reduced even more and the sedimentation rate is lower, favouring a great development of pedogenic carbonates. Furthermore, sand deposition was reduced or nil and the gradient of the slope was low, so that marine floods over the coastal plain were more frequent, permitting the precipitation of carbonates and sulphates in coastal salt pans.

PÉREZ-LÓPEZ, A., SOLÉ DE PORTA, N. and ORTÍ, F., 1996. Facies carbonato-evaporíticas del Trías Superior y tránsito al Lías en el Levante español: nuevas precisiones estratigráficas. Cuad. Geol. Ibérica, 20: 245-270.

PIEREN, A.P., ARECES, J.L., TORAÑO, J. and MARTÍNEZ-GARCÍA, E., 1995. Estratigrafía y estructura de los materiales permotriásicos del sector Gijón-La Collada (Asturias). Cuad. Geol. Ibérica, 19: 309-336.

PIQUE, A. and LAVILLE, E., 1996. The Central Atlantic rifting: reactivation of Palaeozoic structures. J. Geodyn., 21: 235-255.

During Late Triassic and Early Liassic times, clastic and evaporitic sequences were deposited in Morocco, eastern Canada and the U.S.A., in angular unconformity, upon deformed Palaeozoic rocks. This unconformable sedimentary cover was accompanied by tholeiitic flows, sills and dikes. In Morocco, all of these rocks show evidence of a thermal episode, isotopically dated to around 200 Ma, which represents the synrift metamorphism. The American and African Upper Triassic-Lower Liassic sequences present several differences: (1) In the nature of the depositional environment, lacustrine in the onshore American basins and lagoonal and marine in the offshore American basins and onshore African basins. (2) In the shape of the basins which are mainly halfgrabens in America and symmetric grabens in Morocco. (3) In the thermal regime, at most incipient in America, but strong enough to have favoured development of a synrift metamorphism in Morocco. (4) In the volume of the emitted magnas, being more abundant in the African margin. All of these differences suggest that the Atlantic rifting was asymmetrical, probably controlled by an E-dipping detachment fault. This crustal and/or lithospheric structure is thought to correspond to Palaeozoic shear zones, reactivated during the Mesozoic extension, at the end of the post-Alleghanian lithospheric delamination.

PIQUE, A. and LAVILLE, E., 1995. The Central Atlantic initial opening. Bull. Soc. Géol. France, 166: 725-738.

The development of the Central Atlantic is well known, for the periods that follow the initiation of the oceanic accretion, dated around 175 Ma. However, the preceeding stages of its development remain less studied. They are considered here in the conjugate margins of the ocean. Comparison between the Triassic sedimentary and magmatic rocks, and the contemporary extensive structures in the American and African margins of the central Atlantic shows that the rift was asymmetrical: the sedimentary rocks are coarser and they were deposited earlier on the American side than on the African one. Similarily, the thermal and magmatic activity, coeval with the extension, was more pronounced on the African side of the future ocean. The assymmetrical rift developed as the result of the simple shear along a detachment fault corresponding to old, Alleghanian and Hercynian, thrusts. Several mechanisms of lithospheric thinning, following the Alleghanian continental collision, may have triggered the motion along the detachment fault.

PLASIENKA, D., 1995. Passive and active margin history of the northern Tatricum (western Carpathians, Slovakia). Geol. Rundschau, 84: 748-760.

The Tatricum, an upper crustal thrust sheet of the Central Western Carpathians, comprises pre Alpine crystalline basement and a Late Paleozoic-Mesozoic sedimentary cover. The sedimentary record indicates gradual subsidence during the Triassic, Early Jurassic initial rifting, a Jurassic-Early Cretaceous extensional tectonic regime with episodic rifting events and thermal subsidence periods, and Middle Cretaceous overall flexural subsidence in front of the orogenic wedge prograding from the hinterland. It is argued that passive to active margin conversion is an integral part of the general shortening polarity of the Western Carpathians

during the Mesozoic that lacks features of an independent Wilson cycle. An attempt is presented to explain all the crustal deformation by one principal driving force - the south-eastward slab-pull generated by the subduction of the Meliatic (Triassic-Jurassic Tethys) oceanic lithosphere followed by the subcrustal subduction of the continental mantle lithosphere.

PUTZ, M.K. and TAYLOR, E.L., 1996. Wound response in fossil trees from Antarctica and its potential as a paleoenvironmental indicator. IAWA-Journ. 17: 77-88.

Numerous permineralized axes of Middle Triassic age from Fremouw Peak, Antarctica show evidence of mechanical wounding and wound responses. These consist of both elongate and triangular shaped scars. Some scars can be detected beneath subsequent secondary xylem, indicating that wounding occurred early in stem development. In other stems, scars remained open suggesting late wounding and the permanent disruption of the cambium. In cross section most stems display little callus tissue, but wound periderm can be seen along the margin of the scar. In some stems the wound phellogen has formed phellem and phelloderm within the wounded area oriented perpendicular to the growth rings. Although some scars resemble those produced by fires, we were unable to document the presence of charcoal around scars. In modern ecosystems wounds may be caused by other agents, including debris drifting in floods, flowing ice, avalanches, and animals. Each of these potential sources is reviewed in relationship to the paleoclimate in the region during the Triassic.

RADZINSKI, K.-H., 1995. Zum Unteren und Mittleren Buntsandstein im Unstruttal bei Nebra (Südwestrand der Querfurter Mulde). Mitt. Geol. Sachsen-Anhalt, 1: 85-103.

A detailed classification of the Lower and Middle Bunter could be made in the Unstrut valley in the Nebra area. The subdivision is demonstrated with the help of a selected geophysical well-log. It is based also on survey of exposures and investigation of partly cored drillings from adjoining areas. The section may be regarded as a key section for actual lithostratigraphic correlation. The stratigraphic position of the Bröckelschiefer and the boundary between the Zechstein and the Lower Bunter were discussed in detail, also the subdivision of these two units by oolitic horizons. The author has compared his own classification with the local stratigraphic nomenclature used by Heinzelmann (1969).

RAMOVŠ, A. and ANIČIĆ, B., 1995. Lower Triassic and Lower Anisian development in the Mišnica valley east of Rimske Toplice, east Slovenia. Rudar.-Metal. Zbornik, 42: 143-155.

Along the reconstructed road in the Mišnica valley well exposed beds of the Lower Triassic and Lower Anisian were studied. The lowermost sparsely exposed variegated shales, marls and quartz sandstones with undeterminable pelecypod imprints can be correlated with the Seis Member in the South Tyrolian Dolomites (Griesbachian). The lower dolomitic succession with dolomite oolite and the variegated limestone oolite with *Coelostylina werfensis*, as well as numerous pectenid pelecypods correspond to the Gastropod oolite Member (Nammalian). Not documented paleontologically is the succession of marl limestone, variegated marl and mudstone. It probably corresponds to the Campil Member in the Dolomites (Nammalian). The upper succession, above 100 m thick, with lumachelle in its middle part, is not documented paleontologically. In it no ammonites were found. Preliminarily it is compared to the Val Badia Member (Spathian). The upper part of the Lower Triassic is dark grey and black recrystallized biomicritic limestone in which a crinoid horizon with the foraminifer *Meandrospira pusilla* and pelecypod remains occur about 20 m below the Lower Triassic/Lower Anisian boundary. This ho-rizon corresponds to the Cencenighe Member in the Dolomites (Spathian). The Lower Triassic limestone is overlain by ca. 30 m of dislocated dolomite and 10 m of bedded grey dolomite with individual undeterminable foraminifers (? *Meandrospira* sp., pelecypod remains and echi-

noderms). Approximately 10 m higher *Meandrospira dinarica, Glomospira* sp. and ostracods occur in recrystallized biomicrosparitic dolomite and in stromatolitic biolithitic dolomite. In the upper part of about 100 m of a dolomite profile no fossil remains were found. The authors place the transition boundary Scythian/Anisian on the lithologic boundary limestone/dolomite. Problematic remains the age of the lowermost dolomite beds with *Meandrospira* sp., pelecypods and echinoderm remains. In addition, the comparison with Lower Triassic beds studied in detail in the surroundings of Žiri, at Tržič and in the northern Julian Alps was performed.

Ramovš, A. and **Goričan, Š.**, 1995. Late Anisian - Early Ladinian radiolarians and conodonts from Šmama Gora near Ljubljana, Slovenia. Razprave 4. razreda Slov. Akad. Znan. Umet., 36: 177-219, Ljubljana.

A 1.60 m succession of red micritic limestone with chert exposed on the southern slopes of Šmarna Gora has been studied. The limestone contains rich radiolarian and common conodont faunas assignable to the Late Anisian or earliest Ladinian. Fifty-one radiolarian species are identified, among them *Archaeospongoprunum mesotriassicum* Kozur & Mostler, *Hindeosphaera? spinulosa* (Nakaseko & Nishimura), *Hozmadia rotunda* (Nakaseko & Nishimura), *Paroertlispongus rarispinosus* Kozur & Mostler, *Tiborella florida* (Nakaseko & Nishimura), *Tiborella magnidentata* Dumitrica, Kozur & Mostler, *Triassocampe deweveri* (Nakaseko & Nishimura) and *Triassospongocyrtis longispinosa* Kozur & Mostler. The following conodont species are identified: *Neogondolella constricta* (Mosher & Clark), *Neogondolella cornuta* (Budurov & Stefanov), *Paragondolella excelsa* Mosher, *Paragondolella* n. sp. ex gr. *excelsa* Mosher, sensu Kozur, Krainer & Mostler, *Paragondolella* ex gr. *excelsa* Mosher, *Paragondolella? pridaensis posteroacuta* Kozur, Krainer & Mostler and *Paragondolella? trammeri praetrammeri* (Kozur & Mostler). Two radiolarian (*Spongopallium? tetrapterum, Pseudosepsagon? emonaensis*) and one conodont species (*Paragondolella praealpina*) are newly described.

Rampino, M.R. and **Haggerty, B.M.**, 1996. The Shiva hypothesis: impacts, mass extinctions, and the galaxy. Earth, Moon and Planets., 72: 441-460.

The "Shiva Hypothesis", in which recurrent, cyclical mass extinctions of life on Earth result from impacts of comets or asteroids, provides a possible unification of important processes in astrophysics, planetary geology, and the history of life. Collisions with Earth-crossing asteroids and comets $\geq$ a few km in diameter are calculated to produce widespread environmental disasters (dust clouds, wildfires), and occur with the proper frequency to account for the record of five major mass extinctions (from $\geq 10^8$ Mt TNT impacts) and similar to 20 minor mass extinctions (from 10^7 - 10^8 Mt impacts) recorded in the past 540 million years. Recent studies of a number of extinctions show evidence of severe environmental disturbances and mass mortality consistent with the expected after-effects (dust clouds, wildfires) of catastrophic impacts. At least six cases of features generally considered diagnostic of large impacts (e.g., large impact craters, layers with high platinum group elements, shock related minerals, and/or microtektites) are known at or close to extinction event boundaries. Six additional cases of elevated iridium levels at or near extinction boundaries are of the amplitude that might be expected from collision of relatively low Ir objects such as comets. The records of cratering and mass extinction show a correlation, and might be explained by a combination of periodic and stochastic impactors. The mass extinction record shows evidence for a periodic component of about 26 to 30 Myr, and an similar to 30 Myr periodic component has been detected in impact craters by some workers, with recent pulses of impacts in the last 2-3 million years, and at ~ 35, 65, and 95 million years ago. A cyclical astronomical pacemaker for such pulses of impacts may involve the motions of the Earth through the Milky Way Galaxy. As the Solar System revolves around the galactic center, it also oscillates up and down through the plane of the disk shaped galaxy

with a half cycle similar to 30 ±3 Myr. This cycle should lead to quasi-periodic encounters with interstellar clouds, and periodic variations in the galactic tidal force with maxima at times of plane crossing. This 'galactic carrousel' effect may provide a viable perturber of the Oort Cloud comets, producing periodic showers of comets in the inner Solar System. These impact pulses, along with stochastic impactors, may represent the major punctuations in earth history.

RETALLACK, G.J., VEEVERS, J.J. and MORANTE, R., 1996. Global coal gap between Permian-Triassic extinction and Middle Triassic recovery of peat forming plants. Geol. Soc. Amer. Bull., 108: 195-207.

Early Triassic coals are unknown, and Middle Triassic coals are rare and thin. The Early Triassic coal gap began with extinction of peat forming plants at the end of the Permian (ca. 250 Ma), with no coal known anywhere until Middle Triassic (243 Ma). Permian levels of plant diversity and peat thickness were not recovered until Late Triassic (230 Ma). Tectonic and climatic explanations for the coal gap fail because deposits of fluctuating sea levels and sedimentary facies and paleosols commonly found in coal bearing sequences are present also in Early Triassic rocks. Nor do the authors favor explanations involving evolutionary advances in the effectiveness of fungal decomposers, insects or tetrapod herbivores, which became cosmopolitan and much reduced in diversity across the Permian-Triassic boundary. Instead, they favor explanations involving extinction of peat forming plants at the Permian-Triassic boundary, followed by a hiatus of some 10 m.y. until newly evolved peat forming plants developed tolerance to the acidic dysaerobic conditions of wetlands. This view is compatible not only with the paleobotanical record of extinction of swamp plants, but also with indications of a terminal Permian productivity crash from $\delta^{13}C_{org}$ and total organic carbon of both nonmarine and shallow marine shales.

RETTORI, R., 1995. Le associazioni a foraminiferi nel Carnico. Ann. Univ. Ferrara, Sci. Terra, 5(Suppl.): 101-111.

The present paper attempts to give a summary of the most typical and frequent foraminifers which can be recorded in Carnian carbonate platform sequences. The stratigraphic resolution of the lower part of the Carnian is up to now very difficult when the investigation is based on foraminifers without comparing with data from other fossil groups such as ammonoids, conodonts, palynomorphs, bivalves and calcareous sponges. During the Carnian several new diversified groups of foraminifers appear together with others of clear Jurassic affinity. Diversification of the microfaunas can be recorded in the late Ladinian-early Carnian as adaptation to the developed carbonate platforms. Most of the new taxa are directly derived from groups already existing during the Anisian whose evolution has been inhibited by sudden paleoenvironmental changes. In the late Ladinian, but above all in the Carnian, the microfaunas can again develop showing morphologic and structural complexity linked to adaptation to specific sub-environments of the carbonate platforms such as back reef and perirecifal to basin environments. The main groups recorded from the late Ladinian to Carnian are represented by the Involutinacea (Aulotortinae, Triadodiscinae and Lamelliconinae) and Miliolina associated with ubiquitarian endothyroid foraminifers which together with Trochamminidae, Textulariidae, Tetrataxidae, Nodosariidae etc. are present all throughout the Triassic. The studies of the microfaunal-foraminiferal assemblages together with the evolutive and paleoecologic analysis can give valid biostratigraphic information regarding Carnian carbonate platform successions together with the comparison of stratigraphic data from other fossil groups.

RIBBERT, K.H., 1995. Der Buntsandstein der Mechernicher Trias-Senke. Mainzer geowiss. Mitt., 24: 237-252.

Based on a reference profile the lithostratigraphical fundamentals of the Bunter in the northern Eifel are introduced and the criteria of the Middle/Upper Bunter boundary are discussed. Detailed information concerning thickness distribution and the lateral development of sedimentary facies are restricted mainly to the Middle Bunter. To special aspects like heavy minerals, pebbles of coarse conglomerates and sandstone petrography additional information is presented.

RIEPPEL, O. and KEBANG, L., 1995. Pachypleurosaurs (Reptilia: Sauropterygia) from the lower Muschelkalk, and a review of the Pachypleurosauroidea. Fieldiana: Geology, N.S., 32: 1-44.

The type material of all pachypleurosaurs from the lower Muschelkalk is redescribed and pachypleurosaur systematics are reviewed. Three species of lower Muschelkalk pachypleurosaurs are recognized, *Anarosaurus pumilio* Dames, *Anarosaurus heterodontus* n.sp., and *Dactylosaurus gracilis* Gürich. A cladistic analysis based on 50 characters shows *Keichousaurus* to be the sister-taxon to all other pachypleurosaurs; *Dactylosaurus* is the sister-taxon to *Anarosaurus* plus the *Serpianosaurus-Neusticosaurus* clade; *Anarosaurus* is the sister-taxon to the *Serpianosaurus-Neusticosaurus* clade; *Serpianosaurus mirigiolensis* is the sister-taxon to *Neusticosaurus*. The genus *Neusticosaurus* includes four species, *N. edwardsii, N. peyeri, N. pusillus,* and *N. toeplitschi*. The stratigraphic and biogeographic relations of pachypleurosaurs indicate that pachypleurosaurs reached the European epicontinental sea (Muschelkalk Basin) by invasion from the east in Anisian times, and that a faunal interchange was possible between the Muschelkalk Basin and the southern Alpine intraplatform basin facies at least during late Anisian and Ladinian times.

RIGO, F., 1996. N-Tunisian Sahara hosts giant Triassic, I. Paleozoic prospects. Oil Gas J., 94: 52-57

ROGHI, G., 1995. Analisi palinologica della sezione di Stuores Wiesen (Prati di Stuores, Dolomiti): dati preliminari. Ann. Univ. Ferrara, Sci. Terra, 5 (Suppl.): 37-40.

The preliminary results of a palynological research in the lower part of Stuores Wiesen section are presented here. This section has a good ammonoid biostratigraphy interpretation with a proposed boundary of the *Frankites regoledanus* Subzone and the *Daxatina* cf. *canadansis* Subzone (*Protrachyceras* Zone-*Trachyceras* Zone). Two palynological assemblages are described, the upper one with a typical Carnian flora association.

ROGHI, G., MIETTO, P. and DALLA VECCHIA, F.M., 1995. Contribution to the Conodont Biostratigraphy of the Dolomia di Forni (Upper Triassic, Carnia, NE Italy). Mem. Sci. Geol., 47: 125-133.

A large number of conodonts has been found in the dolomitic-bituminous facies of the Dolomia di Forni in the Carnia area (NE Italy). These faunas, marked by *Epigondololella slovakensis* (Kozur), provided the first biostratigraphic and chronologic data about the Dolomia di Forni. This unit is well known in the literature for its important vertebrate fauna, characterized by fishes and flying reptiles, Late Triassic in age. By adopting the evolutive trend analysis of the platform conodonts, it has been possible to define the age of the stratigraphic layers bearing fossil vertebrates. In this way the layers have been referred to the middle-upper part of the Alaunian (middle Norian).

ROMANO, S.L. and PALUMBI, S.R., 1996. Evolution of scleractinian corals inferred from molecular systematics. Science, 271: 640-642.

Scleractinian corals have a continuous fossil record from the mid-Triassic, but taxonomic difficulties have impeded an understanding of their evolution. A molecular phylogenetic

analysis of mitochondrial 16S ribosomal RNA showed departures from previous hypotheses of coral evolution. Families clustered into two major groups that do not correspond to morphologically based suborders. These clades differed in their 16S ribosomal DNA sequence by 29.4 %, which suggests evolutionary divergence before the appearance of scleractinian skeletons 240 million years ago. Together, these fossil and molecular data suggest multiple origins of the scleractinian skeleton, and the great morphological diversity of present day scleractinians may be a reflection of these multiple origins.

ROSENFELD, U. and THIELE-PAPKE, I., 1995. Zur Mikrofazies im Unteren Muschelkalk am Nordrand der Rheinischen Masse (Trias, NW-Deutschland). N. Jb. Geol. Paläont., Abh., 198: 197-221.

The Lower Muschelkalk (Triassic) of the Osning Hills (northern border of the Rhenish Massif) developed as an inner part of a carbonate ramp, as shown by 8 characteristic microfacies types. The microfacies belts reflect the structural subdivision of the region in the Hunte High, the Bielefeld Bay and the northeastern rim of the Rhenish Massif. The facies zonation is best to be observed in the marker horizons, less well in the Wellenkalk facies. Hunte High and Bielefeld Bay shift in southeastern direction in the course of time; the northeastern rim of the Rhenish Massif represents a high-energy sedimentary environment in Lower Muschelkalk times.

ROSS, C.A., BAUD, A. and MENNING, M., 1994. A time scale for Project Pangea. In: G.D. Klein (ed.), Pangea: paleoclimate, tectonics, and sedimentation during accretion, zenith and breakup of a supercontinent. Geol. Soc. Amer., Spec. Paper, 288: 81-83.

RÜFFER, T., 1995. Entwicklung einer Karbonat-Plattform: Fazies, Kontrollfaktoren und Sequenzstratigraphie in der Mitteltrias der westlichen Nördlichen Kalkalpen (Tirol, Bayern). Gaea heidelbergensis, 1: 1-282.

The sedimentation of the North Alpine Middle and early Upper Triassic passed through three stages, the homoclinal ramp in the late Anisian, the distal steepened ramp in the Fassanian, and the rimmed platform in the Longobardian and early Julian. The evolution from homoclinal ramp to rimmed platform was a continuous, dynamic process, resulting in a morphologically more distinctive depositional basin. The most striking features of the north Alpine Anisian are third order transgressive intervals, causing a ramp stacking. During the late Anisian to early Ladinian time interval a distally steepened ramp evolved as a precursor for the rimmed platform. In contrast to the homoclinal ramp, where the rates of production and accumulation were similar for all depositional environments, a considerable differentiation started during the distally steepened phase. In the Fassanian, most reefs evolved during rising or stabilised high sea-levels. Compared to the homoclinal ramp, a distinct faunal diversification occurred. Therefore, sedimentation within the inner ramp balanced third-order sea-level rises. Previous models for the evolution of the Ladinian reefs have only considered local tectonic controls. However, the initial conditions for the transformation from a homoclinal to a distally steepened ramp comprising the first north alpine reefs were caused by a basinwide or global sea-level rise (late Anisian to early Ladinian transgression). The gradual transition from distally steepened ramps to rimmed platforms occurred during late Fassanian to early Longobardian times, where the margin and upper slope of the rimmed platform were characterized by sediments deposited above the normal wave base. The Middle Triassic of the western part of the Northern Calcareous Alps comprises eight third-order depositional sequences. Regional controls on water depth have been eliminated to extract a sequence stratigraphic model representing basinwide controls on sedimentation. Furthermore, detailed information on reef development and facies is given.

RÜFFER, T. and BECHSTÄDT, T., 1995. Interpretation des Deckenbaus in den westlichen Nördlichen Kalkalpen: Widerspruch zwischen tektonischen und sedimentologischen Daten. Jb. Geol. B.-A., 138: 701-713.

The tectonic subdivisions of the western part of the Northern Calcareous Alps have been established mainly on the base of distinct sedimentation patterns in order to simplify the paleogeographic environments. In view of recent sedimentologic and biostratigraphic knowledge, these generally accepted tectonic reconstructions lead to a complicated, unrealistic paleogeography. The progradation patterns of the Wetterstein-Formation, for example, indicate depositional environments crossing the borders of the Inntal and Lechtal Nappes and point to the existence of only one Ladinian to early Carnian carbonate platform in the central western part of the Northern Calcareous Alps. Sedimentology, biostratigraphy and tectonic data could be brought into line by a few changes in the tectonical interpretation: the outcrops in the Inn valley south of Mieming Range and Lechtal Alps could not belong to the Lechtal Nappe, and the Lechtal Nappe is only overthrusted partly by the Inntal Nappe. Therefore, the model of one carbonate platform in Mieming Range and Wetterstein Mountains, founded on sedimentology, changes the tectonic interpretation not in principle. It matches well with a north alpine nappe complex of several nappes, but not with isolated nappes, stacked on each other.

RÜFFLER, T. and ZÜHLKE, R., 1995. Sequence stratigraphy and sea-level changes in the Early to Middle Triassic of the Alps: a global comparison. In: B.U. Haq (Ed.), Sequence stratigraphy and depositional response to eustatic, tectonic and climatic forcing, Kluwer Academic Press, Dordrecht, Boston, London, pp. 161-207.

During Early and early Late Triassic times, the Northern Calcareous Alps (Austria, southern Germany) and the Dolomites (northern Italy) were situated at the margin of the western Tethys. In the Scythian, widespread clastic-carbonate deposition on the shelf prevailed. Carbonate ramps revived in the earliest Anisian. From the late Anisian to the early Ladinian, carbonate ramps evolved to rimmed carbonate platforms. The Dolomites comprise five Scythian sequences, controlled by low amplitude sea-level changes and progressively increasing tectonic subsidence rates. During the Anisian to Ladinian, the sea-level fluctuations increased in amplitude. Five Anisian, three Ladinian and two early Carnian depositional sequences developed. Tectonic subsidence rates changed significantly over intervals of 2-5 Ma in the northwestern Dolomites, but developed steadily in the northeastern Dolomites. The Northern Calcareous Alps comprise two Scythian, five Anisian, four Ladinian and two early Carnian depositional sequences. The completely marine successions were only weakly affected by early tectonics. A distinct increase in subsidence occurred in the late Ladinian, leading to the change from distally steepened ramps to rimmed platforms. Only during this time interval, a rapid tectonic subsidence signal overprinted the sea-level signal. Depositional sequences in the Early to early Late Triassic of the Northern Calcareous Alps and the Dolomites can be correlated, supported by biostratigraphic data. In order to assess global sea-level changes, data from the northwestern Tethys have been compared to sea-level data from other Pangean margins.

SANDY, M.R., 1995. Early Mesozoic (Late Triassic-Early Jurassic) Tethyan brachiopod biofacies: possible evolutionary intraphylum niche replacement within the Brachiopoda. Paleobiology, 21: 479-495.

Distributions of brachiopods from low latitude paleogeographic settings, primarily in the Tethyan Ocean of southern Europe, with additional data from North America allow some observations on the bathymetric distribution of early Mesozoic brachiopod orders. Norian and latest Triassic (Rhaetian) brachiopod biofacies are dominated in shallowest waters by short

looped terebratulids (Terebratulidina) while spire bearing athyrids (Athyrida) are common components of deeper water environments in the latest Triassic. In the late Early Jurassic (Pliensbachian), shallow water brachiopod faunas are dominated by rhynchonellids, short looped terebratulids are commoner in relatively deeper shelf waters, and spiriferids and long looped terebratulids (Terebratellidina) are abundant in deeper water shelf environments. Following the end-Triassic extinction event there appears to be niche-replacement in deep water shelf environments of Late Triassic athyrids by spiriferids and long looped terebratulids in the Early Jurassic. Rhynchonellids appear to have diversified into shallowest water environments; specialized short looped terebratulids may have occupied deeper water niches that resulted ultimately in the success of the enigmatic Pygopidae later in the Jurassic and Cretaceous.

SATTERLEY, A.K., 1996. Cyclic carbonate sedimentation in the Upper Triassic Dachstein Limestone, Austria: the role of patterns of sediment supply and tectonics in a platform reef basin system. J. Sed. Res., B Strat. Glob. Stud., 66: 307-323.

Factors that controlled the deposition of (i) peritidal Lofer cycles on a carbonate platform, and (ii) platform margin (reef slope) deposits have been deduced at localities in the Austrian Alps (the Steinernes Meer and Hochkonig Massif). These locations are part of an entire Late Triassic platform reef basin system that is preserved with most original stratigraphic relationships intact. Platform Lofer cycles shallow upward from a subtidal grainstone through a variety of intertidal dolomitic mudstones to a supratidal weathering horizon (soil), Lofer cycles show random, non-hierarchical stacking patterns, limited lateral continuity, varied progradation directions, complete shoaling (98% of cycles), and very low stratigraphic completeness (only 1-20%). Exponential frequency distributions of cycle thickness suggest random, aperiodic cycle deposition, rather than regular deposition in response to regular eustatic sea level oscillations. Sediments in the adjacent reef complex record storms and the lateral migration of sand shoals and stromatolite capped banks, not sea level fluctuations and intermittent subaerial exposure. On the basis of these observations, in contrast to many previous interpretations, Lofer cycles are interpreted to be mostly autocycles formed within a tidal flat island system by lateral migration of wide, low, emergent banks separated by shallow subtidal areas. Preservation potential of individual cycles is thought to have been low; reworking was almost certainly very important in this system. Extensional regional tectonics in the Late Triassic exerted a long-term control over the development of the tidal flat island system on the platform top, and appears to have left a tectonic overprint in Lofer cycle successions. Differential subsidence of individual platforms across the region is suggested by substantial regional thickness variations (1200-3000 m) in the Norian/Rhaetian platform carbonates of the Northern Calcareous Alps. Two important tectonic deepening events in the Steinernes Meer section almost caused platform drowning, and correlate with a lowermost Rhaetian transgression in the Western Tethys. Many other tectonic events may have gone unrecorded on the platform. Within a 716 m thick measured succession of Lofer cycles, intervals of enhanced paleokarst development and stacked intertidal to supratidal beds are present with 20-75 m vertical spacing. These platform units are interpreted to represent prolonged periods in which greater areas of the platform were occupied by intertidal to supratidal sediments. These units correlate with thick units of debris flows on the reef slope. What may be 'tectonic highstands' (the result of a vertical tectonic movement) are recorded as packstone to grainstone deposition on the reef slope. A holistic model driven by aperiodic fault controlled downdropping, resulting in switching loci of sediment export patterns from a continuously operative subtidal carbonate factory (the reef complex) best explains vertical facies patterns in the platform and reef slope successions. It is not a static sea level model, although third, fourth, and fifth order eustasy is not required. The model could explain the sporadic

occurrence of shallowing-up cycles in the adjacent Kössen Basin. Late Triassic eustatic sea level fluctuations were ineffective in controlling sedimentation as a result of the processes described above.

Schneider, J.A., 1995. Phylogeny of the Cardiidae (Mollusca, Bivalvia): Protocardiinae, Laevicardiinae, Lahilliinae, Tulongocardiinae subfam. n. and Pleuriocardiinae subfam. n. Zool. Scripta, 24: 321-346.

In a preliminary cladistic analysis of the bivalve family Cardiidae (Schneider 1992), members of the subfamilies Protocardiinae, Lahilliinae, and Laevicardiinae, plus the genus *Nemocardium*, were found to be the least derived taxa of cardiids. A cladistic analysis is undertaken of the genera and subgenera of these cardiid taxa, plus several Mesozoic taxa which have never been assigned to any subfamily. The Late Triassic *Tulongocardium*, which is placed in Tulongocardiinae subfam.n., is the sister taxon to all other cardiids. Protocardiinae is restricted to the genus *Protocardia*. Most other Mesozoic taxa which have been placed in the Protocardiinae are found to be members of the Lahilliinae. *Nemocardium* is placed in the Laevicardiinae. *Incacardium*, *Pleuriocardia*, and *Dochmocardia* form a monophyletic group, Pleuriocardiinae subfam. n. Pleuriocardiinae, Laevicardiinae, and the remaining members of the Cardiidae (herein informally termed 'eucardiids') form a monophyletic group.

Sciunnach, D. and Garzanti, E., 1996. Sedimentary record of Late Paleozoic rift and break up in northern Gondwana: a case history from the Thini Chu Group and Tamba Kurkur Formation (Dolpo Tethys-Himalaya, Nepal). Geodin. Acta, 9: 41-56.

Quantitative compositional data from selected sandstone samples in the Upper Paleozoic to lowermost Triassic succession of the central Dolpo Tethys-Himalaya (Thini Chu Group and base of the Tamba Kurkur Formation) are relevant to understand the tectonic and climatic evolution of the northern margin of Gondwana from continental rift to break up and spreading in the Neotethys Ocean. In central Dolpo, where the Upper Permian is thicker than in other sections of the Northern India and Nepal Tethys Himalaya, and sandstones occur both just below and above the Permian/Triassic boundary, the Thini Chu Group rests disconformably over Lower Carboniferous carbonates. A terra rossa paleosoil documents a major hiatus that possibly spans the Visean to Early Bashkirian ("rift unconformity"). Another major unconformity overlain by the Murgabian Midian? "Costiferina arenites" is interpreted as indicating final break up and initial spreading in Neotethys ("break up unconformity"). In fact, arenite lenses mantling the unconformity yielded euhedral grains of Cr-rich chromian spinel, indicating enhanced partial melting of the asthenosphere rising beneath the Northern India Nepal "upper plate" margin. Regional correlations indicate a late Early Permian age for this event. Lithozones recognized within the Thini Chu Group are here correlated with formations recently established to the east in Manang (Nepal), largely according to their petrofacies. The Atali Quartzarenite (Petrofacies 1; "white quartzarenites") best corresponds with the Bangba Fm. of Manang, whereas the "Costiferina arenites" (Petrofacies 2a), the "ochre pelites" and "estuarine quartzarenites" (Petrofacies 2b), and the "black shales and glauco-phosphorites" (Petrofacies 3, 4 and 5) are broadly coeval with Member C of the Puchenpra Formation. Detrital feldspars appear in the middle part of the Thini Chu Group (Petrofacies 2) and sharply and progressively increase upwards (Petrofacies 3), until they peak around the Permian/Triassic boundary (Petrofacies 4 to 5). This trend may be explained with continued uplift of rift shoulders after breakup, or rather with rapidly increasing aridity towards the close of the Permian, while Gondwana was shifting northwards toward the Southern Tropic. Arkosic composition around the Permian/Triassic boundary may be also consistent with an arid episode at global scale.

SENNIKOV, A.G., 1996. Evolution of the Permian and Triassic tetrapod communities of Eastern Europe. Palaeogeogr. Palaeoclimatol. Palaeoecol., 120: 331-351.

The Permo-Triassic terrestrial and freshwater tetrapod communities of Eastern Europe are reconstructed as food webs. The Late Permian theriodont dinocephalian community (Ocher, Mezen, Isheyevo) changes to a latest Permian theriodont pareiasaur community (North Dvina, Vyazniki). After a major extinction, the Triassic thecodontian dicynodont communities appear, a lystrosaurid one in the Early Triassic (Lower and ?Upper Vetluga), and a kannemeyerid one in the later Early Triassic (?Yarenga) and the Mid Triassic (Donguz, Bukobay). Similar stages are represented in the evolution of aquatic communities: the Late Permian temnospondyl community (Ocher, Isheyevo), the latest Permian chroniosuchian one (North Dvina, Vyazniki), the Lower and Middle Triassic new temnospondyl one (from Vetluga to Bukobay). The faunal changes in Eastern Europe are mirrored in other parts of the world, although there are some endemic Russian forms.

SHEN, S.Z., HE, X.L. and SHI, G.G., 1995. Biostratigraphy and correlation of several Permian/Triassic boundary sections in southwestern China. J. Southeast Asian Earth Sci., 12: 19-30.

Detailed investigations of five complete Permian/Triassic boundary sections in southwestern China demonstrate the transitional nature of the Permian/Triassic boundary and the presence of a white clay at the boundary in the working area. The uppermost Permian is represented by the *Neochonetes substrophomenoides-Notothyris crassa-Waagenites pigmaea* brachiopod assemblage or the *Clarkina changxingensis-C. deflecta* conodont zone. The transitional beds of basal Triassic are represented by the *Lingula fuyuanensis-Crurithyris flabelliformis* brachiopod assemblage, or the *Pteria ussurica variabilis-Towapteria scythicum-Eumorphotis multiformis* bivalve assemblage, which is overlain everywhere by the *Pseudoclaraia wangi* bivalve zone. Faunal correlations show that the stratigraphy and faunal composition of the Permian/Triassic boundary sections in southwestern China do not differ substantially from the other two Global Stratotype Section Point candidates in south China and the transitional beds approximately correspond to the *Otoceras woodwardi* ammonoid zone, but the *Hindeodus parvus* conodont zone only corresponds to the upper part of transitional beds.

SHI XIAOYING, YIN JIARUM and JIA CAIPING, 1996. Mesozoic to Cenozoic sequence stratigraphy and sea-level changes in the Northern Himalayas, Southern Tibet, China. Newsl. Stratigr., 33: 15-61.

The marine Mesozoic and Cenozoic developed continuously in the northern Himalayan region of southern Tibet. From the Lower Triassic to the upper Eocene, 73 sequences have been identified, with an average duration of 2.9 Ma; these can in turn be grouped into 24 supersequences and 6 supersequence sets. Most of the sequences can be correlated with those distinguished by Haq et al., but some of them do show their own distinctive features owing to the regional tectonic effects, especially at the higher ranks. During the Mesozoic and Cenozoic, several large sea-level falls occurred in the eastern Neo-Tethys, which resulted in a number of hiatuses in the strata, various exposed surfaces, and disconformities. Among the recognized sea-level falls, the most important ones include those at the ages of 255 Ma, 177 Ma, 107 Ma, 68 Ma and 50 Ma. Those at 239 Ma, 215 Ma, 157 Ma, 138 Ma and 80 Ma are also significant. Study shows that the third-order sequences and sea-level cycles probably reflect mainly global sea-level fluctuations, while the higher rank cycles seem more closely related to the basin evolution of the Neo-Tethys. Tectonic movements apparently exerted a great influence not only on the relative changes in the sea-level, but also on the characters of the sequences. Based on the study, six major periods are suggested for the tectonic evolution of the eastern Neo-Tethys and the plates, i.e. the Pangea Period (Pre-Triassic), Continental Rifting Period (Triassic to Early Jurassic), Inter-Continental Sea Period (Middle Jurassic), Continental Divergence Period (Late Jurassic to Early Cretaceous), Continental Convergence

Period (Late Cretaceous) and the Continental Collision Period (Palaeogene). These major periods can be further subdivided into eight stages according to the basin evolution. In each of the periods and stages, sequences and their boundaries show clear characters related to the tectonic background. The present study indicates that the initial breakup of Pangea along the Indus-Yarlong may have taken place around 239 Ma. The late Bathonian to early Callovian seems to have been a critical time in the evolution of the Neo-Tethys, with the turning point around 158 Ma. The blocks split from the northern margin of the Gondwana Continent did not obviously drift away from the Indian Plate until the Callovian. The oceanic crust subduction in the Neo-Tethys may have started at 113 Ma, while the contraction of the ocean probably began at 107 Ma. The initial contact of the Indian plate with the Eurasian plate may have taken place around 80 Ma, with strong uplift and thrusting in the late Palaeocene.

SHINARQ, R., 1996. Subsurface Triassic sediments in Jordan: stratigraphic and depositional characteristics, and hydrocarbon potential. J. Petrol. Geol., 19: 57-76.

Unconformity surfaces have been used to divide the subsurface Triassic sediments of Jordan into five sequences. These sequences show a gradual transition from fluviatile deltaic sedimentation during the Permian, to mixed sedimentation of sandstones, silty shales and claystones together with shallow-water carbonates from the Scythian to the end of the Ladinian. Anhydritic dolomites and evaporites became prevalent during the Carnian-Norian. Isopach and facies maps for these sequences show that the Triassic sediments of Jordan were deposited in a set of environments which range from fluviatile deltaic for the coarse grained clastics; to restricted shelf lagoons and tidal flat settings for the fine grained clastics; to a shallow carbonate shelf for the fossiliferous carbonates; and restricted shelf lagoons, sabkhas and salinas for the carbonate evaporite sequence.

SRIVASTAVA, S.C. AND JHA, N., 1995. Palynostratigraphy and correlation of Permian-Triassic sediments in Budharam Area, Godavari Graben, India. J. Geol. Soc. India, 46: 647-653.

The subsurface sedimentary sequences pertaining to the Gondwanas in Budharam Area of Godavari Graben have yielded nearly a complete palynological sequence from Early Permian to Early Triassic represented by Talchir, Karharbari, Barakar, Barren Measures,Raniganj and Kamthi palynofloras. The presence of leiosphaerids and *Botryococcus* in Talchir palynozone indicates marine influence during the deposition of these sediments. The palynological transition from the Late Permian (Raniganj) to the Early Triassic (Kamthi Formation) is gradual and corroborates with the lithological succession.

STEPHENSON, R.A., DADLEZ, R. and NARKIEWICZ, M., 1995. Implications of tectonic subsidence models for crustal structure beneath the Mid-Polish Trough. Stud. Geophys. Geodaet., 39: 289-297

Tectonic subsidence analysis of the preserved and reconstructed stratigraphy of the Polish Basin indicates an initial Late Permian-Early Triassic (255-241 Ma) syn-rift phase of development with a subsequent extensional rejuvenation during the Late Jurassic (ca. 157-152 Ma). Forward modelling of the subsidence data, in view of existing geophysical interpretations which show the presence of a deep Moho and a very high seismic velocity lower crustal layer beneath the Mid-Polish Trough (MPT), suggest that Permo-Mesozoic basin development may be related at least in part to the intrusion of mantle material into and densification of the lower crust rather than exclusively to crustal extension and thinning.

STETS, J., 1995. Die Rolle der "Quarzitschwelle von Mettlach-Sierck" im Mittleren Buntsandstein des Saargaues (Südwestliches Rheinisches Schiefergebirge). Mainzer geowiss. Mitt., 24: 217-236.

Geological mapping, profiling, and the research of cross-bedding give an idea of the development of the 'Fazies von Kastel', i.e. a special formation of the Middle Bunter near the

northern margin of the ‚Quarzitschwelle von Mettlach-Sierck'. This paleogeographic mountain chain is situated in the sedimentation area of the Lower Triassic at the southwesternmost edge of the Rheinische Schiefergebirge. It acted as a barrier within the general flow system, and was filled up with sediments 100 m thick during the Middle Bunter. Inselbergs remained until the Middle Triassic. Sedimentation in the foreland occurred above a nearly flat plain of Upper Rotliegend origin covering a pre-existing late hercynian relief. In the northern foreland of the barrier, mixing occurred between psammitic components that were brought up from the southwest, and gravel coming down from the barrier along short valleys. By this mixing, the 'Fazies von Kastel' came into being. Eolian transport can be excluded in this area. The cross bedding points to fluvial transport.

STUMP, T.E. and VAN DER EEM, J.G., 1995. The stratigraphy, depositional environments and periods of deformation of the Wajid outcrop belt, southwestern Saudi Arabia. J. Afr. Earth SCI., 21: 421-441.

The Wajid outcrop belt in southwestern Saudi Arabia is an area of over 22,000 km^2 where strata of Middle(?) Cambrian through to Jurassic crop out. The Early Palaeozoic sediments in southwestern Arabia have been placed in the Wajid sandstone. This paper elevates this unit to group status and recognizes its former members as formations. The Permian Khuff Formation unconformably overlies the Juwayl and the former was deposited in shallow marine settings. The base Khuff Formation unconformity resulted from a period of major coastal onlap. The Early Triassic Sudair shale succeeds the Khuff and the former was deposited during a period of coastal offlap in lagoonal to coastal plain settings. Near the end of the Early Triassic the Arabian Peninsula underwent a period of tectonism. In central and southwest Saudi Arabia this event is reflected by the erosion of the Sudair shale and older units from the higher portions of reactivated fault blocks and the syndepositional thickening of the Jilh Formation on the down-thrown sides of these fault blocks.

SWIFT, A., 1995. A review of the nature and outcrop of the White Lias facies of the Langport Member (Penarth Group, Upper Triassic) in Britain. Proc. Geol. Assoc., 106: 247-258.

The 'White Lias' facies of the Langport Member consists predominantly of pale-coloured micritic rocks, with subordinate shales and clays, all of shallow-water origin. These characteristic rock types, with their low diversity biota dominated by mussels and oysters, are encountered throughout the outcrop. Thickness is variable, rarely exceeding 6 m, and was controlled by both depositional and post-depositional factors. The outcrop is discontinuous, extending from the southeast Devon coast northwards into Somerset and South Wales and thence northeastwards to Nottinghamshire and possibly beyond. From Leicester northwards the unit becomes reduced to a single, patchily distributed bed.

SWIFT, A., 1995. Conodonts from the Late Permian and Late Triassic of Britain. Monogr. Palaeont. Soc. London, 147(598), 80 pp.

The following species of conodonts have been recovered from English Zechstein (EZ) rocks: *Merrillina divergens* (Bender & Stoppel), *Merrillina* sp., *Mesogondolella phosphoriensis* (Youngquist, Hawley & Miller), ?*Mesogondolella phosphoriensis, Xaniognathus abstractus* (Clark & Ethington), *Xaniognathus* spp. and *Prioniodina*? sp. One element remains unassigned. Horizons yielding *Mesogondolella phosphoriensis* and *Merrillina divergens* correlate with sequences containing the same species in North America and Asia, and with Zechstein beds in Europe. Elements recovered from British Late Triassic sequences are referred to *Misikella posthernsteini* Kozur & Mock, *Misikella coniformis* nom.nov., *Chirodella verecunda* sp.nov. and *Prioniodina*? spp. *Misikella posthernsteini* allows correlation with sequences in Europe, North America and the Far East. Thermal maturation levels are low in the Late Permian and very low

in the Late Triassic. Both British Permian and Triassic conodont faunas responded to environmental changes. Late Triassic forms are amongst the last known in the conodont record, are extremely small and may be vestigial.

TAYLOR, E.L., 1996. Enigmatic gymnosperms: structurally preserved Permian and Triassic seed ferns from Antarctica. Rev. Palaeobot. Palynol., 90: 303-318.

Representative organs from the seed fern groups Glossopteridales and Corystospermales are commonly found in Gondwana during the Permian and Triassic, respectively. To date, both groups have been reconstructed predominantly on the basis of compression fossils and, in the case of the glossopterids, impressions. As a result, many details of their morphology remain unclear, and their taxonomic status and relationship to other groups are somewhat enigmatic. Collections of anatomically preserved fossils from permineralized peat in the central Transantarctic Mountains, Antarctica include a number of organs assignable to these two orders. Anatomical characters provide an opportunity to correlate isolated plant organs and to develop new reconstructions of these plants. Combined with paleoecological data, these fossils are beginning to provide a more accurate picture of the habitat and life history of these unique seed plants.

TAYLOR, M.A., 1995. A plesiosaur from the Linksfield Erratic (Rhaetian, Upper Triassic) near Elgin, Morayshire: further note. Scottish J. Geol., 31: 182.

THOMAS, D.W. and COWARD, M.P., 1996. Mesozoic regional tectonics and South Viking Graben formation: evidence for localized thin skinned detachments during rift development and inversion. Marine and Petroleum Geology, 13: 149-177.

A regional thin-skinned model of South Viking Graben development is presented in which Zechstein marginal evaporites and interpreted salt have acted as a key decollement horizon, along which mechanical decoupling of post-salt Triassic and younger strata, from pre-salt 'basement' has occurred. The western margin of the South Viking Graben defines an asymmetrical Late Jurassic half-graben, controlled by episodic extension along a NNE-SSW trending, eastward dipping, fault system. An initial, minor phase of rifting in the Triassic is suggested by the slight westward thickening and associated divergence of interpreted Triassic sequences at depth. The scarcity/absence of Upper Triassic and Lower Jurassic sequences is believed to result from a subsequent phase of uplift which affected the region in the mid-Cimmerian, attributed to the development of a thermal dome at the future site of a Jurassic rift triple junction to the southwest. The onset of large scale extension, from the Late Callovian onwards, marked the major phase of half-graben formation and created a regional hanging-wall tilt, which locally caused gravity gliding of post-salt section to the WNW, with resultant low-angle extensional faulting upslope and salt-cored buckling downslope. The Late Jurassic half-graben was subsequently tightened by a phase of thin-skinned inversion in the Latest Jurassic-Early Cretaceous, associated with back-steepening of the western margin fault system, with resulting reactivation of the extensional detachment system. The effects of this inversion have been noted in many parts of the northern North Sea. Within the South Viking Graben, shortening estimates vary between 14 and 18% and are expressed on seismic data by localized hanging-wall folds and the back-steepening of faults along the western margin fault complex of the graben, together with out-of-graben thrusting up the hanging-wall dip-slope. Variation in both the extension and inversion mechanisms appears to be controlled by interpreted NW-SE transfer systems which compartmentalize the graben into three subgraben, within which differential Zechstein basin development occurred.

TICHY, G., 1995. Ein früher, durophager Ichtyosaurier (Omphalosauridae) aus der Mitteltrias der Alpen. Geol. Paläont. Mitt. Innsbruck, 20: 349-369.

For the first time a nearly entirely intact skeleton of a primitive species of an ichthyosaur has been discovered close to Salzburg, Austria. It is a new form of the durophagous ichthyosaur probably belonging to the genus *Omphalosaurus,* which previously has only been described from remnants in Spitsbergen (Svalbard), Norway and Nevada, U.S.A. It is also the first instance that remains of a reptile could be saved from the Hallstatt limestone. This Hallstatt limestone was deposited in a pelagic facies and is specifically known as Lercheck limestone. The stratigraphic range covers the Upper Anisian to the Lower Ladinian, while the stratigraphic age of *Omphalosaurus wolfi* nov.sp. is lowermost Ladinian. Beside the few finds of the genus *Tholodus* there are no reports of durophagous ichthyosauri in the Western Tethys.

TIWARI, R.S. and VIJAYA, 1995. Differential morphographic identity of Gondwanic palynomorphs. Palaeobotanist, 44: 62-115.

The exine structures, bauplan and germinal apertures are the basic characters for the morphographic identification of fossil spores and pollen. The apparent but unreal form-similarities of some bisaccate pollen taxa of *Sporae dispersae* from Gondwanaland on the one hand and those in the contemporary Euramerian sequences on the other have been sorted out in this paper. Trends of different exine structures and saccus organizations have been identified in pollen. This concept has been exemplified by the fact that the pollen taxa *Lunatisporites, Lueckisporites* and *Klausipollenites* of the north possess mostly imperfect reticulae, compactly placed grana, columnar elements, rodlets, vermicular, verrucae or similar elements mixed together, rounded or multifaceted islands of various shapes and sizes, incomplete or even isolated closely packed muri as exinal elements which make the infrastructure of the sexine in the corpus. In contrast to this trend, the major pattern of exine structure in apparently similar taxa of the Gondwanaland is different; most of the pollen groups exhibit perfectly infrareticulate structure on corpus with complete muri and distinct meshes. Such a differential morphographic identity may lead to a more rational model of the palaeo-phytogeography based on palynofossils, because the genuine similarities and differences could he effectively used in delimiting the floral provinces. The distinctions in the mother vegetations, which had produced pollen and spores in two regions, corroborate the distinctions in the groups of palynotaxa discussed here. This paper proposes the theory of the Apparent Form Similarity (AFSIM factor) and highlights certain lines of differentiation amongst the similar-looking but basically different spore-pollen components produced by unrelated plant groups. Some aspects of palynofloral distribution vis-a-vis climatic changes through Gondwana have also been discussed.

TUREK, A. and KIM, C.B., 1995. U-Pb zircon ages of Mesozoic plutons in the Damyang Geochang area, Ryongnam Massif, Korea. Geochem. J., 29: 243-258.

The Damyang Geochang area in the southwestern part of the Ryongnam massif, Korea, is composed of Precambrian gneisses that have been intruded by Triassic to Jurassic, felsic to mafic, batholiths and stocks. Since the Triassic this area has been affected by four orogenies. Eight K/Ar, Ar/Ar, and Rb/Sr ages have previously been reported for some of the rocks in the area, and the ages range from 159 to 228 Ma. This study reports the first U-Pb-zircon ages for the Korean peninsula. In the Damyang Geochang area, Mesozoic plutonism appears to span the period from 219 Ma to 176 Ma. The first period of Mesozoic plutonism resulted in the emplacement of the (unnamed) foliated granite, the foliated gabbro, and the Daegang foliated granite, at 219-212 Ma.

TWITCHETT, R.J., 1996. The resting trace of an acorn worm (class Enteropneusta) from the Lower Triassic. J. Paleont., 70: 126-129.

A new trace fossil from the Lower Triassic of northern Italy is described. It is a sinuous resting trace of a bilaterally symmetrical worm-like animal. The anterior end is characterised by a pair of lateral projections. It most closely resembles an acorn worm (class Enteropneusta) in morphology. As such, it is the only known resting trace of an acorn worm from the fossil record.

UPCHURCH, P., 1995. The evolutionary history of sauropod dinosaurs. Phil. Trans. Roy. Soc. London, Ser. B, Biol. Sci., 349: 365-390.

Most recent studies of dinosaur phylogeny have concentrated on theropods and ornithischians. As a result, the evolutionary relationships of sauropod dinosaurs are poorly understood. In this paper previous studies of sauropod phylogeny are reviewed and contrasted with the results of a recent cladistic analysis. This analysis forms the basis for a reconstruction of sauropod phylogeny. Sauropods diverged from other dinosaurs at some time in the Upper Triassic, but a large part of their early history is totally unknown. *Vulcanodon* is currently the most primitive sauropod. Many, but perhaps not all, of the Jurassic Chinese sauropods form a monophyletic radiation (the Euhelopodidae) which may reflect the geographic isolation of China during the Lower Jurassic. Members of the Euhelopodidae, such as *Mamenchisaurus*, are not considered to be closely related to the Diplodocidae. 'Forked' chevrons, which have played such an important role in previous studies of sauropod phylogeny, are here considered to have evolved twice within the Sauropoda. This convergence may reflect a correlation between chevron shape and the use of the tail as a weapon within these two sauropod families. The 'Neosauropoda' (sister group to the Euhelopodidae) contains the Brachiosauridae, Camarasauridae and the new superfamilies Titanosauroidea and Diplodocoidea. The Cetiosauridae (here defined in a rather restricted sense) is also provisionally included within the Neosauropoda, but may be removed in future studies. The enigmatic Upper Cretaceous sauropod, *Opisthocoelicaudia,* is thought to be the sister taxon to the Titanosauridae and not a camarasaurid as previously suggested. The Diplodocoidea contains two well established families, the Dicraeosauridae and Diplodocidae, and the new family Nemegtosauridae. Finally, an overview of sauropod phylogeny is compared with recently published palaeogeographic reconstructions. There are many difficulties associated with the analysis of sauropod biogeographic distribution. Nevertheless, some aspects of sauropod phylogeny may be linked to the break up of Laurasia and Gondwanaland during the Jurassic and Cretaceous.

VIJAYA, 1995. Revision of the Late Permian-Triassic pollen genus *Playfordiaspora* Maheshwari & Banerji 1975. Palaeobotanist, 43: 54-67.

The genus *Playfordiaspora* was proposed by Maheshwari and Banerji (1975) to accommodate trilete, 'apparently monosaccate' miospores with very fine reticulate 'flange'. The present study reveals that it bears an enveloping single layered, endoreticulate, empty monosaccus without an in-fill. This records the occurrence of eusaccate pollen during Late Permian-Triassic from widely separated palaeogeographical areas of Gondwanaland, Europe and America. Although the affinity of *Playfordiaspora* is difficult to ascertain, a pteridospermous relationship seems probable on the basis of above morphographic features.

VILA, J.M., BENYOUSSEF, M., CHIKHAOUI, M. and GHANMI, M., 1996. A large submarine middle Albian salt glacier in north-western Tunisia (250 km^2): the Triassic rocks of Ben Gasseur diapir and of El Kef anticline. C.R. Acad. Sci., Sér. II, Fasc. A. Sci. Ter. Planet., 322: 221-227.

Close to El Kef in Tunisia, the large masses (approximately 165 km^2) of Triassic rocks of the Ben Gasseur El Kef anticline area are included within the middle Albian formations and show, underneath and on top, two originally horizontal sedimentary limits. Several Albian reefs, along

the upper limit, allow estimation of a large lenticular saliferous body of probably 250 km², after straightening the two Tertiary foldings. This framework is interpreted as a large submarine 'salt glacier', emplaced over a previously marine slope, within a hot rifted setting, following a scenario similar to the 'salt glacier' Ouenza (Algeria) emplacement. This new interpretation allows considerable simplification of the regional tectonic features. The large Triassic outcrops of nearby north central Tunisia should be interpreted similarly, taking into account the several mining and petroleum drillings.

VISSCHER, H., BRINKHUIS, H., DILCHER, D.L., ELSIK, W.C., ESHET, Y., LOOY, C.V., RAMPINO, M.R. and TRAVERSE, A., 1996. The terminal Paleozoic fungal event: evidence of terrestrial ecosystem destabilization and collapse. Proc. Nat. Acad. Sci. U.S.A., 93: 2155-2158.

Because of its prominent role in global biomass storage, land vegetation is the most obvious biota to be investigated for records of dramatic ecologic crisis in Earth history. There is accumulating evidence that, throughout the world, sedimentary organic matter preserved in latest Permian deposits is characterized by unparalleled abundances of fungal remains, irrespective of depositional environment (marine, lacustrine, fluviatile), floral provinciality, and climatic zonation. This fungal event can be considered to reflect excessive dieback of arboreous vegetation, effecting destabilization and subsequent collapse of terrestrial ecosystems with concomitant loss of standing biomass. Such a scenario is in harmony with predictions that the Permian-Triassic ecologic crisis was triggered by the effects of severe changes in atmospheric chemistry arising from the rapid eruption of the Siberian Traps flood basalts.

VISSER, J.N.J., 1995. Post-glacial Permian stratigraphy and geography of southern and central Africa: boundary conditions for climatic modelling. Palaeogeogr. Palaeoclimatol. Palaeoecol., 118: 213-243.

The post-glacial stratigraphy of southern and central Africa comprises mudrocks with subordinate sandstones and coal measures belonging to the Ecca Group overlain by fossiliferous mudstones and sandstones of the Beaufort Group (Madumabisa Mudstone of south-central Africa), preserved in the Karoo, Congo and extreme western margin of the Parana basins, the Kalahari-Zambezi and East Africa-Malagasy basin complexes, and the Nyasa basin and range complex. The palaeogeography of the region was controlled by the stable, elevated Kalahari and Congo cratons, a NE-trending weak zone between the cratons (site of the Kalahari-Zambezi-Malagasy basin complexes), a NNW-trending weak zone between the cratons and the Mozambique mobile belt (site of the Nyasa basin and range complex) and an E-W mobile belt along the southern margin of the continent (site of the foreland Karoo Basin). The postglacial Artinskian landscape which was inherited from the Permo-Carboniferous glaciation, consisted of a rugged interior plateau and shallow seas and seaways in the south and west. The early Late Permian landscape was still dominated by an uneven coastline in the south and freshwater lakes in the Congo Basin and along the Kalahari-Zambezi-Malagasy drainage systems. A marine incursion occurred in the Malagasy Basin. Relief on the interior plateau was steadily denuded. By Kazanian times large lakes covered the Karoo and Parana basins whereas along the coastal region all shallow seas were destroyed by an orogen. Freshwater lakes in the interior had reached their maximum extent. The Permo-Triassic landscape shows an increase in the interior relief due to renewed graben formation with lakes becoming smaller and more desiccated. The surface area of southwestern Gondwana covered by water reached a maximum of 34% during the early Late Permian and decreased to about 6% at the Permo-Triassic boundary. Climatic zones shifted southeastwards as southwestern Gondwana drifted into lower latitudes during the Permian. The ice margin started to retreat in central Africa during the Sakmarian, but the marine ice sheet in the Karoo Basin collapsed only in the Artinskian. Deglaciation was followed by a cool wet climate suitable for the

formation of peatlands. In central and south-central Africa this climate was followed by temperate to warm, seasonal conditions which became progressively wetter with less seasonal fluctuation towards the east (Malagasy Basin) and drier towards the west. These conditions lasted until the end of the Kazanian. In the Karoo Basin the cool wet climate of the Artinskian became more temperate and also lasted until the end of the Kazanian when warm, semi-arid conditions expanded over the entire southern and central Africa. The geographic controlling factors for Permian climatic change were the interplay of latitudinal setting and continental evolution (formation of orographic barriers and loss of coastal seas).

Von Gosen, W., 1995. Polyphase structural evolution of the southwestern Argentine Precordillera. J. South Amer. Earth Sci., 8: 377-404.

The western and southwestern parts of the Argentine Precordillera display complex geometries which are not consistent with those of a typical high-level fold and thrust belt. They are the result of a polyphase structural evolution which spans the Early Paleozoic to Late Tertiary period. After an Early Paleozoic folding and shearing event under a greenschist facies metamorphism, uplift, erosion, and deposition of Late Carboniferous to Early Permian clastics were accompanied by extensional faulting. This was followed by a Permian folding and faulting event which led to a partial inversion of the Late Carboniferous-Early Permian graben fill. Permian to Triassic crustal extension was combined with block faulting and the deposition of a thick volcanic sequence. The subsequent Late Tertiary crustal shortening partly reactivated older fault lines. Excluding folds, a few thrusts, and reverse faults, the crustal shortening within the older blocks was accommodated by a dominant sinistral strike-slip faulting under a W-E compressive regime. Above a major decollement, the entire sequence of faulted and folded blocks was carried from west to east towards its present position. The regional situation indicates that this southern part of the orogen was transferred further to the east with respect to the central thin-skinned parts. The movements are interpreted to be related to an important thrust fault which obliquely cuts through the fold and thrust belt.

Wang Cheng-yuan, 1995. Conodonts of Permian-Triassic boundary beds and biostratigraphic boundary. Acta Palaeont. Sinica, 34: 129-151.

The Permian-Triassic boundaries in South China may be strictly classified into the eventostratigraphic boundary and the biostratigraphic boundary. The basal limit of the 'boundary clay' bed is known as the eventostratigraphic boundary, whereas the biostratigraphic boundary can not be defined in relation with the 'mixed beds' or 'transitional beds' altogether. The Zhongxin Dadui section at Meishan, Changxing, is known as the best GSSP of the Permian-Triassic boundary. In terms of definition, the best P/T biostratigraphic boundary is the first appearance of *Hindeodus parvus* Morphotype 1, which was derived from *Hindeodus latidentatus* Morphotype 1. This boundary falls within Boundary Bed 2 (=Mixed Bed 2 of Sheng et al., 1984), 15 cm higher than the eventostratigraphic boundary at Zhongxin Dadui section. An essential conodont faunal change just happened within the boundary beds. In the absence of *Hindeodus parvus* M. 1, the supplementary criteria for the Permian-Triassic biostratigraphic boundary might be the extinction of *Clarkina changxingensis, C. deflecta, C. dicerocarinata, Clarkina* sp. nov., *Hindeodus latidentatus, H. julfensis, H. typicalis* and the first appearances of *Hindeodus turgidus, H. parvus* M. 2, *Ophiceras, Claraia wangi. Hindeodus parvus* is a seximembrane apparatus. This biostratigraphic boundary falls within the monofacies strata. The first appearance of *Hindeodus parvus* Morphotype 1 is also the upper limit of the Changhsingian Stage. All species of the Permian-Triassic boundary beds are discussed, with the description of *Hindeodus changxingensis* sp. nov. which might be an event species.

WANG SHANG-YAN and WANG NING, 1995. Two new ichnogenera from Early Triassic Anshun Formation of Mengguan, Guiyang. Acta Palaeont. Sinica, 34: 375-380.

Here described are two new ichnogenera, *Biconcavichnus* ichnogen. nov. and *Fasciarichnus* ichnogen. nov. from dolomites of the Early Triassic Anshun Formation at Mengguan Village, Guiyang, with discussion on the forming patterns and environments of these ichnogenera.

WANG, Z.Q., 1996. Recovery of vegetation from the terminal Permian mass extinction in North China. Rev. Palaeobot. Palynol., 91: 121-142.

A two stage sequence of vegetation recovery following the terminal Permian mass extinction is proposed, based on a suite of fossil plants from the Triassic redbeds in North China. This includes two plant assemblage zones: an Early Triassic *Pleuromeia* zone with three subzones, and a Middle Triassic *Tongchuanophyllum* zone with *Isoetes* and *Scytophyllum* subzones. The first of these, in the Early Triassic, was an arid patchy vegetation, represented by a monospecific *Pleuromeia* phase in the first half of the Early Triassic and a bi- or trispecific phase in the second half. The second assemblage zone was characterized by an expansion of xeric mesic transitional vegetation in the Middle Triassic. It was represented by a river bank phase extending along permanent rivers in the earliest Middle Triassic, followed by an anastomosingly distributed vegetation developing both within drainage systems and on vast plains surrounding the inland basin in the later Middle Triassic. Refuges and expanding ecotones played an active role in the climatically determined Triassic vegetational recovery. The key floristic mechanism of the recovery is the development of the river bank phase along permanent rivers as a signal of a natural hedgerow model ecotone.

WANG ZHI-HAO, 1994. Triassic conodonts from different facies in eastern Yunnan, western Guizhou and northern Guangxi. Acta Micropal. Sinica, 11: 379-412.

The conodonts described here were collected from 28 sections in eastern Yunnan, western Guizhou and northern Guangxi which represent different facies, with 22 genera and 79 species, including 4 new species. Those collected from different facies are different in character. The distribution of conodonts mostly depends on the sedimentary environment and facies. In this region two major types of conodont zonation have been recognized: the 'platform facies type' occurring mostly in the shoal area of a platform, and the 'basinal facies type' occurring in the open shelf, the slope and basin facies, with a total of 12 'platform facies type' and 15 'basinal facies type' conodont faunas. Also discussed is the problem of the Permian-Triassic boundary.

WEBER, R., 1995. A new species of *Scoresbya* Harris and *Sonoraphyllum* gen. nov. (Plantae *incertae sedis*) from the Late Triassic of Sonora, Mexico. Rev. Mexicana Cienc. Geol., 12: 94-107.

Scoresbya dentata Harris, *Scoresbya pinnata* sp.nov. and *Sonoraphyllum mirabile* gen. et sp. nov. are described from the Carnian (and/or Norian?) Santa Clara Formation, Barranca Group, southeastern central Sonora, northwestern Mexico. The original generic diagnosis of *Scoresbya*, based on *Sc. dentata*, is modified due to the recent discovery of *Sc. integrifolia* Meng Fan-son and *Sc. pinnata*, whose leaves have entire-margined or pinnate segments and lobes, respectively. An earlier tentative assignment of *Scoresbya* to the Dipteridaceae is discarded. *Sonoraphyllum* is a foliar genus showing an extremely unusual leaf architecture. The only known specimen, regardless of whether it is a whole leaf or a fragment, is deeply laciniate. Its venation is composed of a stout midrib and pinnately arranged secondary veins forking once at the bases of the lobes; the resulting arms enter independently into different neighbouring lobes. Each lobe, consequently, has two subparallel main veins. Its tertiary venation is reticulate. Both genera are probably related to the pteridosperms and formed part of the channel-far communities within the flood-plain paleoenvironment of the Santa Clara Formation.

Weber, R. and Zamudio-Varela, G., 1995. *Laurozamites,* a new genus and new species of bennettitalean leaves from the Late Triassic of North America. Rev. Mexicana Cienc. Geol., 12: 68-93.

The Carnian-and/or Norian?-Santa Clara taphoflora from Sonora, Mexico, yields a large number of bennettitalean leaves. Most common are those placed here in *Laurozamites* gen.nov. Species are described as *L. fragilis* (Newberry) comb.nov., *L. yaqui* sp.nov., *L. pima* sp.nov. and *L. tarahumara* sp.nov. - with two varieties, *tarahumara* var.nov. and *dubius* var.nov. The first three species are differentiated mainly according to the dimensions of the pinnae measured in specimen-rich palaeodemes, while the fourth, is distinguished by the low venation density. From the Late Triassic of the United States of America, *Laurozamites powellii* (Fontaine) comb.nov., *L. macombii* (Newberry) comb.nov. and *L. paraiconicus* sp.nov. are also assigned to the new genus. All the previously known species assigned here to *Laurozamites* had been placed either in *Pterophyllum, Otozamites* or *Zamites,* but this practice unduly expands these genera. The new genus represents a more natural taxon restricted to North America, at least during the Late Triassic.

Whittle, G.L., Alsharhan, A.S. and Ain, A., 1995. Observations on the diagenesis of the Lower Triassic Sudair Formation, Abu Dhabi, United Arab Emirates. Facies, 33: 185-194.

The Lower Triassic Sudair Formation in the United Arab Emirates (U.A.E.) ranges in thickness from 178-297 m and comprises three units consisting of interbedded limestone, argillaceous limestone, dolomite and anhydrite. The Lower Unit contains variable energy shallow-marine, slightly argillaceous mudstones and subordinate oolitic peloidal packstones and grainstones with minor dolomite and anhydrite. The Middle Unit consists of argillaceous and ferroan dolomite deposited in a lagoonal to supratidal setting. The Upper Unit comprises argillaceous mudstones and dolomites at the base grading upward into argillaceous anhydrite deposited in a restricted shallow-marine to sabkha setting. These units represent the transition from a carbonate/ evaporite shelf with significant terrestrial input to an evaporitic platform defined by an overall shallowing-upward sequence. Diagenesis in the Sudair includes extensive leaching of grain-supported carbonates, partial to complete dolomitization, evaporite formation, clay nucleation, fracturing/pressure solution, late cementation by coarse calcite spar and saddle dolomite, and hematite formation. These processes have had the cumulative effect of reducing the secondary porosity. Dolomitization occurred in two stages: an earlier progression of rhombic-sucrosic-aphanocrystalline dolomite, and a later coarse crystalline and saddle dolomite fracture fill.

Wood, R., 1995. The changing biology of reef building. Palaios, 10: 517-529.

The close packing of calcified organisms necessary for reef development is achieved either by larval aggregation (aclonal/solitary metazoans) or by competition for limited or patchy hard substrate (clonal/modular metazoans and encrusting algae). Buildups constructed predominantly by aclonal/solitary metazoans tend to be small, ephemeral soft-substrate communities, with relatively low relief, spatial heterogeneity and biotic diversity. In contrast, frameworks constructed by clonal/modular metazoans or encrusting calcified algae are often sizeable, long-lived structures with high topographic complexity, diversity and biomass. Several groups of fossil organisms currently considered as major reef builders may be re-interpreted either as common cryptobionts (early Cambrian archaeocyath sponges, Paleozoic-Mesozoic sphinctozoan sponges) or as soft-substrate platform-dwellers (Paleozoic-Mesozoic stromatoporoid and chaetetid sponges, rudist bivalves). Throughout the Phanerozoic as well as in modern reefs, sessile solitary calcified heterotrophs (filter- and suspension feeders) have been more important members of the cryptos than the open surface, framework constructing community. Heterotrophs were however more common members of the open-surface community during

the Paleozoic-Mesozoic than the Cenozoic. Yet most open-surface communities have always been dominated by phototrophic organisms: various calcified algae and microbes during the Paleozoic-early Mesozoic and mixotrophic metazoans, primarily scleractinian corals, from the late Triassic/early Jurassic onwards. The established nomenclature describing reefal fabrics must be revised in the light of these observations. The acquisition of photosymbionts by scleractinian corals in the late Triassic/early Jurassic may have been related to the appearance of dinoflagellates at this time, and was favoured by increased predation pressure from the Late Mesozoic onwards. In particular, the appearance of many groups of herbivorous and predatory fish in the Eocene promoted coral domination. Photosymbiosis imparted novel metabolic capabilities to scleractinian corals allowing them and hence reef communities to invade the previously unexploited low nutrient, shallow-marine environment.

YANG FENGQUING and WANG ZHIPING, 1995. Reconstruction of Permian paleo-ocean of Qinling orogenic belt. Earth Sci., J. China Univ. Geosci., 20: 641-647.

YANG, S.R., 1995. Ladinian-Carnian conodonts and their biostratigraphy in Asia. J. Geol. (Vietnam), Ser. B, 5-6: 127-398.

YANG, Z.Y., SHENG, J.Z. and YIN, H.F., 1995. The Permian-Triassic boundary: the Global Stratotype Section and Point (GSSP). Episodes, 18: 49-53.

YAPP, C.J. and POTHS, H., 1996. Carbon isotopes in continental weathering environments and variations in ancient atmospheric CO_2 pressure. Earth Planet. Sci. Lett., 137: 71-82.

Abundance and carbon isotope data from an $Fe(CO_3)OH$ component in apparent solid solution in oolitic goethites have been used to infer ancient atmospheric CO_2 pressures. A test of the validity of these estimates might be comparisons of the carbon isotope compositions of $Fe(CO_3)OH$ in oolitic goethites with time equivalent pedogenic calcites. Temporal trends of the oolitic goethite and pedogenic calcite $\delta^{13}C$ values are generally similar, but time equivalent samples from each of these two groups are not common in the existing data. To facilitate discussion of the concept, comparisons were made of available goethite and calcite samples even though ages of the compared samples in each pair were not identical. In four out of the five comparisons, $Fe(CO_3)OH$ abundance and $\delta^{13}C$ data were combined with pedogenic calcite $\delta^{13}C$ data to calculate physically reasonable soil CO_2 concentrations for the ancient calcitic soils. This suggests that the compared oolitic goethite and pedogenic calcite systems were responding to the same global scale phenomenon (i.e., atmospheric CO_2). Atmospheric P_{CO_2} as determined from the goethites in these four 'well behaved' cases ranged from values indistinguishable from modern (within analytical uncertainty) to values up to approximately 16 times modern (modern atmospheric P_{CO_2} was taken to be 10 ($\pm$3.5) atm). One interpretation of the fifth, 'anomalous', comparison is that atmospheric CO_2 levels increased from about 3 times modern to about 18 times modern from the Triassic into the Early Jurassic. This inferred value for the P_{CO_2} of the Early Jurassic atmosphere is not uniquely constrained by the existing data and needs to be substantiated. However, even considerably lower Early Jurassic atmospheric P_{CO_2} values of 6 to 9 times modern (i.e., 1/3 to 1/2 of the estimated value of 18 times modern) would still indicate significant differences between the global carbon cycles then and now. These results highlight the need for more research on the behavior of the atmosphere during and after the Triassic-Jurassic transition.

YIN, H.F., ZHANG, K.X., WU, S.B. and PENG, Y.Q., 1995. Global correlation and definition of the Permian-Triassic boundary (PTB). J. Geol. (Vietnam), Ser. B, 5-6: 139-152.

ZAKHAROV, Y.D., 1994. Induan-Olenekian boundary stratotype. Lower Triassic. Tikhookeanskava geologyiya, 4: 33-44. (in Russian)

ZAKHAROV, Y.D. and OLEINIKOV, A.V., 1994. New data on the problem of the Permian-Triassic boundary in the Far East. Canad. Soc. Petrol. Geol., 17: 845-856.

ZHANG, K.X., LAI, X.L., DING, M.H. et al., 1995. Conodont sequence and its global correlation of Permian-Triassic boundary in Meishan section, Changxing, Zhejiang province. Earth Sci., J. China Univ. Geosci., 20: 669-676.

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SUBMISSION OF MANUSCRIPTS FOR ALBERTIANA

Contributions should be sent to the editor on **MS-DOS formatted floppy discs**, preferably in WordPerfect 5.1 or any other kind of word-processing program that can be converted into WordPerfect 5.1 (e.g. Word, WordStar or as a plain ASCII file) together with a **printed hard copy**. Those who do not have the possibility to submit a manuscript in electronic format, are kindly requested to send smooth and clearly typed manuscripts in a 12-point typeface with single line spacing. Tables and schemes should be in **camera-ready** format, clearly drawn or printed; only originals can be accepted, poor xerox copies cannot be accepted. Due to time restrictions it is not possible to redraw tables and schemes.

Special attention should be paid to grammar and syntax. References should be in the format used in the 'Annotated Triassic Literature'. The use of names of names of biostratigraphic units should be in accordance with the International Stratigraphic Guide:

- "The formal name of a biostratigraphic unit should be formed from the names of one, or preferably no more than two, appropriate fossils combined with the appropriate term for the kind of unit in question."
- "The writing and printing of fossil names for stratigraphic units should be guided by the rules laid down in the *International Code of Zoological Nomenclature* and in the *International Code of Botanical Nomenclature*. The initial letter of generic names should be capitalized; the initial letter of the specific epithets should be in lowercase; taxonomic names of genera and species should be in italics. The initial letter of the unit-term (Biozone, Zone, Assemblage Zone) should be capitalized; for example, *Exus albus* Assemblage Zone."
- "The name of the fossil or fossils chosen to designate a biozone should include the genus name plus the specific epithet and also the subspecies name, if there is one. Thus *Exus albus* Assemblage Zone is correct. After the first mention, the genus name may be abbreviated to its initial letter if there is no danger of confusion with some other genus beginning with the same letter; for example, *Exus albus* may be shortened to *E. albus*. On the other hand, the use of the specific epithet alone, in lowercase or capitalized, in italics or not (*albus* Assemblage zone, *Albus* Assemblage zone, albus Assemblage zone, or Albus Assemblage zone), is inadvisable because it can lead to confusion in the case of frequently used species names. However, once the complete name has been cited, and if the use of the specific epithet alone does not cause ambiguous communi-cation, it may be used, in italics and lowercase, in the designation of a biozone; for example, *uniformis* Zone."

From: SALVADOR A. *(ed.), 1994. International Stratigraphic Guide. Second Edition. International Commission on Stratigraphic Classification of IUGS International Commission on Stratigraphy. IUGS/GSA, Boulder, Co, p. 66*

The deadline for the submission of contributions for ALBERTIANA 18

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- letters
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- notices
- comments

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