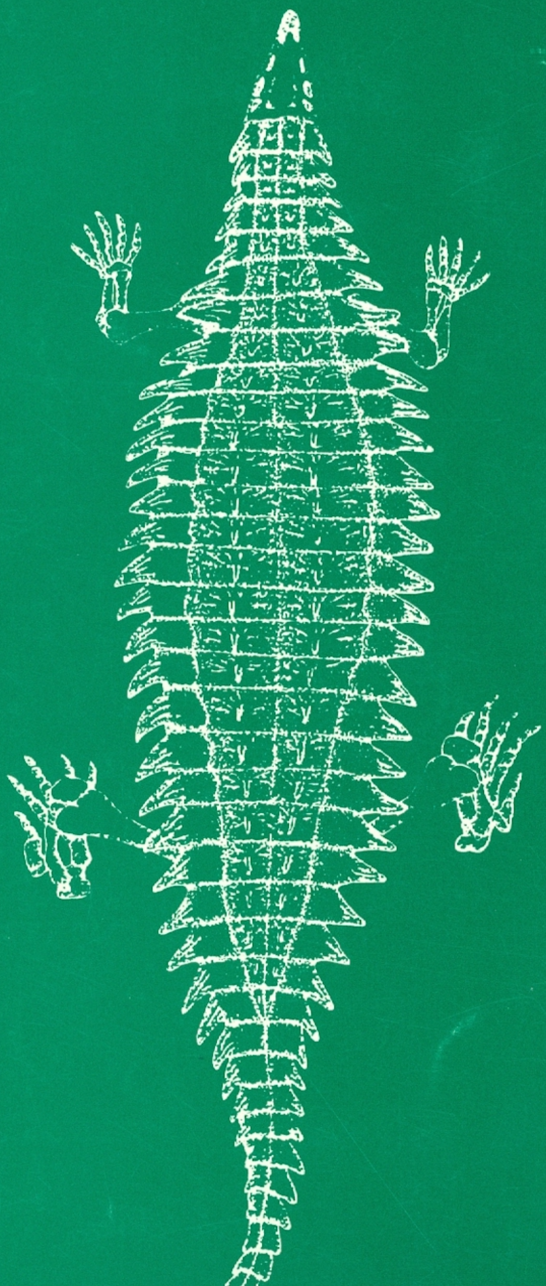
ALBERTIANA



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ALBERTIANA

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

CONTENTS ALBERTIANA 16

Cover: Longosuchus, *a typical Chinle group aetosaur. (from S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. & Sci., Bull. 3: G41)*

SEE PAGE 94 FOR METHODS OF PAYMENT OF ALBERTIANA 16

REPORT FROM THE CHAIRMAN CONCERNING

THE VOTE OF THE STS VOTING MEMBERS AND NEXT MEETING

Dear colleagues,

Following my report published in ALBERTIANA 15 and the questions proposed to the voting members, twenty-five ballots have come back with the following results:

Question 1: Do you accept the election of Prof. Maurizio GAETANI as our next chairman?
approval: 24, abstention: 1

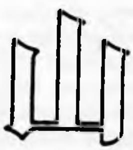
Question 2: Do you accept the election of Dr. Mike ORCHARD, Prof. Hans RIEBER and Prof. Yuri ZACHAROV as vice-chairmen of our Subcommission?
Dr. Mike ORCHARD, approval: 25
Prof. Hans RIEBER, approval: 24, abstention: 1
Prof. Yuri ZACHAROV, approval: 22, abstention: 2, not approved: 1

Question 3: Do you accept the election of Dr. Geoffroy WARRINGTON as our next secretary?
approval: 24, abstention: 1

Question 4: Do you accept the election of Dr. H. BUCHER, Dr. G. STANLEY and Dr. VIJAYA as voting members?
Dr. H. BUCHER, approval: 23, abstention: 1, not approved: 1
Dr. G. STANLEY, approval: 23, abstention: 1, not approved: 1
Dr. VIJAYA, approval: 22, abstention: 1, not approved: 2

A very large majority of the voting members of our Subcommission has approved the future STS board and voting members list. These vote results have been sent to the Chairman of the International Commission on Stratigraphy (ICS) for approval by the voting members of this Commission. Our new board will begin work at the 30th IGC in Beijing, next August 4-14th, 1996. Please note that the general assembly of our subcommission will be held during the IGC, the evening of August 6th, 1996.

Aymon Baud



FRIEDRICH AUGUST VON ALBERTI

- FOUNDER OF THE TRIASSIC SYSTEM -

BORN 200 YEARS AGO

Max Urlichs

The life of Friedrich von Alberti, rich in success and respect, has been portrayed several times (Berkchemer, 1941; Carle, 1978, 1982; Fraas, 1880; Pfeiffer, 1934; Popp and Riexinger, 1978; Urlichs, 1995; Virgili and Visscher, 1983). Therefore, only a short abstract of his life is now given with special reference to his most important proposal, the introduction of the term Triassic published in the book: *"Beiträge zu einer Monographie des bunten Sandsteins, Muschelkalks und Keupers, und die Verbindung dieser Gebilde zu einer Formation"* (Alberti, 1834). It is, however, hitherto unknown since when scientists have been using Alberti's Triassic system. The present paper is presenting an account on the scientific response to Alberti, and on his scientific collection.

Friedrich von Alberti was born in Stuttgart on September 4th, 1795. In 1809, he entered the military school, where then also specialists in mining, mineralogy and geology were trained. At an age of nearly 20 years, Friedrich von Alberti left this school in 1815 as a "Bergkadett", and went to the saltworks at Sulz southwest of Tübingen. He supervised the drillings until 1818. Alberti moved to Jagstfeld near Friedrichshall in 1820 to do the same job. In 1820, he was appointed inspector of the new saltworks in Jagstfeld. In 1823 and 1824, he successfully drilled rock-salt deposits near Schwenningen and Rottweil. As a result two saltworks bearing the same name, Wilhelmshall, were founded near Schwenningen and Rottweil, where salt was produced for the export to Switzerland. Alberti summarized his observations of the drilling periods near Sulz, Jagstfeld and Schwenningen and mapped the surroundings of these localities in his first book, published in 1826. At that time, he subdivided the sediments above the basement into "Rother Sandstein" (= Buntsandstein), limestones below and above the salt (= Lower and Upper Muschelkalk) and the salt-layer as an index formation. He combined the gypsum, marls and sandstone of the overlying Keuper, which had been named just two years before by A. v. Humboldt as Keuper, with the sediments of the Jurassic. Later, in 1834, he separated the Liassic and combined the three other formations to one in his famous book *"Beiträge zu einer Monographie des bunten Sandsteins, Muschelkalks und Keupers, und die Verbindung dieser Gebilde zu einer Formation"*. In this book he (Alberti, 1834: 323-324) introduced the Triassic as follows: "Whoever examines more closely the forgoing analysis and tabulates all the fossils of the three hitherto separate formations; whoever examines, further, the transition of the different forms one into another, and, indeed, considers the entire structure of the mountains and markedly different character of the fossils of the Zechstein from those of the Lias, will realize that the Bunter Sandstone, Muschelkalk and Keuper are the result of a single period, their fossils, to use Elie de Beaumont's words, being the thermometer of a geological period; that their separation to three formations is not appropriate, and that it is more in accord with the concept of a formation to unite them into a single formation, which I shall provisionally name Trias" *(= Wer die vorstehende Zusammenfassung näher prüft, wer die*

Petrefakten der 3 bis jetzt getrennt gehaltenen Formationen zusammenreiht, und hierzu die Uebergänge der verschiedenen Glieder ineinander, wer überhaupt den ganzen Habitus des Gebirges näher prüft und die wesentlich verschiedenen Versteinerungen des Zechsteins und des Lias in die Wagschale legt, dem kann es nicht entgehen, daß bunter Sandstein, Muschelkalk und Keuper das Resulatat einer Periode, ihre Versteinerungen, um mich der Worte E. de Beaumont's

Friedrich von Alberti (1795-1878)

zu bedienen, die Thermometer einer geologischen Epoche seyen, daß also die bis jetzt beobachtete Trennung dieser Gebilde in 3 Formationen nicht angemessen, und es mehr dem Begriffe Formation entsprechend sey, sie zu einer Formation, welche ich vorläufig Trias nennen will, zu verbinden). However, Alberti (1834: 326-340) cited the Triassic in the remaining text without question and reservation. One fundamental basis for Alberti's (1834: 326, 335, 336) proposal was the fact, that some fossils range from the Buntsandstein into the Muschelkalk and finally into the Lower Keuper. To this he made the following comment: "I include the Bunter Sandstone into the Muschelkalk, because its upper beds contain Muschelkalk fossils... we still find the characteristic fossils of the Bunter Sandstone and Muschelkalk above the gypsum of the Lettenkeuper *(= Den bunten Sandstein rechne ich zum Muschelkalke, weil... seine oberen Schichten Versteinerungen des Muschelkalks führen... Wir finden über dem Gypse der Lettenkohlengruppe noch immer die charakteristischen Versteinerungen des bunten Sandsteins und Muschelkalks").* Furthermore, Alberti (1834: 327, 330) demonstrated, that the fauna is typical of the Triassic system and distinctly differs from the fauna of the Zechstein and Liassic.

In 1836, von Alberti was appointed mining counsellor. From this year on he travelled all over Europe and visited the different saltworks. As a result he published one of his major books, "Halurgische Geologie" in 1852, which remained a unique text-book on salt-mining for a long time. From 1854 to 1870 he was the manager of the saltworks at Friedrichshall. Because of a drop in salt export to Switzerland the Friedrichshall shaft was constructed under very difficult conditions from 1854 to 1858. (With the construction of this shaft the centre of Württemberg's salt production was shifted from Wilhelmshall near Schwenningen to Friedrichshall). In 1870, Alberti retired at an age of 75 years. His last years he spent very secludedly at Heilbronn. Alberti died there on September 12th, 1878.

Coining the term "Triassic System"

Nowadays scientists generally assume that the Triassic System was introduced without opposition and within a few years. However, the term Triassic was partly ignored for some years. At the conference of the "Deutsche Naturforscher und Ärzte" (German Scientists and Physicians) in Stuttgart 1834, Alberti explained the results of his research. However, nothing of that was reported in the first summary of this conference (Anonymus, 1835). According to G. F. Jaeger's handwritten reminiscences (housed in the archive of the Naturkundemuseum Stuttgart), Jaeger was the secretary of the conference and the author of the summary. A friend of Alberti, Althaus (1835: 457), criticized the summary immediately afterwards and pointed out the importance of "Alberti's Trias". In the official report on the conference, Kielmeyer and Jäger (1835: 89) only acknowledged that Alberti "had brought his very interesting collection of fossils from the Muschelkalk and Keuper to Stuttgart and that he had presented it to the members with extraordinary willingness and let it for study." *(= "... seine ganz höchst interessante Sammlung von Petrefacten des Muschelkalks und Keupers nach Stuttgart gebracht und den Mitgliedern mit ausgezeichneter Bereitwilligkeit gezeigt und zum Studium überlassen hatte.")*

The first one who used "Alberti's Trias-Formation" was Gressly (1836: 672); he referred to Bunter Sandstone, Muschelkalk and Keuper as a unit. One year later Bronn (1837a: 132; 1837b: 30) used the name Triassic twice, and another year later Hehl (1838: 123) already characterized Alberti's book as a classic. Some time later Wissmann (1840: 535-536, 1842: 310) and Münster (in: Wissmann and Münster, 1841: 145) described fossils from the T r i a s, which means that they were the first to apply the Triassic in a figurative sense. However, other authors (e.g. Meyer, 1840; Credner, 1842) continued to describe Buntsandstein, Muschelkalk and Keuper, without uniting them as Triassic, and Jaeger (1843: 117) still expressed doubts against the combination of the Muschelkalk with the Keuper. Quenstedt (1843: 13) though, acknowledged the term: "Mr. v. Alberti has appropriately united Buntsandstein, Muschelkalk und Keuper under the name Trias". Subsequent to Quenstedt's statement, the term Triassic was used in textbooks (Geinitz, 1845: Tab. 1; Hehl, 1850: 3, 21) and additional papers (Meyer, 1844: 337; 1845: 297; Schmid and Schleiden, 1846: 6; Volger, 1846: 818). In the year 1847 it was recorded in several other papers of the "Neues Jahrbuch für Mineralogie..." (Credner, 1847: 315; Giebel, 1847: 50; Meyer, 1847: 186, 572). From then on the term Triassic was widely accepted by German speaking authors, and in d'Orbigny's (1850) fossil catalogue, the terms "Terrains triasiques" and "Terrains jurassiques" were cited at the same level. From then on the term Triassic was used worldwide (e.g. Hauer, 1854, Curioni, 1855).

Alberti's collection

The main basis for Alberti's research was his own collection of fossils, rocks and minerals. During the 55 years Alberti was in office, he had collected about 30 000 specimens. The most important part of his collection are fossils from the Triassic of Württemberg. He had described them in his fundamental book, published in 1834, and later he illustrated several specimens (Alberti in Zieten, 1833; Goldfuss, 1834-1841; Alberti, 1845, 1864). Alberti's collection especially contains small fossils showing characteristic features important for research. He obviously expressed a strong scientific interest since the beginning of his career. Alberti exchanged letters with many important contemporary palaeontologists, e.g. Louis Agassiz, Heinrich Georg Bronn, Heinrich Credner, Oscar Fraas, August Goldfuss, Georg Friedrich Jaeger, Hermann von Meyer, Georg von Münster, Friedrich August Quenstedt, Fridolin Sandberger, Franz Unger und Carl Hartwig von Zieten. He lent material that he could not work on himself to several of these colleagues. In 1863, Alberti's collection was purchased by the former "Württembergisches Naturalienkabinett" (now: Staatliches Museum für Naturkunde Stuttgart). The majority of the Alberti collection of Triassic fossils is still available, despite of losses of other parts of the museum's collections. It is still an important section of the museum's Triassic holdings.

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ANNOUNCEMENT

International Field Excursion on

Permian-Triassic sections on the North Caucasus

July 20-28, 1996

Mineralny Vody, Russia

IGCP Projects 359, 343 and North Caucasus Organizing Committee invite you to attend the Field Excursion which will be held on the North Caucasus in July, 1996. The unique Upper Permian and Triassic sections containing abundant and diverse fossils will be shown. Geological field trips will be held in the basins of the Laba and Belaya rivers. It is planned to demonstrate:

1. the Upper Permian (Dorashamian) sections in various facies (reefogenic, carbonate and terrigenous) (Nikitin, Severnaya sections)
2. the Lower Permian red-colour continental deposits (Khamyshki sections)
3. the Triassic deposits (lower-middle - Rufabgo, Sakhray sections; middle-upper Tkhach, Maly Bombak sections).

Cost of Excursion: $ 600.-

This is the first announcement. If you would like to participate and receive future announcements please contact:

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

PARASTRATOTYPE OF THE OLENEKIAN STAGE (LOWER TRIASSIC)

A. Dagys and E.S. Sobolev

Introduction

More than twenty stages and substages have been proposed for the Lower Triassic (Tozer, 1984) and, depending on different schemes, the Lower Triassic has been subdivided into one to four stages.

During the "Symposium on Triassic Stratigraphy", in Lausanne (October, 1991), this problem was discussed again, and at the official meeting of the "Subcommission on Triassic Stratigraphy" a twofold subdivision of the Lower Triassic into the Induan and the Olenekian as standard Stages, has been recommended.

The Olenekian Stage was introduced by Kiparisova and Popov (1956) with the stratotype near the mouth of the Olenek River (Mengilekh Creek) which contains the famous ammonoid faunas described by Keyserling (1845) and Mojsisovics (1886, 1888).

Later investigation have shown that in the stratotype of the Olenekian only two zones (*Spiniplicatus* Zone and *Grambergi* Zone) can be recognized (Lazurkin and Korchinskaya, 1963; Zakharov, 1978; Dagys et al., 1979).

The new zonal scheme of the Olenekian stage (Dagys and Ermakova, 1993) is based on investigations of several additional sections (parastratotypes or auxiliary stratotypes) located at the lower reaches of the Lena and Olenek Rivers, as well as in Eastern Taimyr.

The best parastratotype for the Upper Olenekian (Spathian) exists in Eastern Taimyr (Chernokhrebetnaya River Basin) at Divny Creek (text-fig. 1), situated close to the famous Triassic sections at Cape Tsvetkov. The sections at Divny Creek was briefly described by Dagys et al., (1989), and later reinvestigated by one of the authors (Sobolev, 1992). It contains in sequence almost all biostratigraphical units of the Upper Olenekian (except the oldest subzone). The sections at Ostantsovaya Creek, nearby the former one, are also very important, especially for the zonation of the terminal Olenekian and the definition of the Lower/Middle Triassic boundary of the Boreal Realm.

1. East Taimyr, Divny Creek, left tributary of the Chernokhrebetnaya River
(10.5 km from mouth)

Total thickness of the section about 680 m.

1st unit: Dark-red sandstone alternating with greenish-grey siltstone.
Fauna:
Clypeoceratoides gantmanni (Popov), *Arctoceras blomstrandi* (Lindstr.).
30 m covered

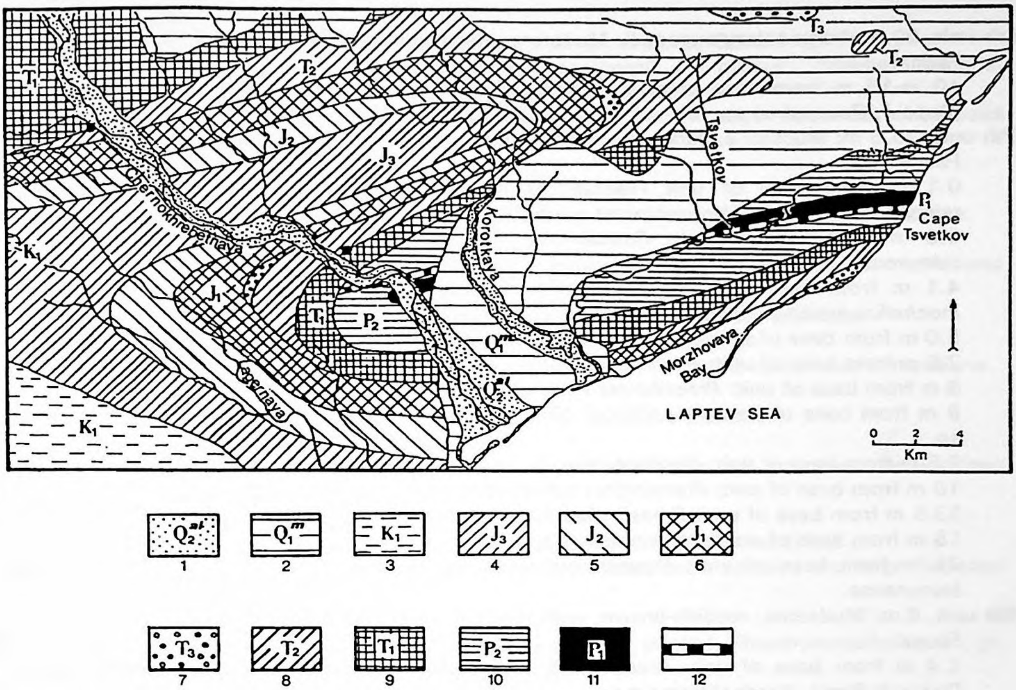

Fig. 1: 1 - Quarternary, alluvial deposits; 2 - Quarternary, morain; 3 - 11 Lower Cretaceous - Lower Permian deposits; 12 - Zones of tectonic crushing; 13 - Main Upper Olenekian sections.

Main sections

2nd unit, 20 m (fragmentary exposed): Mudstone, greenish-grey or dark-grey, with rare, small, clayish limestone concretions.

Fauna:

1 m from base of unit: *Boreoceras planorbis* Dagys & Ermakova.

20 m from base of unit: *Bajarunia* sp., *Boreoceras* cf. *planorbis*.

35 m covered

3rd unit, 20 m: Sandstone, fine-grained, light-grey, alternating with greenish-grey siltstone.

4th unit, 41 m (fragmentary exposed): Mudstone, dark-grey, with small calcareous nodules.

Fauna:

40 m from base of unit: *Bajarunia euomphala* (Keys.), *Boreoceras* cf. *demokidovi* (Popov)

35 m covered

5th unit, 23.6 m: Mudstone, dark-grey, with medium sized, clayish calcareous concretions (diameter 5-10 cm).

Fauna:

13 m-23 m from base of unit: *Bajarunia euomphala*, *Boreoceras demokidovi*, *Koninckitoides posterius* (Popov).

6th unit, 20 m (fragmentary exposed): Mudstone, dark-grey, with large calcareous concretions.

Fauna:

10 m-15 m from base of unit: *Pseudosageceras* sp., *Nordophiceras* ex. gr. *contrarium* (Popov), *Boreoceras* sp. juv. (cf. *lenaenses* Dagys & Konst.)

7th unit, 23.6 m: Mudstone, dark-grey, with frequent interlayers of small calcareous nodules.

Fauna:

0.1 m from base of unit *Praesibirites tuberculatus* (Dagys & Konst.), *Anoploceras taimyrense* Schastl., *Nordophiceras* n. sp., *Pseudosageceras* sp.

2.6 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* sp., *Anoploceras taimyrense*.

4.1 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp., *Phaedrysmocheilus evolutus* Sobolev, *Anoploceras taimyrense*.

5.0 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp.

7.5 m from base of unit: *Praesibirites tuberculatus, Anoploceras taimyrense*.

8 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* sp.

9 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp., *Pseudosageceras* sp.

9.5 m from base of unit: *Nordophiceras* n. sp., *Anoploceras taimyrense*.

10 m from base of unit: *Praesibirites tuberculatus, Anoploceras taimyrense*.

13.5 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp.,

18 m from base of unit: *Nordophiceras* sp.

21 m from base of unit: *Praesibirites tuberculatus, Nordophiceras* n. sp., *Anoploceras taimyrense*.

8th unit, 8 m: Mudstone, reddish-brown, with frequent small calcareous nodules.

Fauna:

1.4 m from base of unit: *Praesibirites tuberculatus* (transitional to *Praesibirites egorovi* Dagys & Erm.), *Nordophiceras* n.sp.

2.6 m from base of unit: *Praesibirites egorovi*.

3.9 m from base of unit: *Praesibirites egorovi*.

4.1 m from base of unit: *Praesibirites* ex gr. *egorovi, Nordophiceras* n. sp., *Phaedrysmocheilus evolutus*.

5.7 m from base of unit: *Praesibirites egorovi* (transitional to *Parasibirites kolymensis* Bychk.)

6.0 m from base of unit: *Parasibirites kolymensis, Sibirites* aff. *elegans* Dagys & Erm.

6.2 m from base of unit: *Parasibirites kolymensis, Para.* sp.

6.4 m from base of unit: *Parasibirites kolymensis*.

7.4 m from base of unit: *Parasibirites kolymensis, P.* ex gr. *grambergi* (Popov), *P.* aff. *kolymensis*.

9th unit, 31.5 m: Mudstone, dark-grey, with frequent horizons of small calcareous nodules.

Fauna:

3.5 m from base of unit: *Parasibirites grambergi*.

6.0 m from base of unit: *Parasibirites grambergi, Para. mixtus* Popov, *Sibirites elegans*.

7.5 m from base of unit: *Parasibirites grambergi, Sibirites elegans*.

11.5 m from base of unit: *Parasibirites grambergi, Pseudosageceras* sp., *Arctomeekoceras* sp.

18.5 m from base of unit: *Parasibirites grambergi, P. mixtus, Nordophiceras kazakovi* Dagys & Erm., *Anoploceras* cf. *taimyrense*.

25.5 m from base of unit: *Parasibirites subpretiosus* Popov, *P.* aff. *grambergi, Subolenekites* aff. *pilaticus* (Tozer).

27.5 m from base of unit: *Parasibirites grambergi, P. subpretiosus, Sibirites elegans,*

Subolenekites aff. *pilaticus*, *Phaedrysmocheilus* ex gr. *evolutus* Sobolev.
29.5 m from base of unit: *Parasibirites grambergi*, *P. mixtus*, *Sibirites elegans*, *Pseudosageceras* sp., *Phaedrysmocheilus* ex gr. *evolutus* Sobolev.

10th unit, 4.4 m: Siltstone, sandy, dark-greenish-grey, with large flattened calcareous concretions.
Fauna:
3.5 m from base of unit: *Parasibirites grambergi.*

11th unit, 17.5 m: Siltstone, clayish, greenish-grey, with numerous small calcareous nodules.
Fauna:
6.5 m from base of unit: *Parasibirites grambergi*, *Sibirites elegans*, *Nordophiceras kazakovi*.
11.5 m from base of unit: *Parasibirites grambergi*, *Subolenekites* aff. *pilaticus*.
16.5 m from base of unit: *Parasibirites grambergi*, *Subolenekites* sp.

12th unit, 3.9 m: Siltstone, clayish, greenish-grey, with large, flattened calcareous concretions.
Fauna:
3.3 m from base of unit: *Phaedrysmocheilus* ex gr. *evolutus* Sobolev.
3.8 m from base of unit: *Parasibirites grambergi.*

13th unit, 17.2 m: Siltstone, greenish-grey, with small (diameter 1-3 cm) and medium-sized (diameter 10-15 cm) calcareous concretions.
Fauna:
9.2 from base of unit: *Parasibirites grambergi*, *Subolenekites* cf. *altus* (Mojs.).

14th unit, 5 m: Siltstone, greenish-grey, with rare small calcareous nodules and large flattened concretions.
Fauna:
2.5 m from base of unit: *Boreomeekoceras keyserlingi* (Mojs.), *Phaedrysmocheilus* ex. gr. *nestori* Schim.

15th unit, 22.4 m: Siltstone, sandy, greenish-grey, with rare small calcareous nodules.

16th unit, 50 m: Siltstone, sandy, greenish-grey, with layers of large flattened calcareous concretions.
Fauna:
7.5 m from base of unit: *Phaedrysmocheilus* ex gr. *nestori* Schim.
9.6 m from base of unit: *Phaedrysmocheilus nestori*.
49 m from base of unit: *Parasibirites efimovae* Bychk.

17th unit, 13 m: Siltstone, sandy, greenish-grey, with flattened calcareous concretions,
Fauna:
1.0 m from base of unit: *Sibirites pretiosus* (Mojs.), *Olenekoceras laevigatum* Dagys & Erm., *Boreomeekoceras keyserlingi*.

18th unit, 28 m: Siltstone, dark grey, with rare small calcareous nodules and layers of large flattened calcareous concretions.
Fauna:
10.3 m from base of unit: *Olenekoceras laevigatum*.
12.8 m from base of unit: *Olenekoceras* cf. *laevigatum*.
14.8 m from base of unit: *Parasibirites efimovae*, *Sibirites pretiosus*, *Boreomeekoceras keyserlingi*.
18.5 m from base of unit: *Sibirites pretiosus*, *Subolenekites altus*, *Boreomeekoceras keyserlingi*.
19.0 m from base of unit: *Parasibirites efimovae*, *Sibirites pretiosus*, *Subolenekites altus*, *Boreomeekoceras keyserlingi*.

19.3 m from base of unit: *Sibirites eichwaldi* (Keys.), *Subolenekites altus*, *Boreomeekoceras keyserlingi*.
19.8 m from base of unit: *Nordophiceras karpinskii* (Mojs.).

19th unit, 28 m: Sandstone, fine-grained, dark-red, alternating with dark-greenish-grey, siltstone, with rare flattened calcareous concretions.
Fauna:
0.1 m from base of unit: *Olenekites altus*, *Boreomeekoceras keyserlingi*.
1.0 m from base of unit: *Olenekoceras middendorffi* (Mojs.), *O. nikitini*, *Arctomeekoceras rotundatum* (Mojs.).
2.0 m from base of unit: *Sibirites eichwaldi*, *Olenekoceras middendorffi*, *Subolenekites altus*, *Boreomeekoceras keyserlingi*, *Arctomeekoceras* sp.
3.0 m from base of unit: *Subolenekites altus*, *Boreomeekoceras keyserlingi*.
8.4 m from base of unit: *Olenekoceras middendorffi*, *Boreomeekoceras keyserlingi*, *Phaedrysmocheilus subaratus* (Keys.).
18.8 m from base of unit: *Olenekoceras middendorffi*.

20th unit, 240 m: Sandstone, fine-grained, dark-red or reddish-green, interbedded with thin layers of greenish-grey siltstone. About in the middle of the unit 25 m medium- to coarse-grained, dark-grey sandstones.

21st unit, 50 m: Mudstone, dark-grey, with rare small calcareous nodules.
Fauna:
upper 10 m: *Svalbardiceras spitzbergense* (Freb)., *Svalbardiceras* sp., *Prosphingites czekanowskii*, *Prosphingites tenuis*, *Nordophiceras* sp., *Keyerlingites* (?) sp.

22nd unit 10 m: Siltstone, dark-greenish-grey, with large calcareous concretions and thin interbeds of phosphatic nodules.
Fauna:
5.0 m from base of unit: *Costispiriferina lenaensis* Dagys.
8.0 m from base of unit: *Karangatites* sp.

2. East Taimyr, mouth of Ostantsovaya Creek, right tributary of Chernokhrebetnaya River
(23 km from mouth)

Total thickness of section: about 178 m

1st unit, 27 m: Siltstone, dark-grey, alternating with fine-grained sandstone.
Fauna:
10 m from base of unit: *Olenekoceras middendorffi*, *Boreomeekoceras keyserlingi*, *Subolenekites* sp., *Sibirites eichwaldi*.

2nd unit, 8 m: Siltstone, greenish-grey.
Fauna:
5 m from base of unit: *Boreomeekoceras keyserlingi*, *Subolenekites* sp.

3rd unit, 20 m: Sandstone, fine-grained, grey, interbedded with greenish-grey siltstone.

4th unit, 5 m: Siltstone, greenish-grey.

5th unit, 10 m: Sandstone, fine- and medium-grained, gray.
Fauna:
8 m from base of unit: *Olenikites spiniplicatus* (Mojs.), *Olenekoceras middendorffi*, *Boreomeekoceras keyserlingi*.

6th unit, 18 m: Sandstone, medium-grained, dark-gray or dark-green, interbedded with greenish-gray siltstone.

7th unit, 36 m: Siltstone, dark-greenish-gray, with calcareous concretion, with interbeds of fine-grained, greenish-gray sandstone (at about the middle of the unit).

Fauna:

3-8 m from base of unit: *Olenikites spiniplicatus*, *Olenekoceras middendorffi*, *Pseudosvalbardiceras sibiricum* (Mojs.), *Prosphingites czekanowskii.*

20-30 m from base of unit: *Olenikites spiniplicatus*, *Olenekoceras nikitini* (Mojs.), *Keyserlingites subrobustus* (Mojs.), *Subolenekites altus*, *Pseudosvalbardiceras sibiricum*, *Prosphingites czekanowskii*, *Propsphingites tenuis*, *Phaedrysmocheilus* n.sp.

8th unit, 10 m: Siltstone, dark-greenish-gray.

Fauna:

8.5 m from base of unit: *Svalbardiceras* cf. *spitzbergense*, *Keyserlingites* sp., *Prosphingites* sp.

9th unit, 8.5 m: Sandstone, dark-greenish-gray, with scattered small pebbles (diameter 1-3 cm).

Fauna:

8.0 m from base of unit: *Karangatites arkhipovi* Dagys & Erm., *Stenopopanoceras karangatiense* (Popov), *Arctonautilus ljubovae* (Schastl.), *Costispiriferina lenaense.*

10th unit, 15 m: Mudstone, greenish-gray, with interlayers of phosphatic lenses (0,1-0,3 m) and nodules.

Fauna:

11.7 m from base of unit: *Karangatites* sp.

12.0 m from base of unit: *Karangatites* aff. *arkhipovi*, *K.* sp.

Zonation

Section I (Divny Creek) contains almost all Upper Olenekian zones and subzones described by Dagys and Ermakova (1993). The underlying beds belong to the *Kolymensis* Zone of the Lower Olenekian (Unit 1).

Analogues to the *Tardus* Zone (uppermost Lower Olenekian) and the lower part (*Eiekitensis* Subzone) of the *Euomphala* Zone (lowermost Upper Olenekian) are unknown so far in the Chernokhrebetnaya River region, perhaps due to the partly coverage of the sections.

The ammonoid assemblage from Unit 2 - 5 is characteristic for the *Euomphala* Zone.

Unit 2 contains the index fossil for the *Planorbis* Subzone; Unit 3 - 5, with *Bajarunia euomphala* and *Boreoceras* ex. gr. *demokidovi* indicate the *Apostolicum* Subzone.

The small fauna of the badly exposed Unit 6 (*Nordophiceras* cf. *contrarium*, *Boreoceras* ex gr. *lenaense*) indicates most probably the *Lenaense* Subzone (lowest subdivision of the *Contrarium* Zone); its base coincides with the first appearance of the genus *Nordophiceras*.

The twelve succeeding calcareous nodule-layers from Unit 7 contains a uniform ammonoid fauna (*Nordophiceras taimyrensis*, *Praesibirites tuberculatus*), characteristic for the

Tuberculatus Subzone (*Contrarium* Zone). The base of this subzone is characterized by the first appearance of the genus *Praesibirites*.

Unit 8 embraces two distinct successive ammonoid assemblages. While the fauna of the lower part (*Nordophiceras* sp., *Praesibirites egorovi*) is indicating the *Egorovi* Subzone of the *Contra-*

rium Zone, the upper one clearly belongs to the *Grambergi* Zone (*Kolymensis* Subzone) as shown by the first appearance of the genus *Parasibirites* (*P. kolymensis*) and *Sibirites* (*S. elegans*).

The ammonoid fauna from Unit 9 - 13 is characterized by a quite uniform assemblage dominated by *Parasibirites* ex gr. *grambergi* (*P. grambergi, P. mixtus, P. subpretiosus),* indicating the *Mixtus* Subzone of the *Grambergi* Zone.

Unit 14 - 18 (lower 19 m) with *Parasibirites efimovae, Sibirites pretiosus* and *Olenekoceras laevigatum* can be attributed to the *Efimovae* Subzone (*Grambergi* Zone).

The ammonoid fauna of the upper part of Unit 18 and Unit 19 (*Olenekoceras middendorffi, Subolenekites altus, Boreomeekoceras keyserlingi, Sibirites eichwaldi*) is characteristic for the lower part of the *Spiniplicatus* Zone.

While Unit 20 is without any fossils, the terminal Unit 21 of this section contains an ammonoid assemblage unknown until now from Siberia, in which species of the genera *Svalbardiceras* and *Prosphingites* are dominating.

In section II (mouth of Ostantsovaya Creek) the upper part of the Olenekian is more fossiliferous. In this section the ammonoid faunas of the uppermost biostratigraphical Olenekian unit of Siberia - the *Spiniplicatus* Zone - allows a threefold subdivision. For this reason a new subzonal scheme is proposed here for the terminal Olenekian.

OLENIKITES SPINIPLICATUS ZONE

Index species: *Dinarites spiniplicatus* Mojsisovics, 1886 (p.10, pl.1, fig.1; Arctic Siberia, Olenek River).

Fauna: The ammonoid assemblage of this zone is the most diverse and richest of the Olenekian Stage. It contains the following genera: *Nordophiceras, Pseudosvalbardiceras, Arctomeekoceras, Boreomeekoceras, Svalbardiceras, Timoceras, Olenikites, Subolenekites, Olenekoceras, Keyserlingites, Prosphingites* and *Pseudosageceras.*

Lower boundary: First appearance of the genera *Olenekites, Timoceras, Pseudosvalbardiceras, Arctomeekoceras,* and some very characteristic species such as *Olenekoceras middendoffi, Sibirites eichwaldi, Nordophiceras karpinskii* etc.

Subdivision: Three subzones: *Sibirites eichwaldi - Prosphingites czekanowskii - Svalbardiceras spitzbergense.*

SIBIRITES EICHWALDI SUBZONE

Index species: *Ceratites eichwaldi* Keyserling, 1845 (p.249, p.3, fig. 11-14); Olenek River, Arctic Siberia.

Stratum typicum: Unit 1 - 6, Ostantsovaya Creek, East Taimyr.

Fauna: Most characteristic ammonoids are species of the genera *Olenekoceras* (*O. middendorffi, O. nikitini*), *Nordophiceras* (*N. karpinskii, N. schmidti*), *Sibirites* (*S. eichwaldi*), *Pseudosvalbardiceras* (*P. sibiricum*), and moreover some species which first appeared in the *Efimovae* Subzone of the *Grambergi* Zone: *Boreomeekoceras keyserlingi, Subolenekites altus.*

Lower boundary: Coincides with the lower boundary of the *Spiniplicatus* Zone.

PROSPHINGITES CZEKANOWSKII SUBZONE

Index species: *Prosphingites czekanowskii* Mojsisovics, 1886 (p.64, pl.15, figs. 10 -12), Olenek River, Arctic Siberia.
Stratum typicum: Unit 7, Ostantsovaya Creek, East Taimyr.
Fauna: The ammonoid assemblage is similar to that of the *Eichwaldi* Subzone. It differs from it by the appearance of *Prosphingites czekanowskii, Prosphingites tenuis,* and *Keyserlingites subrobustus*.
Lower boundary: First appearance of the genera *Prosphingites* and *Keyserlingites.*

SVALBARDICERAS SPITZBERGENSE SUBZONE

Index species: *Lecanites ? spitzbergensis* Freboild, 1929 (pl.VI, fig.1), Svalbard.
Stratum typicum: Unit 8, Ostantsovaya Creek, East Taimyr.
Fauna: Characteristic for this subzone are species of the genera *Svalbardiceras* and *Prosphingites*; in addition the genera *Nordophiceras* and *Keyserlingites* are recorded. The ammonoid assemblage of this subzone needs further investigations.
Lower boundary: First appearance of the genus *Svalbardiceras.*

<table>
<tr><th colspan="2">NE Asia (Siberia)</th><th>Arctic Canada</th><th>British Columbia</th><th>Svalbard</th></tr>
<tr><td rowspan="3">Olenikites spiniplicatus</td><td>Svalbardiceras spitzbergense</td><td rowspan="2">Keyserlingites subrobustus</td><td rowspan="2">Keyserlingites subrobustus</td><td rowspan="2">Keyserlingites subrobustus</td></tr>
<tr><td>Prosphingites czekanowskii</td></tr>
<tr><td>Sibirites eichwaldi</td><td rowspan="3"></td><td rowspan="7"></td><td rowspan="7"></td></tr>
<tr><td rowspan="3">Parasibirites grambergi</td><td>Parasibirites efimovae</td></tr>
<tr><td>Parasibirites mixtus</td></tr>
<tr><td>Parasibirites kolymensis</td><td>Subolenekites pilaticus</td></tr>
<tr><td rowspan="3">Nordophiceras contrarium</td><td>Parasibirites egorovi</td><td rowspan="3"></td></tr>
<tr><td>Parasibirites tuberculatus</td></tr>
<tr><td>Boreoceras lenaense</td></tr>
<tr><td rowspan="3">Bajarunia eumorphala</td><td>Boreoceras apostolicum</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Boreoceras planorbis</td></tr>
<tr><td>Bajarunia eiekitensis</td></tr>
</table>

Table 1: Biostratigraphic correlation chart of Boreal Upper Olenekian zonal scheme.
The *Subrobustus* Zone of the Canadian Arctic and Svalbard containing the genera *Svalbardiceras, Keyserlingites* etc. are correlative only with the upper part of the *Spiniplicatus* Zone (*Czekanowskii* and *Spitsbergense* Subzones).

The two lower subzones of the *Spiniplicatus* Zone are widely distributed in North-East Asia, from Eastern Taimyr up to the Okhotsk Sea (Dagys et al., 1979), but usually they have not been subdivided. Analogues of the upper subzone has been recorded, apart from Eastern Taimyr, only from the Lena River delta. In this regions ammonoid assemblages characteristic for the *Eichwaldi* and *Czekanowskii* Subzones are known from the upper part of the Ystannakh Formation (Dagys and Kazakov, 1984). From the overlaying Pastakh Formation some rare specimens of *Svalbardiceras* sp. have been collected, most probably indicating the *Spitsbergense* Subzone.

Correlation

The detailed correlation of the boreal Upper Olenekian has been discussed in some previous publications (Dagys and Ermakova, 1993; Dagys and Weitschat (1993).

The *Euomphala* and *Contrarium* Zones are known until now only from the eastern parts of the Boreal basin, and the absence of reliable analogues in the western areas is one of the most discussed biostratigraphical problems of the Boreal Triassic.

First Late Olenekian ammonoids have appeared in western boreal regions only in the *Grambergi* Zone. The Arctic Canadian *Pilaticus* Zone (Tozer, 1967) may be correlated with the Siberian *Kolymensis* Subzone of the *Grambergi* Zone, because in Siberia the distribution of *Subolenekites pilaticus* is restricted to this subzone only (Table 1).

Analogues of the *Mixtus* and *Efimovae* Subzones (*Grambergi* Zone) and of the *Eichwaldi* Subzone (*Spiniplicatus* Zone) are unknown until now in western parts of the boreal Triassic basin.

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LATE TRIASSIC-EARLIEST JURASSIC GEOMAGNETIC POLARITY REFERENCE SEQUENCE FROM CYCLIC CONTINENTAL SEDIMENTS OF THE NEWARK RIFT BASIN (EASTERN NORTH AMERICA)

D. V. Kent, P. E. Olsen and W. K. Witte

Introduction

The global nature of geomagnetic polarity reversals has made magnetostratigraphy an essential tool for precise correlation between widely distributed sections of rocks of different lithological and biotic facies. The best documented history of geomagnetic polarity reversals is for the Jurassic to Recent and is based on the analysis of numerous marine magnetic anomaly profiles from the global ocean [e.g., Cande and Kent, 1992; Gradstein et al., 1994]. The relative spacing of polarity intervals established from the anomaly patterns is calibrated in time by correlation to magnetostratigraphic sections with biostratigraphy, radiometric dates, and cyclostratigraphy. Because of the absence of seafloor and hence marine magnetic anomalies, a precise geomagnetic polarity reference scale for pre-Jurassic time has been more difficult to develop. There has already been significant progress made for the Late Triassic by assembling relatively condensed or discontinuous marine [e.g., Gallet et al., 1992; 1993] and continental [e.g., Molina-Garza et al., 1991] sedimentary sections, but thick, continuous magnetostratigraphic sections with good chronostratigraphic control are needed to construct a high resolution reference scale.

A very thick sequence of lacustrine and fluvial sediments is represented in the Newark Basin, one of the largest of a chain of Mesozoic rift basins that developed along the margin of eastern North America in the early stages of formation of the Atlantic Ocean (Fig. 1a). Deposition in the basin is now known to span much of the Late Triassic to earliest Jurassic [Cornet and Olsen, 1985] and was punctuated only by a brief igneous intrusive and extrusive episode just after the Triassic/Jurassic boundary [Olsen and Sues, 1986; Fowell et al., 1994] and dated at 201-202 Ma [Sutter, 1988; Dunning and Hodych, 1990]. The lacustrine sediments that constitute much of the Newark Basin section record climatically induced lake level variations reflecting Milankovitch orbital forcing [Van Houten, 1964; Olsen, 1986]. These climatic cycles constitute a basis for detailed lithostratigraphic correlation as well as chronological scaling.

The Newark Basin sedimentary section has revealed the presence of numerous polarity reversals [McIntosh et al., 1985; Witte et al., 1991] and thus provides an opportunity to obtain a cyclostratigraphically scaled, high-resolution timescale of Late Triassic and earliest Jurassic geomagnetic polarity reversals. Outcrop exposure is, however, typically poor and discontinuous due to the low relief and urbanized setting of the basin. This difficulty was addressed by the U.S. National Science Foundation-sponsored Newark Basin Coring Project (NBCP) which resulted in the recovery of a virtually complete stratigraphic section through the thick continental rift basin sequence of central New Jersey. The lithostratigraphy and cyclostratigraphy of the

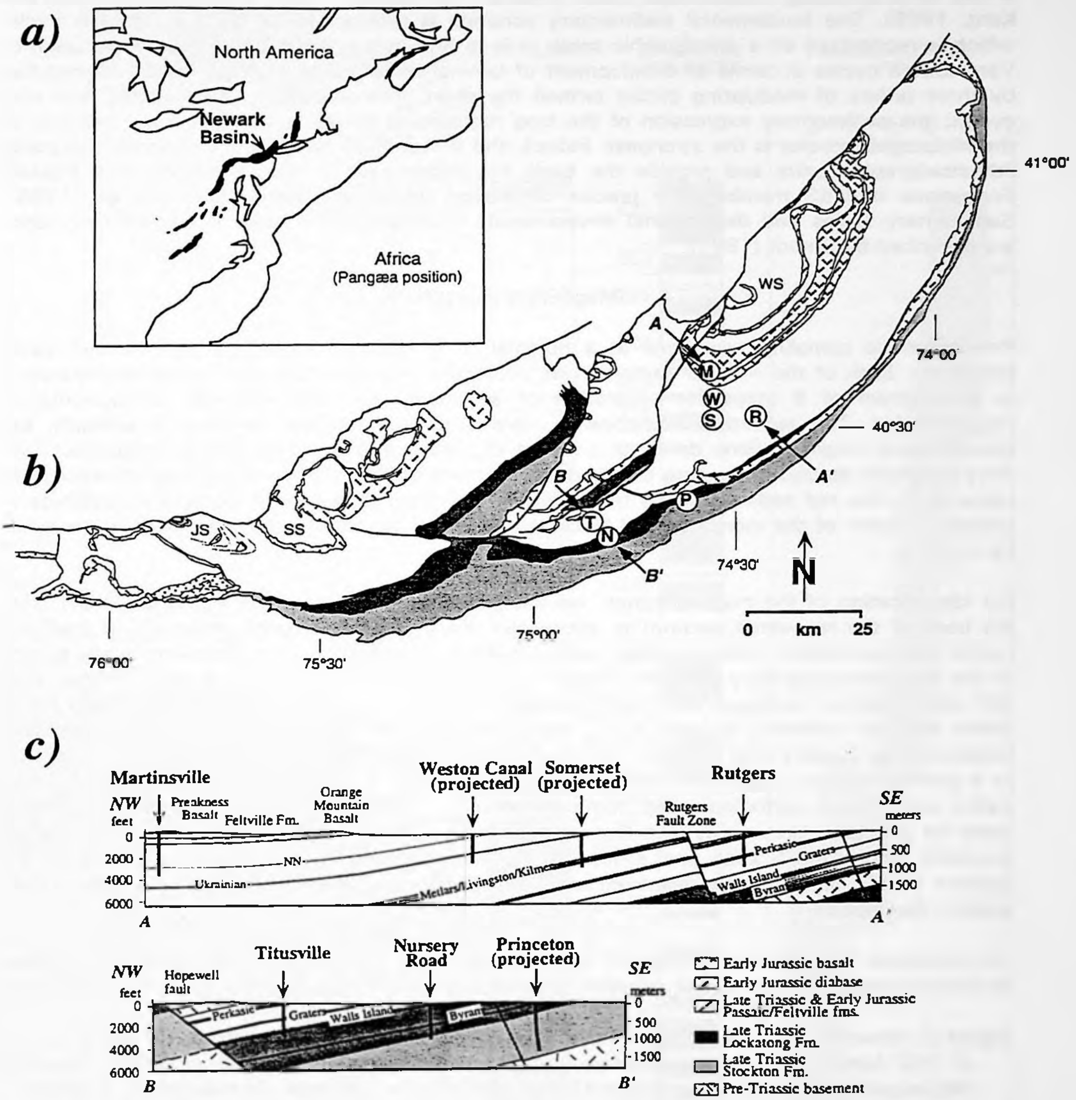
NBCP cores are described by Olsen et al. [1995] and Olsen and Kent [1995]. The magnetostratigraphy of the NBCP cores is reported in Kent et al. [1995] and summarized here.

Geological Setting

A complete stratigraphic section was obtained by drilling in the rift basin sequence of the eastern and southeastern parts of central New Jersey (Figure 1b). The section was assembled from an array of seven relatively shallow (~800 to 1200 m) continuously cored drill holes. The drill holes intersected overlapping stratigraphic intervals along two transects (Figure 1c) to avoid drilling through the Palisade sill, a thick igneous intrusive unit. The regional 5° to 15° northwest formation dip made the offset drilling strategy possible. A total of 6770 m of 6.3-cm-diameter core was drilled at the seven coring sites, including about 25% redundancy between the stratigraphically overlapping drill cores. Core recovery overall was virtually complete (better than 99% of the cored intervals). Supporting information was obtained from a full suite of slimhole geophysical logs [Goldberg et al., 1994].

Cornet [1977, 1993] and Cornet and Olsen [1985] recognized four pollen and spore zones in the Newark Basin section (Figure 2). These provide the best presently available ties to standard geologic ages, and the age assignments are generally supported by vertebrate assemblages from the Newark Supergroup [e.g., Huber et al., 1993]. The Stockton and Lockatong Formations are of Carnian age, although there are hardly any age diagnostic fossils in the lower and middle Stockton Formation. Assemblages belonging to the New Oxford-Lockatong palynofloral zone of late Carnian age occur in the upper Stockton Formation, the Lockatong Formation, and up to member C (called member B by Cornet [1977]) in the lowermost Passaic Formation. The Carnian/Norian boundary should lie between member C and the Graters Member in the lower Passaic Formation where the lowest assemblage of the Lower Passaic-Heidlersburg palynofloral zone of Norian age occurs. The Lower Passaic-Heidlersburg palynofloral zone extends to member FF and is succeeded in the lower Cedar Hill Member by the Upper Balls Bluff-Upper Passaic palynofloral zone (renamed from Manassas-Upper Passaic by Litwin et al. [1991]). This palynofloral change may approximate the level of the Norian/Rhaetian boundary, although criteria for recognition of the "Rhaetian" are very uncertain [e.g., Tozer, 1993]. The Triassic/Jurassic boundary is placed within the Exeter Member in the uppermost Passaic Formation, 20 m below the contact with the Jacksonwald Basalt that is correlative to the Orange Mountain Basalt, based on the well-defined transition from the Upper Balls Bluff-Upper Passaic palynofloral zone to the Corollina meyeriana palynofloral zone [Fowell and Olsen, 1993; Fowell et al., 1994]. A spike in the spore/pollen ratio is found to be coincident with a regional extinction of more than half of the palynoflora at the Triassic/Jurassic boundary which is also closely associated with terrestrial vertebrate extinctions [Olsen et al., 1990; Silvestri and Szajna, 1993]. An assemblage of the Corollina meyeriana palynofloral zone can be found just below the Boonton fish bed of the Boonton Formation [Olsen, 1980], suggesting that the overlying igneous extrusive sequence and interbedded sediments are all within the Hettangian (earliest Jurassic).

Figure 1. (a) Location of the Newark Basin among other early Mesozoic rift basins (dark shading) in eastern North America which is shown in a predrift (Pangea) continental configuration with respect to Africa. (b) Geological sketch map of the Newark Basin with the location of Newark Basin Coring Project drill sites indicated by the circled first letter of the site name. Other localities are WS, Watchung syncline; SS, Sassamansville syncline; JS, Jacksonwald syncline. (c) Cross sections showing positions of NBCP drill sites projected onto A-A' and B-B' of Figure 1b.


a)
North America
Newark Basin
Africa
(Pangæa position)
b)
WS
A
M
W
S
R
A'
B
T
N
P
B'
JS
SS
41°00'
74°00'
40°30'
74°30'
75°00'
75°30'
76°00'
N
0 km 25
c)
Martinsville
NW
feet
Preakness Basalt
Feltville Fm.
Orange Mountain Basalt
Weston Canal (projected)
Somerset (projected)
Rutgers
Rutgers Fault Zone
SE
meters
NN
Ukrainian
Metlars/Livingston/Kilmer
Perkasie
Graters
Walls Island
Byram
A
A'
Titusville
Nursery Road
Princeton (projected)
Hopewell fault
B
B'
Early Jurassic basalt
Early Jurassic diabase
Late Triassic & Early Jurassic Passaic/Feltville fms.
Late Triassic Lockatong Fm.
Late Triassic Stockton Fm.
Pre-Triassic basement

The sedimentary facies of the lacustrine Lockatong, Passaic and Feltville Formations have several orders of cyclic variation that are interpreted to represent climatically-induced changes in lake level reflecting Milankovitch orbital forcing [Van Houten, 1964; Olsen, 1986; Olsen and Kent, 1995]. The fundamental sedimentary variation is referred to as the Van Houten cycle, which is recognized on a stratigraphic scale of 3 to 6 m in the NBCP cores. The expression of Van Houten cycles in terms of development of lamination and drab to black colors is modified by three orders of modulating cycles termed the short, intermediate or McLaughlin, and long cycles; the sedimentary expression of the long modulating cycles is the weakest, and that of the McLaughlin cycles is the strongest. Indeed, the McLaughlin cycles are effectively mappable lithostratigraphic units and provide the basis for subdivision of the Lockatong and Passaic Formations into 53 members for precise correlation within the basin [Olsen et al., 1995]. Sedimentary facies and depositional environments represented by Newark sedimentary rocks are described by Smoot [1991].

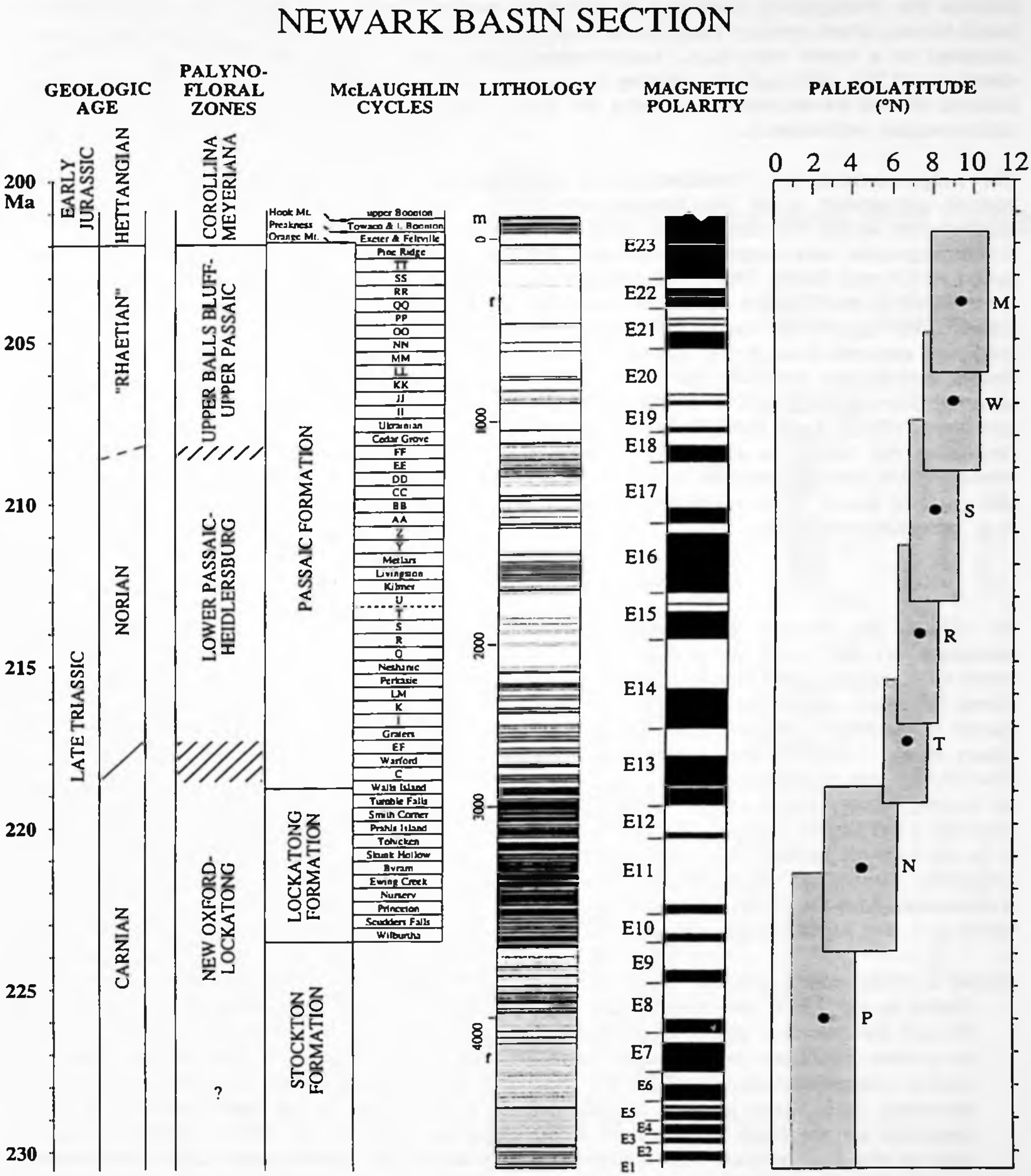
Magnetostratigraphy

Paleomagnetic sampling was done at a nominal 3 m interval, about the Van Houten cycle frequency. Each of the ~2400 samples was subjected to progressive thermal demagnetization in a minimum of 9 steps for separation of secondary and characteristic components of magnetization. The secondary components were used to orient the samples in azimuth; the characteristic magnetizations delineate a record of normal and reversed polarity magnetozones. Rock magnetic studies show that the magnetic carriers of the characteristic magnetizations are hematite in the red sediments and magnetite in the gray shales; a ferromagnetic sulphide is present in some of the more reduced black shales where no characteristic magnetization could be resolved.

For identification of the magnetozones, we assign integers (in ascending numerical order from the base of the recovered section) to successive pairs of predominantly normal and predominantly reversed polarity intervals. Each ordinal number is prefixed by the acronym for the source of the magnetostratigraphy (Newark Supergroup of the Newark Basin, but using "E" rather than "N" which can be confused with the conventional designation for normal polarity), and has a suffix for the dominant polarity (n is normal polarity, r is reversed) of each constituent magnetozone. Polarity intervals that occur within a magnetozone of higher rank can be labeled in a parallel manner, appended after a decimal point to the higher-order magnetozone designation and given a suffix indicating dominant polarity. The basic scheme is thus similar to that used for the Late Cretaceous and Cenozoic geomagnetic polarity sequence based on marine magnetic anomalies [Cande and Kent, 1992], except that the numbering sequence in the present system always proceeds from older to younger which is more convenient for stratigraphic description.

We designate the incomplete reversed polarity interval at the bottom of the recovered section as magnetozone E1r, and define succeeding polarity magnetozone couplets (e.g., E2 = E2n and

Figure 2. Newark Basin composite section transformed into a chronostratigraphy, using an age of 202 Ma for the Triassic/Jurassic boundary and assuming that the lithologic members (McLaughlin cycles) each represent 413 kyr and that the Stockton Formation has a sedimentation rate of 140 m/m.y. Palynofloral zonation is from Cornet *[1977, 1993] and* Cornet and Olsen *[1985]. Mean paleolatitudes (solid circles) and associated 95% confidence intervals (width of shaded boxes) are based on the mean characteristic magnetizations for the NBCP drill cores whose stratigraphic intervals are indicated by the heights of the shaded boxes.*


NEWARK BASIN SECTION
GEOLOGIC AGE
PALYNO-FLORAL ZONES
McLAUGHLIN CYCLES
LITHOLOGY
MAGNETIC POLARITY
PALEOLATITUDE (°N)
0 2 4 6 8 10 12
200 Ma
205
210
215
220
225
230
EARLY JURASSIC
HETTANGIAN
"RHAETIAN"
NORIAN
CARNIAN
LATE TRIASSIC
COROLLINA MEYERIANA
UPPER BALLS BLUFF-UPPER PASSAIC
LOWER PASSAIC-HEIDLERSBURG
NEW OXFORD-LOCKATONG
?
Hook Mt.
Preakness
Orange Mt.
PASSAIC FORMATION
LOCKATONG FORMATION
STOCKTON FORMATION
upper Boonton
Towaco & l. Boonton
Exeter & Feltville
Pine Ridge
TT
SS
RR
QQ
PP
OO
NN
MM
LL
KK
JJ
II
Ukrainian
Cedar Grove
FF
EE
DD
CC
BB
AA
Z
Y
Metlars
Livingston
Kilmer
U
T
S
R
Q
Neshanic
Perkasie
LM
K
I
Graters
EF
Warford
C
Walls Island
Tumble Falls
Smith Corner
Prahls Island
Tohicken
Skunk Hollow
Byram
Ewing Creek
Nursery
Princeton
Scudders Falls
Wilburtha
m
0
1000
2000
3000
4000
E23
E22
E21
E20
E19
E18
E17
E16
E15
E14
E13
E12
E11
E10
E9
E8
E7
E6
E5
E4
E3
E2
E1
M
W
S
R
T
N
P

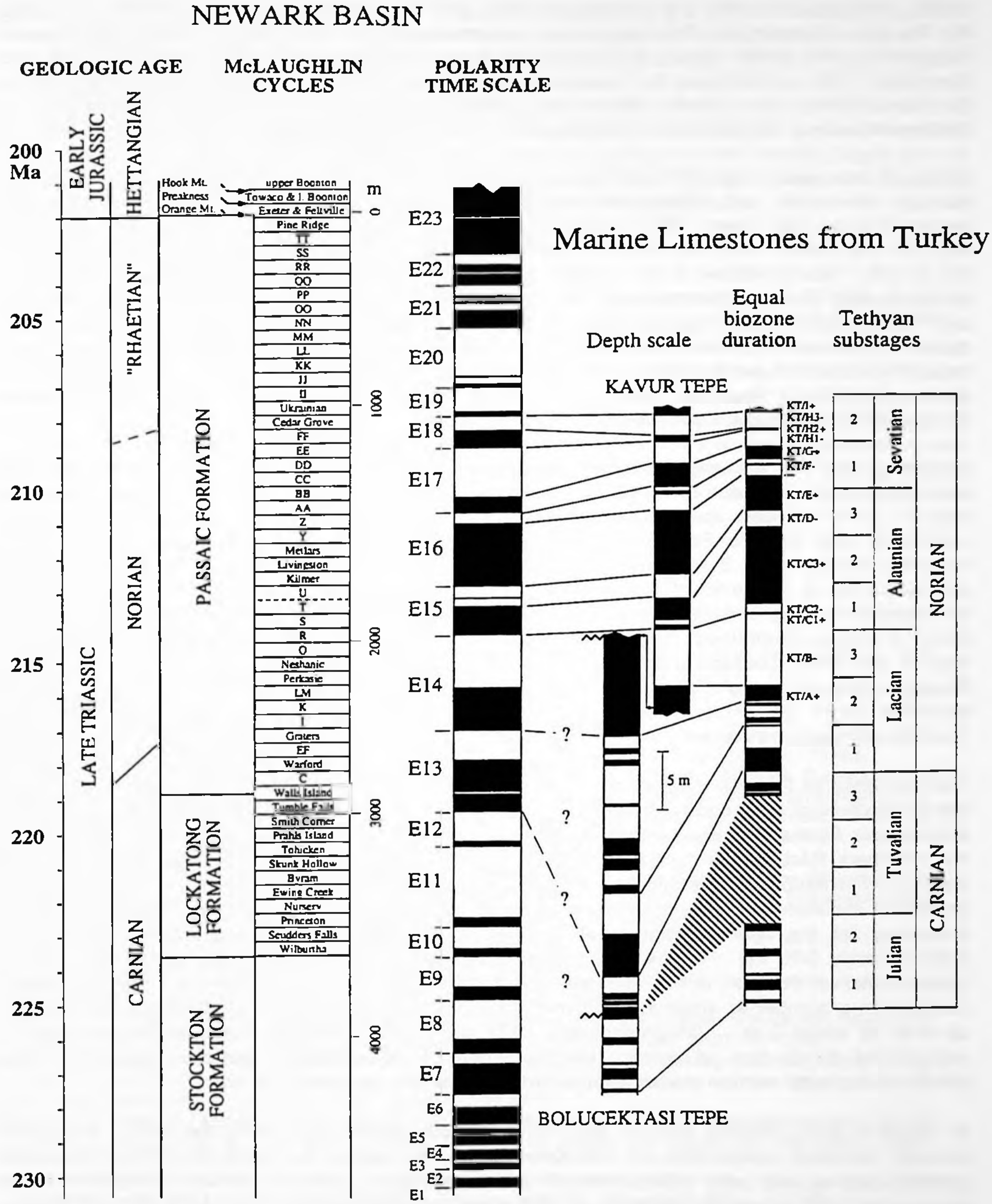
E2r, E3 = E3n and E3r, etc.) from the base of the overlying normal polarity interval (Fig. 2). To balance the stratigraphic thickness of first rank magnetozones over the entire section and to avoid having short polarity intervals at their boundaries, several short polarity intervals were assigned to a lower rank (e.g., submagnetozones E13n.1n, E13n.1r, and E13n.2n in magnetozone E13n). Although the ranking of magnetozones is inevitably arbitrary, the hierarchical scheme should nevertheless be useful for description at different levels of resolution and to accommodate refinements.

The magnetozones and lithostratigraphic members in the lacustrine facies are in excellent mutual agreement in all six between-site comparisons, supporting their interpretation as isochronous levels for correlation. The between-site correlations allow the assembly of a lithostratigraphic and magnetostratigraphic composite section for the Newark Basin from the seven NBCP core holes. The cored stratigraphic section has a composite thickness of 4660 m (normalized to the Rutgers drill core) and a total of 59 polarity intervals (magnetozones E1r to E23n). The uppermost normal polarity interval (magnetozone E23n.2n) in the NBCP cores evidently extends through the overlying Preakness Basalt, Towaco Formation, Hook Mountain Basalt, and at least the lower part of the Boonton Formation on the basis of previous studies of samples from outcrop and Army Corps of Engineers drill cores [McIntosh et al., 1985; Witte and Kent, 1990]. Even though the top is not defined, magnetozone E23n.2n at about 750 m (including the lavas) is already the thickest magnetozone in the Newark sequence. The remaining 58 polarity intervals have an average stratigraphic thickness (scaled to the Rutgers drill core) of about 70 m, ranging from about 4 m (e.g., magnetozone E23n.1r) to over 300 m (e.g., magnetozone E11r).

Geomagnetic polarity timescale

To convert the Newark Basin magnetostratigraphic sequence into a geomagnetic polarity timescale, an age model is developed on the basis of biostratigraphy, radiometric dates, and cycle stratigraphy. The Triassic/Jurassic boundary is constrained by palynology to lie within the Exeter Member, correlated to be about 20 m below the contact with the Orange Mountain Basalt in the NBCP section [Olsen et al., 1990; Fowell and Olsen, 1993; Fowell et al., 1994; Olsen et al., 1995]. There is no physical evidence of an unconformity associated with the Triassic/Jurassic boundary interval. Concordant radiometric dates of 202 ± 1 Ma [$^{40}Ar/^{39}Ar$ date on biotite; Sutter, 1988] and 201 ± 1 Ma [U-Pb dates from zircon and baddeleyite; Dunning and Hodych, 1990] were obtained from the Palisade sill which is linked physically and geochemically to the basaltic lavas (most likely the Preakness Basalt) of the Newark igneous extrusive zone [Ratcliffe, 1988]. On the basis of cyclostratigraphy of the sediments of Jurassic age that are interbedded with the lavas, the entire Newark extrusive zone is believed to represent a relatively short ($\sim$1 m.y.) igneous and depositional episode [Fedosh and Smoot, 1988; Olsen and Fedosh,

*Figure 3. Magnetostratigraphies from marine limestone sections from Turkey (BolŸ cektasi Tepe [*Gallet et al., *1992] and Kavur Tepe [*Gallet et al., *1993]) with possible correlations to the Newark geomagnetic polarity timescale. Subdivisions of the Norian and Carnian are plotted on a linear timescale with arbitrary scale assuming equal duration of the Tethyan (sub)substages; magnetostratigraphies of the limestone sections are shown in terms of measured thickness (see scale) and as transformed in a composite to an equal biozone duration timescale on the basis of conodont biostratigraphy [*Gallet et al., *1992, 1993]. The upper third of the BolŸ cektasi Tepe section, which includes an approximately 25-m-thick normal polarity interval which was correlated to the KT/C3+ magnetozone in Kavur Tepe [*Gallet et al., *1993], has been omitted for clarity.*


NEWARK BASIN
GEOLOGIC AGE
McLAUGHLIN CYCLES
POLARITY TIME SCALE
EARLY JURASSIC
HETTANGIAN
"RHAETIAN"
NORIAN
CARNIAN
LATE TRIASSIC
PASSAIC FORMATION
LOCKATONG FORMATION
STOCKTON FORMATION
200 Ma
205
210
215
220
225
230
m
0
1000
2000
3000
4000
Hook Mt.
Preakness
Orange Mt.
upper Boonton
Towaco & l. Boonton
Exeter & Feltville
Pine Ridge
Ukrainian
Cedar Grove
Metlars
Livingston
Kilmer
Neshanic
Perkasie
Graters
Warford
Walls Island
Tumble Falls
Smith Corner
Prahls Island
Tohicken
Skunk Hollow
Byram
Ewing Creek
Nursery
Princeton
Scudders Falls
Wilburtha
E23
E22
E21
E20
E19
E18
E17
E16
E15
E14
E13
E12
E11
E10
E9
E8
E7
E6
E5
E4
E3
E2
E1
Marine Limestones from Turkey
Depth scale
Equal biozone duration
Tethyan substages
KAVUR TEPE
BOLUCEKTASI TEPE
5 m
KT/I+
KT/H3-
KT/H2+
KT/H1-
KT/G+
KT/F-
KT/E+
KT/D-
KT/C3+
KT/C2-
KT/C1+
KT/B-
KT/A+
Sevatian
Alaunian
Lacian
Tuvalian
Julian
NORIAN
CARNIAN

1988]. This suggests that the radiometric dates can be used to provide an estimate of ~202 Ma for the palynological Triassic/Jurassic boundary as recorded in the uppermost Passaic Formation. U-Pb zircon dates of 202±1 Ma from the North Mountain Basalt [Hodych and Dunning, 1992], which lies a few meters above the palynological Triassic/Jurassic boundary in the Fundy basin, Nova Scotia [Fowell and Olsen, 1993], support the close synchroneity of igneous activity in the Newark rift basins and a Triassic/Jurassic boundary age of ~202 Ma.

Although age estimates for the Triassic/Jurassic boundary vary widely among published geologic timescales and criteria for recognition of the Norian/"Rhaetian" boundary are very uncertain [e.g., Van Veen, 1995], most timescales give consistent estimates of around 15-17 m.y. for the duration between the Carnian/Norian and Triassic/Jurassic boundaries (e.g., 220.7 Ma to 205.7 Ma [Gradstein et al., 1994]). There are 38 to 40 lithologic members or McLaughlin cycles in this 15-m.y. interval (using the most recent timescale of Gradstein et al. [1994]) of the Passaic Formation. The resulting average duration of about 400 kyr for the McLaughlin cycles is close to a main Milankovitch periodicity of climate change, calculated as 413 kyr from celestial mechanical terms of the cycle of eccentricity of Earth's orbit [Berger et al., 1992]. The same periodicity is found in spectral analyses of the full, broadband Newark climatic record [Olsen, 1986; Olsen and Kent, 1995].

Assuming that the McLaughlin cycles represent the 413-kyr celestial mechanical cycle, the Lockatong Formation with 11 to 12 members spans about 4.75 m.y. and the Passaic Formation with 41 to 42 members spans about 17 m.y. The long term sedimentation rate in the lacustrine Lockatong and Passaic Formations averages about 160 m/m.y.; the magnetostratigraphic sampling interval of ~3 m corresponds to a nominal temporal resolution of 15 to 20 kyr, approximately at the level of the Van Houten cycles. Cycles have not been identified in the Stockton Formation, and with the absence of biostratigraphic control the timescale in this fluvial facies is poorly constrained. If the sedimentation rate in the Stockton Formation was similar to that of the lower Lockatong Formation in the Princeton drill core, the cored interval of the Stockton Formation might span about 6.8 m.y. Allowing approximately 1 m.y. for the igneous extrusive zone, the entire Newark section may thus represent nearly 30 m.y. of the Late Triassic and earliest Jurassic.

The sequence of Newark magnetozones was transformed into a geomagnetic polarity timescale using the chronological control outlined above (Figure 2). Polarity reversal ages in the Lockatong and Passaic Formations were interpolated from the position of magnetozone boundaries within the members (McLaughlin cycles) which were each assumed to be 413 kyr in duration. In the Stockton Formation, where McLaughlin cycles are not apparent, polarity reversal ages were estimated assuming a constant sedimentation rate of 140 m/m.y. Average geomagnetic reversal frequency for the entire section is about 2/m.y., or an average polarity interval duration of approximately 500 kyr. For the better chronicled post-Stockton Formation sequence, average polarity interval duration is 560 kyr and reversal frequency is about 1.8/m.y. Polarity intervals range from a number as short as 0.03 m.y. (magnetosubchrons E15r.1n and E22n.1r) to a few as long as about 2 m.y. (magnetochrons E11r and E16n), with an overall resemblance to an exponential distribution of polarity lengths. There is no significant polarity bias, with 46% (54%) of the total section duration represented by normal (reversed) polarity.

In addition to a detailed polarity sequence, paleomagnetic data from the NBCP drill cores provide improved constraints on paleogeography. The paleopoles from the NBCP drill cores generally agree well with other North American reference poles and show a systematic age progression. An important element of this apparent polar wander can be portrayed as the change of the locality's paleolatitude with time, a representation that is not strongly dependent on uncertainties in azimuthal core orientation or any local vertical-axis rotations. Over the ~30 m.y. interval of the Late Triassic-earliest Jurassic represented by the Newark Basin section, eastern North America evidently drifted northward by about 7° (Figure 2). The NBCP drill cores suggest a shift in paleolatitude from about 2.5° to 6.5° north over the Carnian (Princeton to Nursery to Titusville) and from about 6.5° to 9.5° north over the ensuing Norian-"Rhaetian" and earliest Jurassic (Titusville to Martinsville). A tropical setting for the Newark Basin and an overall slow rate of northward motion over the Late Triassic and earliest Jurassic are robust interpretations of the data that are also relevant to Pangea paleogeography.

Conclusions

We suggest that the magnetic polarity sequence from the NBCP drill cores constitutes a reference section for a Late Triassic-earliest Jurassic geomagnetic polarity timescale. The inferred ages of the palynologically defined stage boundaries are generally a few million years younger but within the quoted uncertainties of age estimates in the most recent Mesozoic timescale of Gradstein et al. [1994]. A possible correlation with magnetic polarity sequences derived from Carnian and Norian "Hallstatt" marine limestones in southwestern Turkey [Gallet et al., 1992, 1993] is shown in Figure 3. While the correlation should be regarded as tentative and needs to be tested, we believe that the available results provide motivation and opportunity to develop an integrated (marine and nonmarine), global timescale for the Late Triassic comparable in detail to that developed for the later Mesozoic and Cenozoic.

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TRIASSIC CONTINENTAL STRATA AND CONCHOSTRACAN FAUNAS IN CHINA

Liu Shuwen

Triassic continental strata are widely distributed in China, especially in the Ordos Basin where outcrops of Triassic strata are widespread and well exposed. This is one of the most ideal areas for the study of continental Triassic strata in China because of its good exposures and abundant fossils (Table 1). The Triassic strata of this area are divided from the bottom to the top into to the Shiqianfeng Group, the Ermaying Formation and the Yanchang Group; the contacts between them are generally conformable (Inst. Geol. CAGS, 1980).

The Shiqianfeng Group was separated into three formations; from the bottom to the top: the Sunjiagou Formation, Liujiagou Formation and Heshanggou Formation.

1. The Sunjiagou Formation consists of dark purplish-red mudstones alternated with greyish-green and yellowish-green sandstones. The lower part of the formation is characterized by the larger number of sandstones intercalating with mudstones which contain calcareous nuclei and irregular bands. The upper part of the formation mainly consists of mudstone and many fossils have been found in this part. The thickness of this formation varies from 152 to 523 m.

The more abundant fossils preserved in the upper part of the Sunjiagou Formation include several vertebrates: *Shihtienfenia*, *Stiansisaurus* and conchostraca: *Falsisca (Sinolimnadiopsis) yaoxianensis*, *Huanghestheria longellipsa*.

The conchostracan assemblage of the Sunjiagou Formation is equivalent to the *Falsisca-Cornia-Cyclotunguzites* assemblage occurring in the middle part of the Guodikeng Formation, the so-called "Sesame cake bed", Jimusar, Xinjiang (Liu Shuwen, 1989). This is assemblage also ocurs in the Maltsevian Formation in the Kuznetsk Basin and the Pukialikt Formation in the upper part of Korvuntchan Group in the Tunguska Basin and the Induan Stage in the Yakut Region, Russia.

A marine intercalation has been found in the upper part of the Sunjiagou Formation along the southern border of the Ordos Basin. The sequence crops out in a section of a village named Houzhougonmiao, Qishan county, Shaanxi Province (Yang Zunyi et al., 1979). This marine bed consists of greyish-green and bluish-grey shale with some thin-bedded muddy limestone containing brachiopod and bivalve fossils. These bivalves were identified as *Eumorphotis multiformis*, *Promyalina intermedia*, *P. putiatinensis* and *Homomya impressa*. They occur together with *Claraia* and are widespread in south China. Therefore the Sunjiagou Formation was assigned to the Early Triassic. At least the upper part of Sunjiagou Formation which contains marine bivalves should be considered as Early Triassic, Induan.

It would be possible that the *Falsisca-Cyclotunguzites* assemblage occurring in Xinjiang first appears in the lower part of Liujiagou Formation and the top part of Sunjiagou Formation, although this assemblage has not been found in these formations in the Ordos Basin.

Age / Area	Zone	Xinjiang	Ordos Basin	Shanxi	Sichuan
Late Triassic	8. *Euestheria-Howellites* 9. *Euestheria-Anyuanestheria* 10. *Euestheria* 11. *Euestheria-Mesolimnadiopsis*	Huangshanje Fm. *Euestheria jiosarensis* *Mesolimnadiopsis karamaica* *M. pingliangouensis* *M. zhungaricus*	Yangchang Fm. *Euestheria deforma* *E. shensiensis, E. brodieana* Tongchuan Fm. *Euestheria gibba* *E. hanchengensis, E. cf. minuta* *Howellites hanchengensis* *H. tongchuanensis* *Aquilonoglypta hanchengensis*		Xujiahe Fm. *Euestheria minuta, E. yanjiangxiensis* *E. yipinglangensis* *Palaeolimnadia globosa* *Anyuanestheria ornata, A. sichuanensis* *Polygrapta? chinensis* *P.? xinchangensis* *Loxomegaglypta tanbaensis*
Middle Triassic	6. *Xiangxiella-Protomonocarina* 7. *Brachystheria-Pseudestheria*		Ermaying Fm. *Brachystheria subdisca* *Polygrapta wupuensis* *Pseudestheria subgibba* *P. zhangjiayanensis*	Ermaying Fm. *Protomonocarina binoda* *Trisitum multilineatus* *Gabonestheria shanxiensis* *G. arcuata, G. fusiformis* *Palaeolimnadia pusilla* *Punctestheria minuta* *P. cornuta, P. qinxianensis*	Badong Fm. *Diaplexa(?) xuanhanensis*
Early Triassic	1. *Falsisca-Cornia-Cyclotunguzites* 2. *Falsisca-Cyclotunguzites* 3. *Leptolimnadia-Paleoleptestheria* 4. *Gabonestheria-Diaplexa* 5. *Eosolimnadia-Triasestheria*	Jiucaiyuan Fm. *Flasisca subovata, F. fabiformis* *Cycloestherioides dalongkouense* *Cyclotunguzites brevus, C. dalongkouense* Guodikeng Fm. *Falsisca qitaiensis* *F. dalongkouensis, F. triangularis* *Shaerestheria* cf. *minuta* *Cyclotunguzites qitaiense, C. dalongkouense* *Beijianglimnadia rotunda* *B. multilinearis, B. elegans* *Cyclestherioides triangularus* "Zhimabing bed" *Falsisca multilinearis* *F.* cf. *jeskinolca, F.* cf. *kanandaensis* *Trinodus minutus, Huangestheria subovata* *H. magnapicalis, H. xinjiangensis* *Cornia beijiangensis, C.* cf. *sileenica* *Beijianglimnadia minuta, B. dalongkouensis* *Cyclotunguzites xinjiangense*	Heshanggou Fm. *Cornia guchengensis* *Diaplexa varidicta* *Palaeolimnadia ovata* *Dictyostriaca subcyclata* *Gabonestheria clinotuberica* *G. guchengchuanensis* Sunjiagou Fm. *Falsisca (Sinolimnadiopsis) yaoxianensis* *Huangestheria longellipsa*	Heshanggou Fm. *Palaeolimnadia magnapicalis* *Eosolimnadia subquadrata* *E. xingxianensis, E. shanxiensis* *Triasestheria shanxiensis* Liujiagou Fm. *Leptolimnadia shanxiensis* *L. jiaochengensis* *Loxomegaglypta jiaochengensis* *Palaeolimnadia shanxiensis* *P. multilineata, P. komiana* *Paleoleptestheria* cf. *minuta*	

Table 1a: Chinese Triassic conchostracan fossils distribution table

Age / Area		Hubei	Jiangsu	Yunnan	Guizhou	Jiangxi
Late Triassic	8. *Euestheria-Howellites* 9. *Euestheria-Anyuanestheria* 10. *Euestheria* 11. *Euestheria-Mesolimnadiopsis*			Yipinlang Fm. *Euestheria lata, E. angusta* *E. yipinlangensis, E. minuta* *E. dazuensis, E. mupangensis* *E. kawasakii, E. shimanurai* *E. xiangyunensis, E. obliqua* *Shipingia paxinensis* *S. hebaozhaiensis* *S. xinjieensis* *Diaplexa? ovata*	Langdai Fm. *Palaeolimnadia lubrica, P. globosa* *Diaplexa(?) brevis* *D.(?) langdaiensis* *D.(?) guangdaoyaensis* *D. (?) ovata* Banan Fm. *Howellites curvatus* *H. subquadratus*	Anyuan Fm. *Palaeolimnadia* sp. *Anyuanestheria subquadrata* *Euestheria* cf. *yipinglangensis*
Middle Triassic	6. *Xiangxiella-Protomonocarina* 7. *Brachystheria-Pseudestheria*	Badong Fm. *Xiangxiella elongata, X. acuta* *X. bicostata, X. xilingxiansis* *Protomonocarina buzhuangheensis* *P. oblonga, P. sinensis* *Euestheria lepida* *Dictyolimnadia subquadrata* *Palaeolimnadia machaolingensis*	Huangmaqing Fm. *Palaeolimnadia* sp., *Diaplexa* (?) sp. *Xiangxiella bicostata* *X. palaeolimnadiformis* *Protomonocarina sinensis* *P. ziguiensis* *Diconiostracus zhongshanensis* *Euestheria* sp.			
Early Triassic	1. *Falsisca-Cornia-Cyclotunguzites* 2. *Falsisca-Cyclotunguzites* 3. *Leptolimnadia-Paleoleptestheria* 4. *Gabonestheria-Diaplexa* 5. *Eosolimnadia-Triasestheria*			Kayitou Bed *Lioestheria* (?) *laibinensis* *L.*(?) *fuyuanensis* *Palaeolimnadia xuanweiensis* *Loxopolygrapta sphzongensis*	Yongningzhen Fm. *Euestheria minuta* *E. leidayanensis* Feixianguan Fm. *Euestheria minuta* *E. langdaiensis* *Palaeolimnadia pusilla*	

Table 1b: Chinese Triassic conchostracan fossils distribution table

2. The Liujiagou Formation consists of greyish-white, purplish-red and purplish-grey sandstones intercalated with some siltstones, pelitic siltstones and sandy mudstones. The formation has a thickness between 160 and 400 m.

The upper part of the Liujiagou Formation in the Peijiashan section, Jiaocheng county, Shanxi Province (Wang Ziqiang and Wang Lixin, 1989), is terrestrial and many plant fossils has been found in this part including *Pleuromeia jiaochengensis*, *Neocalamites* sp., *Crematopteris circinatis*, *C. brevipinnata*, *Phyllotheca yusheensis* and *Taeniopteris* sp. Therefore the age of the Liujiagou Formation is considered to be Early Triassic. Some conchostracan fossils of the *Leptolimnadia-Paleoleptestheria* assemblage have also been found in this formation.

In sections along the southern border of the Ordos Basin such as the section of Zhishiya, Linyou county, Shaanxi Province (Yang Zunyi et al., 1979), marine bluish mudstones and muddy limestones occur in the lower part of the Liujiagou Formation, and a large amount of marine fossils has been found, including bivalves (*Pteria* cf. *murchisoni*, *Pataconello elliptica*, *Unionites* spp., *Bakevellia costata*, *Gervilleia exporrecta*, *Mytilus eduliformis subpraecusor*) and brachiopods (*Mentzelia* sp., *Pseudospiriferina?* sp.) and ophiurids (*Ophiolepis shaanxiensis*) (Liu Shuwen, 1989). The Liujiagou Formation is therefore considered to be of Olenekian age on the basis of these Early Triassic marine fossils.

3. The Heshanggou Formation consists darkish-red and brownish-red mudstone and sandy mudstone, intercalating with greyish-white and greyish-purple sandstone, and usually with greyish-green shale and lenses of mudstone in the middle and top parts. The thickness of this formation lies between 110 and 135 m.

The lower part of the Heshanggou Formation in the Hougyatou section, Yushe county, Shanxi Province (Wang Ziqiang and Wang Lixin, 1989) has yielded plant fossils including *Pleuromeia sternbergii*, *P. epicharis*, *Ruehleostachys? hongyantouensis*, *Yuccites* sp., *Equisetites* sp., *Neocalamites* sp., *Cardiocarpus* sp. Two different assemblages of conchostracan fossils are found: the *Gabonestheria-Diaplexa* assemblage in the middle part of the Heshanggou Formation in the Ordos Basin, and the *Eosolimnadia-Triasestheria* assemblage in the upper part of the Heshanggou Formation in Shanxi Province. The age of the Heshanggou Formation is considered to be Olenekian on the basis of fossils from the lower part of the formation.

4. The Ermaying Formation is characterized by its lithology consisting of greyish-green, yellowish-green and purplish-grey sandstone interbedded with purplish-red and dark red mudstone, intercalated with green mudstone, shale and dark shale. The thickness of this formation ranges from 350 to 810 m.

This formation contains vertebrate remains, *Sinokannemeyeria*, *Parakannemeyeria*, *Ordosiodon*, *Shansiodon* and therefore it is usually assigned to the Anisian. In addition to vertebrate remains, it contains also an abundance of conchostracan fossils of which two successive assemblages can be distinguished:
a. The *Xiangxiela-Protomonocarina* assemblage is well represented in the the lower part of both the Ermaying Formation in Shanxi Province and the Badong Formation in Hubei Province. The Badong Formation is an alternation of terrestrial and marine strata and contains an ammonoid fauna including *Prigonoceratites*, *Beyrichites* as well as the *Neotlingites-Semiornites* assemblage, and bivalve fossils such as those of the *Leptochondria illyica - L. subillyrica* assemblage in marine beds. The Badong Formation is therefore considered to be of Anisian-Ladinian age (Bur. Geol. Miner. Res. Hubei, 1990)

			Ordos Basin and Shanxi Province				
			Plants	Vertebrates	Bivalves	Ostracoda	Conchostraca
Late Triassic (T3)	Yangchang Group	Yanchiang Fm.	*Danaeopsis fecunda* *Cladophlebis gigantea* *Annulariopsis* sp., *Baiera* sp. *Bernoullia zeilleri*		*Unio huangbogouensis* *Shaanxiconcha triangulata* *Sibireconcha shensiensis*	*Darwinula liulingchuanensis* *Lutkevichinella costata* *Camphocythere*? *pulchra* *Tungchuania perelegana* *T. houae*, *T. agrestata*	*Euestheria brodieana* *E.* cf. *multireticulata* *E. shensiensis* *E. deforma*
		Tongchuan Fm.	*Pleuromeia labiata* *Danaeopsis magnifolia* *Neocalamites carcinoides* *Tongchuanophyllum concinnum*		*Unio huangbogouensis* *Shaanxiconcha fragilis*	*Tungchuania houae* *Darwinula accuminata* *D. liulingchuanensis*	*Euestheria celeta* *E. tongchuanensis* *E.* cf. *dorsorecta*, *E.* cf. *minuta* *Howellites hangchengensis* *H. tongchuanensis*
Middle Triassic (T2)		Ermaying Fm.	*Equisetites* sp. *Todites* cf. *shensiensis* *Voltzia* cf. *walchiaeformis*	*Sinokannemeyeria* *Parakannemeyeria* *Shansiodon* *Orosiodon*	*Naiadites shichuanheensis* *Spirorbis* cf. *abberans* *Shaanxiconcha*? *minor* *Zhifangia typica*	*Shensinella gaoyadiensis* *Lutkevichinella minuta* *Darwinula subovatiformis* *Tungchuania quadratiformis*	*Pseudestheria subgibba* *Brachyestheria subdisca* *Protomonocarina binoda* *Punctestheria minuta* *Garbonestheria arcuata* *G. shanxiensis*
Early Triassic (T1)	Shiqianfeng Group	Heshanggou Fm.	*Pleuromeia sternbergii* *Pl. epicharis* *Cardiocarpus* sp. *Ruehleostachys*? *hongyantouensis*	*Capitosauridae* *Benthosuchidae* *Ceratodus* *Fugusuchus*	*Shaanxiconcha antiqua* *S. heshangouensis*	*Darwinula triassiana* *Darwinula parva* *Darwinula rotundata*	*Eosolimnadia subquadrata* *Triasestheria shanxiensis* *Diaplexa varidicta* *Gabonestheria clinotuberica* *Cornia guchengensis* *Palaeolimnadia ovata*
		Liujiangou Fm.	*Pleuromeia jiaochengensis* *Phyllotheca yusheensis* *Crematopteris circinalis* *C. brevipinnata*		*Pteria* cf. *murchinsoni* *Palaeoneilo elliptica* *Unionites* spp. *Bakevellia costata* *Cervillia exporrecta* *Mytilus eduliformis supraecusor*		*Leptolimnadia shanxiensis* *L. jiaochengensis* *Loxomegaglypta jiaochengensis* *Palaeolimnadia shanxiensis* *Paleoleptestheria* cf. *endybalica*
		Sunjiagou Fm.		*Shitienfenia* *Shansisaurus*	*Eumorphotis multiformis* *Leptochondria* aff. *virgalensis* *Promyalina putiatinensis* *P. intermedia* *Homomya impressa*		*Falsisca* (*Sinolimnadiopsis*) *yaoxianensis* *Huangestheria longellipsa*

b. The *Brachystheria-Pseudestheria* assemblage occurs in the upper part of the Ermaying Formation in the Ordos Basin.

5. The Yanchang Group is group is divided into five members from bottom to top (T3Y1-T3Y5). The age of this group was previously considered to be Late Triassic. Now it is regarded as Middle Triassic because of the presence of plant fossils such as *Pleuromeia labiata, Tongchuanophyllum concinnum, Danaeopsis magnifolia, Neocalamites carcinoides* which occur in the lower two members. The lower part of the Yanchang Group (T3Y1-T3Y2) is referred to the Middle Triassic and named Tongchuan Formation. The Tongchuan Formation is characterized by greyish-green and pinkish-red sandstones and fine sandstones intercalated with greyish-green and greyish-back shales, mudstones and oil shales.

The upper part of Yanchang Group (T3Y3-T3Y5) is named Yanchang Formation. This formation is characterized by greyish-green and yellowish-green sandstones intercalated with mudstones, shales and coalbeds, containing plants fossils like *Danaeopsis fecunda, Annulariopsis* sp., *Beroullia zeilleri* and *Baiera* sp. This formation has been dated as Late Triassic.

The thickness of the Yanchang Group ranges from 405 to 1349 m and the thicknesses of the Tongchuan Formation and Yanchang Formation are 100-596 m and 305-753 m respectively.

Within the Yanchang Group two assemblages of conchostracan fossils are found:

a. The *Euestheria-Howellites* assemblage occurring in the Tongchuan Formation in the Ordos Basin and the Banan Formation in Guizbou Province (Zhang Wentang et al., 1976).

The Banan Formation is an alternation of terrestrial and marine strata containing bivalve fossils: *Halobia rugosoides, Cassianela* cf. *beyrichii, Costatoria kweichowensis, Heminajas forutata*. The age of the Banan Formation is Carnian-Norian (Bur. Geol. Miner. Res. Guizhou, 1987).

b. The *Euestheria* assemblage occurring in the Yangchang Formation in the Ordos Basin.

According to the conchostracan fossils, the Yangchang Group should be dated as Late Triassic rather than Middle-Late Triassic.

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TRIASSIC DICYNODONT BIOCHRONOLOGY

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Abstract

Based on the stratigraphic distribution of dicynodonts, five biochrons of Triassic age can be recognized: *Lystrosaurus* biochron of early Induan age, *Kannemeyeria* biochron of late Olenekian-early Anisian age, *Shansiodon* biochron of early Anisian age, *Dinodontosaurus* biochron of Ladinian? age and *Placerias* biochron of late Carnian age. The youngest dicynodont fossils are of early Norian age. Dicynodont genera were cosmopolitan across Pangea during the Induan-Anisian, but became provincialized during the Ladinian-Norian.

Introduction

Dicynodonts were terrestrial therapsids of the Permo-Triassic that were primarily herbivorous. Dicynodonts had a Pangea-wide distribution during most of the Triassic (Fig. 1), so they have great potential for correlating Triassic nonmarine strata. Here, I briefly review Triassic dicynodont biochronology. The biochronology presented here (Fig. 2) differs somewhat from the biochronologies proposed by Cooper (1982), Cox (1991) and Battail (1993), primarily because of differences in taxonomy and stratigraphic precision.

Taxonomy, Cross Correlation and Temporal Resolution

A robust biochronology must be based on sound alpha taxonomy. For a dicynodont biochronology of the Triassic, I use the genus as the operational taxonomic unit because few named species of dicynodont are known from more than a single locality. This largely reflects taxonomic oversplitting, not real endemism. This oversplitting has also "provincialized" much of the genus level taxonomy of dicynodonts. However, the genera here used to identify biochrons are well established and widely recognized. Nevertheless, some of the generic synonyms I propose are not accepted by all workers, as discussed below.

Cross correlation of Triassic nonmarine tetrapod occurrences, such as those of dicynodonts, to the standard global chronostratigraphic scale (SGCS) based on marine biochronology is not always certain. Ochev and Shishkin (1989), Hunt and Lucas (1991a) and Battail (1993) published much of the rationale behind the cross correlations advocated here (Fig. 2).

Triassic dicynodont biochronology provides resolution below the level of stage-age, but temporal coverage is patchy. In Derek Ager's words, it is more gaps than record. More complete coverage of Triassic time can be achieved by adding to the dicynodont biochronology the biochrons of other tetrapods, especially temnospondyl amphibians for the Early-Middle Triassic and aetosaurs/phytosaurs for the Late Triassic (Ochev and Shishkin, 1989).

Lystrosaurus biochron

Lystrosaurus has a nearly Pangea-wide distribution in early Induan strata, being known from South Africa, Antarctica, India, China, Russia and possibly Laos and Australia (e.g., Colbert, 1974; Cosgriff et al., 1982). Its occurrences define a *Lystrosaurus* biochron previously referred to as the *Lystrosaurus* zone or *Lystrosaurus* beds. I use the term biochron here to refer to the time equivalent to a taxon range zone, instead of the biostratigraphic term zone or the lithostratigraphic term bed, both of which do not necessarily refer to a time interval. The small dicynodont *Myosaurus gracilis* co-occurs with *Lystrosaurus* in South Africa and Antarctica (Hammer and Cosgriff, 1981). Cooper (1982) considered the *Lystrosaurus* "Zone" to be of Late Permian age, but I follow virtually all other workers who assign the strata that contain *Lystrosaurus* to the earliest Triassic (Fig. 2).

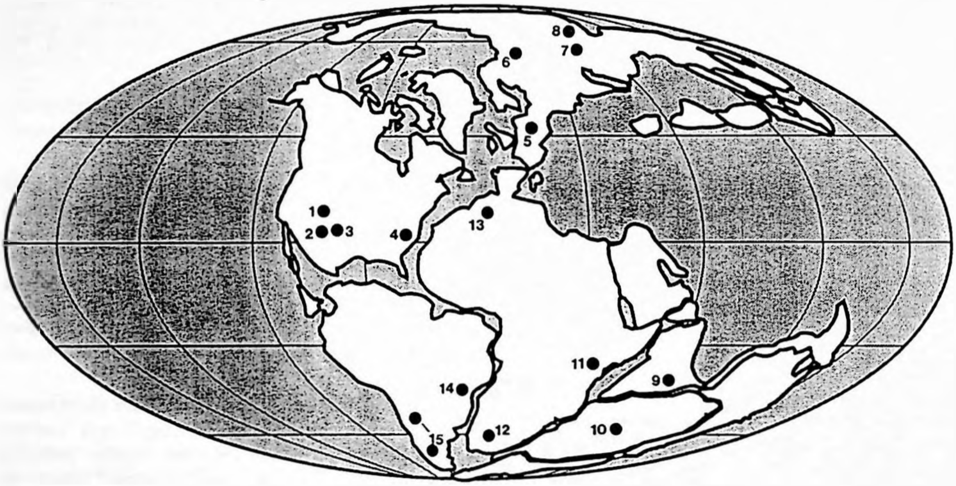

Fig. 1. Map of Triassic Pangea showing principal dicynodont localities.

> *Localities are: 1 - Popo Agie Formation, Chinle Group, Wyoming, USA; 2 - Blue Mesa Member, Petrified Forest Formation, Chinle Group, Arizona, USA; 3 - Los Esteros Member, Santa Rosa Formation, north-central New Mexico, USA; 4 - Pekin Formation, Newark Supergroup, North Carolina, USA; 5 - Muschelkalk and Lettenkeuper, France and Germany, 6 - Donguz svita, Cis-Urals, Russia; 7 - Guodikeng Formation, Junggur basin, China; 8 - Ermaying Formation, Ordos Basin, China; 9 - Yerrapalli and Maleri Formations, Pranhita-Godavari Valley, India; 10 - Fremouw Formation, Antarctica; 11 - Kingori Sandstone and Manda Formation, Tanzania; 12 - Karoo basin, South Africa, 13 - Argana Formation, Morocco; 14 - Santa Maria and Catturrta Formations, Brazil; 15 - Puesto de Viejo, Cerro de las Cabras, Ischichuca, Ischigualasto and Los Colorados Formations, Argentina.*

Note, however, that a problem exists, unresolvable at present, with regard to assigning the *Lystrosaurus* biochron to the Permian, Triassic or Permian-Triassic (Lucas et al., 1994). Most workers have long assumed that the first appearance datum (FAD) of *Lystrosaurus* corresponds to the base of the Triassic, even though there is no convincing way to correlate this FAD to the base of the marine Triassic, which is the base of the Induan = the FAD of the ammonoid *Otoceras* (Tozer, 1984). Furthermore, the FAD of *Lystrosaurus* has long been supposed to postdate the last appearance datum (LAD) of the characteristically Late Permian dicynodont *Dicynodon* (= *Daptocephalus*).

However, in the Junggur basin of northwestern China and the Karoo basin of South Africa, fossils of *Dicynodon* and *Lystrosaurus* co-occur in an overlap zone. At Dalonggkou in the Junggur basin, in the upper part of the Guodikeng Formation, they co-occur over a 30-m-thick interval of mostly purplish red silty mudstone (Cheng and Lucas, 1993). In South Africa, *Dicynodon* and *Lystrosaurus* overlap in a 15-m-thick interval at the base of the Palingkoof Member of the Balfour Formation (Smith, 1993). No biostratigraphic data available from either the Chinese or South African sections provides a convincing correlation to the SGCS, but evidence from Russia and Greenland indicates that at least some (though not necessarily all) *Lystrosaurus* fossils are of Triassic age. In Russia, *Lystrosaurus* co-occurs with the amphibians *Luzocephalus* and *Tupilakosaurus* (Ochev and Shishkin, 1989). These amphibians are also known from marine strata with Induan ammonoids in Greenland (Ochev and Shishkin, 1989). This is the most direct evidence that part of the *Lystrosaurus* biochron is Triassic, but whether or not the FAD of *Lystrosaurus* is the base of the Triassic still needs to be determined.

Kannemayeria biochron

Kannemeyeria has a distribution in deposits that straddle the Early-Middle Triassic boundary that is nearly as broad as that of *Lystrosaurus.* Its fossils are known from Argentina, South Africa, South West Africa, Zambia, Tanzania, Russia, China and India. The type species of *Kannemeyeria* is *K. simocephalus* (Weithofer, 1888) from South West Africa. I consider only one other species to be valid, *K. cristarhynchus* Keyser and Cruickshank, 1979 (= *K. argentinensis* Bonaparte, 1966).

Critical to broad recognition of the *Kannemeyeria* biochron is the synonymy of *Rechnisaurus, Uralokannemeyeria* and *Shaanbeikannemeyeria* with *Kannemeyeria.* Cox (1991) synonymized *Uralokannemeyeria* and *Shaanbeikannemeyeria* with *Rechnisaurus*, and I fully agree with this decision. However, Cox (1991) as well as King (1988), Bandyopadyhay (1989) and DeFauw (1993) have retained *Rechnisaurus* as a genus distinct from *Kannemeyeria.* The principal character that can be marshalled to distinguish *Rechnisaurus* from *Kannemeyeria* is the former's possession of a blunt snout. Like Keyser and Cruickshank (1979), I regard this as a species-level difference between *K. cristarhynchus* and *K. simocephalus*.

In the Karoo basin of South Africa, the stratigraphic range of *Kannemeyeria* in the Burgersdorp Formation has long been considered to be equivalent to that of the *Cynognathus* assemblage zone; indeed, some workers have used the name *Kannemeyeria* zone instead of *Cynognathus* zone. However, recent work by Hancox and Rubidge (1994) suggests that *Kannemeyeria* is confined to the lower part of the *Cynognathus* assemblage zone. Stratigraphically higher, large dicynodont postcrania, formerly identified as *Kannemeyeria*, are now known to be associated with cranial material of a large, tuskless dicynodont, possibly *Wadiasaurus.*

Kannemeyeria biochron horizons and localities are: (1) Yerrapalli Formation, Pranhita-Godavari Valley, India; (2) Kingori Sandstone Formation, Tanzania; (3) lower Omingonde Formation (Etjo Beds), Etjo Mountain, South West Africa; (4) Burgersdorp Formation, South Africa; (5) lower fossiliferous horizon of N'tawere Formation, Luangwa Valley, Zambia; (6) upper Puesto Viejo Formation, Mendoza Province, Argentina; (7) lower Ermaying Formation, Ordos basin, China; and (8) Donguz svita, Orenburg district, Russia. These occurrences are mostly of late Early Triassic (late Olenekian) age; some are of earliest Middle Triassic (early Anisian) age (Bandyopadyhay, 1988; Ochev and Shishkin, 1989; Battail, 1993).

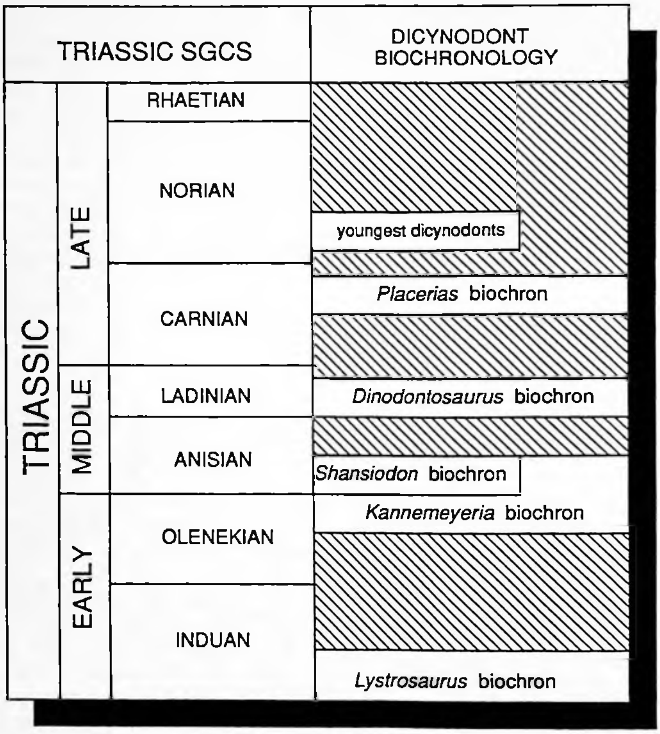

Fig. 2. Biochronology of Triassic dicynodonts.

Shansiodon biochron

Lucas (1993c) established the *Shansiodon* biochron for the distribution of this small- to medium-sized dicynodont. Its occurrences are: (1) Ermaying Formation, Ordos basin, China; (2) Donguz svita, Orenburg district, Russia; (3) Manda Formation, Tanzania; (4) Omingonde Formation, South Africa; (5) N'tawere Formation, Zambia; and (6) Cerro de las Cabras Formation, Mendoza Province, Argentina. All of these occurrences are of earliest Middle Triassic (early Anisian) age. Thus, the *Kannemeyeria* and *Shansiodon* biochrons overlap during the early Anisian.

Cooper (1982) identified a *Tetragonias* "Zone" (I consider *Tetragonias* to be a junior synonym of *Shansiodon*: Lucas, 1993c), which also included occurrences of *Kannemeyeria* younger than his *Kannemeyeria* "Zone." I prefer instead to indicate the clear temporal overlap of *Kannemeyeria* and *Shansiodon* in the biochronological scheme (Fig. 2).

In northern China (Junggur and Ordos basins), the so-called "*Sinokannemeyeria* fauna" or "kannemeyeriid fauna" includes *Shansiodon* (e.g., Sun, 1972; Cheng, 1981). The Chinese endemic dicynodonts *Sinokannemeyeria* and *Parakannemeyeria* are thus of *Shansiodon*-biochron age, except for the earliest record of *Parakannemeyeria*, which is in older *Kannemeyeria*-biochron age strata of the lower Ermaying Formation of the Ordos basin (Cheng, 1981; Lucas, 1993a).

Dinodontosaurus biochron

A dearth of Middle Triassic (Ladinian) nonmarine tetrapod faunas exists, the main ones being from South America (Argentina and Brazil). *Stahleckeria potens* (= *Barysoma lenzii*: Lucas, 1993b) and *Dinodontosaurus* (= *Chanaria*) have been listed as Late Triassic dicynodonts from the Santa Maria Formation of Rio Grande do Sul, Brazil (King, 1988), but they are of Middle Triassic age (Barbarena, 1977; Barbarena et al., 1985; Lucas, 1993b; Lucas and Harris, 1996). *Dinodontosaurus* is a monotypic genus known only from its type species, *D. oliveirai*; Huene's (1935) species *D. tener* and *D. turpior* are *nomina dubia* (Lucas and Harris, 1996).

Dinodontosaurus occurs in the Santa Maria Formation of Brazil and the Ischichuca (Chañares) Formation of Argentina (Cox, 1965, 1968), strata generally considered to be of Ladinian age, though the basis for correlation to the SGCS is highly tenuous. Because of its restriction to South America, correlation of the *Dinodontosaurus* biochron across Pangea is problematic. An isolated dicynodont humerus from the Ladinian interval of the Muschelkalk in Germany most resembles *Dinodontosaurus* but cannot be identified with certainty at the generic level (Lucas and Wild, 1995).

Stahleckeria is the largest dicynodont of the *Dinodontosaurus* biochron (indeed, it is the largest dicynodont), but it is known only from Brazil. The endemism of so large a herbivore on Pangea suggests endemism of the land-vertebrate fauna of the Ladinian. The best candidate for an occurrence of *Stahleckeria* outside Brazil is "*Elephantosaurus*" from Russia, but its holotype is so incomplete that it is best considered a *nomen dubium* (King, 1988; Lucas and Wild, 1995). Cooper (1982) recognized successive *Dinodontosaurus* and *Stahleckeria* "Zones" in his biostratigraphic scheme. I do not, simply because both genera co-occur in the Santa Maria Formation of Brazil, which is a correlative of the Ischichuca Formation of Argentina (Lucas and Harris, 1996).

Placerias biochron

One of the last dicynodonts, *Placerias* is known from late Carnian (Tuvalian) strata in the USA (Wyoming, Arizona, North Carolina) and Morocco. Lucas and Hunt (1993) reviewed the North American *Placerias*, recognizing only one species, *P. hesternus* (= *P. gigas*). Lucas and Wild (1995) argued that the dicynodonts from Upper Triassic strata of the Argana Formation in Morocco named by Dutuit (1980, 1989a, 1989b) represent one taxon, *Placerias nmachouensis*, of late Carnian age. Cooper's (1982) assignment of his *Placerias* "Zone" to the entire Carnian and Norian cannot be supported; *Placerias* is known only from upper Carnian strata.

The only Late Triassic dicynodont reported from Brazil is a skull named *Jachaleria candelariensis* by Araujo and Gonzaga (1980) from the Caturrita Formation, which overlies the Santa Maria Formation in Rio Grande do Sul. I cannot, however, differentiate this skull from that of *Ischigualastia* (Lucas, 1993b). Dicynodont taxa from the Upper Triassic of Argentina are *Ischigualastia jenseni* Cox, 1962 and *Jachaleria colorata* Bonaparte, 1970. Correlation of *Ischigualastia* occurrences in Argentina with other Late Triassic tetrapod faunas outside of South America has always been fraught with problems because of the endemism of the South American faunas (e.g., Battail, 1993). I continue to advocate earlier arguments (Hunt and Lucas, 1991b; Lucas et al., 1992; Lucas and Hunt, 1993) that the *Ischigualastia* occurrences are of late Carnian age and therefore of *Placerias* biochron age.

Indeterminate dicynodonts have been reported from the Upper Triassic Maleri Formation in India by Kutty et al. (1988) and Kutty and Sengupta (1989). These specimens are skull fragments, a partial humerus and an atlantal neural arch (Kutty and Sengupta, 1989), but they have not been described or illustrated. The occurrence of the primitive phytosaur *Paleorhinus* in the Maleri Formation indicates the *Paleorhinus* biochron of late Carnian (Tuvalian) age (Hunt and Lucas, 1991a), which overlaps the *Placerias* biochron. It is thus likely that the Maleri Formation dicynodonts are of *Placerias* biochron age.

The youngest dicynodonts and paleobiogeography

Dicynodont extinction has long been perceived to be a terminal Carnian event (e.g., Benton, 1994, fig. 22.5). However, there are two records of dicynodonts of probable early Norian age.

The holotype of *Jachaleria colorata* is from the lowermost Los Colorados Formation in Argentina. The tetrapod assemblage stratigraphically higher in the Los Colorados Formation is dominated by prosauropod dinosaurs and is considered to be of late Norian age (e.g., Bonaparte, 1982; Hunt, 1991). The *Jachaleria* specimen is well below this assemblage and well above the late Carnian Ischigualasto Formation tetrapods. It may be early Norian.
S. Chatterjee (oral commun., 1994) informs me that a dicynodont has been discovered in the lower part of the Bull Canyon Member of the Dockum Formation (Chinle Group) in West Texas, USA. Palynomorphs and tetrapods establish the age of the lower Bull Canyon Member as early Norian (Lucas, 1993d).

One obvious and interesting pattern of dicynodont paleobiogeography emerges from the biochronology proposed here. Dicynodonts of the *Lystrosaurus*, *Kannemeyeria* and *Shansiodon* biochrons were relatively cosmopolitan across Pangea. However, those of the *Dinodontosaurus* and *Placerias* biochrons were much more geographically restricted in their distribution. This progressive Triassic provincialization of the dicynodonts may reflect factors that led to their extinction during the early Norian.

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THE DISTRIBUTION OF LOWER TRIASSIC CRINOIDS

H. Hagdorn and T. Baumiller

Previous work has demonstrated the high diversity and abundance of crinoids, which suffered a near extinction during the Permo-Triassic event, by the Middle Triassic. The often rich Middle Triassic crinoid faunas, especially those of the Muschelkalk, are not matched by those of the Lower Triassic. In fact, our knowledge of Lower Triassic crinoids is quite limited and until recently has been largely restricted to a few descriptions of poorly preserved, fragmentary material. Nevertheless, in the geological literature on the Lower Triassic one often finds mention of sections in which *"Pentacrinus"* columnals occur and are often abundant. During the last several years we have visited and collected crinoid material from several such localities. Our aim has been to use these data to gain a better understanding of the biogeographic and temporal distribution of the earliest post-Paleozoic crinoids. To date we have collected material from:

Europe:
- Italy (Dolomites): Weißhorn; Werfen Fm., Cencenighe Mb. (Olenekian)
- Hungary (Balaton Highland): Sóly, Hidegkút; Czopak Marl Fm. (Olenekian)

U.S.A.:
- Idaho: Fall Creek, Montpellier Canyon, Paris, Hot Springs Canyon (Bear Lake); Thaynes Fm. (Smithian, Spathian)
- Utah: Salt Lake City (Fort Douglas); Thaynes Fm. (Smithian, Spathian)
- Nevada: Montello, Montello Springs, Thaynes Fm. (Smithian, Spathian). Lost Cabin Springs, Frenchman Mountains (Clark County); Moenkopi Fm., Virgin Limestone Mb. (Spathian).

We would greatly appreciate receiving information regarding any Lower Triassic crinoid material, regardless whether it occurs in the field, or is deposited in museum or private collections. If you have information regarding such material (localities and/or collections), please contact either of us.

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SOME COMMENTS ON:

Dagys, Algirdas, 1995. Zonation of Eastern Boreal Lower Triassic and Induan/ Olenekian boundary. ALBERTIANA, 15: 19-23.

A DISCUSSION BY

Yuri D. Zakharov

1. I have learned with the greatest pleasure that A. Dagys (1995) considers *Otoceras concavum* Tozer to be absent in the Triassic of the Verkhoyansk region (I have never agreed with Arkhipov's determination). But it seems illogical to indicate the *O. concavum* Zone at the scheme for Siberia (Dagys, 1994) now (everyone knows that there is no criteria for its distinction except a single ammonoid species - *O. concavum* Tozer).

2. I agree that the Lower Triassic Burgagandzha River section in the Verkhoyansk region needs detailed investigation - apart from myself, it was investigated only by Korostelev (1972) and Truschelev (personal com.), I think. I should like to see documented data on a series of faults and overthrusts which were overlooked by me, as Dagys considered.

Irrespective of this, it should be mentioned that in Burgagandzha River, many representatives of *Kingites korostelevi* have been met in association with abundant early Induan ophiceratid ammonoids (Zakharov, 1978). Consequently, it is strongly suggested that my species *Kingites korostelevi* Zakharov cannot be used as an index-species for the uppermost zone of the Induan. I am very sorry, but the evidences received "a quarter of a century back" sometimes are useful.

3. The *Parasibirites grambergi* unit is present in my scheme (Zakharov, 1994, Fig.1, see number 14), but in rank of the ammonoid beds within the *Spiniplicatus* Zone because *P. grambergi* Popov associates in Siberia with such typical representatives of this zone as *Olenekoceras middendorffi* (Keys.). Both *Olenekoceras* and *Olenikites* are predominant in the late Olenekian ammonoid association of the Olenek River basin.

4. I agree that the Verkhoyansk region offers the best perspective in the boreal area for the search for a candidate stratotype section and the point of the Induan/Olenekian boundary, but the uppermost beds of the Induan must be investigated in detail here.

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30th INTERNATIONAL GEOLOGICAL CONGRESS

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

CALL FOR ABSTRACTS

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.

Abstracts for both oral and poster presentations must reach the IGC Organizing Committee by **November 1, 1995**. Only registrants to the Congress may submit abstracts. The Scientific Programme Committee reserves the right to accept or reject contributions on the basis of the submitted abstracts. The Scientific Programme Committee will take the author's preference for oral or poster session into consideration, but the final decision will be made by the Committee.

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. Please note this in your registration form, otherwise the organizers will arrange for you other activities around Nanjing.

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. Those who prepare to make a presentation please contact the convenors. No cost for participation.

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PERMIAN-TRIASSIC BOUNDARY WORKING GROUP

NEWSLETTER No. 4 (October 1, 1995)

Yin Hongfu

1. Work since the issue of PTBWG Newsletter no. 3

Teamwork has been carried out on the Permian-Triassic transitional strata in South China (Meishan), Japan (Mino-Tamba), central Iran (Abadeh Area) and other areas. A number of books and papers have been devoted to the P-T boundary problem (see the incomplete list below). In addition, the abstract volumes of the International Symposium on Permian (Guiyang, China, 1994) and the XIII International Congress on Carboniferous-Permian (Kraków, Poland, 1995) contain many contributions to the Permian-Triassic boundary problem.

List of publications:

BAGYS, A., 1994. Correlation of the lowermost Triassic. Albertiana, 14: 38-44.

LOZOVSKY, V.R., 1994. Continental sequence of Permian and Permian/Triassic Boundary Working Group. Permophiles, 25: 9-12.

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2. Result of the questionnaire

A questionnaire was distributed to members of the PTBWG in June. Twenty voting members and two corresponding members replied. The results from the voting members are:

1. Do you think it is now time to make a decision on the GSSP of the PTB? 15 yes, 5 no.
2. If yes, which level will you recommend for the base of the Triassic? 13 *Hindeodus parvus (Isarcicella parva)*, 2 *Otoceras*.
3. If yes, which section will you recommend for the GSSP? 15 Meishan, others none.
4. If no, please comment what work should the PTBWG do in the near future? Answers include:
   - more publications on the PTB, especially that of Meishan.
   - reconsideration of the exact level of the PTB in Meishan; this includes two alternative suggestions:

   a) the base of Bed 26, regarding it as coeval of the *woodwardi* or *latilobatum* zone;

   b) the base of Bed 27, doubting that the non-occurrence of *Hindeodus parvus (Isarcicella parva)* in Beds 27a & b is due to collection failure.

- research on the range of conodonts and relationship to ammonoids in Arctic sections, and clarification on the problem whether the first appearance of *Hindeodus parvus (Isarcicella parva)* is linked to ecological conditions, e.g. diachronism, regarding that its reported coexistence with *Ophiceras commune* in Greenland would make a correlation of *woodwardi* with *O. commune* possible.
- research on the conodont and ammonoid biostratigraphy in the Spiti sections to see if they can shed new lights on the boundary.
- taxonomy and lineage of *parvus (parva)*, including its morphotypes.

The above results show that the necessary majority has reached a consensus on the type section of the Permian-Triassic boundary. Considering the opinions of those preferring postponement of the vote and following the advice of A. Baud, chairman of the STS, the chairman of the PTBWG has decided not to press on a vote and pursue the ratification of the PTB before or during the 30th IGC. However, since the PTBWG has been existing for 15 years and many members have called for a solution in the near future, we should expect to have gathered enough information and to have a vote in the near future. In this regard, some comments and information on new advancements in this newsletter may be useful.

3. Some comments and information

3.1. The synchrony of the first appearance of *Hindeodus parvus (Isarcicella parva)*.

This is based on three lines of evidence:

a) The consistent biostratigraphical level at the basal Triassic through the pan-Tethyan (and North American, too) correlation of all well-known sections (Table 3; Chinese PTBWG, 1993).
The reported coexistence of *Hindeodus parvus (Isarcicella parva)* with *Ophiceras commune* in Greenland (oral report of Kozur, 1993, Calgary). If it is proved to be its first appearance there, this would change the traditional correlation between Tethyan and Arctic lowermost Triassic. Nevertheless, even if this proves to be right, it is not necessary to provoke too much agitation because that traditional correlation is based on the unsure criterion of synchrony of different species (*O. woodwardi* versus *O. boreale* or *O. concavum*) of *Otoceras*, and because Changxingian conodonts have reportedly been found in Arctic *Otoceras* beds. In other words, this will become a choice between two criteria: synchrony of *Otoceras* (*O. woodwardi* and *O. boreale* or *O. concavum*) or synchrony of *Hindeodus parvus (Isarcicella parva)*. We await further information from there.

b) The consistent successive appearance along the *latidentatus-parvus(parva)-turgida-isarcica* lineage which theoretically verifies the synchrony of the first appearance of *parvus (parva)*. This lineage has been found at Meishan, South China (Ding et al., in press, see also Table 1), Dorasham, Transcaucasia (Kozur, 1990, 1995), Salt Range (Wardlaw, in press), Gartnerkofel, Southern Alps (Schönlaub, 1991), and an incomplete sequence containing three segments of this lineage has been reported from Iran, Sicily and Hungary.

c) The consistent orderly sequence of Ir anomaly (not necessarily a spike), $\delta^{13}C$ excursion and *parvus (parva)* in 8 sections, as shown in attached Table 2, which represents a reasonable sequence of events: catastrophe (Ir anomaly) - mass extinction ($\delta^{13}C$ excursion) - first newcomer *parvus (parva)*.

Stage	Bed no.	Section A (YIN (ed.), in press	Section B (CLARK *et al.*, 1986)	Section C	Section F (YIN (ed.), in press)	Section D (ZHANG, 1984,1987; CLARK *et al.*, 1986; SHENG *et al.*, 1987; YIN (ed.), in press)	Section E (YIN (ed.), in press)	Section Z (CLARK *et al.*, 1986; SHENG *et al.*, 1987; WANG, 1994, 1995; YIN (ed.), in press)	Conodont zonation
Gries-bachian	29	*Ellisonia* sp.		*Clarkina planata*	*Clarkina* sp.	*C. planata* *C. carinata* *H. typicalis* *I. turgida* *Ellisonia* sp.		*H. parvus (I. parva)* Morphotype 1,2 *H. typicalis* *H. turgidus (I. turgida)* *Clarkina carinata* *Ellisonia transita*	*I. isarcica* zone
	28	*Isarcicella isarcica* *(H. isarcicus)*		*Hindeodus parvus* *(Isarcicella parva)* *Isarcicella* sp.	*Isarcicella* sp.	*H. parvus (I. parva)* *I. turgida* *Ellisonia* sp. Sc. el.		*Hindeodus typicalis* *Hindeodus* sp. *Clarkina* sp.	
	27d					*Ellisonia* sp. M. el.		*H. parvus (I. parva)* Morphotype 1,2 *Hindeodus typicalis*	*I. parva* zone
	27c		*Clarkina carinata*			*H. parvus (I. parva)*		*H. parvus (I. parva)* Morphotype 1,2 *I.* cf. *turgida* *H. latidentatus, H. julfensis* *C. changxingensis, C. carinata*	
Chang-xingian	27b		*Hindeodus typicalis*			*Hindeodus typicalis* *H.* sp. Sc. el. *X. elongatus*		*C. changxingensis, H. typicalis* *H. latidentatus, Merrilina* sp. *I.* cf. *turgida*	*H. typicalis* interval
	27a	*Hindeodus typicalis*	*Ellisonia* sp.		*Ellisonia* sp. Sc. el. *Hindeodus* sp.	*Hindeodus* sp.	*Hindeodus* sp.	*H.* sp., *C. changxingensis, C. carinata* *C. subcarinata, C. deflecta* *H. typicalis, H. latidentatus* *Ellisonia transita* *I.* cf. *turgida, H. changxingensis*	
	26	*Clarkina changxingensis*	*C. carinata* *Hindeodus typicalis* *Ellisonia* sp.	*C. changxingensis* *C. deflecta*	*C. shangxingensis* *C. deflecta* *C. carinata* *C. meishanensis* sp.nov. *H. typicalis*	*C. changxingensis* *C. deflecta* *C. meishanensis* sp.nov.	*C. changxingensis*	*C. changxingensis, C. deflecta* *C. decerocarinata, C. carinata* *C. xiangxiensis* *H. latidentatus (I.latidentata)*	*Clarkina changxingensis - Clarkina deflecta* zone
	25	*C. changxingensis* *C. carinata* *C. deflecta* *C. meishanensis* sp.nov.	*C. carinata* *C. deflecta* *Hindeodus typicalis*	*Hindeodus latidentatus* *(Isarciella latidentata)* *C. deflecta*	*C. shangxingensis* *C. carinata* *C. deflecta*	*C. changxingensis* *C. deflecta* *C. orientalis*	*C. carinata*	*C. changxingensis* *C. carinata* *C. deflecta* *C. xiangxiensis*	
	24e	*C. changxingensis* *C. subcarinata* *H. typicalis* *E. ziegleri* *X. elongatus*	*C. shangxingensis* *C. carinata* *C. subcarinata* *C. deflecta* *Hindeodus typicalis* *Ellisonia* sp.	*C. shangxingensis* *C. carinata* *Hibbardella* sp. *E. ziegleri*	*C. shangxingensis* *C. carinata* *C. deflecta* *C. orientalis* *C. subcarinata* *C. jesmondi* *H. typicalis* *E. ziegleri* *X. elongatus*	*C. changxingensis* *C. carinata* *C. deflecta* *E. ziegleri* *X. elongatus*	*C. changxingensis* *C. carinata* *C. deflecta* *E. ziegleri* *Xaniognathodus elongatus*	*C. changxingensis* *C. carinata* *C. deflecta* *C. subcarinata* *C. denticulata* *C. wangi* *Hindeodus typicalis* *Ellisonia* sp.	

Table 1. Conodont distribution and zonation across the Permian-Triassic Boundary Beds at Meishan of Changxing

Table 2. Succession of the PTB markers

Meishan (Xu and Yan, 1993)	
first appearance of *I. parva*	= PTB
$\delta^{13}C$ excursion	ca. 5 cm below PTB
first appearance of *Otoceras?* sp.	Bed 26(3) (6 cm), 8-14 cm below PTB
Ir spike	top 1 cm of Bed 26(3), 9 cm below PTB
Shangsi (Li *et al.*, 1989)	
$\delta^{13}C$ excursion	Bed 28a, within 17 cm below PTB
Ir spike (AG253)	Bed 27c, within 21 cm below PTB
Selong (Orchard *et al.*, 1989)	
first appearance of *I. parva*	= PTB
first appearance of *Otoceras latilobatum*	the same level*
Nammal Nala, Salt Range	
first appearance of *I. parva* (Pakistani-Japanese Research Group, 1985)	lower part of 1.4 m thick Middle Kathwai Member, also in Zaluch section
$\delta^{13}C$ excursions (Baud *et al.*, 1989)	both above and below PTB, see text for explanation
Kuh-e-Ali Bashi (Baud *et al.*, 1989)	
first appearance of *I. parva*	Bed 22L = PTB
$\delta^{13}C$ excursion	sample 33 in Bed 21, below PTB
Sovetashen, Transcaucasia (Zakharov, 1985; Baud *et al.*, 1989)	
first appearance of *I. parva*	= PTB
$\delta^{13}C$ excursion	just at the PTB level
Tesero, Southern Alps	
first appearance of *I. parva*	lower Mazzin
$\delta^{13}C$ excursion (Margaritz *et al.*, 1989)	sharp drop from *Bellerophon*, but
continuous	drop in Mazzin, no excursion
Gartnerkofel, Repwand outcrop (Holser and Schönlaub, 1991)	
first appearance of *I. parva*	7 m from the base of Tesero
$\delta^{13}C$ excursion	6.7 m from the base of Tesero
Ir spike (0.196 ppb)	4.17 m from the base of Tesero (0.22
ppm)	

* Because of a long gap between the Permian and the *O. latilobatum-I.parva* horizon, whether the earliest *Otoceras* is synchronous with *parva* cannot be proved. *O. latilobatum* is an advanced *Otoceras* lacking flattened ventral flanks and not belonging to the *O. concavus* group. The earliest *Otoceras* should have appeared earlier.

3.2. The exact level of the PTB at Meishan

Extensive fossil collecting has been done at the seven sections of Meishan. They are all located along the southern slope of Meishan Hill and due to exhaustive quarrying they form a continuous and laterally traceable outcrop. The distances from west to east are: A-80m-B-70m-C-200m-F-100m-D-400m-E-100m-Z. Estimated 200 kg blocks of Bed 27 and its equivalents, being 16 cm thick, have been processed for conodont collection. Table 1 (the distribution of conodonts at the PTB of Meishan) shows that:

a) Conodonts at the PTB of Meishan are not rare, but relatively abundant.

b) Bed 26 yields, besides *Otoceras?* sp., *Hypophiceras* spp. and Permian brachiopods, exclusively Permian conodonts. The Permian nature of this abundant conodont assemblage is too definite to place it in the Triassic. The occurrence of Permian conodonts in *Otoceras-Hypophiceras* beds has already been reported from Greenland (orally by Kozur) and Kashmir (Nakazawa, 1993). If we do not stick to the traditional view that *Otoceras* is exclusively Triassic, shortcomings of which have been comprehensively discussed (Chinese PTBWG, 1993), the reasonable conclusion will be that Bed 26 belongs to the Permian.

c) Beds 27a & b also yield Permian conodonts, as shown in Section Z of Table 1 (*Clarkina changxingensis, Hindeodus latidentatus*, and recently a *C. deflecta*). Quantitative sampling of beds a & b indicates that the absence of *parvus (parva)* there is not due to a collection failure, but due to the non-existence of *parvus (parva)* in these beds. Positioning the PTB within Bed 27 is also in accordance with the IGC guide preferring the location of boundaries within a monofacial continuum.

3.3. Re-evaluation on the possibility of choosing the GSSP of the PTB in Gondwanan Tethys areas such as Kashmir and Spiti

Unlike in South China where the Permian-Triassic continuum is commonly accepted, except for a few specialists, in the peri-Indian-Subcontinent part of the Gondwanan Tethys a regional discontinuity exists at the Permian-Triassic interval which applies to all sections in this region except Guryul Ravine. This has demonstrates two major shortcomings of these sections:

a) The lack of typical Changxingian or Dorashamian ammonoid and conodont faunas in the strata underlying the *parvus (parva)* Zone. This also applies to Guryul Ravine.

b) The discontinuity between the Permian and Triassic, including in sections in Spiti. At the Xishan (Western Hills) section of Selong, Tibet, which is said to have a continuous Permian-Triassic sequence, the obvious hiatus lying a few centimetres below the PTB makes that 'continuum' meaningless. Taking into account this regional discontinuity, one should be very cautious in dealing with other reported continuous sections in this region which may possibly be specious.

Although the position of the Permian-Triassic boundary is theoretically only defined by the base of the Triassic, we really should take the completeness of the uppermost Permian as a necessary factor into serious consideration for setting the PTB. It is unimaginable to position the GSSP of the PTB in a section where the existence of uppermost Permian (according to ammonoids and conodonts) is uncertain or a hiatus occurs within a short distance below the boundary.

	Subdivisions	Conodonts	Ammonoids	MEISHAN Sheng *et al.*, 1984, 1987; Yang *et al.*, 1987; Yin *et al.*, 1994	SHANGSI Li *et al.*, 1986, 1989; Yang *et al.*, 1987; Chinese PTBWG, 1993	GURYUL RAVINE Nakazawa *et al.*, 1975; Matsuda, 1981; Kapoor, 1992; Yin, 1993	NARMAL NALA Kummel *et* Teichert, 1970; Pak.-Jap. Res. Gr., 1985	SELONG Rao *et* Zhang, 1985; Yao *et* Li, 1987; Wang *et al.*, 1989; Orchard *et al.*, 1994	HAMBAST C (Abadeh) Iran.- Jap. Res. Gr., 1981	KUH-E-ALI-BASHI Teichert *et al.*, 1973 Altiner *et al.*, 1980; Golshani *et al.*, 1986	DORASHAM II-3 Kotlyar, 1991; Kotlyar *et al.*, 1983; Zakharov, 1985, 1992	TESERO Broglio Loriga *et al.*, 1986; Broglio Loriga *et* Cassinis, 1992	GARTNERKOFEL Holser *et al.*, 1991
T	6	*Isacicella isarcica*	*Ophiceras*	mixed bed 3 (beds 28 up) *I. isarcica* *I. parva, I. turgida* *Ophiceras* *Pseudoclaraia wangi* *C. giesbachi*	beds 9-15 *I. isarcica* *I. parva* *C. griesbachi* *Ps. wangi* *H. decrescens*	Kuhnamuh E3 (beds 60 up) *I. isarcica* *Ophiceras* *C. griesbachi* *C. carinata*	Kathwai Upper Unit *I. isarcica* *Ophiceras connectens* *C. carinata*	bed 22 *I. parva* *Ophiceras* *C. carinata*	Elikah Unit a, beds 3 up *I. parva* *I. turgida* *I. isarcica* *Claraia* *Xenodiscus*	Claraia limestone (22 M, U & up) *Claraia* spp. *Ophiceras* *I. isarcica*	Claraia beds 23-24 (Zakharov, 1992) *I. isarcica* *I. parva* *I. turgida* *Ophiceras* *Claraia*	Mazzin, beds 40 up *Claraia* (bed 40) *I. isarcica* (bed 46A)	Mazzin *I. isarcica* *I. turgida* *I. parva*
T	5	*Isarcicella parva*	U. *Otoceras*	bed 27 c,d *I. parva* *H. typicalis* *H. julfensis* *H. latidentatus* *Clarkina changxingensis*	beds 7-8 *Claraia* *H. decrescens* *2	E2 beds 56-59 *O. woodwardi* *I. parva* *H. typicalis*	Middle Unit *I. parva* *H. typicalis* *Ophiceras connectens*	*3 bed 20u-21 *I. isacrcica, I. parva* *Oto. woodwardi* bed 20L, M. *Oto. latilobatum* *I. parva* *H. typicalis* *C.aff.changxingensis* *'Peribositra'*	Unit a, beds 1-2 *I. parva* *H. typicalis*	bed 22L *I. parva?* *H. typicalis*	beds 13b-22 (Zakharov, 1992) *I. parva* *Claraia* (rare) *I. latidentata* (Kozur, 1980) *I. turgida* (Kotlyar, 1991)	L. Mazzin *Unionites-Lingula* *I. parva* *Ellisonia* sp. no Perm. brachi. & forams	L. Mazzin *I. parva*
P	4	*Hindeodus typicalis*	L. *Otoceras*	bed 27 a,b *H. typicalis*		E2 bed 55 *H. typicalis* *C. carinata* *Kyanites*	*H. typicalis*			bed 21 *H. typicalis?*	red clays and marls *C. changxingensis* *C. deflecta* *H. typicalis* *H. latidentatus* (Kotlyar, 1991)	U. Tesero - lowest Mazzin *Towapteria scythica* (bed 12) Perm. brachi.	
P	3	*Clarkina changxingensis* *C. deflecta*		mixed bed 1 (beds 25,26) *Otoceras?* *Hypophiceras* *H. typicalis* *H. latidentatus* *C. changxingensis* *C. deflecta* *'Peribositra'* Perm. brachi.	bed 6 *Hypophiceras* *C. changxingensis* bed 5 (black clay) *4 *Metophiceras* *Tompophiceras* *Pseudotirolites?*	E2 beds 52-54 *O. woodwardi* *'Glyptophiceras'* *'Peribositra'* *H. typicalis* Perm. brachi.	Lower Unit Perm. brachi. & forams unstable clay	------	Unit a, bed 0 (shale)	Ali Bashi Fm. *C. changxingensis* *?Pleuronodoceras* *?Pseudotirolites*			U. Tesero + basal Mazzin *H. typicalis* *I. latidentata*
P	2		*Pseudotirolites-Pleuronodoceras*	beds 24 down *Palaeofusulina* *Pleuronodoceras* *Rotodiscoceras* *C. changxingensis* *C. deflecta*	*Pseudotirolites* *Pleuronodoceras* *Clarkina changxingensis* *C. deflecta*	? Kunahmuh E1 Perm. brachi. & forams *'Peribositra'*	-------				*Pleuronodoceras occidentale* with some conodonts as the overlying bed	L. Tesero 'Mixed fauna' Perm. brachi. & forams	L. Tesero Bellerophon Fm. *Hemigordius* *Globivalvulina*
P	1	*Clarkina subcarinata*	*Paratirolites* *Shevyrevites*	L. Changxing Fm. *Tapashanites* *C. subcarinata*	L. Dalong Fm. *Tapashanites* *C. subcarinata*	Zewan D?	-------	-------	Hambast Fm. U 7 *Paratirolites* *Iranites* *Julfotoceras* *C. subcarinata* *Shevyrevites*	Ali Bashi Fm. *Paratirolites* zone *C. subcarinata* *Shevyrevites*	*Paratirolites kittli* *C. subcarinata* *H. typicalis* Permian forams	Bellerophon Fm. beds 1-7b Perm. brachi. & forams	
Underlying strata						Zewan D	Chhidru Fm.	Selong Gr.					

Table 3. Pan-Tethyan correlation of the Permian-Triassic boundary.

The discontinuity may also have caused disorder in the Ir anomaly-$\delta^{13}C$ excursion - *parvus (parva)* sequence as seen in Nammal, Salt Range, where two $\delta^{13}C$ excursions occur instead of one near the PTB; the lower one being a diagenetic result due to fresh water inflow during the period of non-deposition represented by the hiatus (Baud et al., 1989).

The accessibility of Guryul Ravine is still a problem. Dr. Kapoor, ex-director of the Indian Geological Survey, wrote me that the situation is bad there due to abductions and even killings of foreigners by mercenaries from foreign countries. Therefore, the Indian Government will not permit working in that area. This explains why we failed to acquire cooperation from the National IGCP Committee and other institutions of India on this section. We can only hope the situation will change within the near future.

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Erratum

Careful readers will have noticed that Table 1 of the paper by H. Kozur (ALBERTIANA 15, p. 41) in fact belongs to the paper by H. Kozur, K. Krainer and H. Mostler in the same issue, pp. 24-26. We apologise for this error.

FAR EASTERN, SIBERIAN AND EAST EUROPEAN PERMIAN-TRIASSIC EVENTS

(Annual Report 1995 of the IGCP 359 Russian National Working Group)

Yuri D. Zakharov

Summary of achievement

1 - Early Carboniferous radiolarians were recently found by V.S. Rudenko, I.V. Kemkin and A.V. Prokopiev (1994) in chert sequences of Indigirka River. New data on radiolarians and conodonts from Permo-Triassic boundary beds in cherty deposits of Sikhote-Alin have been reported by V.S. Rudenko, E.S. Panasenko and S.V. Rybalka (Rudenko, 1994; Rudenko, Panasenko, 1994; Rudenko and Rybalka, in press). In an outcrop of red and gray bedded cherts of Pantovyi Creek no more than 20 m thick, they have found a succession of radiolarian assemblages of the six Permian stages:

(1) *Pseudoalbaillella scalprata* (Upper Sakmarian),
(2) *Spinodeflandrella acutata* (Yakhtashian-Bolorian),
(3) *Pseudoalbaillella corniculata* (Kubergandinian),
(4) *Pseudoalbaillella globosa* (Murgabian-Lower Midian),
(5) *Follicucullus? monacanthus* (Middle Midian), and
(6) *Follicucullus porrectus* (Upper Midian).

Most assemblages are characterized by conodonts. In the neighbouring section, 100 m northeast of the first, the radiolarian assemblages of the three Upper Permian stages were found in gray bedded cherts no more 6 m thick:

(7) *Follicucullus porrectus* (Upper Midian),
(8) *Neoalbaillella optima* (Dzhulfian), and
(9) *Neoalbaillella pseudogrypa* (Dorashamian).

Both outcrops represent the areas of a single plate. The presence of the conodonts *Gondolella carinata* Clark, *G. subcarinata subcarinata* (Sweet), *G.* ex gr. *orientalis* Barskov et Koroleva, *Clarkina changxingensis* (Wang et Wang) in the uppermost Permian sequences is testimony of their position near the Permian-Triassic boundary. An Induan (?) assemblage was recognized in the Fudinov Kamen' Mountain area - few Sphaeroidea were met together with conodont fragments resembling *Hindeodus* ex gr. *parvus* (Kozur). Abundant Sphaeroidea were found only in Lower Triassic cherts of Breevka Village area.

2 - The stratigraphical significance of the foraminifer genus *Sphairionia* has been discussed by G.P. Pronina (1994). The representatives of this genus characterize the lower part of the Midian.

3 - Y.D. Zakharov (Zakharov and Oleinikov, 1994; Zakharov, Kotlyar and Oleinikov, 1995) has described new taxa of Late Dorashamian ammonoids: *Dzhulfoceras orientale* n.sp. and *Sutchanites oleinikovi* n. gen. et sp.

4 - Stratotype sections of the Induan and Olenekian (Chhidru, Buur-Nyykabyt, Mengilyakh, etc.), and a type section of the Induan-Olenekian boundary (Tree Kamnya Cape area in South Primorye) are suggested by Y.D. Zakharov (1994a,b; in press).

5 - For the first time a rich assemblage of foraminifers (more than 70 species) was discovered in exotic blocks within the Eskiordinian Formation of Crimea by G.P. Pronina and V. Ja Vuks (1994) (I.O. Chediya, G.S. Kropatcheva and Y.D. Zakharov collection).

6 - The two characteristic groups of Late Triassic frame-builders show that: (1) within the Tethys, corals can excellently be correlated at species level (of the northern Caucasus seventeen species, of which only one is endemic, the others have a wide distribution), (2) at the same time sphinctozoa can only be correlated at generic level (of the total number of eleven species, known from the southwestern Caucasus, only *Ascosymplegma expansum* Seilacher is found in North America) (Belyaeva and Punina, 1994).

7 - T.A. Punina (in press) proposed a stratigraphical scheme for the Triassic limestones of Sikhote-Aline (on the basis of corals): (1) *Coryphyllia moisseevi* beds (Ladinian? - Lower Carnian),

(2) *Volzeia badiotica* beds (Upper Carnian),
(3) *Margarosmilia charlyana* beds (Lower Norian),
(4) *Gablonzeria kiparisovae* beds (Middle Norian),
(5) *Meandrostylis tener* beds (Upper Norian), and
(6) *Retiophyllia buonamici* beds (Rhaetian).

8 - On G.I. Buryi's (1995) data, in the oceanic basin of Sikhote-Alin underwater erosion of bottom sediments apparently took place in Triassic time. The intraformation breaks in the cherty deposits formed under the pelagic environment and, apparently, with the contoured current participation.

Selected publications

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PRONINA, G.P. and VUKS, V.J., 1994. New data on the Triassic foraminifers of Crimea. Ibid.: 39.

Punina, T.A., (in press). Classification and correlation of Triassic limestones in Sikhote-Alin (on the basis of corals). *In:* J.M. Dickins, Z.V. Yang and H.F. Yin (eds.), Late Palaeozoic and Early Mesozoic Circum-Pacific Events and their Global Correlation. Cambridge Univ. Press.

RUDENKO, V.S., 1994. Permian radiolarians of Primorye. 7th Meeting of the Intern. Association of Radiolarian Paleontologists. Abstracts: 100. Osaka Univ.

RUDENKO, V.S., KEMKIN, I.V. and PROKOPIEV, A.V., 1994. The first finding of Early Carboniferous radiolarians from cherty deposits of northeast Yakutia, Russia. Ibid: 141.

RUDENKO, V.S. and PANASENKO, E.S., 1994. Upper Permian and Lower Triassic radiolarians in cherty deposits of Primorye. Ibid: 101.

RUDENKO, V.S., PANASENKO, E.S. and RYBALKA, S.V., (in press). Radiolaria from Permo-Triassic boundary beds in cherty deposits of Primorye (Sikhote-Alin). *In:* J.M. Dickins, Z.Y. Yang, and H.F. Yin (eds.), Late Palaeozoic and Early Mesozoic Circum-Pacific Events and their Global Correlation. Cambridge Univ. Press.

ZAKHAROV, Y.D., 1994a. Induan-Olenekian boundary stratotype. Lower Triassic. Tikhookeanskaya geologiya, 4: 33-44 (in Russian).
ZAKHAROV, Y.D., 1994b. Proposals on revision of the Siberian standard for the Lower Triassic and candidate stratotype section and point for the Induan-Olenekian boundary. Albertiana, 14: 44-51.
ZAKHAROV, Y.D., (in press). The Induan-Olenekian boundary in the Tethys and Boreal realm. *In:* E.Kristan-Tollmann (ed.), Shallow Tethys 4, Wien.
ZAKHAROV, Y.D., KOTLYAR, G.V. and OLLEINIKOV, A.V., 1995. Late Dorashamian (Late Changsingian) invertebrates of Far East and volcanogenic peculiarities of the Permian-Triassic boundary time in western Circum-Pacific. Tikhookeanskaya geologiya, 1: 40-50 (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.

Recently published literature

DOBRUSKINA, I.A., 1995. Keuper (Triassic) Flora from Middle Asia (Madygen, Southern Fergana). Bull. N.M. Mus. Nat. Hist. Sci., 5: 1-49.

The New Mexico Museum of Natural History & Science has devoted another of its bulletins to Triassic palaeontology and stratigraphy. This time it is the description of Keuper flora of Madygen, Southern Fergana (Kirgizstan, Middle Asia) by Dr. I.A. Dobruskina from the Hebrew University in Jerusalem. It is a laudable effort that this flora is now published in English. Most of the Russian literature is very difficult to trace and to obtain and this book will definitely fill a gap in many libraries.

The rich and abundant Madygen flora was first discovered in 1933 and the material was mainly collected in the 1940s. The Madygen flora was earlier described in a number of contributions by Sixtel (between 1949 and 1968) and later by the present author. The introductory chapters are pretty lengthy and the descriptive part is only about 13 pages long and published under the heading "Description and preliminary determinations of the Madygen fossil plants". Only a part of the collection has been described yet. The material is illustrated on 46 plates of reasonable quality. Some of the pictures are either rather greyish, too small or not showing sufficient detail. However, altogether is a helpful photographic documentation.

In fact, this paper seems to be an English compilation of the earlier papers which were published in Russian. The author thereby revised many of Sixtel's identifications. These are listed in separate tables. Apparent is the lack of references to relevant recently published literature. The most recent citation is from 1985 (sic!). I was really perplexed when I found the following reference in the literature list: *Dobruskina, I.A. (1988): Lunz flora - a standard for Karnian floras. Abh. Geol. B.A., Wien (in press)*, this in a paper published by that same author in 1995! This suggests that this is a manuscript that has been accepted long after it had been written, and without any of the necessary revisions. However, in such a case the editors should have been a little bit more critical. Although it is good that the Madygen flora has now been published in English and that it is easily obtainable (see the order form overleaf), the palaeobotanical community looked forward to an up-to-date paper and not to an old, out-of-date manuscript.

Hans Kerp

International Symposium on the Epicontinental Triassic

Halle/Saale, Germany

September 1998

First Circular

Five years after the successful Symposium on the Nonmarine Triassic in Albuquerque, New Mexico, a three-day international Symposium on all aspects of the epicontinental Triassic will be held in Halle, Germany, by the Institute of Geosciences and Geiseltal Museum and the German Subcommission on Permian and Triassic Stratigraphy in the second half of September 1998.

The Symposium will cover stratigraphy, correlation, chronology, sequence stratigraphy, paleontology, sedimentology, paleoclimatology, paleoecology, and paleogeography. It will also provide an overview of the classic Germanic Triassic. The International Subcommission on Triassic Stratigraphy has been invited to hold a meeting in conjunction with the Symposium. Short papers and abstracts will be published in a Symposium Volume.

Two days of field trips before the Symposium and a 4-day post-Symposium field trip are planned to examine the Buntsandstein, Muschelkalk and Keuper (as well as the Rotliegend, Zechstein and Lias) in their classic regions in Germany.

The 1000 year old City of Halle with its 500 year old university is located in a region famous for its history and geology. Halle can readily be reached by autobahn or train, or by airplane via Leipzig-Halle Airport.

We cordially invite all colleagues interested in the Triassic to attend the Symposium and to return the preliminary questionnaire. This first circular has been mailed to those on the enclosed list. Please send a copy of this circular to additional people or institutions who might be interested in the Symposium.

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Institute of Geosciences and Geiseltal Museum
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Tel.: + 49-345-37781
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Please return to the organisers as soon as possible:

G.H. Bachmann, G. Beutler, H. Haubold
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International Symposium on the Epicontinental Triassic

Halle/Saale, Germany
September 1998

Preliminary Questionaire

Name: ______________________________
Family Name / First Name
☐ Ms ☐ Mr ☐ Dr ☐ Prof

Institution: ______________________________

____

Address: ______________________________
Street

____
City / Postal Code / Country

Telephone: ______________ Fax: ______________

I plan to attend the Symposium (please tick ✓)
☐ Very probably ☐ Probably ☐ Unlikely

I plan to contribute with an
☐ Oral paper ☐ Poster

Subject/Provisional title: ______________________________

____

____

I plan to attend the pre-Symposium field trips (number of days)
☐ ☐ Very probably ☐ ☐ Probably ☐ ☐ Unlikely
1 2 1 2 1 2

I plan to attend the 4-day post-Symposium field trip
☐ Very probably ☐ Probably ☐ Unlikely

Primary field of interest: ______________________________

____

Probable number of accompanying persons: ________

Comments/suggestions: ______________________________

____

The second circular will be sent only to those who reply to this one.

____
Signature/Date

ANNOTATED TRIASSIC LITERATURE

Hans Kerp and Henk Visscher[1]

AMODEO, F. and BAUMGARTNER, P.O., 1994. Stratigraphic revision of the "Scisti Silicei" Formation (Upper Triassic-Upper Jurassic), Lagonegro Basin, southern Italy. Preliminary Report. Palaeopelagos, 4: 35-46.

The "Scisti Silicei" Formation is part of a Mesozoic deep-water sequence deposited in the Lagonegro Basin. The formation shows regionally consistent vertical and lateral variations in colour and relative amounts of carbonate, fine terrigenous, and biosiliceous sediments. This allows for a subdivision into five members. From the thinner, condensed successions four stratigraphically superposed members are recognized and described: (1) lower variegated member (late Norian-Rhaetian), (2) black calcareous member (?Rhaetian-?Toarcian) (3) red shale member (?Toarcian-?Bajocian), (4) green radiolarite member (Bathonian or older to Late Jurassic). An upper variegated member (5) (Bathonian-Callovian to Late Jurassic) is described from the upper part of the thicker successions of the Scisti Silicei Formation; it is at least partially contemporaneous with the Green radiolarite member. Late Triassic (late Norian and Rhaetian) radiolarian and conodont faunas are present in the Lower variegated member (1). Middle and Late Jurassic radiolarian faunas are enumerated from the green radiolarite member (4) and the upper variegated member (5). The lower limit of the "Scisti Silicei" appears to be diachronous (upper Norian-Rhaetian) and does not show a N-S oriented trend.

AMPORNMAHA, A., 1995. Triassic carbonate rocks in the Phatthalung area, Peninsular Thailand. J. SE Asian Earth Sci., 11: 225-236.

Carbonate rocks in the Phatthalung area and others in Peninsular Thailand have been known as the Permian Rat Purl Limestone. The study area is characterized by several isolated limestone mountains and is located in Phatthalung province. Micropaleontological study of these carbonate rocks indicates that they should be assigned a late Early to Late Triassic age. The Chaiburi Formation is newly proposed and divided into three members: the Phukhaothong Dolomite, Chiak Limestone and Phanomwang Limestone in ascending order. The Phukhaothong Dolomite consists of thickly bedded to massive dolomite and yields *Neospathodus kummeli* Sweet, *N. waageni* Sweet, *N.* cf. *waageni* Sweet and other conodonts that indicate Dienerian to Smithian (Early Triassic). The Chiak Limestone Member consists of bedded and laminated limestone with intercalated thin chert layers and nodules. This limestone commonly yields Early Triassic to Middle Triassic conodonts such as *Neospathodus timorensis* (Nogami) and *N. kockeli* (Tatge), both reliable indicators of latest Spathian to early Anisian, and rare occurrences of *Neogondolella bulgarica* (Budurov and Stefanov), an indicator of the middle Anisian. The Phanomwang Limestone Member is mostly massive limestone with intercalated reef limestone (coral buildups) and yields abundant

[1] The help of Sabine Gibas and Gaby Swenzien (Münster), and Dr. Zwier Smeenk and Dipl.-Geol. Wolfram Kürschner (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.

fossils that indicate Carnian (Late Triassic). Microfacies analysis and stratigraphic sequences of carbonate rocks in this area show the gradual change of depositional environment from low to high energy conditions.

ANDJELKOVIĆ, M., PEŠIĆ and ANDJELKOVIĆ, D., 1992. Paleogeography of the Upper Permian Dinarides. Ann. Géol. Penins. Balk., 56: 1-15.

The paleogeographic relationships of the Upper Permian in the Dinarides are considered for both marine and terrestrial environments. The marine environment is divided into sea basins, bathymetric relations are considered, character of depositional environments, type of sedimentation and character of fauna, temperature and salinity of sea water, and paleogeographic communication between basins in the Dinarides and the East Tethys. Terrestrial environments are divided into freshwater basins and lands.

ARTABE, A.E., MOREL, E.M. and ZAMUNER, A.B., 1994. Estudio paleobotanico y tafonomico en la formacion Paso Flores (Triasico superior), en el Cañadón de Pancho, Neuquen, Argentina. Ameghiniana, 31(2): 153-160.

Two Triassic plant assemblages found at Cañadón de Pancho locality, belonging to Paso Flores Formation, are characterized as two different taphocoenosis belonging to different sedimentary facies. The lower burial contains fossil plants belonging to Corystospermales, Cycadales and Coniferales, as shrubs or trees; this facies is associated with lacustrine environments. The characteristics of the plant remains suggest that the fossils underwent a short transportation and the parent communities grew in the area surrounding the lake. The upper burial is an autochthonous or hipautochthonous taphocoenosis, dominated by the herbaceous *Scleropteris grandis* n. sp. and related to a fluvial environment. Although of a slender structure, complete fronds of *S. grandis* n. sp. suggest fossilization *in situ*. This taxon grew on top of bars and was dominant over other taxa, as *Sphenobaiera robusta, Czekonowskia rigali* and *Cordaicarpus* sp. that occur occasionally, probably coming from neighbouring areas. The chronostratigraphic analysis based on fossil plants suggests a late Upper Triassic age.

BASU, A.R., POREDA, R.J., RENNE, P.R., TEICHMANN, F., VASILIEV, Y.R., SOBOLEV, N.V. and TURRIN, B.D., 1995. High-He-3 plume origin and temporal-spatial evolution of the Siberian flood basalts. Science, 269(5225): 822-825.

An olivine nephelinite from the lower part of a thick alkalic ultrabasic and mafic sequence of volcanic rocks of the northeastern part of the Siberian flood basalt province (SFBP) yielded a $^{40}Ar/^{39}Ar$ plateau age of 253.3 $\pm$ 2.6 million years, distinctly older than the main tholeiitic pulse of the SFBP at 250.0 million years. Olivine phenocrysts of this rock showed $^{3}He/^{4}He$ ratios up to 12.7 times the atmospheric ratio; these values suggest a lower mantle plume origin. The neodymium and strontium isotopes, rare earth element concentration patterns, and cerium/lead ratios of the associated rocks were also consistent with their derivation from a near-chondritic, primitive plume. Geochemical data from the 250-million-year-old volcanic rocks higher up in the sequence indicate interaction of this high-^{3}He SFBP plume with a suboceanic-type upper mantle beneath Siberia.

BENIGNI, C. and FERLIGA, C., 1995. Review and morphology of *Amphitomella* Bittner, 1890 (Brachiopoda, Carnian) from San Cassiano Formation (Cortina d'Ampezzo, Italy). Riv. It. Paleont. Strat., 100: 511-536.

Within the compass of Cassian brachiopod faunas from the Ampezzan Valley (Belluno), *Amphitomella hemisphaeroidica* (Klipstein, 1844), a taxon noted in the literature for the abnormal development of its median septum in both valves, is analysed. This structure has been examined in detail with regard to morphology, ontogenesis and ultrastructure. Other significant diagnostic and morphofunctional characters are: brachidium, cardinalia, peripheral margin. For the first time, the presence of the saddle in the brachidium is reported, thereby changing Bittner's reconstruction (1890). The cardinalia comprise a cardinal lamina and a cardinal pit; they are massive and probably thus fitted for the attachment of very developed diductor muscles. The anterolateral margin presents snugly fitting internal ridges and grooves and an external gutter covered by mantle; these elements reduce the gape of the shell and affect the mode of absorption of nutrients. Median septa are thus necessary for enhancing water flow through the mantle cavity.

BERNECKER, M. and WEIDLICH, O., 1994. Attempted reconstruction of Permian and Triassic skeletonization from reefbuilders (Oman, Turkey): quantitative assessment with digital image analysis. Abh. Geol. B.-A., 50: 31-56.

Upper Permian and Upper Triassic reefbuilders from different tectonic units of the Oman Mountains and Turkey were analyzed quantitatively with respect to skeletonization (skeleton in area percent) and skeletal mass (skeleton in g/cm^3). Data were derived from thin sections using the digital image analysis system 'Vidas'. The quantitative data were combined with taxonomy, description of gross morphology and microfacies analysis in order to understand the influences of diagenesis in the differing sizes and orientations of thin sections. The investigated skeletons exhibit a wide range of preservation, ranging from unaltered to recrystallized with relic structures. Reefbuilders studied were "sphinctozoans", "inozoans", "chaetetids", rugose corals, scleractinians, and hydrozoans. The measured parameters vary considerably for higher taxa (e.g., skeletonization of sphinctozoan sponges is 21-54 %) as well as for species (e.g., the sphinctozoan *Alpinothalamia bavarica* is 29-51 %). The variation is regarded to be triggered by three main factors: a) differences in morphotypes, b) intraspecific variability, and c) variation of skeletal elements within the colony. Well-skeletonized and weakly skeletonized higher taxa were observed in the mean skeletonization and the mean skeletal mass. These data help refine the guild concept proposed by Fagerstrom (1987). The quantitative assessment of the skeletonization and skeletal mass may provide data for the discussion about paleoproductivity of reefbuilders and the sedimentary net budget of ancient reefs.

CALZADA, S., PEYBERNES, B., KAMOUN, F. and YOUSSEF, M.B., 1994. *Tunethyris*, un noveau genre de brachiopode du Trias de Tunisie centrale. Revue de Paléobiologie, 13(1): 117-124.

A new genus of brachiopods, *Tunethyris* n. gen., is described from the Triassic series (Norian) of Dj. Rheouis (Central Tunisia). Its diagnosis is: Medium size Dielasmatidae of ovate outline with a sulciplicate anterior commissure. Both valves subequally convex. Dental plates present. Strong medium septum. The new genus is monotypic at the present time and its type-species, also new, is named *Tunethyris punica* n. sp.

CANTRILL, D.J., DRINNAN, A.N. and WEBB, J.A., 1995. Late Triassic plant fossils from the Prince Charles Mountains, East Antarctica. Antarctic Science, 7: 51-62.

Megafloral remains recovered from the Jetty Member and the upper part of the Flagstone Bench Formation, Amery Group include *Dicroidium* and *Pagiophyllum*. *Dicroidium zuberi* and *D. crassinervis* f. *stelznerianum* occur with *Pieruchus dubius* and support a Mid to Late Triassic age. A new species of conifer, *Pagiophyllum papillatus*, is recognized along with an undetermined conifer pollen cone.

Carter, E.S., 1994. Evolutionary trends in latest Norian through Hettangian radiolarians from the Queen Charlotte Islands, British Columbia. Geobios, M.S. 17: 111-119.

Uppermost Triassic and lowermost Jurassic (Hettangian) radiolarians from continuous sequences of the Sandilands Formation (Kunga Group), Queen Charlotte Islands, British Columbia, Canada, provide a rare glimpse into faunal patterns of evolution, radiation, extinction, and regeneration near a major stratigraphic boundary. The radiolarians are dated by Triassic ammonoids and conodonts, and Jurassic ammonites. Uppermost Triassic radiolarians are from strata equivalent to the Amoenum and Crickmayi ammonoid zones. Lowest Jurassic faunas are Planorbis Zone equivalent. The direction and pace of evolution in the highly diverse uppermost Triassic fauna is variable. Conservative taxonomic groups such as the pantanelliids and canoptids evolve gradually with only minor morphological change. Species extinctions occur regularly throughout the interval and across the boundary, with most genera ranging into the Jurassic. Current data confirm that *Betraccium* persists to the topmost Triassic but not into the Jurassic. Architecturally complex forms such as *Squinabollela* and *Praecitriduma* apparently have short ranges; they are common in uppermost Triassic beds but not found in the Lower Jurassic. Other radiolarian groups experience periodic bursts of radiation evidenced by multiple new species, and even new genera, most of which survive to the topmost Triassic but not beyond e.g. *Ferresium* and *Laxtorum.* Finally, ancestral forms of some typical Lower Jurassic taxa are first recognized in uppermost Triassic beds e.g. *Bipedis, Canutus, Crucella,* and *Droltus.* Lowermost Jurassic radiolarians are easily distinguished from uppermost Triassic ones by their primitive appearance and low diversity, and by the absence of all distinctive uppermost Triassic taxa. Lower Hettangian faunas are characterized by latticed, spherical, irregularly spinose forms with poorly organized meshwork; non-distinctive spongy forms with spines; very simple nassellarians; and *Archaeocenosphaera laseekensis. Pantanellium tanuense* is the only pantanelliid species in Lower Hettangian collections.

Cirilli, S. and **Montanari, L.**, 1994. The Carnian evaporite succession of Bistriça river (southern Albany). Palaeopelagos, 4: 107-118.

An evaporite succession, belonging to the Jonian palaeodomain has been investigated in Southern Albany. The succession, about 150m thick was deposited in a carbonate ramp evolving to a carbonate platform under dry climate conditions. In the investigated portion of the evaporite succession two type of cycles (A and B), having a thickening upward trend, have been recognized. Palynological analysis documented, for the first time, the presence of a Carnian assemblage. In detail, the combined occurrences of *C. secatus, E. vigens, P. summus, V. ignacii, P. densus* with *S. speciosus* are indicative of Tuvalian. The presence of the southern element *S. speciosus* jointed to other taxa is indicative of the Onslow Microflora, a mixture of Laurasian and Gondwana floras which should border, during Mid-Late Triassic, the continental margins of the Tethys. Therefore it represents a new further finding useful for depicting the palaeogeography of the Tethys during the Triassic. Quantitative analysis of the palynological content and lithology (the section contains evaporites) pointed out the presence of an arid climate which affected, during the Late Triassic, this portion of the Tethys.

Cirilli, S., Bucefalo Palliani, R. and **Pontini, M.R.**, 1994. Palynostratigraphy and palynofacies of the Late Triassic *R. contorta* facies in Northern Apennines: II) The Monte Cetona Formation. Revue de Paléobiologie, 13(2): 319-339.

This paper provides preliminary palynological data from the Monte Cetona Fm. sampled in the type area and in other localities of the Northern Apennines. On the basis of palynological assemblage dominated by *C. meyeriana, C. torosus, D. hallii, G. rudis, O. pseudoalatus, T.*

ancorae, T. pseudomassulae, the Monte Cetona Fm. can be dated as Late Rhaetian (mainly comprised within the Schuurman's Phase IV); the presence of microfloras belonging to the *Heliosporites* Assemblage Zone at the base of the upper member of the formation, in the southeastern outcrops, could date this interval to the Rhaetian/Hettangian boundary. From the palynofacies analysis and sedimentologic studies the depositional environment can be referable to a carbonate ramp characterized by relative sea level fluctuations which caused palaeoenvironmental variations: off shore (amorphous debris facies) vs. near shore (vascular tissue facies) vs. off shore.

CRASQUIN-SOLEAU, S. and TEHERANI, K., 1995. Première découverte d'ostracodes triasiques dans la Formation de Khaneh Kat, Montagne Michparvar (ouest Iran). Rev. Micropaléont., 38: 27-36.
Well preserved ostracodes are found in the Khaneh Kat Formation (Zagros facies) in Iran. They are attributed to the Lower Carnian. They are the first ostracodes described from this part of Iran. Five species are recognized, three are new: *Movschovitschia* cf. *interrupta* Kristan-Tollman 1983, *Hungarella* cf. *usuriensis* (Gramm 1970), *Metacyrtheropteron ? zagrosensis* n.sp., *Cytherella persensis* n.sp., *Reubenella khanekkatensis* n.sp. This fauna was extracted from thin beds of limestones in a dolomite formation. The species differ from species found in other Iranian areas (Late Ladinian of Aghdarband, Rhaetian of Bagerabad).

CREMER, H., 1994. Zwei neue chaetetide Schwämme aus der Obertrias (Nor) von Südanatolien. Abh. Geol. B.-A., 50: 89-96.
?*Blastochaetetes astrocanalis* nov.sp. and a second chaetetid sponge (Genus et sp. indet. Form A) are described from Upper Triassic (Norian) reworked reef blocks ("Cipit" limestones) of the Western Taurids (Antalya-Region, SW Turkey). Both organisms exhibit a typical chaetetid-like skeleton.

CREMER, H., 1995. Spicule pseudomorphs in Upper Triassic (Norian) chaetetid sponges from the Western Taurids (Antalya-Region, SW Turkey). Geobios, 28: 163-174.
Four spicule-bearing chaetetid sponges are described from Upper Triassic (Norian) reef carbonates of the Western Taurids (Antalya-Region, SW Turkey): *Atrochaetetes alakirensis* Cuif & Fischer, *Blastochaetetes dolomiticus* Bizzarini & Braga, *Ptychochaetetes* sp. and ?*Bauneia* sp.. Spicules are preserved as calcitic pseudomorphs. They are either short and thick or long and slender, corresponding to typical styles; oxes are rarely present in *Atrochaetetes alakirensis.* The styles are mainly embedded in the secondary rigid skeleton, but their rounded ends appear to be attached to the primary wall. In *Blastochaetetes dolomiticus* and ?*Bauneia* sp. styles are also embedded in the primary wall. A comparison of these spicule-skeletons with those of other chaetetids, especially Paleozoic species, confirms the polyphyletic origin of the Taxon Chaetetida.

CUNY, G., GODEFROIT, P. and MARTIN, M., 1995. Micro-restes de Vertébrés dans le Trias Supérieur du Rinckebierg (Medernach, G-D Luxembourg). N. Jb. Geol. Paläont. Abh., 196: 45-67.
New vertebrate micro-remains from the Upper Triassic of Rinckebierg include Actinopterygii, Dipnoi, Temnospondyli, Sauropterygia, carnivorous Archosauria, Crocodylotarsi, Pterosauria, Cynodontia and Mammalia. The faunal composition suggests a Norian age for this bone-bed and a deltaic depositional environment.

Dalrymple, G.B., Czamanske, G.K., Fedorenko, V.A., Simonov, O.N., Lanphere, M.A. and **Likhachev, A.P.**, 1995. A reconnaissance $^{40}Ar/^{39}Ar$ geochronologic study of ore-bearing and related rocks, Siberian Russia. Geochim. Cosmochim. Acta, 59: 2071-2083

$^{40}Ar/^{39}Ar$ age spectra of biotite from a mineralized vein in the ore-bearing, Noril'sk I intrusion and from picritic-like gabbrodolerite from the weakly mineralized, Lower Talnakh intrusion show that these bodies were emplaced at 249 ± 2 Ma, which is not significantly different from the age of the Permian-Triassic boundary. The ore-bearing intrusions postdate the lower third of the flood-basalt sequence in the Noril'sk area and, on the basis of geochemistry, can best be correlated with lavas slightly younger than those which they cut. Thus, flood basalt was erupted at the time of the Permian-Triassic mass extinction event, although its role in this event is, as yet, ill defined. Additional new $^{40}Ar/^{39}Ar$ age data for a group of intrusive and extrusive rocks on the western margin of the Siberian craton indicate that mafic magmatism extended over a period of several tens of million years, whereas paleomagnetic data suggest that the bulk of the Siberian flood-basalt sequence near Noril'sk has been erupted in only a million years or so. $^{40}Ar/^{39}Ar$ ages of plagioclase from early flood-basalt flows are about 2% younger than those obtained for biotite from the crosscutting, Noril'sk I intrusion, probably because of slight alteration and Argon loss from the plagioclase.

di Bari, D., 1994. Foraminiferi glomospirali della Formazione di S.Cassiano (Carnico, Dolomiti). Palaeopelagos, 4: 267-274.

Some glomospiral foraminifers belonging to the species *Glomospira perplexa* Frank, 1936 are described. The variability of the coiling and the composition of the test are discussed.

Edel, J.B. and **Schneider, J.L.**, 1995. The Late Carboniferous to Early Triassic geodynamic evolution of Variscan Europe in the light of magnetic overprints in Early Permian rhyolites from the northern Vosges (France) and central Black Forest (Germany). Geophys. J. Int., 122: 858-876.

This paper demonstrates how magnetic overprints of a geological series can provide information over a long time period, which can be interpreted in terms of geotectonic evolution. According to these new results, the Late Carboniferous-Early Permian rhyolites from the northern Vosges have recorded the magnetic held over a major part of the Permian. Recent radiometric dating assigns a Late Carboniferous-Early Permian age (298 Ma) to the previously 'Middle Permian' rhyolitic volcanism of the northern Vosges. The distribution of the palaeomagnetic directions suggests that, from the Late Autunian to the Late Thuringian, overprinting due to low-temperature alteration of titano-magnetite and crystallization of secondary haematite was more or less continuous. The apparent polar wander path (APWP) computed with the new results and the published poles shows a hairpin, which implies a drastic change of the European plate motion during the Permian. The clockwise rotation of Europe initiated in the Late Visean-Namurian stopped in the Late Autunian-Early Saxonian. This event corresponds to the end of the Variscan convergence and of the Appalachian orogeny. In the northern Vosges, the hinge of the APWP is also associated with the tectonic phase responsible for the tilting of the volcanic layers. The motion of the European plate was then converted into a counterclockwise rotation and a northward drift until the Late Triassic.

Edon, M., Ramboz, C. and **Gable, R.**, 1995. Halokinesis in the Jurassic of the southeast basin (France): Evidence for a thermal anomaly in the deep Triassic rocks. C. R. Acad. Sci., Ser. II, Fasc. A - Sci. Terre Planet., 321: 185-192.

In the SE basin, a first major halokinesis of Triassic formations at Callovo-Oxfordian times along basement faults is synchronous with the trapping of dense fluids at minimum P-T conditions of similar to 260-400 °C and similar to 1.8 kbar (Edon et al., 1994). Maximum conductive temperatures were modelled in the sedimentary pile at the Upper Callovian before halokinesis. Calculations show that pressures similar to 1.8 kbar were reached at the base of the collapsed Triassic rocks for a value of the offset similar to the present one. Temperatures, however, are always lower than the minimum values given by fluid inclusions. The existence of a convective thermal anomaly in the deep Triassic rocks at this time is demonstrated. Part of the carbonic component in the diapiric fluids, injected from below along basement faults, could have caused heat transfer, and favoured the abrupt salt uplift.

Egorov, A.Y. and Bragin, N.Y., 1995. First finds of radiolarians in Triassic sediments of the north of Siberia. Dokl. Akad. Nauk, 340: 649-652.

Faure, K., de Wit, M.J. and Willis, J.P., 1995. Late Permian global coal hiatus linked to ^{13}C-depleted CO_2 flux into the atmosphere during the final consolidation of Pangea. Geology, 23(6): 507-510.

At a time when all continents were finally arrayed in their Pangea supercontinental configuration (250 ± 50 Ma), Earth's stratigraphy records a global and very abrupt coal discontinuity. From the Tartarian stage of the Late Permian to the Middle Triassic, reduced coal productivity and/or preservation overlaps with a period of anomalous oceanic and atmospheric decrease in ^{13}C, as recorded in marine carbonates and organic matter, and terrestrial plant and animal fossils from the Northern and Southern hemispheres. During the same short period, the peripheral margin of the entire supercontinent Pangea, except for the southern shores of Tethys, was effectively under compressive stress. This unique tectonic state caused deformation and uplift of coal-bearing foreland basins and oxidation of Pangea's vast peat deposits. The latter resulted in a rapid, massive ^{13}C-depleted CO_2 flux into the atmosphere, which in turn may have forced global warming.

Fowell, S.J. and Olsen, P.E., 1995. Time calibration of Triassic/Jurassic microfloral turnover, eastern North America - Reply. Tectonophysics, 245: 96-99.

Fowell, S.J. and Traverse, A. 1995. Palynology and age of the upper Blomidon Formation, Fundy basin, Nova Scotia. Rev. Palaeobot. Palynol., 86: 211-233.

The detailed palynostratigraphy established for basins of the Newark Supergroup south of the Canadian border has proven inapplicable to the oxidized, palynologically barren outcrops typical of the Fundy basin of the Maritime Provinces. Dating of the Fundy stratigraphic section has thus been based on lithostratigraphic correlations, radiometric dates, and rare palynomorphs. Palynofloral assemblages recently recovered from an outcrop of the uppermost Blomidon Formation in the Nova Scotia arm of the Fundy basin permit the first correlations with Triassic/Jurassic boundary palynofloras throughout the Newark Supergroup. The well-preserved palynofloras are all dominated by the genus *Corollina,* but examination of the less common elements indicates that only those assemblages at the top of the Blomidon Formation, immediately below the North Mountain Basalt, are of Early Jurassic age. These palynofloras contain species that are also present in earliest Jurassic assemblages from the Hartford basin. Palynomorph assemblages 30 cm downsection from the basalt contain rare specimens of the Late Triassic index species *Patinasporites densus* and an array of monosulcate grains correlative with late Rhaetian assemblages from the Newark basin. Three new monosulcate species (*Cycadopites ginker, C. tattoo,* and *C. schlischii*) are described herein.

Ganuza, D., Spalletti, L., Morel, E. and Arrondo, O., 1995. Paleofloras y sedimentologia de una sucesion lacustrine-fluvial del Triasico tardio: la formacion Paso Flores en Cañadón de Pancho, Neuquén, Argentina. Ameghiniana, 32(1): 3-18.

The Paso Flores Formation at Cañadón de Pancho (southern Neuquén Province, Argentina) is composed of four successive sedimentary facies associations: a) thick, lenticular beds of clast-supported conglomerates and sandstones deposited in a braided fluvial system, b) laterally persistent laminated and rippled mudstone and siltstone (lacustrine facies) in which three upward coarsening and thickening sandbodies occur (progradational wave-reworked mouth bars), c) interbedded tabular mudstones and more lenticular sandstones which are interpreted as the deposit of a low-sinuosity meandering fluvial system, and d) lenticular bodies of coarse-grained sandstone and granule conglomerates formed in a braided fluvial system. The palaeofloristic horizon, located in the lacustrine mudstone, is composed of Corystospermae, Cycadales, Ginkgoales and Coniferales. These fossils indicate a latest Triassic age for the Paso Flores Formation at Cañadón de Pancho. The studied "lacustrine" flora shows some remarkable differences when compared with the classic "fluvial" floras from other Paso Flores Formation localities.

Garzanti, E., Gnaccolini, M. and Jadoul, F., 1995. Anatomy of a semiarid coastal system: the upper Carnian of Lombardy (Italy). Rivista Italiana di Paleontologia e Stratigrafia, 101(1): 17-36.

The mixed terrigenous-carbonate-evaporitic S.Giovanni Bianco Formation and dolomitic Campolungo Tongue (upper part of the Breno Formation), generally 200 to 300 m thick, are assigned to the Late Carnian. They respectively overlie lagoonal limestones (Gorno Fm.) and peritidal carbonates (Annunciata Member of the Breno Fm.), and underlie intraformational breccias and recrystallized limestones (Castro Fm.). Recognition of an unconformity, ascribed to a relative fall of sea-level (sequence boundary), allowed the authors to subdivide the Upper Carnian succession into two parts. In the *lower part* (SGB1), six lithosomes were recognized. Red to green alluvial clastics in the south-east and south-west pass northward to mixed terrigenous-carbonate coastal sediments and finally to dolostones deposited in carbonate tidal flats. In the proximal sections of the Brescia Prealps, renewed north-westward progradation of alluvial redbeds with intercalated calclithite conglomerates points to a stage of tectonic uplift. A distinct increase in quartz, representing a regional petro-graphic marker followed all across Lombardy, indicates deepening of erosion into the metamorphic wallrocks of the volcanic belt. A major hiatus at the top of the SGB1 is best documented in the northern Presolana area by a silcrete crust directly overlying the Julian Annunciata Member of the Breno Formation. In the Brembana Valley area, the discontinuity occurs within a greenish siliciclastic coastal plain succession, and may be traced at the top of a marker interval of interbedded reddish siltstones and sandstones. The *upper part* (SGB2) consists of four lithosomes. Greenish sandstones and siltstones, accumulating in coastal plains in the south-west, passed northward to mudrocks and dolostones. In the southern-most Camonica Valley area, mudrocks are locally interbedded with calcarenites containing bored or pedogenized lithoclasts ripped from the underlying sequence and varied bioclasts, testifying to relatively open shallow-marine conditions during transgression. Next, thick gypsum accumulated in coastal salinas barred by locally oolitic platform carbonates to the north. Rare sandstone lenses occurring in the Brembana Valley at the top of the unit contain exclusive rhyolitic detritus, indicating either a terminal phase of explosive volcanism or erosion of older felsic volcanic products.

Gauffre, F.X., 1995. First description of a prosauropod dinosaur from the Upper Triassic of southern France (Alzon, Gard). C.R. Acad. Sci., Ser. II Fasc. A - Sci. Terre Plan., 320: 1219-1223.

Prosauropod dinosaur remains are described for the first time from the Upper Triassic of southeastern France, on the basis of apomorphic characters. However, because of insufficient taxonomic information, they cannot be placed more accurately. Nevertheless, this adds information on the geographical distribution of prosauropods during this period.

Gavrilova, V.A., 1995. A new pterinopectinid genus (bivalvia) from the Lower Triassic of Mangyshlak. Paleontologičeskij Žurnal, 1: 114-118, Moscow.

The new genus *Epiclaraia* with the type species *E. khvalynica* sp. nov. is described from the Tartali Formation of mountaneous Mangyshlak and from the lower part of the Uzen' Formation in southern Mangyshlak.

Gaździcki, A. and **Lipiec, M.**, 1995. Anisian foraminifers from the Ogarle-Opalone unit (legh Tatric Series, Polish Tatra Mts, Southern Poland). Przegląd Geologiczny, 43(5): 385-387. (in Polish)

The Anisian foraminifers in the High-Tatric Series have been recognized in the Middle Triassic strata at Ogarle section in the Kondratowa Valley. The foraminifer assemblage includes stratigraphically important taxa: *Glomospira densa* (Pantić, 1965), *Glomospirella grandis* (Salaj, 1967), *Meandrospira dinarica* Kochansky-Devidé et Pantić, 1966. Their stratigraphic range coincides with that of the *Glomospira densa* Zone (Range Zone: uppermost Lower Anisian (Bithynian)-Illyrian). It is a typical foraminifer assemblage within the platform successions of the Anisian of the Tethys Realm. Moreover, the investigated assemblage is also related to this from the Muschelkalk facies of Poland and Spain.

Gehrels, G.E., **Dickinson, W.R.**, **Ross, G.M.**, **Stewart, J.H.** and **Howell, D.G.**, 1995. Detrital zircon reference for Cambrian to Triassic miogeoclinal strata of western North America. Geology 23: 831-834.

U-Pb analyses of 656 single zircon grains from Cambrian to Triassic miogeoclinal strata provide a latitudinal and temporal reference for the ages of grains that accumulated along the western margin of North America, Comparisons between this detrital zircon reference and the ages of grains in potentially displaced terranes outboard (west) of the miogeocline should help establish when the terranes first arrived in sedimentary proximity to western North America, North-south variations in the ages of grains in Cambrian and Devonian to Triassic strata, which reflect the north-south changes in the age of cratonal rocks near the margin, should also help place constraints on a terrane's paleolatitude during these time periods, The technique cannot be used to determine paleolatitude during Ordovician time, however, because miogeoclinal strata from northern Canada to northern Mexico are dominated by grains shed from the Peace River arch (northwestern Canada).

Gilder, S.A., **Coe, R.S.**, **Wu, H.**, **Kunag, G.**, **Zhao, X.** and **Wu, Q.**, 1995. Triassic paleomagnetic data from south China and their bearing on the tectonic evolution of the western circum-Pacific region. Earth Planet. Sci. Letters, 131: 269-287.

The authors report Early and Middle Triassic paleomagnetic data from the south Chinese provinces of Fujian and Guangxi. The characteristic magnetization of the rocks in each case is concluded to be a primary remanence that passes the fold test. The Triassic pole from western Guangxi and four other Triassic and Late Permian poles from three provinces that lie on undisputed parts of the Yangtze craton are well clustered. This suggests that Guangxi (except the southeast part) was also a part of the Yangtze craton, at least since the Triassic

and probably since the Late Permian. With respect to the Yangtze craton, between the Early Triassic and the Late Cretaceous, Fujian may have been rotated 121 ± 9° counterclockwise and displaced 22 ± 9° north, or rotated 59 ± 9° clockwise and displaced 3 ± 9° south, depending on the hemisphere in which the magnetization was acquired. Based on consistency with other paleomagnetic results, and in accordance with the geologic data from the area, the former interpretation is preferred. A remarkable coincidence of Mesozoic poles for south China and south Korea is observed which, if true, implies that the South China Block (except for the displaced terranes in the coastal provinces) and Korea may have been part of the same continental landmass from the Triassic onwards. This is consistent with some geologic observations suggesting affinities between the two places. It also implies that the major fault zones in north China (e.g., the Tan-Lu fault) are unrelated to major fault zones in southeast China (e.g., the Changle-Nanao fault), with the former probably associated with the suturing of north and south China and the latter influenced by proto-Pacific plate motion.

GÖTZ, A.E., 1994. Feinstratigraphie des Unteren Muschelkalks und Tektonik am Südwestrand des Creuzburger Grabens (Bl. 4927 Creuzburg/Westthüringen). Geol. Jb. Hessen, 122: 23-38.

A remapping of the southwestern part of the Creuzburg-Graben (geological map 4927 Creuzburg) contains Triassic rocks from the Bunter-Muschelkalk-boundary up to the Middle Keuper. A detailed stratigraphical study of the Lower Muschelkalk in the Creuzburg area (West Thuringia, Germany) is discussed. The outcrop directly situated along the A4 (Herleshausen-Eisenach) exposes Middle Wellenkalk and the two Terebratel-beds (Lower Muschelkalk, Triassic). The microfauna of the Lower and Upper Terebratel-bed, especially conodonts are described.

HAGDORN, H., 1995. Die Seeigel des Germanischen Oberen Muschelkalks. Geol. Paläont. Mitt. Innsbruck, 20: 245-281.

Tests and appendages of the most common Upper Muschelkalk echinoids, *Triadotiaris grandaeva* (n. gen.) and *Serpianotiaris coaeva,* are described. Both genera cannot be integrated into any known echinoid order; therefore the new orders Triadotiaroida and Serpianotiaroida are established combining cidaroid and euechinoid characters. *Triadotiaris* has a flexible test, interambulacral lantern support with apophyses (cidarid), pseudocompound ambulacrals, primitive diadematoid teeth and spines without cortex. The test of *Serpianotiaris* is moderately flexible; the perignathic girdle consists of three adoral inflations (promunturium); below the ambitus, the ambulacrals are pseudocompound and primitively diadematoid compound. The spines have no cortex. *Triadotiaris* is derived from echinoids like *Lenticidaris,* from which it differs in its advanced ambulacrum. *Serpianotiaris* is a descendant of late Palaeozoic echinoids with sutured adoral interambulacrals without apophyses. Both genera occur in the germanotype and alpinotype Triassic (Anisian, Ladinian), *Serpianotiaris* also in Lower Carnian. As stenohaline faunal elements they are restricted in the Upper Muschelkalk to the lower part of the sequence (transgressive systems tract) where they occur together with *Encrinus liliiformis* in the Trochitenkalk. The rapid evolutionary radiation of the Echinoidea started off in Anisian times together with the development of new shallow marine habitats.

HAMMER, W.R., 1995. New therapsids from the upper Fremouw formation (Triassic) of Antarctica. J. Vertebrate Paleontol., 15: 105-112.

Therapsids from the base of the upper Fremouw Formation in the Beardmore Glacier region of Antarctica are described. They are part of a new fauna that also includes large capitosaurid temnospondyl amphibians. *Cynognathus* sp., as well as indeterminate specimens of cynognathids, a diademodontid and a kannemeyeriid occur. While the presence of *Cynog-*

nathus and the kannemeyeriid suggest a late Scythian (late Early Triassic) age for this level in the Fremouw Formation, some aspects of the indeterminant taxa may indicate a slightly younger Anisian (early Middle Triassic) age.

HELLER, F., HAIHONG, C., DOBSON, J. and HAAG, M., 1995. Permian-Triassic magnetostratigraphy - New results from south China. Physics of the Earth and Planetary Interiors, 89: 281-295.

Continuous marine sediments of Permian to Triassic age are widely distributed over large areas in Southern China. They offer the potential for developing magnetostratigraphic columns to investigate the polarity status of the palaeomagnetic field. Three carbonate sections on the Yangtze platform, which represent mainly the Upper Permian but also parts of the Lower Triassic and possibly parts of the uppermost Lower Permian, contain a long-term main R-N-R-N-R polarity succession throughout the Permian. This signal is hidden under-strong overprint magnetizations of variable origin and can be mostly obtained only from directional trends of the natural remanent magnetization during demagnetization rather than from clear stable end-point directions. The new Chinese polarity sequences are in accord with magnetostratigraphic records from the former USSR and Pakistan. Depending on stratigraphic assignment of the lithological formations studied, either they include the boundary between the Lower and Upper Permian and give evidence that the Kiaman reversed polarity superchron had ended before the Upper Permian, or the formations all belong stratigraphically to the Upper Permian, with the oldest reversed interval to be correlated with the reversed zone in the Midian stage of the palaeontologically well-dated Nammal section in Pakistan. This zone is preceded by at least one normal polarity zone at Nammal so that the end of the Kiaman superchron would not be observed in the new Chinese sections.

HOELSTAD, T., PIASECKI, S. and STEMMERIK, L., 1994. Shape and size of lacustrine deposited melanogen (opaque organic matter), Upper Carboniferous, East Greenland. Rapp. Grønlands geol. Unders., 164: 19-28.

The content of opaque particles (melanogen) in eight kerogen concentrates from lacustrine sediments of the Upper Carboniferous of East Greenland are characterised with respect to shape and size by means of electronic image analysis. The method of electronic image analysis is briefly described and the applied sequence of image analysis functions is explained. The main items of the program sequence are shade and intensity correction, object discrimination and object selection. It is demonstrated that the method produces consistent results. Shape indices for circularity ($4\pi \times$ area/perimeter^2) and elongation ($(b/a)^{1/2}$) and the areas of the optical sections have been recorded. These parameters have a distinct relationship to the sedimentary environment; the melanogen particles in the clay-siltstone beds show increasing circularity, decreasing elongation and increasing areas up through the coarsening-upward sequences. Thus, the size and shape of the melanogen particles are not only tied to the sedimentary texture of the actual sample, but also to the overall textural characteristics of the section.

HUNT, A.P. and LUCAS, S.G., 1995. Vertebrate paleontology and biochronology of the lower Chinle Group (Upper Triassic), Santa Fe County, north-central New Mexico. New Mexico Geol. Soc. Guidebook, 46th Field Conf., Geology of the Santa Fe Region, pp. 243-246.

Three Upper Triassic stratigraphic units in southeastern Santa Fe County, the Los Esteros and Tres Lagunas Members of the Santa Rosa and Garita Creek Formations, produce abundant fossil vertebrates. The Lamy amphibian quarry (Gunter bonebed) is in the Garita Creek Formation. The Los Esteros fauna is Adamanian in age based on the presence of *Rutiodon, Desmatosuchus* and *Stagonolepis,* and the Garita Creek fauna is Revueltian in age based on the presence of *Typothorax.* The Tres Lagunas fauna may be Adamanian or Revueltian.

Hunt, A.P. and **Lucas, S.G.**, 1995. Two Late Triassic vertebrate faunas at Petrified Forest National Park. *In:* V.L. Santucci and L. McClelland (eds.), National Park Service Paleontological Research, U.S. Dept. Int., National Park Service, Nat. Res. Publ. Office, Denver, Colorado, pp. 89-93.

Two different vertebrate faunas are present in the Petrified Forest Formation (Upper Triassic) at Petrified Forest National Park, Arizona. The older fauna is Adamanian (Late Tuvalian) in age, occurs in the Blue Mesa Member and is characterized by the presence of *Rutiodon, Desmatosuchus* and *Stagonolepis.* The younger fauna is Revueltian (Norian) in age, occurs in the Painted Desert Member and is characterized by the presence of *Pseudopalatus* and *Typothorax.* These faunas indicate that there was no major extinction at the Carnian-Norian boundary.

Isaksen, G.H. and **Bohacs, K.M.**, 1995. Geological controls of source rock geochemistry through relative sea level - Triassic, Barents Sea. *In:* B.J. Katz (ed.), Source petroleum source rocks. Casebooks in Earth Sciences, pp. 25-50.

Ishibashi, T., **Nakornsri, N.** and **Nagai, K.**, 1994. Permian-Triassic boundary and fauna at Doi Pha Phlung, Northern Thailand. Mem. Fac. Sci., Kyushu Univ., Ser. D, Earth Planet. Sci., 28: 23-40.

Paratirolites-Tapashanites fauna associated with *Palaeofusulina sinensis* and smaller foraminifers of the Dorashamian (Upper Permian) is collected from the Huai Thak Formation distributing at Doi Pha Phlung, Lampang district of northern Thailand. The minor fault forms the boundary between the Huai Thak and the Lower Triassic Phra That Formations. Some ophiceratid ammonoids and *Claraia* are found in the lowermost horizon of the Phra That Formation. The Permian Huai Thak Formation is composed of clastic and calcareous sediments with intercalation of chert and tuff, and is estimated to be 1,100m thick. The uppermost shale bed of the formation, about 10m below the P/T boundary, yields *Paratirolites nakornsrii, Tapashanites yaowalakae* sp. nov., *Pseudogastrioceras* aff. *szechuanense* and *Xenodiscus ?* sp. The Lower Triassic ammonite, *Ophiceras sakuntala* Diener is recognized at the lowest bed 1m above the boundary, and several species of Claraia are also found about 20m above. Those faunas suggest the *Otoceras woodwardi* Zone of the lower Griesbachian. *Palaeofusulina sinensis, Reichelina* aff. *changhsingensis,* smaller foraminifers and *Waagenophyllum* aff. *virgalense* are obtained from the Permian limestone at Doi Pha Phlung (Pha Phlung Mt.). The limestone sequence barren of fossils above the *Palaeofusulina* Zone exceeds the thickness of 100m. The contact between this limestone and the ophiceratid shale is not found in the area. The continuous calcareous bed below the *Palaeofusulina* Zone yields *Pseudophillipsia* (*Nodiphillipsia*) aff. *ozawai, Gallowainella meitienenisis, Siamnautilus ruchae* gen. et sp. nov., and many brachiopods including *Oldhamina squamosa.* The shale bed of the *Paratirolites-Tapashanites* fauna apparently looks stratigraphically higher than the limestone bed of the *Palaeofusulina* one in the area, but the latter represents a related heteroic facies of the former. A new genus and species of nautiloid, *Siamnautilus ruchae,* a new species of Dorashamian ammonoid, *Tapashanites yaowalakae* and a Scythian ophiceratid ammonoid, *Ophiceras sakuntala* are described in this paper.

Juhász, E., **Kopràs, L.** and **Balog, A.**, 1995. Two hundred million years of karst history, Dachstein Limestone, Hungary. Sedimentology, 42: 473-489.

Platform carbonates of the Upper Triassic Dachstein Limestone in Naszály Hill have been karstified extensively over the past 200 million years. They provide an excellent example of polyphase karstic diagenesis that is probably typical of many subaerially exposed carbonate sequences. Seven karstic phases, including three in the Triassic, are recognized in the area, each of which include polyphase karstic events. The first karst phase was associated with the Lõfer cycles. Meteoric waters caused dissolution; enlarged fractures and cavities were filled by marine and/or vadose silts and cement. The second karst phase was caused by local tectonic movements. Bedding-plane-controlled phreatic caves were formed, and filled by silts. The third karst phase lasted from the end of the Triassic to the Eocene. This was a regional, multiphase karstic event related to younger composite unconformities. Bauxitic fill is the most characteristic product of this phase.

KELLICI, I. and DE WEVER, P., 1995. Radiolaires triasiques de massif de la Marmolada, Italie du Nord. Revue de Micropaléontologie, 38(2): 139-167.

The studied material was collected on the South-East of Marmolada Massif (Northern Italy). Radiolarians are extracted from pelagic limestones of the "Livinallongo" type series (basin facies). They do validate the Ladinian age of these series. Eighty species are included in the investigation, among which 12 new species and 2 new subspecies are described. 7 species are formally introduced and 5 described in open nomenclature.

KENT, D.V., OLSEN, P.E. and WITTE, W.K., 1995. Late Triassic-earliest Jurassic geomagnetic polarity sequence and paleolatitudes from drill cores in the Newark rift basin, eastern North America. J. Geophys. Res. - Solid Earth, 100: 14965-14998.

Paleomagnetic study of about 2400 samples from seven drill sites in the Newark continental rift basin of eastern North America provides a detailed history of geomagnetic reversals and paleolatitudinal motion for about 30 m.y. of the Late Triassic and earliest Jurassic (Carnian to Hettangian). Northward drift of only about 7 degrees is recorded in the continental sediments and minor interbedded basaltic lavas in the basin, from 2.5° to 6.5° north paleolatitude in the Carnian and from 6.5° to 9.5° north paleolatitude over the Norian-"Rhaetian" and the early Hettangian. A total of 59 polarity intervals, ranging from about 4 m to over 300 m in thickness, have been delineated in a composite stratigraphic section of 4660 m. The lateral continuity and consistent relationship of lithological lake level cycles and magnetozones in the stratigraphically overlapping sections of the drill cores demonstrate their validity as time markers. A geomagnetic polarity timescale was constructed by scaling the composite section assuming that lithostratigraphic members in the predominant lacustrine facies represent the 413-kyr orbital periodicity of Milankovitch climate change and by extrapolating a sedimentation rate for the fluvial facies in the lower part of the section; a 202 Ma age for the palynological Triassic/Jurassic boundary was used to anchor the chronology based on published concordant radiometric dates linked to the earliest Jurassic igneous extrusive zone. Geomagnetic polarity intervals range from about 0.03 to 2 m.y., have a mean duration of about 0.5 m.y., and show no significant polarity bias. The cyclostratigraphically calibrated record provides a reference section for the history of Late Triassic - earliest Jurassic geomagnetic reversals. Correlations are attempted with available magnetostratigraphies from nonmarine sediments from the Chinle Group of the southwestern United States and marine limestones from Turkey.

KOZUR, H., KRAINER, K. and LUTZ, D., 1994. Middle Triassic conodonts from the Gartnerkofel - Zielkofel area (Carnic Alps, Carinthia, Austria). Jb. Geol. B.-A., 137: 275-287.

In the Gartnerkofel-Zielkofel area, Carnic Alps (Carinthia, Austria) the South Alpine Middle Triassic sequence between the underlying Werfen Formation and the overlying Schlern Dolomite is composed of the Uggowitz Breccia, the Kühweg Member and the Buchenstein-Livinallongo Formation. Pelagic nodular limestones of the Buchenstein-Livinallongo Formation yielded a relatively rich conodont fauna of Early Ladinian age indicated by the occurrence of *Paragondolella trammeri* (Kozur), *Neogondolella balkanica* Budurov & Stefanov, *N. longa*

Budurov & Stefanov and *N. mesotriassica* (Kozur & Mostler). Pebbles from the Uggowitz Breccia yielded Early Olenekian shallow water conodonts of the Werfen facies (*Pachycladina* spp.) and conodonts which immigrated from a pelagic environment during the Val Badia transgression (*Neospathodus triangularis* (Bender), indicating Late Olenekian age. Two new conodont taxa are established and described.

* Kupecz, J.A., 1995. Depositional setting, sequence stratigraphy, diagenesis, and reservoir potential of a mixed-lithology, upwelling deposit: Upper Triassic Shublik Formation, Prudhoe Bay, Alaska. AAPG Bull., 79: 1301-1319.

The Upper Triassic Shublik Formation within the Prudhoe Bay field unit, North Slope, Alaska, is a potentially economic hydrocarbon reservoir comprised of mixed lithology and mineralogy. Its composition includes Limestone, phosphate, shale, siltstone, and sandstone, as well as accessory amounts of siderite, glauconite, pyrite, kaolinite, and dolomite. Within the Prudhoe Bay field unit, the Shublik has been subdivided into four zones, lettered from base to top, D through A, which become thinner and show evidence of deposition under higher energy conditions toward the northeast. The formation is truncated to the east by the regional Lower Cretaceous unconformity. Zones within the Shublik comprise a basal transgressive systems tract (conglomerate lag at the Shublik Formation/Ivishak Formation contact through basal zone C shales) and two highstand shallowing-upward parasequences (zones C through B, and zone A, respectively). The parasequences are bounded by shales interpreted to represent deposition during periods of marine flooding. The contact between the Shublik and the overlying Sag River Formation juxtaposes comparatively deeper marine Shublik with shallower water glauconitic sandstones of the Sag River Formation. The contact is unconformable and is interpreted to represent a regional sequence boundary. Lithofacies of the Shublik are interpreted to have been coeval depositional facies of an upwelling system. Relative sea level changes during Shublik deposition are interpreted to have caused the observed vertical and lateral variability in lithofacies via systematic changes between anaerobic, dysaerobic, and aerobic upwelling conditions. Dissolution of carbonate allochems resulted in the creation of moldic porosity that positively affected reservoir quality (i.e., permeability) in the carbonate packstone/ grainstone facies. Areas of highest porosity are in the northern and northeastern parts of the field, which correspond to a combination of facies-controlled reservoir quality improvement toward the northeast and carbonate dissolution along the Lower Cretaceous unconformity and the North Prudhoe Bay fault zone. Oil in place for the Shublik within the Prudhoe Bay unit is estimated to be between 250 and 500 million bbl, Although permeabilities are generally low throughout the field area, the Shublik Formation has the potential to add significant reserves to the Prudhoe Bay held unit.

Lang, J.R., Lueck, B., Mortensen, J.K., Russel, J.K., Stanley, C.R. and Thompson, J.F.H., 1995. Triassic-Jurassic silica-undersaturated and silica-saturated alkalic intrusions in the Cordillera of British Columbia: implications for arc magmatism. Geology, 23: 451-454.

Alkalic igneous rocks of early Mesozoic age are found in both the Quesnel and Stikine terranes in the Canadian Cordillera and include both silica-undersaturated and silica-saturated types. The saturated complexes are most abundant in Quesnellia and are multiphase complexes dominated by monzonite to diorite intrusions. Undersaturated complexes are distributed through both terranes, are dominated by syenite with lesser monzonite and pyroxenite, and, when present as a single intrusion, are characterized by concentric zoning, igneous layering, and planar mineral fabrics. Both types of complex are associated with Cu-Au mineralization accompanied by potassic and distinctive sodic and calc-potassic alteration assemblages. Although undersaturated and saturated alkalic intrusions are petrographically distinct, a petrogenetic association is suggested by their spatial coincidence in some districts, and similarities in their tectonic environment and associated alteration. The undersaturated complexes represent a distinctive suite of alkalic intrusion with magmatic arc affinities, and their emplacement into both Stikinia and Quesnellia between 210 and 200 Ma suggests that these terranes were either linked at that time or have shared unusual but similar magma-generating tectonic events at identical times.

LAVILLE, E., CHARROUD, A., FEDAN, B., CHARROUD, M. and PIQUE, A., 1995. Negative inversion in Atlasic domain (Morocco): The Kerrouchen Triassic Basin, a structural element of the Atlasic rift. Bull. Soc. Géol. France, 166: 365-374.

This specific geotraverse from Khenifra to Midelt, in addition to previous data related to the early Mesozoic Atlasic rift, provides new data concerning: (1) the centrifugal westward opening of this "Atlasic rift" by reactivation of a Variscan thrust during the Triassic-earliest Liassic; (2) abrupt initiation of a marine flooding with a lithological change from terrigenous to carbonate deposits during the early-Middle Liassic. The most striking point is the importance of pre-existing structures, particularly thrusts, in determining how the basement responds to extensional stress. These structures, including the thrust zone system dipping eastward between the Inner Eastern Zone (Midelt Zone) and the Intermediate Zone (Khenifra allochthonous unit), have been reactivated as extensional faults and they controlled the development of some sedimentary basins in their hanging walls. In the early Liassic time, deposition of the overlying marine carbonate sequence is thought to have been at least in part induced by the post-rift thermal subsidence stage.

LEPPER, J. and UCHMAN, A., 1995. Marine Einflüsse im mittleren Buntsandstein der Hessischen Senke - dargestellt am Beispiel des Weserprallhanges an der Ballertasche bei Hann. Münden. Zbl. Geol. Paläont. Teil I, 1/2: 175-186.

The abundant occurrence of the trace fossil *Diplocraterion parallelum,* rare *Phycodes triadicum,* as well as occurrence of the bivalve *"Avicula" murchisoni* suggest marine influence in a section of the Detfurth-Folge (Middle Buntsandstein, Lower Triassic) in the Weser Valley of Lower Saxony, Germany. Presumably, the sedimentation took place in a tidal-protected brackish (?) lagoon. The top 5 m of the Detfurth-Folge and the overlying lower part of the Hardegsen-Folge are dominated by fluvial deposits containing rare facies-crossing trace fossils (*?Skolithos, Phycodes ?curvipalmatum*), as well as by forms typical of non-marine environments (*?Siskemia* isp., *Stiallia pilosa, "Cylindricum"* isp.).

LESLIE, A.B., TUCKER, M.E., WRIGHT, V.P. and SANDLER, A., 1995. Discussion on a hydrogeological model for the early diagenesis of Late Triassic alluvial sediments. J. Geol. Soc., 152: 732-734.

LEVEN, E.JA., 1995. Permian and Triassic of the Rushan-Pshart Zone (Pamir). Rivista Italiana di Paleontologia e Stratigrafia, 101: 3-16.

Three isolated tectonic blocks, Rushan, Pshart, and Dunkeldyk have conventionally been grouped into the Rushan-Pshart zone. Because of stratigraphic and structural differences, they should be considered separately. The present paper mostly deals with the Pshart block, which is subdivided into East and West Pshart. This kind of subdivision may also be applied to the Dunkeldyk block. A summary of the characteristics of Upper Paleozoic and Mesozoic volcano-sedimentary successions confirms previous hypotheses, which suggest that these sequences have formed under crustal extension, accompanied by basaltic volcanism. These earlier models, however, postulated the existence of a vast oceanic area separating the East Pshart from SE Pamir during Late Permian, Triassic, and Jurassic. This ocean closed during the Early Cretaceous. The interpretation preferred in this paper suggests a narrow sea-way, which closed before the Cretaceous.

Loreau, J.P., Sabbadini, S., Brosse, E. and Frixa, A., 1995. Triassic aragonite in carbonate source-rock from Ragusa Basin (Sicily): Geochemistry, comparison with recent sediments and origin. C. R. Acad. Sci., Ser. II, Fasc. A - Sci. Terre Planet., 321: 111-118.

Aragonitic muds from the upper Trias occur in laminites between two laminae rich in clays and/or organic matter. Two types of aragonite are identified. The first shows rod or needle morphology, with Sr content (9,300 ppm), $\delta^{18}O$ (-1.1 to -1.7) and $\delta^{13}C$ (+2.1 to +2.8) mostly similar to aragonite of Recent sediments. It is not biodetrital in origin but results from direct precipitation at 22-30 °C in sea water with a Sr-m(2+)/Ca-m(2+) ratio very near to Recent values. The second aragonite showing greater prismatic crystals with inclusions of relics of rods and needles, a high content in strontium (15, 800 ppm) and a negative $\delta^{13}C$ (-13.0 to -14.4), is diagenetic.

Lucas, S.G., 1995. Revised Upper Triassic stratigraphy, Petrified Forest National Park. *In:* V.L. Santucci and L. McClelland (eds.), National Park Service Paleontological Research, U.S. Dept. Int., National Park Service, Nat. Res. Publ. Office, Denver, Colorado, pp. 102-105.

Upper Triassic strata exposed in the Petrified Forest National Park belong to the Petrified Forest and Owl Rock Formations of the Chinle Group. In the park, the Petrified Forest Formation consists of the (ascending order) Blue Mesa, Sonsela, and Painted Desert Members. Fossil vertebrates and other biochronologically significant fossils indicate that Chinle Group strata in the park are of Late Carnian-Middle Norian age, about 222-212 million years old.

Lucas, S.G., 1995. The Triassic Sinbad Formation und correlation of the Moenkopi Group, Canyonlands National Park, Utah. *In:* V.L. Santucci and L. McClelland (eds.), National Park Service Paleontological Research, U.S. Dept. Int., National Park Service, Nat. Res. Publ. Office, Denver, Colorado, pp. 54-57.

The eastern limit of the Lower Triassic Sinbad Formation is a 0.2-0.3 m-thick fossiliferous limestone bed in the Holeman Spring Basin (T28S, R18E) of Canyonlands National Park, Utah. The Sinbad Formation here intertongues with uppermost strata of the Ali Baba Formation of the Moenkopi Group.

Lucas, S.G., 1995. Triassic stratigraphy and chronology in New Mexico. New Mexico Geology, 17(1): 8-13, 17.

Triassic rocks in New Mexico are nonmarine strata of Middle and Late Triassic age. Middle Triassic (Anisian) strata belong to the Anton Chico Member of the Moenkopi Formation, an unconformity-bounded tectono-sequence of fluvial red beds as thick as 41 m. Moenkopi strata are present across most of north and central New Mexico, and in southeast New Mexico they crop out in Lincoln County. Upper Triassic (late Carnian-Rhaetian) strata in New Mexico belong to the Chinle Group, an unconformity-bounded tectono-sequence of fluvial, lacustrine, and rare eolian red beds as thick as 650 m. Chinle strata crop out across north, central, and southeast New Mexico. Lithostratigraphy, and biostratigraphy based primarily on tetrapod vertebrates, allow precise correlation of Chinle Group strata that comprise three depositional sequences separated by basinwide unconformities. These depositional sequences resulted from base-level changes driven by eustasy.

Lucas, S.G. and **Heckert, A.B.**, 1995. Triassic stratigraphy around the Sandia uplift, central New Mexico. New Mexico Geol. Soc. Guidebook, 46th Field Conf., Geology of the Santa Fe Region, pp. 233-241.

Triassic strata crop out around the Sandia uplift in the Hagan basin, Placitas and Cedar Crest areas. A uniform Triassic section of nonmarine red siliciclastics as much as 480 m thick is exposed across all three areas. The base of the Triassic section is the Middle Triassic (Anisian) Anton Chico Member of the Moenkopi Formation, which disconformably overlies Permian limestones of the San Andres Formation. Moenkopi strata are as much as 20 m thick and mostly grayish red/pale-red litharenitic sandstones and siltstones. They are disconformably overlain by the Agua Zarca Formation of the Chinle Group, as much as 108 m of mostly yellowish gray sublitharenitic sandstone and extraformational conglomerate with clasts of quartzite and Paleozoic limestone. Overlying gray and purple mudstone dominated strata, as much as 92 m thick, may belong to the Salitral Formation. The uppermost Triassic strata exposed around the Sandia uplift are as much as 260 m of mostly reddish brown bentonitic mudstone assigned to the Petrified Forest Formation. A prominent, bench-forming sandstone/conglomerate unit as much as 37 m thick at the top of the Petrified Forest Formation is the Correo member. It is disconformably overlain by the Middle Jurassic Entrada Sandstone. Few paleontological data are available from Triassic rocks around the Sandia uplift, but they can be readily correlated to nearby Triassic strata on the southern Colorado Plateau and on the southern High Plains, principally by lithostratigraphy.

Lucas, S.G. and **Wild, R.**, 1995. A Middle Triassic dicynodont from Germany and the biochronology of Triassic dicynodonts. Stuttgarter Beitr. Naturk., Ser. B., 220, 16 pp.

The authors describe a left humerus of a dicynodont from the lower Lettenkeuper of Germany. This specimen cannot be assigned with certainty to any known Triassic dicynodont taxon, and they identify it as aff. *Dinodontosaurus* sp. The only other European Triassic dicynodont, a left humerus from the Muschelkalk of France identified by Broili as cf. *Placerias,* is re-identified as aff. *Parakannemeyeria* sp. Most Triassic dicynodonts had a broad distribution across Pangaea and have an abundant fossil record. The authors organize this record to identify five, temporally-successive Triassic dicynodont biochrons: *Lystrosaurus* biochron (early Induan), *Kannemeyeria* biochron (late Olenekian-early Anisian), *Shansiodon* biochron (early Anisian), *Dinodontosaurus* biochron (Ladinian) and *Placerias* biochron (late Carnian).

Lucas, S.G., **Heckert, A.B.** and **Hunt, A.P.**, 1995. Unusual aetosaur armor from the Upper Triassic of West Texas, U.S.A. Paläont. Z., 69: 467-473.

We report two unusual aetosaur scutes from the Tecovas Member of the Dockum Formation, Chinle Group (upper Carnian) of Crosby County, Texas, U.S.A. Originally collected by University of Michigan expeditions in the 1920's, these scutes cannot be assigned with certainty to any known species of aetosaurs known from the American Southwest. One of these scutes may be a cervical horn of *Paratypothorax,* and if so confirms the similarities of this aetosaur to *Desmatosuchus* in the possession of horned lateral spikes. The other is a paramedian scute of a new aetosaur taxon inadequately known at present to be assigned a formal name. These scutes indicate that aetosaurs were more diverse in the Chinle Group than currently known, but do not alter the robust Late Triassic biochronology based on aetosaurs.

Lucas, S.G., Hunt, A.P. and Lockley, M.G., 1995. Dinosaur footprint from the Upper Triassic Rock Point Formation of the Chinle Group, Canyonlands National Park. *In:* V.L. Santucci and L. McClelland (eds.), National Park Service Paleontological Research, U.S. Dept. Int., National Park Service, Nat. Res. Publ. Office, Denver, Colorado, pp. 58-59.

The first dinosaur footprint discovered in Triassic strata of the Canyonlands is a single *Grallator* footprint from the Upper Triassic Rock Point Formation near Upheaval Dome. This discovery further confirms the restriction of virtually all Late Triassic tetrapod footprints in the western United States to uppermost strata (Rock Point Formation and correlatives) of the Chinle Group.

Mangerajetzky, M.A., 1995. Subdivision and correlation of monotonous sandstone sequences using high-resolution heavy mineral analysis, a case study: The Triassic of the Central Graben. *In:* Non-biostratigraphical methods of dating and correlation. Geol. Soc. Spec. Publ., 89, pp. 23-30.

Márquez Sanz, L., 1994. Los foraminíferos triásicos españoles: Puesta al día de los conocimientos existentes. Coloquios de Paleontologia, 46

In this paper, information about Triassic Foraminifera from Spain has been updated. At the moment, the *Pilammina densa* Zone (Middle-Upper Anisian), the *Turriglomina mesotriasica* Zone (*Aulotortus praegaschei* Subzone) (Upper Ladinian, Longobardian) and the *Gandinella falsofriedli* Zone (Upper Triassic) have been identified. The foraminiferal assemblages appear in sediments from protected areas of shallow carbonatic ramps and reef environments. From a palaeobiogeographical point of view, most of the taxa are common in the Tethys realm.

Marsicano, C.A., 1994. Taxonomic status of "*Icanosaurus rectifrons*" Rusconi, 1951 (Amphibia, Temnospondyli) from the Triassic of Mendoza. Ameghiniana, 31: 249-255.

Masaryk, P., Sucha, V., and Lintnerova, O., 1995. Is volcanic material present in the Middle Triassic basin sediments of the Hronic Unit - (Choc Nappe, Western Carpathians)? Geologica Carpathica, 46: 175-181.

The paper on the problem of the occurrence and influence of Middle Triassic volcanic activity in the Reifling intra-platform depression pelagic sediments of the Choc Nappe (Hronic Unit), Central Western Carpathians. The results of the clay and accessory minerals, chemical and mineral composition of clay layers from five selected sedimentological profiles are combined in this work. In comparison with data from neighbouring regions - the Northern Calcareous Alps, Southern Alps, Hungarian Block and Dinarides, where the Middle Triassic volcanic rock products are known and documented, the area of the Central Western Carpathians was distant from the centres of this volcanism. This was probably the main reason why the presence of Middle Triassic volcanic products in the Choc Nappe sediments has not been unambiguously proved. The authors suggest, that in area of the Hronic Unit, the distant volcanism of neighbouring tectonic zones has been manifested only indirectly in the lithological and facial composition of the pelagic carbonates and the mineralogical and chemical composition of the clay fraction.

Mastandrea, A., 1995. Carnian conodonts from Upper Triassic strata of Tamarin section (San Cassiano Fm., Dolomites, Italy). Riv. It. Paleont. Strat., 100: 493-510.

A Late Triassic conodont fauna is described and illustrated for the first time from the San Cassiano Formation of the eastern Dolomites (Tamarin). The co-occurrence of *Metapolygnathus auriformis, M. carnicus, M. baloghi, M. polygnathiformis, Gladigondolella tethydis, G. arcuata* and *G. malayensis malayensis* indicates a Late Julian age. The fauna corresponds to the *auriformis* Zone (Austriacum Zone according to ammonoid zones). This pelagic conodont fauna, characteristic of relatively deep water, shows strong faunal affinities with coeval faunas from European Tethyan regions (mainly Greece, Turkey, NE Hungary, and Alps) and northern Kumaun region of Tethys Himalaya.

MASTANDREA, A. and RUSSO, F., 1995. Microstructure and diagenesis of calcified demosponges from the Upper Triassic of the northeastern Dolomites (Italy). J. Paleont., 69: 416-431.

The calcareous skeletons of 17 species of Triassic demosponges from the northeastern Dolomites have been analyzed for microstructure and diagenesis. The four microstructures recognized (irregular, spherulitic, penicillate aragonitic, and homogeneous granular Mg calcite) are described in terms of mineralogy; shape, dimension, and arrangement of microstructural elements; mode of growth; and possible biomineralization. The diagenesis in these sponge carbonate skeletons is of an aggrading type that occurred in diagenetic units, semiclosed systems, delineated by organic phragmas, which controlled the flux of diagenetic fluids. The authors tentatively interpret these phragmas as the remains of water-insoluble macromolecules for space delineation during the biomineralization process. In the aragonitic skeletons the preservation grade is correlated with Sr content, and the replacement of aragonite by calcite is marked by a Sr value around 4,000 p.p.m. Calcitized aragonite still retains a detectable amount of Sr. In Mg calcite skeletons the continuous and regular increase of grain size is inversely correlated with Mg content and directly with the distance from the organic phragmas.

MCGOWAN, C., 1995. A remarkable small ichthyosaur from the Upper Triassic of British Columbia, representing a new genus and species. Can. J. Earth Sci., 32: 292-303.

A small, nearly complete ichthyosaur skeleton is described from the Upper Triassic of Williston Lake, in northeastern British Columbia. The age of the material, based on conodonts, is early Norian. Although the length of the entire skeleton would probably not have exceeded 1 m, there is no evidence of immaturity-quite the contrary. Named *Hudsonelpidia brevirostris*, the new taxon shares some features with Triassic taxa, as exemplified by Mixosaurus from the European Middle Triassic, and with post-Triassic ichthyosaurs like *Ichthyosaurus*, from the English Lower Jurassic. Mixosaurian characters include an elongate tibia with emarginated pre- and postaxial margins, and phalanges in the hindfin with pre- and postaxial notches. Like *Ichthyosaurus*, the humerus is elongate rather than broad, so too is the pubis and ischium. *Mixosaurus* is unusual among Triassic ichthyosaurs for having a relatively large orbit, but the orbit is even more prominent in Hudsonelpidia, probably because of the shortness of the snout. *Hudsonelpidia* has an unusually large femur that approaches the length of the humerus, dwarfing the rest of the hindfin. The rostrum is unique in being perforated by foramina, but this could possibly be an abnormality.

MENNING, M., 1995. A Numerical Time Scale for the Permian and Triassic Periods - An Integrated Time Analysis. *In:* Scholle, P.A., Peryt, T.A. and Ulmer-Scholle, D.S. (eds.), Permian of Northern Pangea, Vol 1, pp. 77-97. Springer-Verlag, Berlin.

MIYAMOTO, T. and KUWAZURU, J., 1994. Chemical composition of detrital garnets in Permian to Jurassic sandstones of the Kurosegawa Terrane in the Kayaba-Nishinoiwa area, Western Kyushu, Japan. Jou. Sci. Hiroshima Univ., Ser. C, 10: 181-192.

In the Kayaba-Nishinoiwa area, Kumamoto Prefecture, the Miyama Formation, the Kakisako Formation, the Kuma Formation, the Upper Triassic formation, the lower to Middle Jurassic formation and the Hashirimizu Formation are distributed from north to south. The stratigraphy is described in this paper in some detail, and besides detrital garnets in Permian to

Jurassic sandstones in the well-organized stratigraphic units of the Kurosegawa Terrane in this area have been studied from the sedimentary petrological viewpoint. EPMA analysis of detrital garnets (a total of 637 grains) have revealed that: There are significant differences in chemical and mineral composition between detrital garnets of the sandstones from the Upper Permian Kuma Formation and the Triassic to Jurassic formations. Detrital garnets of the Kuma Formation consist mostly of grandite (grossular plus andradite) associated with some almandine and some Mn- and Mg-rich almandine, being chiefly derived from calcareous metamorphic rocks, probably skarn. Detrital garnets of the sandstones of the Upper Triassic formation consist mainly of almandine with some amount of Mg content, some grandite and minor spessartine. And, those of the Jurassic formation consist mainly of Mg-rich almandine, some almandine and minor spessartine without grandite garnets. These Triassic to Jurassic detrital garnets are considered to be chiefly derived from high-grade, partly granulite facies, metamorphic rocks. Based on such mineralogical characters of detrital garnets, it can be pointed out that there are significant differences in provenance between the Upper Permian Kuma Formation and the Mesozoic formations in the Kurosegawa Terrane.

MOLINA-GARZA, R.S., GEISSMAN, J.W. and VAN DER VOO, R., 1995. Paleomagnetism of the Dockum Group (Upper Triassic), northwest Texas: Further evidence for the J-1 cusp in the North America apparent polar wander path and implications for rate of Triassic apparent polar wander and Colorado plateau rotation. Tectonics, 14: 979-993.

The authors report paleomagnetic data for 26 accepted sites collected in two sections of flat-lying strata of the upper Carnian-lower Norian (similar to 225 Ma) Dockum Group, northwest Texas. Six additional sites in coarse-grained conglomeratic sandstones gave no usable results. The total assemblage of 26 VGPs is streaked along the Late Triassic - earliest Jurassic track of the North America apparent polar wander path and their mean is inconsistent with the accepted upper Carnian-lower Norian reference pole. In detail, 12 sites in grayish white (nonhematitic) sandstones have weak magnetizations (less than about 1 mA/m) carried by magnetite or maghemite that give a paleopole at 56.4°N-96.3°E (N=12 dual-polarity VGPs; K=44.2; A95=6.6°) in close agreement with other results for upper Carnian-lower Norian rocks in North America. The 14 remaining sites in tan and red-colored (hematitic) sandstones, siltstones, and claystones give high unblocking temperature characteristic magnetizations carried by hematite, with paleopoles at 59.0°N53.8°E (normal; N=7 VGPs, K-62.4, A95=7.6°) and 59.3°N-77.8°E (reverse; N=7 VGPs, K=204.2, A95=4.2°). These poles fall along the younger track of poles and near the J-1 cusp of the North American APWP as defined by (unrotated) poles derived from Colorado plateau rocks. We suggest that the characteristic magnetization of the non-hematitic sandstones is an "early" magnetization, acquired during or soon after deposition. However, the characteristic magnetization of the red bed sites is interpreted as a secondary magnetization, for which we infer an earliest Jurassic age. The secondary origin for this magnetization is supported by the observation of conflicting magnetostratigraphies. The extreme westward position of the poles derived from red bed sites, particularly those with normal polarity, confirms the general position of the J-1 cusp indicated by poles in the Piedmont province, the Newark basin, and the Colorado plateau; it also suggests that the magnitude of rotation of the Colorado plateau is no greater than about 5 degrees. We compile an apparent polar wander path for North America, including Colorado plateau data, which suggests a fast rate of apparent polar wander throughout the Triassic period (about 0.8°/m.y.) with a gradual increase that preceded the opening of the Atlantic.

MOREL, E.M., 1994. El Triasico del Cerro Cacheuta, Mendoza (Argentina). Parte I: geología, contenido paleofloristico y cronoestrangrafía. Ameghiniana, 31(2): 161-176.

The Triassic sequences exposed in the Cerro Cacheuta are mainly composed of coarse grained epiclastics. Five sedimentary facies were defined: 1) clast-supported conglomerates and diamictites, 2) yellow alternating sandstones and pelites, 3) clast-supported conglomerates and lenticular sandstones, 4) dark pelites and 5) pink and purple sandstones. The palaeofloristic association is composed of 64 taxa: Bryophyta, Lycophyta, Sphenophyta, Ginkgophyta and Coniferophyta. Based on statistical treatment of the biochrons the following ages have been defined for the Triassic units: Potrerillos Formation (late Middle Triassic to early Upper Triassic); Cacheuta Formation (early to late Upper Triassic) and Rio Blanco Formation (late Upper Triassic).

NERI, C., MASTANDREA, A., LAGHI, G., BARACCA, A. and RUSSO, F., 1994. New biostratigraphic data on the S. Cassiano Formation around Sella Platform (Dolomites, Italy). Palaeopelagos, 4: 13-21.

This work deals with the stratigraphy and age of the S. Cassiano Fm. interfingered with the slope of the Cassian Platform of the Sella Massif. Five stratigraphic sections, outcropping on the northern and eastern sides of the massif, have been studied both from sedimentological and biostratigraphic view points. Main results have been achieved with the conodont biostratigraphy of the Sella Pass and Gardena Pass sections, which point out a latest Ladinian age of the S. Cassiano Fm. The Sella Platform, interfingered with the basinal S. Cassiano deposits, is therefore uppermost Ladinian in age.

NESTEROV, I.I., BOCHKAREV, V.S. and PURTOVA, S.I., 1995. Unique section of Triassic sediments in West Siberia. Dokl. Akad. Nauk. 340: 659-663.

NOÉ, S. and BUGGISCH, W., 1994. Sequence stratigraphy in Late Permian and lowest Triassic of the southern Alps (Dolomites; Northern Italy) with special regard to the Permian/Triassic boundary. Jb. Geol. B.-A., 137: 297-318.

The Late Permian (Djulfian and Dorashamian) and lowest Triassic (lower Scythian; Griesbachian and lower Nammalian) strata in the central part of the Southern Alps (Dolomites) have are interpreted sequence-stratigraphically. Special attention was given to the lateral and vertical sedimentation patterns and the foraminifer biostratigraphy. This area was the westernmost part of the Palaeothethys. Relative sea level fluctuations are expressed as coastal onlap patterns. The western boundary of the WNW/ESE striking Palaeotethys is marked by an alluvial plain consisting of red siliciclastic sediments and a marginal marine area with a strong clastic influence. Seawards (eastwards) this series changes into a restricted inner shelf area limited in the east by a structural high.

PAPIER, F. and GRAUVOGEL-STAMM, L., 1995. Les blattodea du Trias: le genre *Voltziablatta* n. gen. du Buntsandstein supérieur des Vosges (France). Palaeontographica, Abt. A, 235: 141-162.

In the large collection of fossil insects (several thousand specimens) from the Voltzia Sandstone, Upper Buntsandstein of the Vosges Mountains (France), the Blattodea are represented by 1752 specimens. The study of the fore wings (1525 specimens), which are the single remains used in the systematics of the fossil cockroaches, allowed to identify a new genus *Voltziablatta* with two species *V. intercalata* and *V. grauvogeli*. The first of them is characterized by intercalated veins, whereas the second one is distinguished by very strong veins appearing double on the specimens. The numerous observed fossil wings underscore their important variability in venation, which is a usual feature in the cockroaches. Systematic description and variability analysis are followed by a comparison with the other Triassic Blattodea, especially from Europe, South-Africa, Australia, China and Japan. *Voltziablatta* shows affinities with the genera *Pedinoblatta, Triassoblatta* and *Samaroblatta* and can be classified in the family Mesoblattinidae.

Piros, O., Mandl, G.W., Lein, R., Pavlik, W., Bérczi-Makk, A., Siblik, M. and **Lobitzer, H.**, 1994. Dasycladaceen-Assoziationen aus triadischen Seictwasserkarbonaten des Ostabschnitts der Nördlichen Kalkalpen. Jubiläumsschrift 20 J. Geol. Zusammenarbeit Österreich-Ungarn, Wien, 2: 343-362.

In recent years, mainly in the framework of the geological mapping program, Dasycladaceae-bearing samples have been taken from Triassic shallow-water limestones. Moreover, macro- and microfossils (mainly conodonts) have been identified from associated rocks that allow to draw conclusions on the Triassic calcareous algal chronology. The re-study of type localities of the Anisian Dasycladaceae taxa identified from the Kalkvoralpen at Türnitz (Gümbel, 1872; Pia, 1912, 1920, 1935) using the conodont fauna of the overlying Reifling beds - has resulted in the confirmation of the formerly disputed (Middle)Anisian age. The Steinalm Limestone localities in the Mürztal Alps and the Schneeberg as well as newly revealed ones of Hohe Wand region have a typical Anisian algal flora which is also backed up by the foraminiferal fauna. As for the Rax-Schneeberg area, contribution can be made to assess the age of Wetterstein Limestone more precisely. As indicated by data concerning conodonts, at the end of Ladinian times the reef development prograded continuously over the one-time subbasins. The lagoon was dominated by *Teutloporella herculea* accompanied in the uppermost covering beds by *Poikiloporella duplicata*, the latter pointing to Lower Carnian age. It has still to be studied wether *Diplopora annulata* species occurs in the central, thus oldest beds of the lagoon. The Upper Carnian algal limestone (Waxeneck Limestone) that is rather widespread in the eastern part of the Mürztal region contains *Poikiloporella duplicata* in mass and its age can be well assessed on the basis of underlying deposits of the Raibl horizon (Julian) as well as the overlying Hallstatt Limestone Lower Norian). Faunal and floral associations from lagoonal Dachstein Limestone (Upper Norian-Rhaetian) in an area SE of Mariazell are presented here. In these associations, *Heteroporella* and endospore-bearing *Diplopora* are the predominant calcareous algal taxa.

Polyanskii, B.V., 1995. Terrigenous minerals as indicators of climate and landscape changes in the Triassic and Jurassic of Central Asia. Strat. Geol. Correlation 3: 273-284.

Specific lithologic changes were recorded at the Triassic - Lower Jurassic and Middle - Upper Jurassic boundaries in continental and shallow marine deposits of Central Asia. Along with landscape factors, these changes were caused mainly by the restructuring of the paleoclimate during the development of corresponding sedimentary basins. These time intervals were characterized by the distinct destruction of carbonate materials and the oxidation of micaceous (chloritization) and feldspar grains in terrigenous sediments. Changes in the mineral composition and color of rocks along with facies changes indicate increasing humidity at the Late Triassic - Early Jurassic boundary and increasing aridity at the Middle - Late Jurassic boundary. Lithologic and facies analysis of the considered Permian-Triassic and Jurassic deposits of the area and the adjacent southern regions allowed the developmental dynamics of sedimentary basins along the northern margin of the Mesotethys to be elucidated.

PRINZ-GRIMM, P., 1995. Triassische Korallen der südlichen Zentral-Anden. Geologica et Palaeontologica, 29: 233-243.

Seventeen species of eleven genera of Upper Triassic corals are presented. Seven of the species are described for the first time from South America. In the second part, biogeographic problems in relation to the extraordinary position of the occurrences and the pacific terranes are discussed.

PUGLIESE, A., 1995. Some observations on *Macroporella retica* Zanin Buri 1965 Dasycladacean green alga from the Upper Triassic. Riv. It. Paleont. Strat., 100: 537-550.

The biometric and morphological characters of *Macroporella retica* Zanin Buri 1965 from the type-locality (Aviatico - Lombardy) are described. On the basis of these observations, it has been possible to confirm that *Macroporella retica* represents a junior synonym of *Griphorella curvata,* as stated by Barattolo et al. (1993).

RACEY, A., LOVE, M.A., BOBOLECKI, R.M. and WALSH, J.N., 1995. The use of chemical element analyses in the study of biostratigraphically barren sequences: An example from the Triassic of the central North Sea (UKCS). *In:* Non-Biostratigraphical Methods of Dating and Correlation. Geol. Soc. Spec. Publ., 89, pp. 69-105.

RADUKIĆ, G., DJORDJEVIĆ, D. and RADAKOVIĆ, A., 1992. Adularia from Triassic effusuve rocks in Rogatica area, eastern Bosnia. Ann. Géol. Penins. Balk., 56: 237-252.

K-feldspar, adularia, from Triassic effusive rocks in the process of K-metasomatic alteration, in Rogatica area (eastern Bosnia), have been examined and the results are presently reported. The examination methods used are optical, electronic microprobe analysis, and X-ray diffraction. The examined adularia is characterised by sanidine optical elements (n_α = 1.523, n_β = 1.525 and n_γ = 1.531) and about 99.7% Or constituent. K-ions in the crystallochemical formula vary from 3.69 to 3.97, whereas Na-ions (from 0.007 to 0.011) and Ca (from 0.004 to 0.008) are very low. The parameters of the unit cell are: a = 0.8586(2) nm, b = 1.3010(7) nm, c = 0.7178(1) nm, and β = 116.08(1)°. Adularia has formed during the K-metasomatic action, due to the primary plagioclase transformation.

RAMOS, A., 1995. Transition from alluvial to coastal deposits (Permian-Triassic) on the island of Mallorca, western Mediterranean. Geol. Mag., 132: 435-447.

Non-marine redbeds (Permian and Triassic) in the island of Mallorca consist of a 0.4 km-thick alluvial succession that passes upwards into siliciclastic-carbonate coastal deposits. Tectonics and sealevel changes have been the main influences in their evolution. Low in this succession (the 'Areniscas y lutitas de Port des Canonge' unit) sandstone sheets with lateral accretion surfaces (macroscale inclined strata) and mudstones with frequent exposure structures are interpreted as the products of a sinuous alluvial system and floodplain. Climatic fluctuations are considered to be responsible for some significant up-section changes in the evolution of the alluvial deposits. Low-angle or horizontally stratified sandy units, interpreted as the result of flash floods, alternate upwards with point-bar deposits in the 'Areniscas de Asá'. The hydrological response to minor climatic changes was evidently nearly instantaneous due to the lack of significant vegetation cover. During accumulation of mudstones and sandstones of the overlying 'Lutitas y Areniscas de Son Serralta' unit, the interpreted environment of deposition changed from a distal braidplain, mainly constructed by superposition of sandy bedforms with straight or linguoid crestlines in low sinuosity river channels, into a coastal plain with evidence of both continental and marine influences. The overlying carbonate platform (Muschelkalk) marks the development of a more homogeneous marine environment resulting from the Tethyan transgressive event that affected the whole

peri-Mediterranean realm during the Anisian (middle Triassic).

Ramovš, A., 1994. Eine Obertrias-Conodontenfauna (Karnium) aus dem unteren Abschnitt der "Kalke und Dolomite von Železniki" (Eisnern, West-Slowenien). Abh. Geol. B.-A., 50: 381-385.
In the lower portion of the Kossmat's limestones and dolomites of Železniki (Eisnern) west of Škofja Loka, West Slovenia, the black arid dark grey micritic limestones contain the following platform conodonts: *Epigondolella nodosa* (Hayashi), *Gladigondolella malayensis* Nogami and *Paragondolella tadpole* (Hayashi). The Upper Carnian (*E. nodosa*-A.Z.) is proved by these remains. *Gl. malayensis*, which does not range higher than Middle Carnian, must consequently be re-transported. Owing to the stratigraphic position of "limestones and dolomites of Železniki" this lithostratigraphic unit should not be correlated with the Norian and Rhaetian Baba Dolomite with chert.

Renesto, S. and Paganoni, A., 1995. A new *Drepanosaurus* (Reptilia, Neodiapsida) from the Upper Triassic of Northern Italy. - N. Jb. Geol. Paläont., Abh., 197: 87-99.
A new fossil reptile from the Argilliti di Riva di Solto formation (late Norian, Late Triassic) in the fossiliferous locality of Ponte Giurino (Bergamo Prealps, Lombardy, Northern Italy) belongs to the family Drepanosauridae, Genus *Drepanosaurus*. The small size and lack of ossification of some tarsal elements suggest that the specimen is a juvenile one. The characters shared by the Drepanosauridae represent adaptations to an arboreal mode of life.

Renesto, S. and Tintori, A., 1995. Functional morphology and mode of life of the Late Triassic placodont *Psephoderma alpinum* Meyer from the Calcare di Zorzino (Lombardy, N Italy). Riv. Ital. Paleont. Strat., 101: 37-48.
The recent find of a new complete specimen of *Psephoderma alpinum* Meyer, 1858 in the Norian Calcare di Zorzino (Zorzino Limestone), in northern Italy, adds to our knowledge of the osteology of this species. The new specimen is the largest so far collected, reaching 180 cm in length. Allometric growth of the limbs during ontogeny is demonstrated. A new interpretation of its palaeoecology and mode of life is given on the bases of both functional morphology and palaeoenvironmental observation. The streamlined keeled carapace is interpreted as having a hydrodynamic rather than a defensive function. The long, stiff tail and, probably, the dorsal caudal plate served for balance. The gap in the carapace, above the sacral region, enabled *Psephoderma* to swim at least as well as trionychid turtles, though no particular swimming adaptations of the pelvic girdle and of the femur are observed. Invertebrates and a rich fish fauna were found together with these placodonts, allowing the restoration of the oxic part of the basins environment as a normal marine one. The surface waters were influenced by tides that possibly generated rather strong local currents close to the mouth of tidal channels crossing the platform. This provided for a rich nectonic and benthic life in the more superficial waters: *Psephoderma* fed on bissate molluscs, such as *Modiolus* and *Isognomon*, dwelling on shallow oxic bottoms at the basins edge. Due to water stratification, a long-lasting anoxic environment developed in the deepest part of the basins themselves, allowing fine preservation (Konservat-Lagerstätten) of allochthonous organisms.

Renne, P.R., 1995. Excess ^{40}Ar in biotite and hornblende from the Noril'sk 1 intrusion, Siberia: Implications for the age of the Siberian Traps. Earth Planet. Sci. Letters, 131: 165-176.
The Siberian Traps represent the largest known Phanerozoic manifestation of continental flood volcanism. The general agreement is now that the volcanism was of short duration (similar to 1 m.y.) and was synchronous with the Permian-Triassic boundary. Discrepancies between different geochronologic results prevent rigorous evaluation of the age and duration of magmatism. Several alkalic mafic intrusions associated with the Siberian Traps represent

subvolcanic feeders for the Trap lavas. The Noril'sk 1 intrusion is intruded into the earliest flows and is chemically and isotopically related to stratigraphically overlying flows. Biotites from the Noril'sk 1 intrusion have previously yielded $^{40}Ar/^{39}Ar$ plateau dates (254-251 Ma) that are significantly older than seemingly reliable $^{40}Ar/^{39}Ar$ plateau dates (250-247 Ma) on plagioclase and whole-rock samples from Trap basalts that are geologically constrained to be older than the intrusion. Possible explanations of this discrepancy include: (1) plagioclase and whole-rock samples are anomalously young due to ^{40}Ar loss via alteration or episodic outgassing, and/or (2) the biotites contain excess ^{40}Ar. Detailed laser heating $^{40}Ar/^{39}Ar$ analysis of six individual grains of biotite in a total of 214 steps yield data that permit characterization of multiple components of Ar through isotope correlation patterns. An isochron age of 250.1 ± 1.5 Ma (2 sigma) and an excess Ar component with $^{40}Ar/^{36}Ar$ = 565 ± 39, are obtained by regression of the 115 highest temperature steps. Step heating of a bulk hornblende sample also reveals excess Ar, with $^{40}Ar/^{36}Ar$ = 327 ± 10 and an isochron age of 249.3 ± 1.6 Ma. Neglecting uncertainties in the ages of neutron fluence monitors, the two dates just overlap at 2 sigma, but are distinctly younger than the previous mean plateau date (253.9 ± 1.6 Ma) for biotite. The different initial $^{40}Ar/^{36}Ar$ for the two phases is interpreted as reflecting the evolution of an initial lower mantle composition towards increasing crustal contamination.

RENNE, P.R., ZHANG, Z.C., RICHARDS, M.A., BLACK, M.T. and BASU, A.R., 1995. Synchrony and causal relations between Permian-Triassic boundary crises and Siberian flood volcanism. Science, 269(5229): 1413-1416.

The Permian-Triassic boundary records the most severe mass extinctions in Earth's history. Siberian flood volcanism, the most profuse known such subaerial event, produced 2-3 million cubic kilometers of volcanic ejecta in approximately 1 million years or less. Analysis of $^{40}Ar/^{39}Ar$ data from two tuffs in southern China yielded a date of 250.0 ± 0.2 my for the Permian-Triassic boundary, which is comparable to the inception of main stage Siberian flood volcanism at 250.0 ± 0.3 my. Volcanogenic sulfate aerosols and the dynamic effects of the Siberian plume likely contributed to environmental extrema that led to the mass extinctions.

RETTORI, R., 1994. Replacement name *Hoyenella,* gen. n. (Triassic Foraminiferida, Miliolina) for *Glomospira sinensis* Ho, 1959. Boll. Soc. Paleont. Ital., 33: 341-343.

The new genus *Hoyenella,* gen. n. (type-species *Glomospira sinensis* Ho, 1939), is herein introduced for a Triassic foraminifer of the Eastern and Western Tethys. The new family Hoyenellidae, fam. n. (type-genus *Hoyenella,* gen. n.) is also established.

RIEPPEL, O., 1995. The pachypleurosaur *Neusticosaurus* (Reptilia, Sauropterygia) from the Middle Triassic of Perledo, Northern Italy. N. Jb. Geol. Paläont. Mh., 4: 205-216.

The pachypleurosaur specimen from the Middle Triassic of Perledo is redescribed and identified as *Neusticosaurus pusillus* (Fraas, 1881). The analysis of the distribution of pachypleurosaurs in the Middle Triassic of Europe shows *Neusticosaurus pusillus* to be the most widespread taxon. Its occurrence in the Perledo Member of the Perledo-Varenna Formation indicates different rates of faunal turnover in different intraplatform basins of the southern Alpine region.

ROBACK, R.C. and WALKER, N.C., 1995. Provenance, detrital zircon U-Pb geochronometry, and tectonic significance of Permian to Lower Triassic sandstone in southeastern Ouesnellia, British Columbia and Washington. GSA Bulletin, 107: 665-675.

U-Pb ages of Permian detrital zircons within eastern Quesnellia are similar to ages of western and southwestern Laurentian basement provinces, suggesting sedimentologic ties between the Quesnellian arc terrane and the Laurentian continental margin. The Permian to Lower Triassic Mount Roberts Formation forms the easternmost exposures of the Harper Ranch subterrane of Quesnellia. The formation consists of interbedded lithic greywacke, argillite, limestone, and volcanic rocks deposited within an ensimatic arc environment. Petrology of Mount Roberts Formation sandstones indicate derivation from lithologically diverse sources that consisted predominantly of volcanic rocks but also included significant amounts of sedimentary, metamorphic, and plutonic rocks. U-Pb ages of 27 individual detrital zircons from a single Permian to Lower Triassic sandstone of the Mount Roberts Formation indicate that detritus was derived from source terranes with ages of approximately 0.37-0.40 Ga, 1.0-1.3 Ga, 1.50 Ga, 1.61-1.66 Ga, 1.8-2.1 Ga, 2.36 Ga, 2.48 Ga, and 2.5-2.7 Ga. Devonian zircons are interpreted to represent first-cycle detritus derived from an igneous source terrane that may make up local basement to the Mount Roberts Formation. Most Precambrian zircons are well rounded by sedimentary abrasion and thus were probably derived from older sedimentary rocks. The ultimate sources of 1.0-1.66 Ga detrital zircons are unknown, but it is unlikely that they were derived from the presently adjacent craton. Zircons 1.0-1.66 Ga may represent detritus ultimately derived from southwestern Laurentia. Zircons 1.8-2.7 Ga are similar in age to geologic provinces within western Laurentia, suggesting presently adjacent provinces within the Laurentian craton as ultimate sources of some Precambrian detritus within the Mount Roberts Formation. Although Laurentia may have been the ultimate source of Precambrian detritus within the Mount Roberts Formation, sedimentologic and petrologic data and regional geologic considerations strongly suggest that most of this detritus was recycled from craton-derived sedimentary and metasedimentary rocks that composed part of Quesnellia.

ROUGIER, G.W., DELAFUENTE, D.W. and ARCUCCI, A.B., 1995. Late Triassic turtles from South America. Science 268(5212): 855-858.

The discovery of Triassic (Norian) turtles from the northwest part of Argentina extends the South American record of turtles by 60 million years. Two skeletons, one almost complete, represent a new genus and species of a basal turtle, *Palaeochersis talampayensis*. This turtle is a member of the family Australochelidae that was recently erected for *Australochelys africanus* from the Lower Jurassic of South Africa. Here, it is proposed that Australochelidae is the sister group of *Proferochersis* plus *Casichelydia*, that turtles were diverse by the Late Triassic, and that *Casichelydia* probably originated during the Jurassic.

SADOONI, F.N., 1995. Petroleum prospects of Upper Triassic carbonates in Northern Iran. J. Petroleum Geol., 18: 171-189.

The development of a sedimentary basin during the Late Triassic in northern Iraq marked the initiation of the Neotethys in the region. Sedimentation was influenced by basement block faulting, the disposition of the basin on different tectonic blocks, and the prevalence of arid and semi-arid climatic conditions. Sediments deposited included carbonates, evaporites and minor clastics. Carbonates were deposited on a shallow-marine shelf (the Kand sub-basin) that received an influx of clastic material at its western and southern margins. A local salina (the Qara Chauq sub-basin) also developed, leading to the deposition of bedded anhydrites and halites. Hydrocarbon prospects are restricted mainly to the NW parts of the Kand sub-basin.

SAMANKASSOU, E., 1995. Early Triassic (Scythian) conodonts from the Werfen Formation, Southern Alps, Italy. N. Jb. Paläont. Mh., 4: 248-256.

The Werfen Formation has been investigated near Vigo di Fassa. Three genera with six species of conodonts, all belonging to the family Ellisoniidae, are described: *Ellisonia* *agordina, E. triassica, Hadrodontina adunca, H. aequabilis, H. anceps* and *Pachycladina obliqua.* The Conodont Alteration Indices (CAI) ranges between 2-3. The stratigraphic range of *Ellisonia agordina,* proposed in Perri & Andraghetti (1987) and Perri (1991), is discussed. The occurrence of *Ellisonia triassica* differs from previous observations: it occurs in the upper part of the Werfen Formation and is absent in the lower part. The multi-element taxonomy applied to *Pachycladina* modifies the results presented by Samankassou (1992): *Pachycladina inclinata* and *P. longispinosa* are seen now as elements of *Pachycladina obliqua.*

Schäfer, P., 1994. Bryozoen der Trias - eine Übersicht. Abh. Geol. B.-A., 50: 387-397.
A systematic overview is given for Triassic bryozoa including information on locality, stratigraphy and facies. The crisis of stenolaemate bryozoa at the Palaeozoic/Mesozoic boundary is discussed on the basis of diversity patterns, evolutionary trends, palaeobiogeography, and facies correlation.

Schaltegger, U., Zwingmann, H., Clauer, N., Larque, P. and Stille, P., 1995. K-Ar dating of a Mesozoic hydrothermal activity in Carboniferous to Triassic clay minerals of northern Switzerland. Schweiz. Mineral. Petrogr. Mitt., 75: 163-176.
Clay fractions of 0.2 μm up to 2-6 μm size from Upper Triassic (Keuper series at Frick) and Upper Carboniferous sediments (Stephanian strata at Weiach, NAGRA drillhole), both in northern Switzerland, were analyzed for their K-Ar ages in order to trace their post-depositional history and to date a hypothetical hydrothermal overprint. The latter had to be assumed because of published K-Ar and Rb-Sr data that are by up to 200 million years younger than the age of deposition in sediments or metamorphism in crystalline rocks, respectively, of the same region. The K-Ar ages from an Upper Triassic marl, a sandstone and a shale are all younger than their depositional age. They do not indicate any hydrothermal overprint, but most likely indicate diffusive Ar loss from poorly organized sheet silicates. Siltstones from the Weiach borehole (Upper Carboniferous from the North Swiss Permocarboniferous Trough, NPT) reflect old detrital components and a post-depositional Ar loss. Three tuff samples interlayered with the siltstones define an age of 183 ± 5 Ma for a penetrative hydrothermal overprint causing complete illitization of the tuffs and extensive cementation of secondary pore space of the siltstones, partly by replacement of precursor clays (kaolinite). The three siltstone samples were differentially overprinted by the fluids, according to their depth in the borehole: The deepest sample shows a nearly size-independent age distribution with a mean value around the proposed age of hydrothermal activity of 183 Ma. Samples higher up in the column are more strongly dominated by their detrital components, exhibiting the typical correlation between apparent age and grain size. Hump-shape type age patterns characterize samples that contain abundant aggregates of small sized particles in their coarse size fractions. A model is proposed, which infers fluid migration in the deeper part of the NPT (1700 to 2050 m) along subhorizontal shear zones, causing highly variable illite/kaolinite ratios depending on the fluid/rock ratio. These fluids may have introduced enough additional heat to create an impact on thermal indicators used for basin modelling, such as porosity, illite/smectite ratios, fluid inclusions and the degree of maturation of the organic material (vitrinite reflection).

Schubert, J.K. and Bottjer, D.J., 1995. Aftermath of the Permian-Triassic mass extinction event: Paleoecology of Lower Triassic carbonates in the western USA. Palaeogeogr. Palaeoclimatol. Palaeoecol., 116: 1-39.
Paleoecologic study of invertebrate faunas from three successive Early Triassic seaways reveals that biotic recovery from the end-Permian mass extinction event was slow, and that

full recovery did not occur until after the Early Triassic. Simple, cosmopolitan, opportunistic generalists, and low-diversity, low-complexity paleocommunities were characteristic of the entire Early Triassic in the Western USA. An increase in guild and taxonomic diversity was observed with the addition of several new higher taxa in the late Early Triassic (Spathian) to the almost exclusively molluscan faunas of the earlier Early Triassic (Nammalian). Potential "disaster forms" (the inarticulate brachiopod, *Lingula*, and the paper pecten, *Claraia*) dominated the earliest Early Triassic faunas (Griesbachian) and even occurred in the late Early Triassic (normal marine stromatolites). Comparison with data on faunas from the Permian and Triassic suggests that even the most diverse Early Triassic faunas (in the Spathian) were rather low in guild diversity and species richness. These characteristics of genera and paleocommunities in the Early Triassic may be typical of mass extinction aftermaths.

SEIDEL., G., 1995. Zur Ausbildung des Oberen Buntsandsteins bei Hildburghausen. Geowiss. Mitt. Thür., 3: 123-134.

A detailed section of the Upper Buntsandstein of the studied area is presented in this paper. Correlations to other sections in the Thuringian Basin are given. The "Salinarröt" sequence, the "Lower coloured layers" and the "red layers" represent a more borderly facies compared to the Thuringian basin. "Upper coloured layers" and "Myophoria layers" show a quite similar pattern as it is known from the central parts of the Thuringian basin.

SENGUPTA, D.P., 1995. Chigutisaurid temnospondyls from the Late Triassic of India and a review of the family chigutisauridae. Palaeontology, 38: 313-339.

Two chigutisaurids (Amphibia, Temnospondyli), *Compsocerops cosgriffi* gen. et sp. nov. and *Kuttycephalus triangularis* gen. et, sp, nov., from the Late Triassic Maleri Formation, Pranhita-Godavari valley, Deccan, India are described. In the past, the only known chigutisaurids have been two genera from Australia and probably two from South America. Relationships within the family are analysed and two groups are recognized. They possess marked differences in their palate and dentition. The Late Triassic beds of the Pranhita-Godavari valley exhibit a rapid faunal change. Two faunal zones are present in the Maleri Formation. The age of the lower zone is possibly Late Carnian and the upper is Early Norian. Chigutisaurids are present in the upper faunal zone only.

SENNIKOV, A.G., 1995. Permian and Triassic diapsid reptiles from eastern Europe. Paleont. Žhūrn., 1: 75-83.

Systematic composition, evolution, stratigraphic distribution and intercontinental connections of diapsid faunas of the Permian and Triassic of Eastern europe are reviewed.

SENOWBARI-DARYAN, B., 1994. *Enoplocoelia? gosaukammensis* - ein neuer thalamider Schwamm aus den obertriadischen Riffkalken des Gosaukammes (Nördliche Kalkalpen, Österreich). Jb. Geol. B.-A., 137: 669-674.

A new thalamid sponge, *Enoplocoelia? gosaukammensis,* is described from the Norian reef limestones of the Gosaukamm Range (Northern Calcareous Alps, Austria). The new sponge is one of the smallest thalamid sponges known so far. Other sponges, foraminifera, microproblematica, spongiostromate crusts occurring together with *Enoplocoelia? gosaukammensis* indicate a biotope within the central reef area.

Senowbari-Daryan, B., 1994. Segmentierte Schwämme ("Sphinctozoen") aus der Obertrias (Nor) des Taurus-Gebirges (S-Türkei). Jb. Geol. B.-A., 50: 415-446.

The Upper Triassic (lower Norian) reef boulders ("Cipit" limestones) exposed in western Taurus-Mountains (western area of Antalya, Turkey) contain a rich fauna of reef builders with an excellent preservation of the aragonitic skeleton. The sponges are the most common frame workers. The most abundant group is represented by the "sclerosponges" ("chaetetids"), followed by representatives of the inozoid and sphinctozoid sponges. Following "sphinctozoan" taxa are described as new: *Gigantothalamia ovoidalis* n.g., n.sp.; *Antalythalamia riedeli* n.g., n.sp.; *Sphaerothalamia vesiculifera* n.g., n.sp.; *Thaumastocoelia sphaeroida* n.sp.; *Thaumastocoelia ovoidalis* n.sp.; *Pseudouvanella parallela* n.g., n.sp.; *Stylothalamia polysiphonata* n.sp. A comparison of thalamid sponges of the reef boulders from southern Turkey with the thalamid sponges of other Norian-Rhaetian reefs in southern and northern parts of the Tethys exhibits the endemic character of the thalamid sponges in south Turkey, not known from the other Norian reefs of the world.

k **Senowbari-Daryan**, B. and **Wurm**, D., 1994. *Radiacella prima* n.g., n.sp., der erste segmentierte Schwamm mit tetracladinem Skelett aus den Dachstein-Riffkalken (Nor) des Gosaukammes (Nördliche Kalkalpen, Österreich). Abh. Geol. B.-A., 1994.

The thalamid sponges ("sphinctozoa") are relatively abundant organisms in the Upper Triassic (Norian) Dachstein-reef limestones in the Alpine-Mediterranean region but no report of a tetracladine sponge of thalamid type is known from this area. *Radiocella prima* n.g., n.sp., described here, is the first lithistid and tetracladin sponge of thalamid type from this region.

Sharp, Z.D., **Frey**, M. and **Livi**, K.J.T., 1995. Stable isotope variations (H, C, O) in a prograde metamorphic Triassic red bed formation, Central Swiss Alps. Schweiz. Mineral. Petrogr. Mitt., 75: 147-161.

In the Swiss Central Alps, the Upper Triassic red beds range from unmetamorphosed Keuper sediments in the northern foreland to staurolite-grade pelites (Quartenschiefer) farther to the south. Individual stratigraphic sequences can be followed intermittently throughout the prograde metamorphic sequence, allowing for isotopic variations in hydrogen, carbon and oxygen to be traced in a single protolith that has undergone essentially a single Alpine metamorphic event. Samples were analyzed from each of four metamorphic grades: (1) unmetamorphosed sediments from the Lindau borehole in the Molasse Basin (MB), T approximate to 100 °C; (2) anchimetamorphosed sediments from the northern Glarus Alps (GA), T approximate to 200-250 °C; (3) epimetamorphic-grade (lower greenschist facies) sediments from the Urseren Zone (UZ), T approximate to 400 °C; (4) epi- and mesometamorphic pelites from the Lukmanier Pass are (LP), T similar or equal to 500-550 °C. The $\delta^{18}O$ (parts per thousand vs SMOW) and the $\delta(13)C$ (parts per thousand vs PDB) values of the carbonate fraction, the $\delta^{18}O$ and δ D values of the silicate residue (parts per thousand vs SMOW) and the total wt% H2O and wt% carbonate were measured for each sample. The silicates are the dominant oxygen reservoir at all but the lowest grades; hence the $\delta^{18}O$(silicate), values are essentially constant throughout the sequence. The $\delta^{18}O$(carbonate), values systematically decrease with increasing grade, approaching equilibrium with the silicates. The scattered $\delta^{13}C$ carbonate values may be due to varying degrees of decarbonation or interaction with organic matter (from adjacent black shales?). The δ D values of the hydrous silicates initially increase, indicating interaction with deuterium-enriched pore waters, and then decrease at higher metamorphic grades due to the removal of water associated with dehydration reactions. The overall isotopic variations can be interpreted in terms of minor C-O-H fluid loss, with no external fluid input.

Siblik, M., 1994. The Brachiopod fauna of the Wetterstein Limestone of the Raxalpe (Austria). Jb. Geol. B.-A., 137: 365-381.

19 taxa have been ascertained during the present study of brachiopods from the Wetterstein Limestone of Raxalpe. Brachiopods belong there to the most characteristic reef-dwellers and seem to be missing in lagoonal facies. Cordevolian age is presumed for the local brachiopod assemblages studied. *Stotzenburgiella baloghi* was ascertained on Raxalpe, known till the present time from the West Carpathians only.

Smith, R.M.H., 1995. Changing fluvial environments across the Permian-Triassic boundary in the Karoo Basin, South Africa and possible causes of tetrapod extinctions. Palaeogeography, Palaeoclimatology, Palaeoecology 117: 81-104.

The Karoo Supergroup is a 12 km thick succession of sedimentary rocks that accumulated in a large intracratonic retroarc foreland basin in southwestern Gondwana. The strata record 100 million years of almost continuous sediment accumulation from the Permo-Carboniferous (300 Ma) through to the Early Jurassic (190 Ma) under a range of climatic regimes and within several tectonically controlled sub-basins. Alluvial sediments dominate the succession from the Late Permian onwards. Fossils of synapsid reptiles and early dinosaurs are sufficiently common to be used in a ten-fold biostratigraphic subdivision of these strata. The Permian/Triassic boundary in the Karoo succession is marked by a major extinction of the herbivorous dicynodonts which coincides with a rapid change in fluvial facies. This study uses field observations of the sedimentary facies, palaeosols and in situ fossils of well exposed P-Tr boundary sequences in the southern Karoo Basin to provide evidence of environmental changes that may have caused the tetrapod extinctions in the main Karoo Basin. Below the P-Tr boundary sequence, the sediments comprise drab greenish-grey mudrocks with a few thick (3-12 m) multistoried, laterally-accreted fine-grained sandstone bodies. The mudrocks host hydromorphic palaeosols with palustrine carbonate horizons and mostly disarticulated skeletal remains of *Dicynodon* Assemblage Zone fauna. Above a transition zone of approximately 20 m thickness these strata change into reddish-brown mudrocks with numerous thin (0.5-5 m) ribbon sandstone bodies and more continuous sheet sandstones, calcic palaeosols with rhizocretions, nodular horizons and pervasive calcareous encrustation of articulated skeletons of *Lystrosaurus* and associated fauna of the *Lystrosaurus* Assemblage Zone. Within a 20-m thick interval of the transitional strata fossils of *Dicynodon* and *Lystrosaurus* occur together. The facies transition that coincides with the latest Permian dicynodont extinction is interpreted as a change in fluvial style from meandering to low sinuosity channels with general drying of the floodplain habitats and redistribution of vegetation belts. The horsetails in particular became significantly reduced in areal distribution. The changes in fluvial style in the Karoo Basin at the end of the Permian were triggered by a pulse of thrusting in the southerly source area dated at 247 Ma (± 2 Ma) which brought about rapid progradation of a large sandy braided fan system (the Katberg Sandstone Fm.) into the central parts of the basin. A concomitant basinward migration of depositional environments allowed the *Lystrosaurus* communities that were adapted to dry floodplains to colonise the entire basin to the detriment of most of the wet floodplain *Dicynodon* fauna that lived there.

Sobolev, A.E. and **Shnai, A.K.**, 1995. Permian-Triassic mafics of Sette-Daban. Dokl. Akad. Nauk, 342: 519-521.

Stanley Jr., G.D. and Swart, P.K., 1995. Evolution of the coral-zooxanthellae symbiosis during the Triassic: a geochemical approach. Paleobiology, 21(2): 179-199.

Scleractinian corals first appeared during Triassic time in tropical shallow water environments. Controversy surrounds the paleoecology of scleractinian corals of the Late Triassic. Were they like their living counterparts, capable of supporting reefs, or had they not yet coevolved the important association with zooxanthellae that facilitated reef growth and construction? Indirect evidence suggests that some Upper Triassic corals from the Tethys played important constructional roles as reef builders within tropical carbonate complexes of the Tethys. To evaluate this idea, the authors have employed a geochemical approach based on isotope fractionation to ascertain if Late Triassic corals once possessed zooxanthellae. The authors have determined evidence for the ancient presence of algal symbiosis in 13 species of Triassic scleractinians from reef complexes in Turkey and northern Italy. In contrast, two higher latitude Jurassic species used as a control group for isotope analysis, lacked isotopic indications of symbiosis. These findings, together with stratigraphic and paleoecologic criteria, support the contention that Late Triassic scleractinian corals inhabiting shallow-water carbonate complexes of the Tethys were predominantly zooxanthellate, like their living counterparts from present day reefs. The authors view the zooxanthellate condition in calcifying reef organisms as a necessary prerequisite for constructional reef development. The results emphasize the power of stable isotope studies in helping to answer paleobiological questions.

Talbot, M.R., Holm, K. and Williams, M.A.J., 1995. Sedimentation in Low-Gradient Desert Margin Systems - A Comparison of the Late Triassic of Northwest Somerset (England) and the Late Quaternary of East-Central Australia. *In:* M.R. Rosen (ed.), Paleoclimate and Basin Evolution of Playa Systems, Geol. Soc. America, Spec. Papers, 289: 97-117.

Tipper, H.W., Carter, E.S., Orchard, M.J. and Tozer, E.T., 1994. The Triassic-Jurassic (T-J) boundary in Queen Charlotte Islands, British Columbia defined by ammonites, conodonts and radiolarians. Geobios, M.S. 17: 485-492.

In the Queen Charlotte Islands, on the Pacific shore of British Columbia, Canada, Triassic-Jurassic boundary beds are present in several well-exposed sections of the Sandilands Formation. Triassic and Jurassic ammonoids, Triassic conodonts and Triassic and Jurassic radiolarians indicate the position of the boundary to within a few metres. The section may be essentially continuous across the boundary. The evidence suggests more or less simultaneous extinction of ammonoid, conodont and radiolarian faunas at the T-J boundary.

Torres, A.M., 1995. *Ivanovia tebagaensis* was a cyathiform Permian codiacean membranous alga with dimorphic corticles. J. Paleont., 69: 381-387.

Species of *Ivanovia* (Codiaceae or Udoteaceae, Chlorophyta) have traditionally been characterized as phylloid or leaflike. Extraordinarily well preserved specimens of *I. tebagaensis* in limestone from the Upper Permian of southern Tunisia indicate that the thallus was cyathiform or cup-shaped, similar to the broadly conical codiacean *Calcipatera* and to living *Udotea cyathiformis*. *Ivanovia* also shared with *Calcipatera* the same general membrane structure consisting of bilateral cortices with palisades of utricles, now filled with micrite, and a medulla of tubular coenocytes, now filled with sparry calcite mosaic. A cyathiform thallus would have had an inner and an outer cortex and those of *I. tebagaensis* were dimorphic. The utricular structure as usually seen in thin sections using transmitted light is much clearer when viewed on polished surfaces of hand specimens using reflected light. Commonly occurring fused membranes suggest that the thalli reproduced vegetatively by budding. The complexity and regularity of the *I. tebagaensis* membrane structure strongly suggest that a model which proposes that *Ivanovia* is simply a diagenetic stage in the fossilization of the red alga, *Archeolithophyllum,* is invalid.

Turnšek, D. and Senowbari-Daryan, B., 1994. Upper Triassic (Carnian-Lowermost Norian) corals from the Pantokrator limestone of Hydra (Greece). Abh. Geol. B.-A., 50: 477-507.

From the Pantokrator limestone of the Island Hydra, Greece, 24 species of corals belonging to 14 genera are described. Two genera and seven species are new (*Palaeastraea mandrakiensis* n.sp., *Stuoresia fluegeli* n.sp., *Conophyllia hellenica* n.sp., *Hydrasmilia* n.g.: *H. rhythmica* n.sp., *H. fossulata* n.sp., *H. ornamenta* n.sp., *Craspedophyllia graeca* n.g. n.sp.). Corals confirm Carnian to lowermost Norian age of localities. Coral species can mostly be compared with south European localities (Italy, Slovenia, south Hungary, Romania, Turkey), and seem to predominate in southern shallows of the Tethys. Nevertheless, almost one third of the new species indicate special and somewhat different environments in Hydra during the Carnian period.

Urošević, D., 1992. *Rectopilammina* n. gen. and *Hoheneggerinella* n. gen. (Foraminiferida) from Triassic sediments of eastern Serbia. Ann. Géol. Penins. Balk., 56: 163-175.

Two new genera, each with two new species, of foraminifers from Middle Triassic (Anisian) sediments of eastern Serbia are presented in the article. The genera are: *Rectopilammina* n. gen. with *Rectopilammina editea* n. gen. n. sp. and *Rectopilammina serbicensis* n. sp., and *Hoheneggerinella* n. gen. with *Hoheneggerinella kneziensis* n. gen. n. sp. and *Hoheneggerinella carinata* n. sp.

Urošević, D. and Sudar, M., 1992. Anisian foraminifera of Merica (Zlatar mountain, western Serbia). Ann. Géol. Penins. Balk., 56: 211-235.

Foraminifera from Bulog Limestones of Illyrian (Anisian) age on the southwestern slopes of Merica peak, Zlatar Mountain (western Serbia), are presented in the article. Besides the identified and described many known species, new taxa (one genus and six species) are established: *Neotolypammina* n. gen., *N. ekaterinae* n. sp., *N. flexoformis* n. sp., *N. meandroformis* n. sp., *Ammodiscella? posidonioformis* n. sp., *Aulotortus ? gibbus* n. sp., and *Nodogordiospira uvaeformis* n. sp.

Vachard, D. and Colin, J.-P., 1994. Etude micropaléontologique et palynologique du "Muschelkalk" de Minorque (Trias, Iles Baléares, Espagne), et précisions sur la systématique des involutinidés (foraminifères). Revue de Paléobiologie, 13(1): 235-257.

The Triassic of Minorca (Balearic Islands, Spain) has been analyzed for lithology and micropalaeontology (foraminifera, calcareous algae and ostracodes). Foraminifera give an Upper Ladinian-Lower Carnian age to the main fossiliferous interval. Ammonites previously dated as lower Ladinian are now considered to belong to the upper Ladinian. Precisions on the systematics of the involutinid foraminifera *Triadodiscus eomesozoicus, Aulotortus praegaschei, Lamelliconus procerus* and *L. biconvexus* are given.

Van der Meer, F., 1995. Triassic-Miocene paleogeography and basin evolution of the Subbetic Zone between Ronda and Malaga, Spain. Geologie en Mijnbouw, 74: 43-63.

During the Triassic, continental and supratidal environments prevailed in the north of the Ronda-Malaga region whereas intertidal and shallow marine environments characterize the south. Backstripping analysis reveals four phases of accelerated subsidence related to extension in the Mesozoic: Anisian-Ladinian, Norian-Hettangian, Callovian-Tithonian and Cenomanian-Turonian. These phases can be correlated with tectonic events in the Central Atlantic Ocean.

\\ **Van Veen, P.M.**, 1995. Time calibration of Triassic/Jurassic microfloral turnover, eastern North America - Comment. Tectonophysics, 245: 93-95.

Vavilov, M.N., 1995. Acceleration and retardation in the ontogeny of boreal Triassic ammonoids. Paleont. Žhurn., 1: 110-114, Moscow.

Acceleration and retardation in the development of different characters in boreal Triassic ammonoids are considered. Combination of these two phenomena is believed to be a characteristic feature of the evolutionary process, which determines the trends of phylogenetic transformations.

Veevers, J.J. and **Tewari, R.C.**, 1995. Permian-Carboniferous and Permian-Triassic magmatism in the rift zone bordering the Tethyan margin of southern Pangea. Geology, 23: 467-470.

Magma was emplaced in the India-Australia rift zone along the Tethyan margin during Permian-Carboniferous and Permian-Triassic time. Permian-Carboniferous alkalic granite and basaltic and rhyolitic lava flows and tuffs formed at the same time as rightlateral transtension of Pangea, as recorded by the magmatic rocks of neocratonic post-Variscan Europe and post-Kanimblan eastern Australia. Permian-Triassic tholeiitic basalt in India, alkalic magmatic rocks in Oman, and rhyolite, dolerite, and undersaturated alkalic volcanic rocks in Western Australia preceded and accompanied the early opening of the Neo-Tethys ocean. Coeval magmatism included the voluminous mid-plate Siberian Traps, the Emeishan Basalt of south China, and the peak activity of the magmatic arc along the convergent Panthalassan margin. The background magmatism probably permitted the Siberian Traps to trigger the environmental catastrophe at the Permian-Triassic boundary.

Viczián, I., 1993. Clay mineralogy of Middle Triassic evaporitic and carbonate rocks, Mecsek Mountains (southern Hungary). 11th Conf. Clay Mineralogy and Petrology, pp. 135-144.

Warren, A.A. and **Schroeder, N.**, 1995. Changes in the capitosaur skull with growth: An extension of the growth series of *Parotosuchus aliciae* (Amphibia, Temnospondyli) with comments on the otic area of capitosaurs. Alcheringa, 19: 41-46.

A species of the family Capitosauridae, previously known only from immature specimens, is now known from an adult which is typically capitosaurian in proportions, although allometrically quite different from the juveniles. It is proposed that the oblique ridge of the pterygoid did not house the stapes in capitosaurs. Instead the stapes passes posterior to the oblique ridge with its distal end only entering the otic notch.

Wignall, P.B., **Hallam, A.**, **Lai Xulong** and **Yang Fengqing**, 1995. Palaeoenvironmental changes across the Permian/Triassic boundary at Shangsi (N.Sichuan, China). Hist. Biol., 10: 175-189.

The section at Shangsi in Sichuan contains one of the most detailed and best records of events during the Permian/Triassic (P/T) mass extinction. Continuous deep water deposition is only punctuated by a minor shallowing in the late Changxingian. The micritic mudstones and wackestones of the Changxingian Dalong Formation contain abundant ammonoids and radiolaria and diverse and common benthic taxa (mostly bivalves and brachiopods) in a thoroughly bioturbated sediment. The presence of a well developed tiered burrow profile is just one line of evidence for a fully oxygenated water column in the late Permian. The faunal crisis occurs in the top few decimetres of the Dalong Formation and severely affected all groups (benthos, nekton and plankton). The extinction coincides precisely with the development of anaerobic and dysaerobic facies. The basal Triassic sediments of the Feixanguan Formation are thinly-bedded or laminated silicic marls and contain pyrite and several levels of

elevated organic carbon concentrations. The fauna is restricted to rare ammonoids and a few bedding planes covered in *Claraia*. The presence of abundant coccoid cyanobacteria in these sediments may indicate an unusually simple trophic web in the early Triassic seas as these picoautotrophs are normally grazed by zooplankton, they are rarely directly incorporated into seafloor sediment. The recent discovery of black shales in P/T pelagic sediments of Japan indicates that the anoxic event also affected deep ocean waters and further strengthens the link between extinction and anoxia.

Yao, X., Taylor, T.N. and **Taylor, E.L.**, 1995. The corystosperm pollen organ *Pteruchus* from the Triassic of Antarctica. Am. J. Bot., 82: 535-546.

The permineralized corystosperm pollen organ *Pteruchus* is described from the early Middle Triassic of Antarctica. *Pteruchus fremouwensis* consists of an axis bearing numerous, helically arranged microsporophylls, each of which terminates in a distal flattened head. The axis is 1-2 mm in diameter and eustelic. Spherical to elliptical secretory cavities are present in the ground tissue of the axis, microsporophyll, and pollen sac wall. The basal stalk of the microsporophyll is vascularized by a C-shaped strand that gives rise to a midvein and numerous lateral veins in the distal head. At least 38 pollen sacs are borne on the abaxial surface of the microsporophyll head. These are arranged in pairs on either side of lateral veins. Each pollen sac is sessile, elongated, and uniloculate. The pollen sac wall is several cell layers thick early in ontogeny, but reduced to a single layer in thickness when mature. Dehiscence is longitudinal along the inner surface. Pollen is monosulcate and bisaccate, and of the *Alisporites*-type. The Triassic specimens are the first structurally preserved pollen organs of the *Pteruchus*-type and can be related to the associated corystosperm stem and leaf genera based on the presence of unique secretory cavities. The morphology of *Pteruchus* and the relationship of this pollen organ with other Mesozoic and Paleozoic pollen organs is discussed.

Yaroshenko, O.P. and **Imam, I.B.**, 1995. Age variability of palynomorph compositions of the Middle and Late Triassic of Syria and their relation to climate and facies. Strat. Geol. Correlation, 3: 375-392.

A succession of eight palynological assemblages designated by characteristic taxa were established in Middle to Upper Triassic carbonate and evaporite deposits in northwest and central Syria. A certain regularity in the distribution of the main palynomorph groups was observed in marine, coastal marine, and lagoon deposits. Palynomorphs, along with some types of rocks, served as indicators of climate and sedimentary environments.

Zamuner, A.B. and **Artabe, A.**, 1994. Estudio de un leño fosil, *Protocircoporoxylon marianaensis* n.sp., de la Formacion Paso Flores (Neotriasico), Provincia de Rio Negro, Argentina. Ameghiniana, 31(3): 203-207.

The fossil wood studied in this paper was collected in massive gravelly sandstones facies belonging to Paso Flores Formation (Late Upper Triassic). The secondary xylem is of homoxylous structure. Tracheary pitting is protopinoid whilst crossfield pitting is of circoporoid nature. These diagnostic characters allow the recognition of a new species of *Protocircoporoxylon* Vogellehner.

Zeeh, S., Bechstädt, T., McKenzie, J. and **Richter, D.K.**, 1995. Diagenetic evolution of the Carnian Wetterstein platforms of the Eastern Alps. Sedimentology, 42: 199-222.

The carbonate platforms of the Wetterstein Formation of the Eastern Alps (Drau Range and Northern Calcareous Alps) show a distinct facies zonation of reefs and lagoons. While some lagoonal areas were episodically emerged and formed lagoonal islands, others remained permanently flooded. The scale of near surface, meteoric or marine diagenesis was related to this lagoonal topography. At shallow burial depth, cementation was dominated by altered marine solutions, which additionally caused recrystallization of metastable constituents of the sediment and earlier marine cements (high magnesian calcite, aragonite) connected with a carbon and oxygen isotopic change to more negative values. Deeper burial cementation shows a succession with two types of saddle dolomite and three types of blocky calcite. Carbon and oxygen isotopic values of these cements show a trend towards more negative values from the first to the last generation, in the following succession: clear saddle dolomite - zoned blocky calcite - cloudy saddle dolomite - post-corrosion blocky calcite - replacive blocky calcite. Fluid inclusion studies of the carbonate cements are interpreted to indicate a deeper burial temperature development that first increases from 175-317°C, followed by a temperature decrease to 163-260°C, and subsequent increase up to 316°C, whereby the samples of the Drau Range always show the lowest values. Calculations of the isotopic composition of the water, from which the carbonate cements were precipitated, yielded positive $\delta^{18}O$ values from 6·66 to 17·81 ‰ (SMOW), which are characteristic for formation and/or metamorphic waters. Also, the isotopic compositions of the palaeofluids probably changed during deeper burial diagenesis, following the temperature development.

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'

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- "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*

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