ALBERTIANA

The 'crowning' of the erathem boundary

from left: Aymon Baud, Yuri Zacharov, Mike Orchard, Rich Lane, Yin Hongfu

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Contents

The primary aim of ALBERTIANA is to promote the interdisciplinary collaboration and understanding among members of the I.U.G.S. Subcommission on Triassic stratigraphy. Within this scope ALBERTIANA serves as the 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 anouncements, literature reviews, progress reports, preliminary notes etc. - i. e. those contributions in which information is presented relevant to current interdisciplinary Triassic research.

Cover: Magnetostratigraphy of the PTB GSSP Meishan Section D (Episodes, 24 (2), p. 110, Yin, Zhang, Tong, Yang & Wu).

Executive Notes

From the Chair

As this issue was going to press, I was informed that **the Shallow Tethys Conference is postponed** until next year. The STS meeting that was to be held in conjunction with this conference therefore no longer has a parent meeting through which proceedings, accommodations, meeting rooms etc. would have been arranged. Nevertheless, the STS executive and our Hungarian hosts have decided to proceed with an STS meeting in Hungary in early September. This will include field trips to potential GSSP sites in the Balaton Highlands and a full day of presentations and discussions, as announced below. As stated elsewhere in this issue, it was planned to make the session on 'Middle Triassic boundaries" the venue for comprehensive discussion of, and scheduling of decisions on, the O/A, A/L, and L/C boundaries. I therefore encourage all those with an interest in, or a contribution to make on these boundaries to attend the meeting. Under pressure form the IUGS/ICS, I have set a goal to come to a final vote on GSSP placement for each of these three boundaries by the end of 2003, starting with the A/L this year.

Because time is getting short and the organizers need as much lead time as possible to make suitable arrangements, **I ask that STS members immediately communicate their interest in attending the STS meeting. Please respond to** haas@ludens.elte.hu and copy to morchard@nrcan.gc.ca. Limited funds may be available for those people whose attendance depends on a subsidy if they propose to contribute to the proceedings of the meeting. Those who seek help with registration, accommodation, or exceptionally with travel should apply to the Chair (M.J. Orchard) stating their exact needs.

Many of you will have learnt that my proposal for an IGCP project on **Triassic time and trans-Panthalassan correlation** has been accepted. This project, IGCP 467, will become a further vehicle for global Triassic studies and will augment STS activities as we push forward toward a the establishment of an unambiguous global time scale. The project will focus on establishing linkages between faunal provinces ('trans-Panthalassa'), as well as between the marine and continental realms, leading to the development of a broadly applicable temporal framework and its application in reconstructing the Triassic world. It is therefore anticipated that IGCP workshops and sponsorship will supplement future STS meetings, as will be the case with those announced herein.

The GAC meeting in Vancouver, 26-28th, May 2003 will feature a full day session on "Extinction events, faunal turnovers, and natural boundaries within and around the Late Triassic." It will be co-sponsored by the STS and by both IGCP projects 458 (T-J boundary events) and 467, and is convened in order to set the stage for C/N and N/R boundary resolution. The subsequent field trip to the classic area of Williston Lake will take place if enough support is shown. We must quickly establish the number of likely participants on this field trip which first involves an hour flight to NE BC, followed by road and boat travel; costs are being worked out. **Please email the Chair ASAP if you are interested in participating in the Williston Lake field trip.** The Chinle field trip is now planned in conjunction with the **GSA meeting, Seattle, November 2003**.

We have recently learned that the **IGC 2004** organizing committee has formally accepted both a session on "Triassic in the Tethys Realm" and a workshop on "The Upper Triassic: definition, subdivision, and correlation" at the Florence meeting in August 2004. We hope to organize field trips before hand to view some Upper Triassic boundary candidates, and make this meeting the final forum for discussion on Upper Triassic GSSPs. **Plan to be there!**

Joint STS / IGCP 467 field meeting on Middle Triassic stage boundaries
Veszprém, Hungary, September 5-8, 2002

Program

September 5, Thursday
Arrival at Budapest
Assembly of participants at the Hungarian Geological Institute (14 Stefánia út)
(with opportunity to visit the building and its Geological Museum, and meet colleagues)
Departure for Veszprém at 6 pm.

September 6, Friday
Field trip to the Balaton Highland
Localities to be visited: Felsörs (Anisian/Ladinian GSSP candidate), Nosztori Valley (Ladinian/Carnian boundary section), Köveskál (Ladinian/Carnian boundary section)

September 7, Saturday
Scientific session
Business meeting of STS with discussion of GSSP issues
Business meeting of IGCP 467

September 8, Sunday
Half-day meeting continuing from previous day, if warranted
Departure for Budapest after lunch

Transportation
Participants are responsible for making their own travel arrangements from their home country to and from Budapest. Transfer from Budapest to Veszprém (and back to Budapest) will be provided by rental bus or minibuses.

Conference venue
Regional Center of the Hungarian Academy of Sciences, Veszprém (The building is located in the historic Veszprém Castle. The building has a large conference hall and a smaller meeting room, its own cafeteria, and guest rooms).

Accommodation
There is a limited number of guest rooms available at the conference venue (double rooms). Additional accommodation as needed will be arranged in the dormitory of the Veszprém University, across the street from the conference venue.

Costs
The following estimates are subject to change depending on the number of participants and final arrangements. Accommodation (3 nights): EURO 75 (per person, double occupancy, breakfast included) Registration fee (including transportation, field trip costs, guide books, meals starting with dinner on September 5 and ending with lunch on September 8): EURO 120

Organization
The local organizing committee consists of J. Haas (Chair), T. Budai, S. Kovács, J. Pálfy, and A. Vörös. The meeting is organized by the Triassic Subcommission of the Hungarian Stratigraphic Commission, the Hungarian Academy of Sciences, and the Hungarian Geological Society.

Pre-registration
Please send an e-mail or fax expressing your interest and a preliminary title if you intend to give a presentation at the scientific session to the following address:
Dr. János Haas
Geological Research Group, Hungarian Academy of Sciences
Pázmány sétány 1/c, Budapest, H-1117 Hungary
Fax: +36 1 381-2128
Email: haas@ludens.elte.hu

After canvassing the membership, both Maurizio and I have concluded that there is insufficient interest in a visit to the Italian Middle Triassic candidate sections and it is therefore not useful to organize a trip for the few who would participate; fortunately most of us have seen them. Similarly, an earlier meeting in June is unlikely to attract many who have already made plans for the summer. On the other hand, I assume that those STS members who were interested in participating in the original Shallow Tethys meeting are more likely to attend a meeting around the original date.

I am therefore proposing, as originally conceived, an STS meeting in Budapest with the focus on Middle Triassic boundaries, to include field excursions to Felsoors and also to Ladinian-Carnian localities as suggested by Sandor. There should be a full day of key presentations and discussion. Maurizio has suggested the itinerary given below, which appears good to me. Please consider it and let me know ASAP your view. Suggest modifications if you wish and let me have information about accommodation, meeting place, costs of field trip etc. so an announcement can be included in Albertiana (this must be given to Wolfram Kurschner by the 9th March). I will also distribute an email and alert the STS membership. You could in fact draft your own circular with a return-by date so that you have immediate notification of attendees for organizational purposes. Suggested itinerary:

September 5, Thu.: Arrival in Budapest.
September 6 Fri: visit to Felsoors, Koveskal and Nostory valley.
September 7 Sat: Full day of discussion on the two boundaries.
Sept. 8 Sun: Departure. (It is important to have the night Sat/Sun for the
week end fare on the flights).

As far as the program is concerned, I would like to see time set aside for a review of each boundary (O-A/ A-L/ L-C) and pertinent presentations thereon. I hope that this can be accommodated in a single day, but I am not adverse to extending the presentations/discussions if it appears necessary (½ day Sunday?). The meeting announcement should include an invitation to present summary and/or new data from key areas. We know these would include at least Jozsef Palfy on the new radiometric dates from the A-L at Felsoors, Marco Balini on the L-C in Spiti, and I think Alda Nicora and I would be ready to summarize the conodonts from the O-A at Desli Caira. I would also like to summarize the conodont biostratigraphy and correlation potential about each boundary in North America. We may not fully resolve these boundaries but I wish the status of all of them to be discussed and a schedule for decisions formulated.

Now that IGCP 467 is a reality, I would like to propose to make this meeting a formal workshop both for STS and IGCP. Some funds may be available from both sources to offset costs.

Looking forward to your final comments.

Mike Orchard, Chair STS (ICS, IUGS)

From the Secretary

J. D. Campbell (1927-2001)

It was with great sadness that I learnt of the death of John Douglas ('Doug') Campbell, at Warrington, New Zealand, on 27 July 2001. Doug was a former member of the Subcommission on Triassic Stratigraphy (Albertiana 10 and 22) who was well known for his studies on brachiopod faunas and Triassic biostratigraphy. An Obituary and an appreciation of his work appeared in Newsletter 126 of the Geological Society of New Zealand (November 2001).

Geoffrey Warrington, STS Secretary

Reports

The new GSSP, base of the Triassic: some consequences

Aymon BAUD

Musee de Geologie, BFSH2-UNIL, 1015 Lausanne Switzerland
aymond.baud@sst.unil.ch

The base of the Triassic was proposed by Yin et al. (1996a) at Meishan (S China) section D, bed 27c with the FAD of the conodont *H. parvus*. This Global Stratotype Section and Point (GSSP) has been adopted by the International Commission on Stratigraphy (Yin et al., 2001). It has been unveiled by an opening Ceremony of the GSSP Monument, August 11 2001, in the Meishan Quarry, during the International Symposium on the Global Stratotype of the Permian-Triassic Boundary and the Paleozoic-Mesozoic Events (10-13 August 2001, Changxing, China). Thanks to our Chinese colleagues for an impressive organization.

According to Yin et al. (1996b) in their proposals for global correlation based on ammonoids and conodonts, the Permian-Triassic boundary interval can be subdivided in 6 units (PTBU) from the lower Changhsingian (PTBU 1) to the upper Griesbachian (PTBU 6). The base of the Triassic corresponds to the base of PTBU 5.

The PTBU 4 corresponds to the interval separating the base of the boundary clay to the FAD of *parvus* (beds 25 to 27b in Meishan).

The upward shift of the boundary from the base of bed 25 proposed twenty years ago to the base of the bed 27c formally adopted in Meishan Quarry (shift which corresponds strictly to the PTBU4), plus recent discoveries, new datations and correlations bear numerous consequences. We will set out below some of them.

1. Following the discovery by C. Henderson of key conodonts in the Otto Fiord area (Ellesmere Island, Arctic Canada) and according to Henderson & Baud (1997), there is an overlap between the upper Changhsingian and the lower Griesbachian (sensu Tozer, 1967). It is why A. Baud, B. Beauchamp and C. Henderson are preparing a redefinition of the Griesbachian substage (abstract: Baud & Beauchamp, 2001).

2. Consequently, the *Otoceras concavum* and *borale* fauna of the Arctic ranging below the *Ophiceras* fauna, are latest Permian in age (partly PTBU 4) and older than the *Otoceras woodwardi* fauna of the Himalayas which co-occurs with *Ophiceras*(PTBU 5).

3. Consequently, due to the normal up to high sedimentation rate in the boreal area (Sverdrup Basin, E. Greenland, Barents Sea, Spitzberg, Verkoyansk area), the base of the Triassic has to be shifted upward by several to tens of meters. The Permian-Triassic boundary (Erathem boundary) occurs within a monotonous shaly facies of great thickness containing impoverished biota with ammonoids (*Otoceas*, *Glyptophiceras*, *Hypophiceras*, *Tompophiceras* and *Ophiceras*), bivalves (*Claraia*) and conodonts (*Hindeodus*, *Neogondolella*). The palynological boundary, with the appearance of the Triassic key palynospecies occurs in the latest Permian (Cirilli et al. 2001).

4. According to Chen and Komatsu (2001), the first Claraia zone or assemblage with *C. baoqingensis*, *C. griesbachi* and *C. bioni* appear in the latest Permian (PTBU 4).

5. The main extinction pulse (top of bed 24 in Meishan, Jin et al. 2000) with an age > 254My, occurs more than 1 million year before the GSSP (= 253My, new data from Mundil et al. 2001).

6. The so called « boundary clay » and the associated volcanic ashes event in Meishan do not occur at the boundary (GSSP) but below and before, in the Late Changhsingian (PTBU 4).

7. Except for the Tethys Himalaya (Spiti, Central Himalaya, Nepal), the well-known base of Triassic transgression is starting in the Late Changhsingian (PTBU 3 to PTBU 4).

8. The sharp negative shift of the carbon isotope profiles (Baud et al. 1989, 1996) occurs in the late Changhsingian (upper part of the PTBU 3 to the lower part of the PTBU4), before the boundary and not at the boundary. The GSSP occurs within a positive rebound following the main negative shift.

9. According to Zhu et al. (1999), the GSSP occurs within a reversal magnetic zone and does not coincide with the base or within a normal magnetic zone as largely accepted (review in Jin et al., 2000).

Part of the misinterpretation or wrong correlations of the boundary is due to the highly condensed nature of the Stratotype (see Baud, 1996) and the apparent short interval deduced from the nearness of the Sequence boundary, the event boundary and the biochronological boundary (GSSP). But we have to remind that proximity (few centimeters) does not mean short time interval.

Measuring the thickness, the PTBU 4 is only twelve centimeters in Meishan, section D. Its duration is more than one million years (see point 5). The PTBU 4 is about 4m thick in Shangsi, 2,8m in Guryul Ravine (Kashmir), one meter in Salt Ranges (Pakistan), 0.6m in Abadeh and 0.4 to 4-6m in the Southern Alps. In the Arctic, with high sedimentation rates, the PTBU 4 has up to some hundred times the thickness of the Meishan one and up to ten times the thickness of the Shangsi one (Figure 1) and values are between 10 and 50m according to the area and sections.

High rate of sedimentation during this time interval can occur in continental area. We have to take care about this when fixing the boundary, which is not an event boundary as mass extinction nor a collapse of terrestrial ecosystems or a so called "fungal spike", nor a physical boundary as a reversal magnetic zone or abrupt facies change.

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Functional Importance of New Skeletal Elements («Eye Capsules») of Euconodonts

[1,3]Galina I. Buryi, and [2]Alla P. Kasatkina

[1]Federal Far Eastern Geological Institute, Far Eastern Branch, Russian Academy of Sciences, Stoletiya Prospect 159, Vladivostok-22, 690022; [2]Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences, 43 Baltiyskaya st., Vladivostok, 690041, Russia
[3]corresp. author: buryi@mail.ru

New skeletal elements of euconodonts have been found in the Lower Triassic deposits of South Primorye. The finding is confined to the siltstone mass (50 m) referred to the *Anasibirites nevolini* ammonite Zone (Buryi, 1979, p. 91) cropped out in the Kamenushka river basin (Perevalnyi creek) (Fig. 1).

In the upper parts of this mass, within the lens of calcareous sandstone, overfull with ammonites *Anasibirites nevolini* Burij and Zharnikova, *Meekoceras subcristatum* Kiparisova, *M. boreale* Diener, *Arctoceras robinsoni* (Kiparisova), *Prosphingitoides ovalis* (Kiparisova), *Juvenites sinuosus* (Kiparisova), abundant conodonts were found (sample 4035): platform - elements of *Neogondolella milleri* (Muller) - 22 specimens, segminate - elements of *Neospathodus lanceolathus* Mosher - 1 specimen, *Smithodus discreta* (Muller) - 19 specimens, *S.csritagali* (Huckriede) - 1 specimen, *S. concervativa* (Muller) - 4 specimens and ramiform elements of *Furnishius triserratus* Clark - 170 specimen, *Ellissonia triassica* Muller - 9 specimens, *E.meissneri* (Tatge) - 3 specimens, *E.magnidentata* (Tatge) - 4 specimens, *E.nevadensis* Muller - 3 specimens, *Hindeodella triassica* Muller - 36 specimens, *H.nevadensis* Muller - 24 specimens, *H.raridenticulata* Muller - 15 specimens, *H.budurovi* Buryi - 7 specimens, *Parachirognathus symmetrica* (Staesche) - 4 specimens, *P.inclinata* Staesche - *Hadrodentina adunca* Staesche - 13 specimens, *H.subsymmetrica* (Muller) - 36 specimens, *H.symmetrica* (Staesche) - 30 specimens, *Xaniognathus curvatus* Sweet - 2 specimens.

Together with these conodont elements, 3 specimens of new skeletal elements analogous to them in color (light brown transparent to deep brown) and in the surface structure. By analogy with P, M, and S conodont elements, we propose to identify new skeletal elements as H elements.

Description of skeletal elements
Several varieties of H elements (Fig. 2 - 4) have

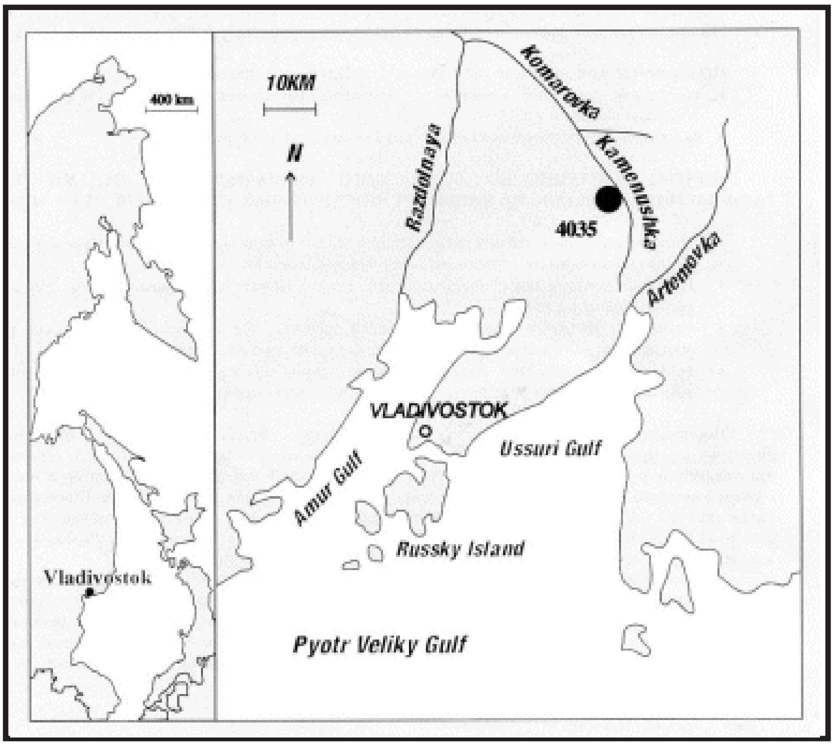

***Figure 1.** Location of Lower Triassic H elements in the Kamenushka River basin (South Primorye).*

been found: H1, H2 and H3 that occur jointly. The tern H elements are proposed for the new skeletal elements by analogy with P, M, and S conodont elements.

H1 elements («bagel»-shaped [Russian baranka] (Fig. 2). The flattened plate shape with a hole on the center, resembling a bagel, is irregular-rounded. Its longer diameter is 0.72 mm and its shorter one is 0.57 mm. The thickness of the plate along the outer margin is about 0.1 mm. The outer margin of the plate is uneven and has abundant projections. At a distance of 0,2 mm from the outer margin, of this plate, nearly parallel to it, an inner margin extends. It is observed to project its surface like a border, a narrow crest bearing hardly visible projections or papillae. We suggest that the muscles, maintaining and governing the conodont elements of the mouth apparatus, were attached that to these papillae on the inner margin, as well as to the projections of the margins of the plate. The space between the outer and inner margins of the plate forms a sort of outer ring characterizing the H1 element.

From the inner margin towards the center, we distinguish its inner ring. In the H1 element, the surface of the outer ring is smooth and lustrous. The element has a crystalline structure similar to that of most of the conodont elements. The surface of the inner ring is composed of uneven, structureless, material, the thickness of which decreases gradually down to the nearly triangular hole in the center. The hole is about 0.3 mm long and its most widened part is 0.09 mm. The opposite lower surface of the plate is smooth. We suggest that it was faced inward the pharynx and had no attaching function.

H2 element (Fig. 3). H2 element is very similar to H1 element, only its outer ring is narrower and the inner ring is absent. The outer ring is hollow and looks like a hollow semisphere, the walls of which are very thin and almost transparent. Tubercular projections of the outer margion, are pronounces (the specimen was broken with a needle during inspection and so it consists of two semi rings).

H3 element (Fig. 4). The third variety of H element is plate-like with no hole in the center. The oval-leaf plate has a maximal diameter 0.87 mm and a shorter one of 0.65 mm. The thickness of this plate is about 0.1 mm.

It has an outer ring, but the projections of its outer margin are less pronounced than in H1 element. The space of the inner ring, having no hole, is filled with four prominent elongated projections, which start from a common pain on the inner margin of the outer ring. Two central projections extend farther to the opposite margin of the outer ring, and two lateral projections come to the middle of the outer ring area. Such arrangement of the projections of the inner ring in H3 element resembles the arrangement of veins in a tree leaf. In contrast to H1 and H2 elements, the surface of the outer ring in H3 element is rough whereas the surface of the projections of the inner ring is smooth and listrous.

Discussion

We suggest that H skeletal elements, described above, were the parts of the euconodont head complex, which is composed of a mouth apparatus and pair skeletal elements of a head.

The mouth apparatus of euconodont is known to be of different modifications of P, M, and S conodont elements (Aldridge et al., 1995; Purnell et al., 1995; Purnell and Donoghue, 1997) in different proportions. Using them, the mouth apparatus provides catching of a prey and feeding of an animal and favours water filtering through the branched tooth net as well as crushing of the filtered prey with the help of more massive platform elements. The mouth apparatus appears to be a rather strong instrument, the work of which needs a strong muscular system. In our opinion, the place of attachment of muscles, joining isolated conodont elements into the mouth apparatus and governing these elements, was a pair of the head attaching plates or H elements.

Thus, we think that in the head part of euconodont there was a single mouth complex composed, probably, of a pharynx, about 15 P, M, and S conodont elements, muscles, and two head attaching plates (H elements) necessary for joining and governing the conodont elements in the mouth apparatus.

In Recent Chaetognatha animals, similar to euconodonts, chitinous setae and crenations of the prehensile apparatus are attached to the body also with two prolate semi-transparent plates arranged on the ventral and dorso-ventral sides of the head (Kasatkina, 1982; Kasatkina and Buryi, 1996, 1997).

There is another interpretation of the functional importance of these structures. In the head parts of the euconodont animal imprints reported from the Carboniferous Granton bed of Edinburg, Scotland, and the Upper Ordovician Soom Shale of South Africa, there were observed lobate structures, similar to H elements, which were suggested to be "eye capsules" (Aldridge et al., 1993; Aldridge and Theron, 1993).

Thus, in spite of the fact that Kasatkina found a now-living conodont animal - "alive fossil" At the depth of 1992-1993 m in the sea of Laptevykh of Arctic Siberia (Kasatkina, 2000), the physiological function of these skeletal plates remains still unclear.

In conclusion we'd like to ask all specialists, who study conodont elements to pay attention to these H elements in their samples.

Acknowledgements

We thank Dr. Kirill Budurov, who in 1974, looking through our collection of conodont elements from South Primorye, found H2 element described in this paper and attract our attention to a great importance of this finding for understanding the structure of a conodont animal. The work was made under the financial support of RFBR grant and 01-04-49416 (Revision of Euconodonta (Conodonta) mouth apparatus features on the basis of the recent euconodont organism original findings and Chaetognatha morphological peculiarities).01-05-64599 ("Palaeontological basis of the *Anasibirites nevolini* and *Tirolites* Zones of the Olenekian in South Primorye and global correlation of the Lower Triassic".

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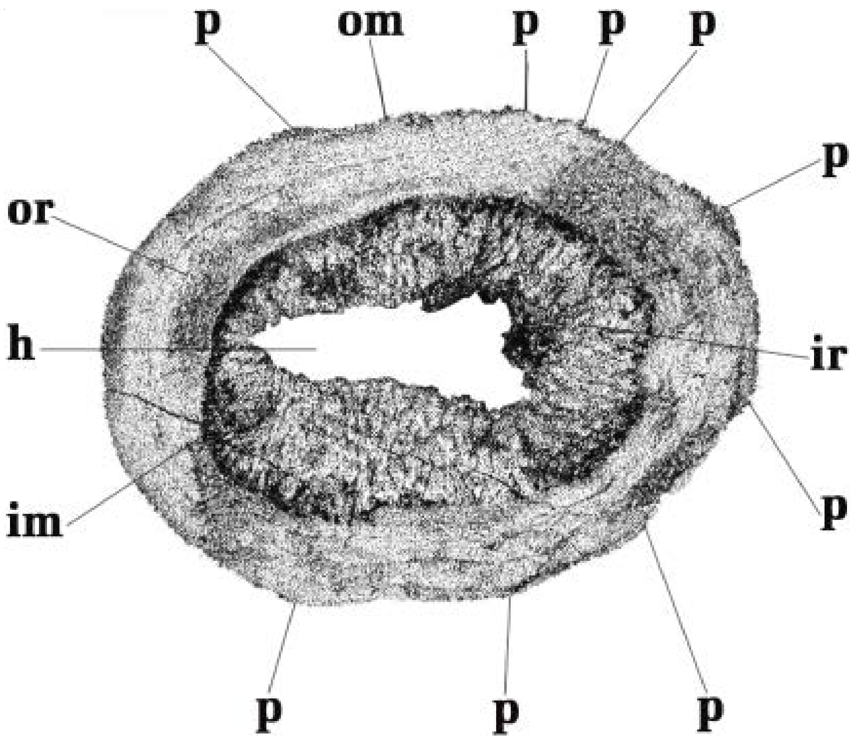

***Figure 2**. Euconodont H_1 element (bagel) - DVGI 3B-1 x 300. Lower Triassic, Olenekian, Anasibirites nevolini Zone. Om - outer margin; p - projection; im - inner margin (border with papillae); or - outer ring; ir - inner ring; h - hole.*

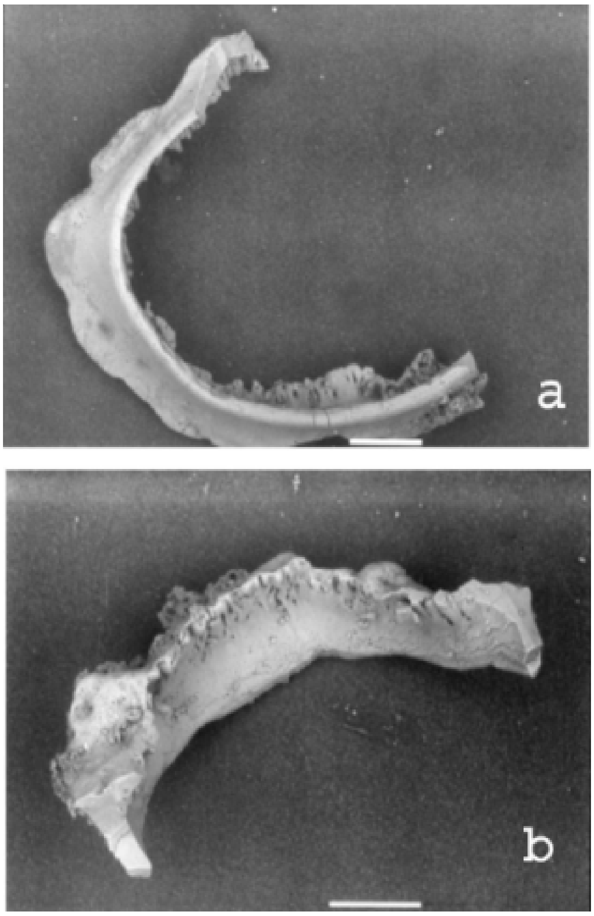

***Figure 3a,b** Euconodont H_2 element (two semi-rings); a - DVGI 3B-2, x 300. b - DVGI 3B-3, x 300. Lower Triassic, Olenekian, Anasibirites nevolini Zone.*

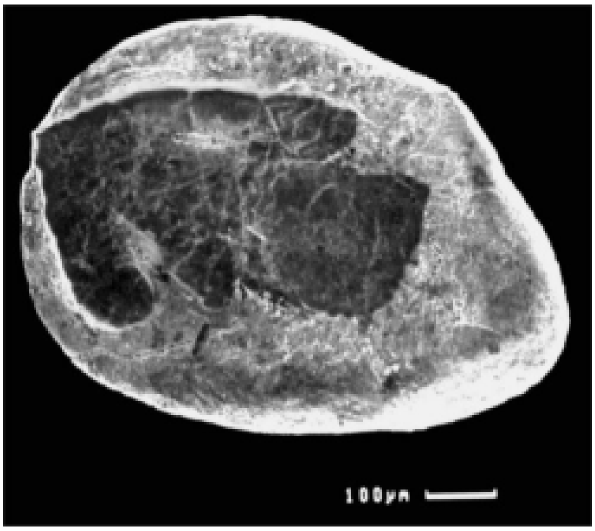

***Figure 4.** Euconodont H_3 element - DVGI 3 B-4. Lower Triassic, Olenekian Anasibirites nevolini Zone.*

Age and Correlation of Triassic Tetrapod Assemblages from Brazil

Spencer G. Lucas

New Mexico Museum of Natural History, 1801Mountain Road N.W., Albuquerque, New Mexico 87104-1375, USA slucas@nmmnh.state.nm.us

Triassic tetrapod fossils from the state of Rio Grande do Sul, Brazil, come from three lithostratigraphic units—Sanga do Cabral, Santa Maria and Caturrita formations—in the Rosário do Sul Group. No detailed lithostratigraphic framework of the Brazilian Triassic tetrapod localities has been developed, and may be impossible, given the heavily vegetated landscape of Rio Grande do Sul, where outcrops are intermittent, many are man made (road cuts, quarries, etc.), and few exposures encompass more than several meters of stratigraphic section. Three distinct biostratigraphic assemblages of Triassic tetrapods can be recognized: (1) Lootsbergian tetrapods from the Sanga do Cabral Formation; (2) the Berdyankian (Chanarian) Dinodontosaurus Assemblage Zone of the middle part of the Alemoa Member of the Santa Maria Formation; and (3) the Adamanian (Ischigualastian) Hyperodapedon Assemblage Zone of the upper part of the Alemoa Member and the Caturrita Formation. Recent attempts to refine this biostratigraphy by recognizing more subdivisions are laudable but lack convincing support from lithostratigraphic or biostratigraphic data.

Introduction

Triassic tetrapod fossils from Brazil come from the state of Rio Grande do Sul (Fig. 1) in strata exposed on the southern flank of the Paraná basin and have been collected for nearly a century (e.g., Woodward, 1907; Huene, 1935-1942; Beltrão, 1965; Barberena, 1977; Barberena et al., 1985a; Schultz et al., 2000; Abdala et al., 2001). These tetrapod fossils come from three lithostratigraphic units—Sanga do Cabral, Santa Maria and Caturrita formations—in the Rosário do Sul Group (e.g., Andreis et al., 1980; Barberena et al., 1985a; Faccini et al., 1995, 2000) (Fig. 1). Much has been written about the age and correlation of these tetrapods, especially since the 1970s (Barberena, 1977; Barberena et al., 1985a, b; Schultz et al., 1994, 1998, 2000; Scherer et al., 1995; Schultz, 1995; Abdala et al., 2001). Based on my studies of collections in Brazil, and an examination in the field of some key localities, I present here an assessment of the age and correlation of the Brazilian Triassic tetrapods.

Stratigraphic Context

As Faccini et al. (2000) state, the Sanga do Cabral, Santa Maria and Caturrita formations (Fig. 1) are mostly fluvial conglomerates, sandstones and mudstones that were deposited in a large intracratonic basin in what was southwestern Gondwana, the Paraná basin. The relatively thin (up to 20 m thick) Sanga do Cabral Formation is fluvial and eolian sandstones disconformably overlain by fluvial sandstone and conglomerate of the Passo das Tropas Member (~20-30 m thick) of the Santa Maria Formation. The overlying Alemoa Member of the Santa Maria Formation (~100-120 m thick) is mostly floodplain mudrocks and minor fluvial channel sandstones. The Caturrita Formation (~60 m thick) is mostly sandy and gravelly river channel deposits. Triassic tetrapod assemblages of biostratigraphic significance come from the middle part of the Sanga do Cabral Formation, the middle and upper part of the Alemoa Member of the Santa Maria Formation and from the Caturrita Formation (Fig. 2).

Previous Schemes of Tetrapod Biostratigraphy

Various schemes of tetrapod biostratigraphy have been proposed for the Brazilian Triassic (Fig. 2). It is essential to understand that no detailed lithostratigraphic framework of the Brazilian Triassic tetrapod localities has been developed. Indeed, such stratigraphic organization may be impossible, given the heavily vegetated landscape of Rio Grande do Sul, where outcrops are intermittent, many are man made (road cuts, quarries, etc.), and few exposures encompass more than several meters of stratigraphic section. Of course, it is possible to order grossly the Triassic tetrapod localities in Rio Grande do Sul by assigning them to formations and members, but a more detailed stratigraphic ordering remains to be demonstrated. This, however, has not hindered some workers (e.g., Schultz, 1995; Abdala et al., 2001) from proposing a temporal ordering of fossil assemblages that lacks detailed support from stratigraphic data.

Also critical to tetrapod biostratigraphy in the Brazilian Triassic is its correlation to the Argentinian Triassic tetrapod assemblages, which can be ordered in a precise lithostratigraphic framework (e.g., Bonaparte, 1966, 1967, 1969, 1970, 1982; Rogers et al., 1993). The Middle-Late Triassic Argentinian assemblages are the basis of provincial

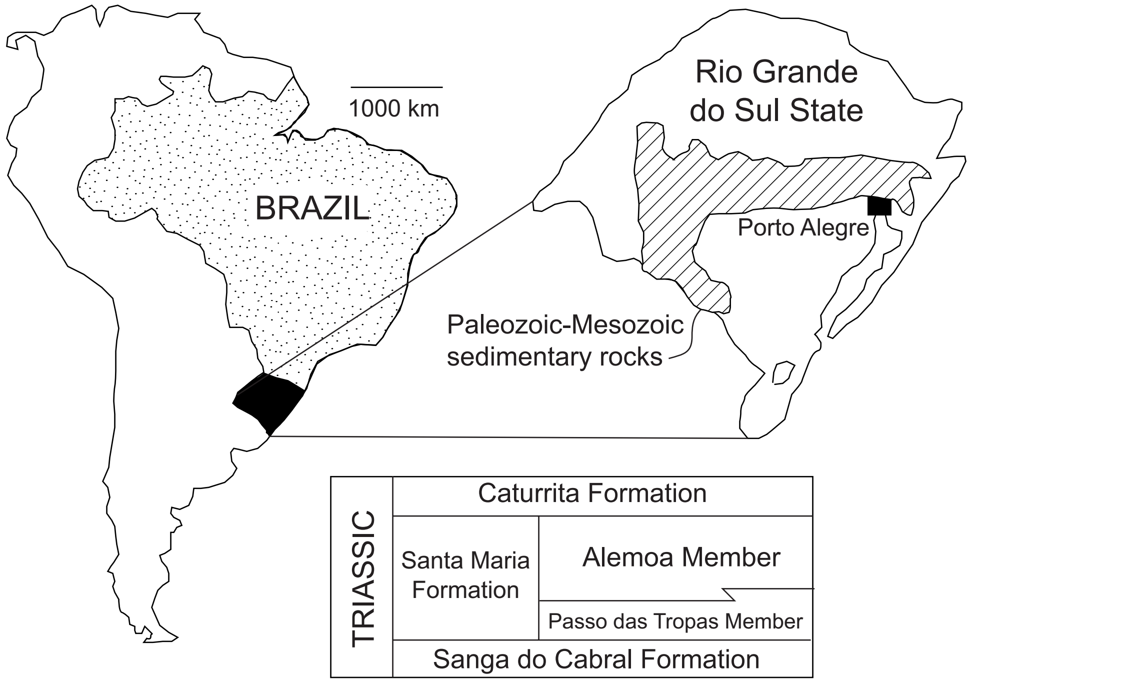

Figure 1: Location of Rio Grande do Sul and its Paleozoic-Mesozoic (Gondwana) strata on the southern flank of the Paraná basin, and summary of Triassic stratigraphy in that basin.

land-vertebrate faunachrons (lvfs), the Chanarian, Ischigualastian and Coloradan, and can be correlated to a global tetrapod biochronology (Lucas, 1998).

Barberena (1977) is the point of departure for all detailed correlation of the Brazilian Triassic tetrapod assemblages. He recognized two tetrapod assemblage zones in the Santa Maria Formation (Fig. 2), correlating the lower, Therapsida Assemblage Zone to the Argentinian Chanarian and the younger, Rhynchocephalia Assemblage Zone to the Ischigualastian. Barberena et al. (1985a) renamed these zones (Fig. 2), but advocated the same correlations. Barberena et al. (1985b; also see Holz & Barberena, 1994) followed suit, but also stressed the identification of four, temporally successive local faunas (Fig. 2). However, as noted by Lucas (1993), no stratigraphic data exist to indicate the Pinheiros and Chiniquá local faunas (= tetrapod assemblages from those areas) are actually temporally successive.

Schwanke (1998) suggested that there are three successive dicynodont assemblages in the Santa Maria Formation, a lower assemblage with *Chanaria*, *Barysoma*, *Dinodontosaurus* and *Ischigualastia* immediately overlain by an assemblage with *Stahleckeria* and *Dinodontosaurus*, and a third, much younger assemblage with *Jachaleria*. Schultz et al. (1994, 1998, 2000) and Scherer et al. (1995) essentially reiterated the zonation of Barberena and co-workers but renamed the zones as “cenozones” (Fig. 2). However, they did distinguish the stratigraphically highest tetrapod assemblage, from the Caturrita Formation, as the “*Jachaleria* interval.” At the same time, though, Schultz (1995) proposed a succession of “associations” (Fig. 2) that, nevertheless, lacked any detailed stratigraphic data to support its temporal ordering. Most recently, Abdala et al. (2001) proposed a slightly modified zonation, adding a Traversodontid Biozone between the *Dinodontosaurus* and Rhynchosaur Biozones (Fig. 2). Nevertheless, the “Traversodontid Biozone’ is based on a single locality (Santa Cruz do Sul) that cannot be ordered stratigraphically with respect to other localities.

Sanga do Cabral Formation

The oldest Triassic tetrapods from Brazil are from the middle part of the Sanga do Cabral Formation, especially in the vicinity of Catuçaba. The assemblage includes a rhytidosteid amphibian, *Procolophon*, other procolophonid specimens, a protorosaurid vertebra, skull material and an ulna of a pareiasaur and a dicynodont stapes (Lavina, 1983; Barberena et al., 1985a; Dias-da-Silva, 1997, 1998; Dias-da-Silva & Schultz, 1999; Schultz & Dias-da-Silva, 1999; Schwanke & Kellner, 1999). Brazilian workers (e.g., Andreis et al., 1980; Barberena et al., 1985a; Faccini et al., 1995; Kellner & Campos, 1999) have long, and, I believe correctly, assigned these tetrapods an Early Triassic age; they are most reasonably (based primarily on

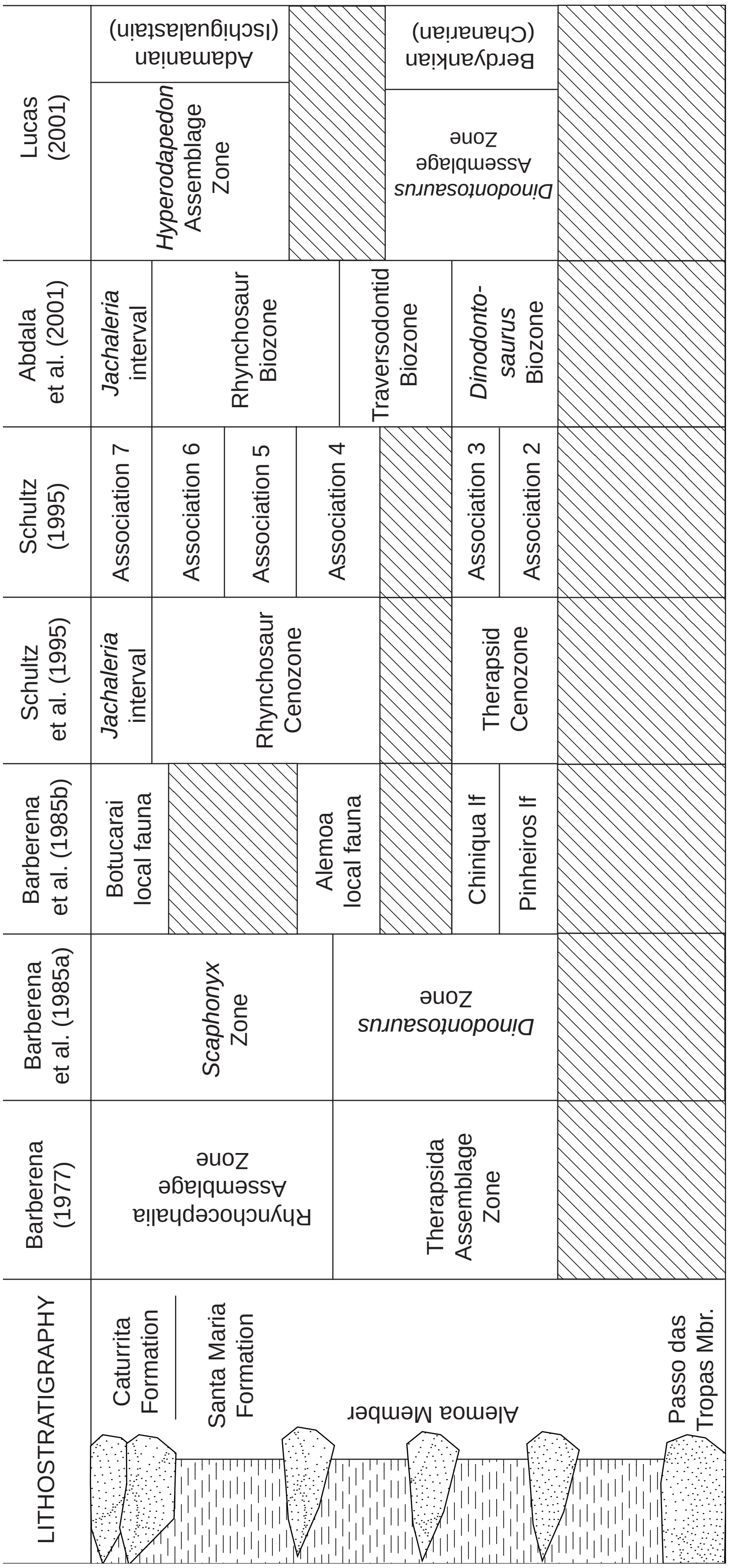

Figure 2: Previous schemes of Triassic tetrapod biostratigraphy of the Santa Maria and Caturrita formations compared with the scheme advocated here.

the presence of *Procolophon*) correlated to the *Lystrosaurus* "zone" of the South African Karoo and thus are of Lootsbergian age *sensu* Lucas (1998). The pareiasaur record here is particularly interesting, as it joins *Sclerosaurus* from the Buntsandstein of the German-Swiss borderland as the only possible Triassic records of pareiasaurs.

Santa Maria Formation

The most extensive Triassic tetrapod assemblages from Brazil come from the Santa Maria Formation and include fossils of procolophonids, rhynchosaurs, proterochampsids, rauisuchids, aetosaurs, crocodylomorphs, dinosaurs, dicynodonts and cynodonts (e.g., Woodward, 1907; Huene, 1935-1942; Romer & Price, 1944; Price, 1947; Cox, 1965; Colbert, 1970; Barberena & Daemon, 1974; Bonaparte & Barberena, 1975; Araújo & Gonzaga, 1980; Araújo, 1981; Barberena, 1982; Zacarias, 1982; Texeira, 1982; Barberena et al., 1985a; Mattar, 1987; Azevedo et al., 1990; Azevedo, 1995; Kellner, 1998; Kellner & Campos, 1999, 2000; Abdala & Ribeiro, 2000; Langer & Schultz, 2000; Abdala et al., 2001; Lucas & Heckert, 2001). These assemblages are usually, and I believe correctly, considered to be Middle to Late Triassic age and correlated to the Chanarian and Ischigualastian lvfs in Argentina (e.g., Barberena, 1977; Barberena et al., 1985a, b; Schultz et al., 1994, 1998, 2000; Scherer et al., 1995; Schultz, 1995; Abdala et al., 2001).

*T*he stratigraphic data (or lack thereof) and the composition of the tetrapod assemblages of the Santa Maria Formation support recognition of two, temporally successive tetrapod faunas separated by a substantial hiatus (Fig. 2). This was the conclusion advocated first by Barberena (1977), and followed by those who have attempted a global correlation of Triassic tetrapod assemblages (e.g., Ochev & Shishkin, 1989; Lucas, 1998, 1999). Recent attempts to refine this correlation by recognizing more subdivisions (e.g., Schultz, 1995; Abdala et al., 2001) are laudable, but they lack support from lithostratigraphic or biostratigraphic data.

Dinodontosaurus Assemblage Zone

The middle part of the Alemoa Member of the Santa Maria Formation yields a tetrapod assemblage dominated by the dicynodont *Dinodontosaurus* (Candelaria and Chiniquà local faunas of Barberena, 1977). Besides *Dinodontosaurus* (= *Chanaria*), key elements of the assemblage include the dicynodont *Stahleckeria* (= *Barysoma*) and the traversodontid cynodonts *Traversodon, Belesodon* and *Massetognathus*. The assemblage of tetrapods from the middle part of the Alemoa Member is readily correlated with the Chañares local fauna of the Ischichuca Formation in Argentina. These assemblages of the Chanarian lvf are generally considered to be of Ladinian age, although the basis of this correlation is tenuous (e.g., Lucas & Harris, 1996). The cynodont-dominated fossil locality in the Alemoa Member at Santa Cruz do Sul (Abdala et al., 2001) is not demonstrably younger than other localities in this assemblage zone, so I see no basis for a “Traversodontid Biozone” younger than the *Dinodontosaurus* Assemblage Zone.

Schwanke Peruzzo (1990) and Schwanke Peruzzo & Araújo-Barberena (1995) assigned a partial skull from near Candelaria, from part of the Pinheiros local fauna, to the dicynodont *Ischigualastia*. This created an apparent range extension of the genus *Ischigualastia*, known only from Ischigualastian age strata in Argentina, into Chanarian age strata in Brazil. However, I have restudied this specimen, and it is *Stahleckeria*.

Hyperodapedon Assemblage

The Upper Triassic vertebrate assemblage from the upper part of the Alemoa Member of the Santa Maria Formation is mostly from the vicinity of Santa Maria City. This is the Rhynchocephalia Assemblage Zone of Barberena (1977) or the *Scaphonyx* Zone of Barberena et al. (1985a). As the rhynchosaurs in this assemblage are dominantly *Hyperodapedon*, not *Scaphonyx* (Langer & Schultz, 2000), I rename the zone the *Hyperodapedon* Assemblage Zone (Fig. 2).

The *Hyperodapedon* Assemblage Zone in the Alemoa Member includes abundant fossils of the rhynchosaur *Hyperodapedon* (formerly *Scaphonyx*); the aetosaur *Stagonolepis* (formerly *Aetosauroides*); less abundant traversodontids and other cynodonts, including *Charrudon*, *Therioherpeton* and *Gomphodontosuchus*; the proterochampsids *Cerritosaurus binsfeldi*, *Rhadinosuchus gracilis*, and *Hoplitosuchus raui*; and the archetypal rauisuchian *Rauisuchus tiradentes.* Alemoa Member dinosaurs are the theropod *Staurikosaurus pricei* Colbert, 1970, the prosauropod *Saturnalia tupiniquim* Langer, Abdala, Richter & Benton, 1999 (also see Kellner & Campos, 2000), and the theropod *Teyuwasu barberenai* Kischlat, 1999.

In this assemblage zone most, if not all, of the rhynchosaurs, long referred to *Scaphony*x, are now assigned to *Hyperodapedon*, a genus known from Otischalkian-Adamanian strata in India and Great Britain (Hunt & Lucas, 1991; Langer & Schultz, 2000; Langer et al., 2000). Argentinian material of *Hyperodapedon* comes from the Ischigualasto Formation (e.g., Contreras, 1999). The aetosaur *Stagonolepis* is also of well documented Adamanian age in the USA and Europe and is abundant in the Ischigualasto Formation in Argentina (Heckert & Lucas, 2000; Lucas & Heckert, 2001). Clearly, the presence of *Hyperodapedon* and *Stagonolepis* supports correlation of the *Hyperodapedon* Assemblage Zone of the Santa Maria Formation with the vertebrates of the Ischigualasto Formation in Argentina, and therefore an Ischigualastian (Adamanian) age assignment (Lucas, 1998; Lucas & Heckert, 2001).

Caturrita Formation

The tetrapod assemblage from the Caturrita Formation includes a sphenodont skull and postcrania, the proterochampsid *Proterochampsa nodosa*, archosaur teeth, phytosaur teeth and jaw fragments, the cynodont *Exaeretodon,* the rhynchosaur *Hyperodapedon*, the dicynodont *Ischigualastia* (= *Jachaleria candeleriensis* Araújo & Gonzaga) and a supposed *Erythrotherium*-like mammalian mandible fragment (Araújo & Gonzaga, 1980; Barberena et al., 1985a; Dornelles, 1990; Ferigolo, 1999; Bonaparte & Ribeiro, 1999; Faccini et al., 2000). Caturrita Formation dinosaurs are the theropod? *Guaibasaurus candelarai* Bonaparte, Ferigolo & Ribeiro, 1999 and a new, undescribed prosauropod (Azevedo, 1993; Azevedo et al., 1998, 1999). Lucas (1993) suggested that the skull assigned to *Jachaleria* belongs to *Ischigualastia*, and I maintain this conclusion, having now studied the Brazilian material firsthand.

The Caturrita assemblage thus shares index taxa with the Ischigualasto Formation of Argentina (*Ischigualastia, Exaeretodon* and *Hyperodapedon*), so I also assign it an Ischigualastian age. I therefore reject correlations, such as Bonaparte (1982), Barberena et al. (1985a) and Schultz et al. (2000), that indicate that at least part of the Caturrita Formation is younger than the Ischigualastian. All Late Triassic tetrapods known from Brazil are of Ischigualastian age (Fig. 2).

Certainly the Caturrita Formation tetrapods are stratigraphically above those from the upper part of the Alemoa Member of the Santa Maria Formation. However, the two assemblages are not, at present, biochronologically separable. Thus, both are of Ischigualastian age, and I include both in the *Hyperodapedon* Assemblage Zone (Fig. 2). More collecting and study of Caturrita Formation tetrapods are needed to provide a basis for recognizing them as a biochronologically distinct assemblage.

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Triassic marine reptiles from China

J.-L. Li[1,2], J. Liu, C. Li

Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences,
[2]Corresp. author: li.jinling@pa.ivpp.ac.cn

Marine deposits of the Triassic are extensive in southern and southwestern China. The first Triassic marine reptile, a small pachypleurosaurid, *Keichousaurus hui*, was described from Xingyi, Guizhou Province by C. C. Young in 1958. By the mid-1990s, some sauropterygians, ichthyosaurs and hupeihsuchids had been reported from the Lower-Middle Triassic of Anhui, Guizhou, Yunnan and Hubei Provinces, Guangxi Zhuang Autonomous Region, and Tibet Zang Autonomous Region. Although all these marine reptile fossils, except those of *Keichousaurus hui* and *Hupehsuchus nanchangensis*, are incompletely preserved, they are significant in understanding the phylogenetic relationship of relative groups and their paleobiogeography. In 1998 numerous complete skeletons of Triassic marine reptiles, including the first placodont and thalattosaur known in China, were recovered from a new horizon and region, the Wayao Member, Falang Formation of Guanling, Guizhou. As a result, all the major groups of Triassic marine reptiles found in west Tethys, including Eosauropterygia, Placodontia, Ichthyosauria, and Thalattosauria, are present in the Triassic of southern and southwestern China.

1) Remains of marine reptiles from the Chinese Lower Triassic are relatively scattered, and six genera and species have so far been described in Guangxi, Anhui, and Hubei provinces. *Chaohusaurus geishanensis* Young et Dong, 1972 from Qinglong limestone (now the Nanlinghu Formation), Chaoxian County, Anhui Province, is a small ichthyosaur about 0.5 m long with a short and narrow snout, labio-lingually widened posterior teeth, and unusually large forefins. Motani and You (1998) considered the other two species, *Chensaurus chaoxianensis* (Chen, 1985) and *Chensaurus faciles* (Chen, 1985) from the same locality as the synonym of *Chaohusaurus geishanensis*.

Kwangsisaurus orientalis Young, 1959 was established on a partial postcranial skeleton collected from the Lower Triassic, Wuming, Guangxi. It was once assigned to Nothosauridae (Handbook of Chinese Vertebrate fossils, 1979; Sun et al., 1992), but was referred to Pistosauroidea (Sauropteygia) by Rieppel (1999) due to its plate-like coracoid, long and distally expanded transverse process on dorsal vertebrae, three carpal ossifications, and curved humerus without an entepicondylar foramen.

Nanchangosaurus suni Wang, 1959 known from Daye Formation in Nanzhang, Hubei, is similar to *Hupehsuchus nanchangensis* (see below) in having a long, flattened rostrum, long neck with short cervical ribs, and small dermal plates over the posterior cervical and trunk vertebrae. These characters give strong evidence of the sister-group affinity for the two genera (Carroll and Dong, 1991). Because the two genera are endemic to eastern Asia, an order and a family (Hupehsuchia Nanchangosauridae) were erected.

Keichousaurus yuananensis (Young, 1965a), *Hanosauruw hupehensis* (Young, 1972a) and *Hupehsuchus nanchangensis* (Young, 1972b) are found in the Jialingjiang Formation in Hubei. The age of the Jialingjiang Formation has been much debated. It was once considered as Middle Triassic, but ages of late Early Triassic-early Middle Triassic (Chen and Jin, 1996) or late Early Triassic (Yang and Zhang, 2000) were then suggested. Since all the three taxa, *Keichousaurus yuananensis, Hanosauruw hupehensis*, and *Hupehsuchus nanchangensis*, are found in the beds below the uppermost part of the Jialingjiang Formation (attributed to Middle Triassic in the concept of the Jialingjiang Formation, Chen and Jin, 1996), they are most likely to be Olenekian. *Keichousaurus yuananensis* is larger than the type species, *K. hui*, and was established based on an incomplete skeleton. Similar to the latter, its humerus is longer than its femur. The outer margin of the ischium in *K. yuananensis* is crooked.

Hanosaurus hupehensis, the holotype of which is incomplete, was originally referred to as a thalattosaur. Rieppel (1998b) assigned it to Pachypleurosauridae based on the following characteristics: nasals meet each other in the midline of the skull; the upper temporal fossa is elongate and curved; the transverse process is developed in caudal vertebra; there is a lack of obvious evidence for the presence of the supratemporal bone. *Keichousaurus* and *Hanosaurus* form two consecutive sister groups to the European pachypleurosaurs.

Hupehsuchus nanchangensis is different from *Nanchangosaurus* in having three layers of dermal plates above the neural spines in the trunk region and in the division of the neural spines into proximal and distal elements. The most conspicuous features of the taxon are its spindle-shaped and laterally compressed body and paddle-like limbs that reflect adaptation for high-speed swimming (Carroll and Dong, 1991). Because of the poor record of diapsid reptiles from the Late Permian to Early Triassic, the relationships of Hupehsuchia to other taxa are uncertain.

Based on an incomplete skeleton from Luxi, Yunnan, Young (1978) identified a new species of *Kwangsisaurus—K. lusiensis*. Rieppel (1999) thought that *K. lusiensis* might represent a taxon closely related to *Lariosaurus*.

2) Marine reptiles from the Middle Triassic in China, including six genera and species of sauropterygians and ichthyosaurs, are comparatively abundant and diverse. Among them, *Mixosaurus maoteiensis* Young, 1965 is the first recorded ichthyosaur in China, and is represented by an incomplete postcranial skeleton discovered in Renhuai, Guizhoi (Young, 1965b). This taxon, with deep amphycoelous vertebrae, expanded rectangular coracoid, and short humerus, resembles the European *Mixosaurus cornalianus* of the same age.

A damaged lower jaw and some disarticulated postcranial bones found in the Middle Triassic (now assigned to the Member I of Guanling Formation) Qingzhen, Guizhou, were recognized as a nothosaur and named as *Chinchenia sungi* (Young, 1965a). This taxon was referred to Pistosauridae on the basis of the amphicoelous vertebrae and the distal expansion of the transverse process. Cladistic analysis shows that *Chinchenia, Kwangsisaurus* and *Corosaurus* are trichotomous in the base of Pistosauroidea; these pistosaurs are closely related to members in North America (Rieppel, 1999).

The second species of sauropterygian, *Sanchiaosaurus dengi* (Young, 1965a), is represented by a tooth, several pieces of skull bone, and most of a postcranial skeleton from the Member I, Guanling Formation in the suburb of Guiyang City, Guizhou. As indicated by Rieppel (1999), *S. dengi* is characterized by an ilium without a trace of a preacetabular process, and by a dorsal blade of the ilium that is broad, bulbous, and ornamented with densely set tubercles. Although the material of *Sanchiaosaurus* is not complete, it can be deduced from cladistic analysis that it is the sister-group of all other nothosaurs.

Keichousaurus hui Young, 1958 and *Nothosaurus* sp. were collected from the Zhuganpo Member of Falang Formation in Xingyi, Guizhou. Since the establishment of *K. hui*, countless complete and incomplete skeletons of the taxon have been excavated from Xingyi and adjacent areas. It has a short rostrum, long neck, and broad ulna. Furthermore, its temporal region is relatively elongated. The growth of the humerus is positively allometric during its lifetime, indicating an important role of the forelimbs in locomotion. *K. hui* is deduced to be an ovoviviparous reptile (Lin and Rieppel, 1998).

Nothosaurus sp., represented by an incomplete skull, was originally named as *Shingyisaurus unexpectus* (Young, 1965a) and was re-described as a nothosaur based on cranial, traits such as pointed conical teeth with striated enamel surfaces, a retracted pineal opening, and contact of the frontal and parietal bones behind the fore-margin of the temporal fossa (Rieppel, 1998a).

3) The fossil localities of the Upper Triassic marine reptiles are distributed in Tibet and Guizhou only. *Himalayasaurus tibetensis* Dong 1972 found in Nyalam, Tunlong, Tibet, is a large ichthyosaur more than 10m long. It has a long rostrum, bioconcave centrum, and a long and narrow scapular bone. Teeth are subpleurodont in the upper jaw and pleurodont in the lower jaw. Another ichthyosaur from Nyalam and Tingji, Tibet, is *Tibetosaurus tingjiensis* (Young, Liu et Zhang, 1982), represented by poorly preserved specimens.

The most important marine reptiles of the Upper Triassic were found in the Wayao Member of the Falang Formation of Guanling, Guizhou. About ten genera, including ichthyosaurs, thalattosaurs and placodonts (the latter two new in China), have been reported. Ichthyosaurs are dominant in the collections. A large number of skeletons of these animals, ranging from several dozen centimeters to 5-6 m in length, were recovered, and probably represent three to four new taxa. Among these, *Qianichthyosaurus zhoui* Li, 1999 has three special features, earlier unreported in other ichthyosaurs. First, the vertebral column has a great arch upwards. Second, the three main bones of the hind limb are slightly stronger than those of the forelimb. Last, in ratio to the cranium, *Qianichthyosaurus* has proportionally the largest orbit in the Order Ichthyosauria. It is similar to shastasaurids from the Triassic in size and shape of limbs, and resembles *Ophthalmosaurus* and *Baptanodon* of the Jurassic in skull shape.

Sinocyamodus xinpuensis Li 2000 is the first record of placodonts in China and in regions outside Europe, North Africa and the Middle East. The species is characterized by its relatively small size, distinctly elongated orbit, pectoral and pelvic girdles located outside carapace, and limbs and tail covered with osteoderms.

Anshunsaurus huangguoshuensis Liu, 1999 was originally referred to Eusauropterygia, but was transferred to Thalattosauria based on characteritics such as the elongated and tapering premaxillary rostrum, retracted nares, contact of premaxilla and frontal bones, and reduced upper temporal fossa. Thalattosaurs are a monophyletic clade of marine reptiles known from the Middle and Late Triassic of Europe and North America. Phylogenetic analysis indicates that *Anshunsaurus* is the sister taxon of *Askeptosaurus italicus* from the Middle Triassic southern Alpine region, but it differs from the latter in the fusion of postorbital and postfrontal bones, the closed upper temporal fenestra, and the elongated posterior process of the jugal etc. (Rieppel and Liu, 2000). *Xinpusaurus* cf. *X. suni* is the second genus of thalattosaurs found in Guanling, Guizhou. It is distinguished from *Askeptosaurus* and *Anshunsaurus* by its relatively small size and its short, slightly ventrally bent snout. A preliminary phylogenetic analysis indicates potential trans-Pacific relationships: *Xinpusaurus* is more closely related to the North American genus *Nectosaurus* (Liu and Rieppel, 2001).

Yin et al. (2000) described nine genera and ten species (among them nine new genera and species) of sauropterygians and ichthyosaurs based on materials discovered in the Wayao Member, Falang Formation. These are part of a private collection, and are not freely accessible to other paleontologists; therefore, until the material can be reviewed and restudied in detail, we do not include these genera and species in the list of marine reptiles.

It is worth mentioning that there have been varying opinions on some genera and fauna. For example, there is a strong argument about the Zhuganpo Member, Falang Formation yielding *Keichousaurus* fauna. It was considered as Middle Triassic (Young, 1958; Chen, 1985), Middle-Late Triassic (Dong et al, 1997), or Late Triassic (Wang, 1996; Wang, 1998). Comparison of Chinese marine reptiles with their counterparts in Europe lead us to agree with Young (1958) and Chen (1985), so we assign the Zuganpo Member to the Middle Triassic. That is, we assign a Ladinic age.

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Triassic Marine Reptiles

	Ichthyosaurs	sauropterygian		thalattosaurs	hupehsuchian
		eosauropterygian	placodonts		
3	*Himalayasaurus tibetensis* *Tibetosaurus tingjiensis* *Qianichthyosaurus zhoui*		*Sinocyamodus xinpuensis*	*Anshunsaurus huangguoshuensis* *Xinpusaurus* cf. *X.suni*	
2	*Mixosaurus maoteiensis*	*Keichousaurus hui* *Nothosaurus* sp. *Chinchenia sungi* *Sanchiaosaurus dengi* *Kwangsisaurus lusiensis*			
1	*Chaohusaurus geishanensis*	*Kwangsisaurus orientalis* *Keichousaurus yuananensis* *Hanosauruw hupehensis*			*Hupehsuchus nanchangensis* *Nanchangosaurus suni*

A proposed area for the study of the Accessory Section and Point of the Terrestrial Permian-Triassic Boundary

PENG Yuanqiao[1,3], YIN Hongfu[1], YANG Fengqing[1] and WANG Shangyan[2]

[1] Faculty of Earth Science, China University of Geosciences, Wuhan 430074, Hubei, China
[2] Guizhou Geological Survey, Guiyang 550004, Guizhou, China
[3]Corresp. author: digushi@cug.edu.cn)

After the establishment of the Global Stratotype Section and Point (GSSP) of the Permian-Triassic boundary (PTB), definition of the Accessory Section and Point (ASP) of the Terrestrial Permian-Triassic Boundary (TPTB) is now on the agenda. However, all good TPTB sections so far known have the following shortcomings: (1) the exact TPTB horizon is difficult to define with high-resolution fossils; (2) correlation between marine and terrestrial PTBs is hard to attain with accuracy. These, of course, enhance the understanding of the global life crisis from marine to land across the Paleozoic-Mesozoic transition. In western Guizhou and eastern Yunnan of southwestern China, some fossiliferous PTB sections from marine via paralic to land facies are well developed, allowing bed-to-bed correlation of the PTB sequences among themselves. Fortunately, the marine PTB sequence in this area is almost the same as the Meishan section, where the GSSP of the PTB locates, which may provide a reliable auxiliary marker for high-resolution demarcation of the TPTB. These merits in western Guizhou and eastern Yunnan made it a good place to study the ASP of the TPTB, so we propose to study the ASP of the TPTB in this area.

Keywords: Terrestrial Permian-Triassic boundary (TPTB), Accessory Section and Point (ASP), Western Guizhou and eastern Yunnan

The Global Stratotype Section and Point (GSSP) of the Permian-Triassic boundary (PTB) was ratified by the IUGS Executive Committee in March, 2001. Thus, the GSSP of the PTB is defined at the base of Bed 27c, the Meishan Section D, Changxing County, Zhejiang Province, China, at the horizon where the conodont *Hindeodus parvus* first appeared (Yin et al., 2001).

With the establishment of the GSSP of the PTB, the Accessory Section and Point (ASP) of the Terrestrial Permian-Triassic Boundary (TPTB) should be defined as well. Cowie et al. (1986) pointed out that the ASP is especially useful in two clearly different kinds of strata such as the correlation of the New Red Sandstone and the marine Triassic. The marine bio-events across the Paleozoic-Mesozoic transition have long been researched along with the study of the GSSP of the PTB, but the Paleozoic-Mesozoic life crisis on land is hard to estimate due to the uncertainty of the TPTB. Therefore, high-resolution definition and correlation of the TPTB or the terrestrial Paleozoic-Mesozoic boundary is now on the agenda.

Status quo of the TPTB research

The terrestrial deposits of the Permian-Triassic are widely developed all over the world. The global distribution of the TPTB strata is no less than that of the marine PTB. However, the study of the TPTB is not so successful as the marine PTB, and the definition and correlation of the TPTB is more difficult than the marine PTB. Some investigators have put forward proposals for the construction of the special time scale (parallel to the existing marine one) for continental deposits (Lozovsky, 1991; Lucas et al., 1992). Accordingly, the search and the establishment of the ASP of the TPTB should be proposed as well. However, researches on the subdivision and correlation of the TPTB sequence and the fauna feature on land are relatively weak. Until now, few type sections of the TPTB have been proposed.

At present, some scholars are inclined to search the ASP of the TPTB in South Africa (Lucas et al., 1996). The Permian-Triassic Beaufort Group of Karoo basin in South Africa belongs to the sediments of a large intracratonic retro-arc foreland basin in southwestern Gondwana (Smith, 1995). Many vertebrate fossils were found and well studied in this area (Kitching, 1977). The *Cistecephalus* Zone and *Lystrosaurus* Zone in this area correspond to the *Dicynodon* fauna and *Lystrosaurus* fauna respectively in Xinjiang, northwestern China (Zhao, 1980; Cheng, 1986). It has become one of the most important areas for the study of the TPTB all over the world, but the study of other kinds of fossils was not as thorough as that of the vertebrates (D'Engelbronner, 1996). Many difficulties are met when attempts are made to establish correlation between the various regional scales, or to locate the continental tetrapod biozones on the universal stratigraphic scale (Battail, 1995; Shishkin, 1994). Some of the problems which are encountered in global correlation are illustrated with the well known example of the biozones of the Beaufort Group of Karoo basin in South Africa by Battail (1995).

The Chinese mainland lay in the east part of Tethys during Pangea time and represents one of the most developed areas of terrestrial Permian and Triassic in the world. The terrestrial Permian and Triassic in China are mainly distributed to the north of Kunlun-Qinling Mts. Among them, the Dalongkou section, Jimsar, Xinjiang is the most exhaustively studied TPTB in China, and its biostratigraphy is well studied. The TPTB defined by integrative subdivision of vertebrates, bivalves, ostracods, plants and palynomorphs can be well correlated among different continents (Yang et al., 1988; Zhou et al., 1997). The eventostratigraphic studies, such as magnetostratigraphy (Li et al., 1997), sedimentary events and climate change events (Yang et al., 1988, 1992), have been carried out as well. Clearly, it represents one of the world's best records of the terrestrial Permian-Triassic transition, and further study of this section could provide more precise correlation to the standard global chronostratigraphic scale and a more detailed understanding of terrestrial biotic changes across the PTB (Lucas et al., 1996). Cheng (1993) and Cheng and Lucas (1993) proposed that the Dalongkou section be considered as a potential auxiliary (non-marine) GSSP for the PTB.

Some other areas, such as the Moscow syneclise in Russia and the Cis-Ural region in Kazakhstan, the Bowen basin and Sydney basin in eastern Australia, and the Zechstein basin in Germany and its surrounding countries, developed typical TPTB sections and have been well studied as well.

At present, however, all the preferable TPTB sections in the world have the following shortcomings. (1) The exact TPTB position is hard to define with high-resolution due to sporadic occurrence of vertebrates in few beds. As a result, between the assured Permian and the assured Triassic, there are always intervals of several tens of meters of uncertain age. Sometimes, mixed fauna, which cannot be correlated with marine GSSP, can be found in it. Among them, different kinds of fossils have different time ranges, so it is hard to demarcate the assured TPTB at those sections. Therefore, the life crisis on land across the TPTB and its sequence are hard to estimate as well. (2) The correlation between marine and terrestrial PTBs is hard to be attained with accuracy. These, of course, hamper the understanding of the global life crisis across the Paleozoic-Mesozoic transition.

If we try to establish the ASP of the TPTB in a wholly continental area, correlation between marine and continental PTBs will be difficult. However, if an area contains both marine and terrestrial PTBs via paralic facies, there is an opportunity to correlate all those different facies directly, and the problems mentioned above might be solved. At last, we found an area (western Guizhou and eastern Yunnan, China) coincident to this condition. In western Guizhou and eastern Yunnan, apparently continuous depositions of PTB strata from marine via paralic facies to land are very well recorded. These strata are fossiliferous. The most advantageous phenomenon is that the marine PTB sequence in this area is almost the same as the Meishan section, the locality of the GSSP of the PTB, allowing bed-to-bed correlation of the type PTB strata with the marine PTB strata of this area, and thus also with the TPTB strata there. The merits of sections in western Guizhou and eastern Yunnan made this area ~~it~~ a good place to study the ASP of the TPTB.

General geology in western Guizhou and eastern Yunnan

The terrestrial strata across the PTB in western Guizhou and eastern Yunnan are composed, in ascending order, of Late Permian Xuanwei Formation, Late Permian and Early Triassic Kayitou Formation, and Early Triassic Dongchuan Formation. Based on detailed study of biostratigraphy, Nanjing Institute of Geology and Palaeontology, Academica Sinica (1980) gave a systematic conclusion of the strata in western Guizhou and eastern Yunnan. They attributed the terrestrial coal-bearing strata, with occasional marine interlayers, into Xuanwei Formation. It is overlain by Kayitou Formation (or Kayitou beds) with conformity. The lithologies of Kayitou Formation are almost the same as that of Xuanwei Formation except no coal beds are interbedded. According to fossils such as bivalves, ostracods and palynomorphs in the Kayitou Formation, it was attributed either to the earliest stage of Early Triassic by the research group of Nanjing Institute of Geology and Palaeontology, Academica Sinica (1980), or to late Late Permian and early Early Triassic (Wang and Yin, 2001). The Dongchuan Formation also overlies Kayitou Formation with conformity. There are clear differences of lithologic colors between Xuanwei Formation, Kayitou Formation and Dongchuan Formation. At the outcrop sections, the gray to gray-green strata belong to the Xuanwei Formation, the variegated strata belong to the Kayitou Formation, while the amaranth(?) strata belong to Dongchuan Formation. The nonmarine PTB strata in western Guizhou and eastern Yunnan all belong to these types and can be well corre-

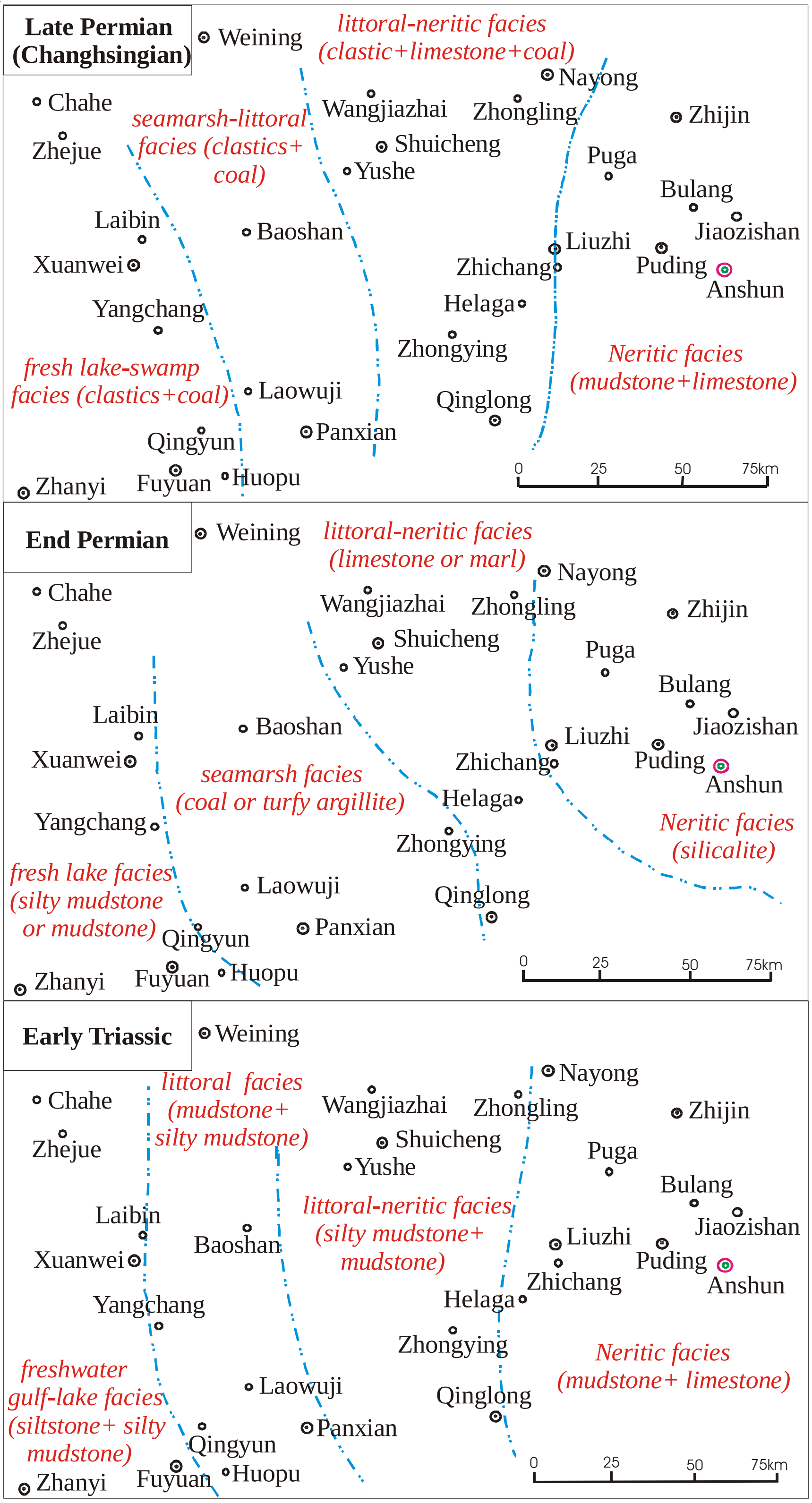

Figure 1. Sketch map of the lithofacies and paleogeography from Late Permian (Changhsingian) to Early Triassic in western Guizhou and eastern Yunnan (after Yao et al., 1980).

lated regionally.

There are many excellent PTB sections from marine via paralic to land in western Guizhou and eastern Yunnan. This area is one of the ideal regions to study the subdivision and correlation of the PTB strata from marine to land. Based on strati-

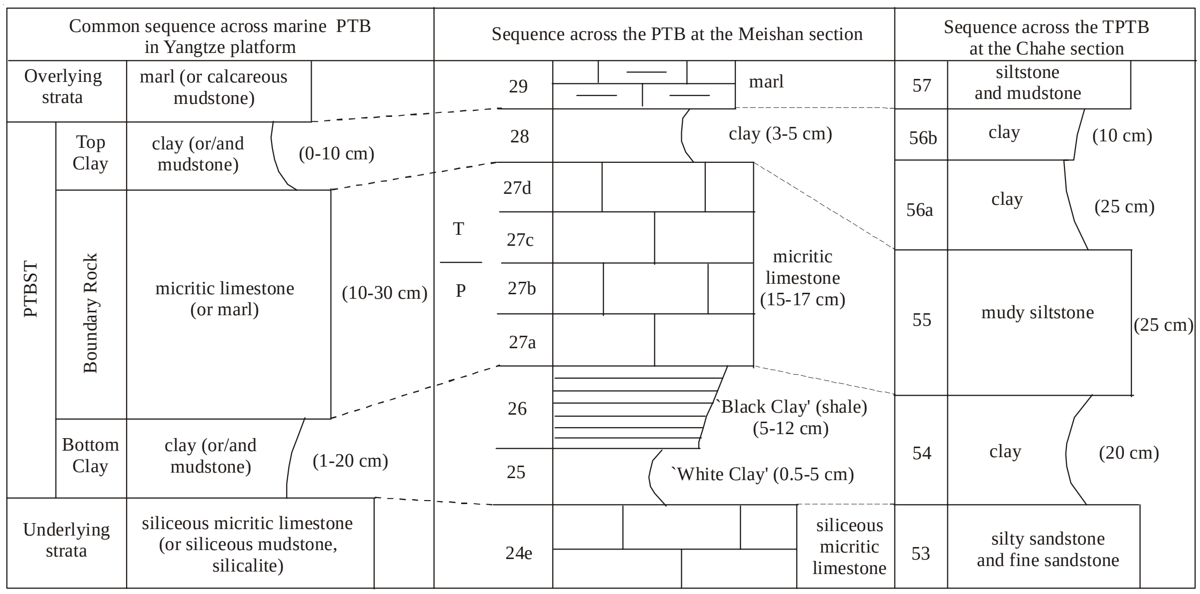

Figure 2. Common sequence across the PTB from marine to land in Yangtze region and its correlation.

graphic study of many sections in western Guizhou and eastern Yunnan from the Late Permian to the Early Triassic, the research group of Nanjing Institute of Geology and Palaeontology, Academia Sinica (1980) drew the sketch evolutionary map of lithofacies and paleogeography of western Guizhou and eastern Yunnan during the Permian-Triassic transition (Fig.1). From this figure it is evident that not only marine PTB (clastic facies and carbonate facies) but also non-marine PTB (paralic facies and terrestrial facies) can be found in this area. The shoreline of Changhsingian rarely regressed to the east of Nayong-Liuzhi line, and the shoreline lay approximately to the east of Shuicheng-Qinglong line at the end of the Permian. At the beginning of the Triassic, the seawater transgressed a little to the west, and the shoreline moved accordingly westward to Xuanwei-Fuyuan line. Thus the genuine TPTB sections should be searched to the west of Xuanwei-Fuyuan line. All three reported TPTB sections, Laibin section, Xuanwei, Yunnan (Nanjing Institute of Geology and Palaeontology, Academia Sinica, 1980), Zhejue section and Chahe section, Weining, Guizhou (Wang and Yin, 2001), lie in the western area.

Similar bed sequence across the PTB from marine to terrestrial facies in western Guizhou and eastern Yunnan

Latest study in western Guizhou and eastern Yunnan reveals a set of TPTB sequences which possess almost the same lithology and event associations as the marine Permian-Triassic Boundary Stratigraphic Set (PTBST) in South China. There are also one to two clayrock beds across the TPTB in western Guizhou and eastern Yunnan. The results of X-ray diffraction indicate that the main mineral compositions of those clayrocks are illite-montmorillonite and kaolinite, which are almost the same as the compositions of the marine PTB clayrocks. Zircon, apatite, hexagonal dipyramid quartz and some other accessory minerals of acidic lava have been found in the TPTB clayrocks at Chahe section, Weining of Guizhou Province and Mide section, Xuanwei of Yunnan Province. Shape parameters (length and width) of the zircons and their total frequencies are recorded. These data show that they are the same as the dirt bands in the coal beds of the Xuanwei Formation, which were considered to be formed by weathering of volcanic sediments (Zhou and Ren, 1983). In addition, transparent hyaline micro-spherules are occasionally found in the boundary clayrocks of the two sections. A lot of transparent hyaline micro-spherules and black metal micro-spherules are also found in the TPTB clayrocks at Zhejue section, Weining of Guizhou Province. Transparent hyaline micro-spherules are usually round, clear and transparent. Black metal micro-spherules are also round, some appear teardrop shaped and some have irregular cracks on their surfaces. Both types of the micro-spherules appear with complete extinction under the cross polarizer. Those characters of the micro-spherules indicate that they are formed through quick condensation of melted materials. Consequently, It is proposed that the TPTB clayrocks are the result of volcanism, which coincides to the formation of the marine PTB clayrocks of South China (Yin et al., 1989).

A typical three-layer structure consisting, in ascending order, of claystone (bed 54), muddy siltstone (bed 55) and claystone (bed 56) appears across the TPTB at the Zhejue section. This kind of TPTB association represents the same as that of the Meishan section, type section of the PTBST (Fig.2) (Peng et al., 2001). The following characteristics are found in the underlying and overlying strata of the terrestrial PTBST. (1) Biostratigraphic aspect: the palynomorph assemblages show clear differences between the underlying and overlying strata of bed 54. Typical members of the Triassic are only abundant in bed 54 and its overlying strata. Plant fossils are abundant in the underlying strata of bed 54 and are few in the overlying strata (Wang and Yin, 2001). (2) The susceptibility appears distinctly different between the underlying and the overlying strata of bed 54 and becomes increasingly higher in ascending order (Wang and Yin, 2001). This kind of changing trend is almost the same as that across the marine PTB in South China and can be correlated with high-resolution (Peng et al., 2000). (3) The data of $\delta^{13}C_{org}$ change abruptly across bed 54 and then recover. $\delta^{13}C_{org}$ data are relatively lower and stable in the underlying strata of bed 54 (-24.51~ -26.98‰) and higher and changeable in the overlying strata (-17.63~ -27.20‰) (Wang and Yin, 2001). These characteristics indicate that the terrestrial PTBST might also represent the high-resolution chronostratigraphic PTB.

The continuous clayrocks from marine via paralic facies to land in western Guizhou and eastern Yunnan provide a reliable auxiliary marker for high-resolution demarcation of the TPTB. Thus, in this area exists potential for high-resolution subdivision and correlation of the PTB from marine to land. This can then help us understand the terrestrial and global life crisis across the Paleozoic-Mesozoic transition.

Conclusions

(1) There are many excellent PTB sections from marine via paralic facies to land in western Guizhou and eastern Yunnan. This area is one of the ideal regions to study the subdivision and correlation of the PTB from marine to land. Thus, we propose to study the ASP of the TPTB in this area.

(2) Marked by the PTB clayrock beds, with the study of the biostratigraphy and some other eventostratigraphic characters such as susceptibility, carbon isotope and radiometric dating across the PTBST, the high-resolution correlation framework of the PTB from marine via paralic to land can be set up in western Guizhou and eastern Yunnan. This will help to establish the high-resolution correlation framework of the PTB in South China and over the world.

(3) Establishment of high-resolution chronostraigraphic TPTB in western Guizhou and eastern Yunnan will help us to understand the global life crisis from marine to land across the Paleozoic-Mesozoic transition.

However, the work in this area is preliminary and further study is necessary. We are appreciative of all cooperation with research in this area.

Acknowledgements

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Meeting Reports

Oman Pangea Symposium and Fieldmeeting, Muscat, Sultanate of Oman, 7-20 January, 2001

Aymon Baud[1], Jean Marcoux[2], Benoit Beauchamp[3]

[1] BFSH2-UNIL, CH-1015 Lausanne, Switzerland, aymon.baud@sst.unil.ch, [2] Paris VII University, Sciences physiques de la terre, Pl. Jussieu 2, F-75251 Paris Cedex 05 France, [3] Geological Survey of Canada, 3303, 33 street NW, Calgary, Alberta T2L 2A7, Canada

The preparation of the International Conférence on the Geology of Oman organised by the Oman Ministry of Commerce and Industry in cooperation with Sultan Qaboos University and the Mineralogical Institute of Bern University was a unique opportunity for a Pangea Symposium proposal in this part of the world. This was done in 1999 by A. Baud and J. Marcoux and accepted the same year by the Organising Committee.

Sponsored by the Subcommission on Triassic Stratigraphie among other institutions, the Symposium and fieldmeeting was to provide a forum to geologists who are interested in the Pangean time interval for discussing global changes related to Pangea integration and North Gondwana and Central Tethys evolution. Members of the International Subcommissions on Permian and on Triassic Stratigraphy were invited. Sedimentologists, statigraphers and paleontologists working within the Permian and Triassic time interval and interested by topics as diverse as biotic crisis, extinction, recovery and evolution across the Palaeozoic-Mesozoic transition used the opportunity to discuss, observe and sample the spectacular Permian and Triassic outcrops of Oman's former continental margin, from shallow shelf to deep marine sediments and sea mounds and to participate in the Pangea Symposium.
A comprehensive report has been published in Episodes, vol. 21/2, p. 126-127 and here we are giving the main results concerning the Triassic stratigraphy.

The thematic of the **Pre-Conference Excursion No.** A01, from January 8 - 11, 2001,was «Permo-Triassic Deposits, from shallow platform to Basin and Seamounts». It was led by A. Baud, F. Bechennec, L. Krystyn, J. Marcoux R. Maury and S. Richoz. Sixteen participants attended this fieldtrip with great interest and took part in the lively discussions on the outcrops.

Very interesting new data concerned the late Triassic and Triassic-Jurassic transition and were presented by Leopold Krystyn. The first occurs in the Baid exotic block wich is a worldwide unique exposure because it witnesses an Early Mesozoic stable pelagic environment. It persisted with just minor changes for more than 100 million years. It represents a tiny piece of a paleogeographic realm where more stable conditions should have provided better survival chances across the T-J crisis interval than the environmentally stressed shallow shelf regions of the oceans. This realm must have been widespread in the tropical belt of the Neotethys ocean but has been lost nearly completely by later subduction and collision. An outcrop of about 20m thick, predominantely nodular thin bedded red ammonoid bearing limestones comparable to the ammonitico rosso facies of the Southern Alps and the Adnet limestone of the Austrian Calcareous Alps have his base in the Norian and his top in the Sinemurian!

The second Triassic outcrop concerns the Al Aqil Block with the Aqil breccia. The reconstructed stratigraphic sequence consits of basal pillow basalts followed mainly by pelagic sédiments on wich the Aqil breccia is resting as debris flow with erosional contact on the lower fan sediments underlain by darkbrown radiolarites. Among the described blocks, there is a basal forereef breccia (Lower Carnian) a crinoidal-brachiopod packstone (Upper Carnian) and finally a cephalopod Hallstatt-type limestone unit (Norian-Sinemurian).

The third Triassic outcrop concerns the Upper Triassic reefal platform margin of the Kawr Group. A careful survey of the base of the Misfah formation has led to the vertical discrimination of 1) a thin basinal interval (about 5m, dated of Tuvalian 3) overlain by 2) allodapic lower slope deposits (50m) changing into 3) reefal limestones (appr. 100m) which are finally topped by 4) cyclic bedded lagoonal megalodont-bearing limestones of several 100m in thickness (Norian).

Between Jan. 12-16, 2001, the Conference on the Geology of Oman has attracted about 400 scientists from all over the world. As part of the Conference, the 2-day **Pangea Symposium** started on Jan. 14 in which 18 oral communications and 5 posters where presented. Between 50 and 100 scientists followed the Symposium. In their introduction, A. Baud and B. Beauchamp stated the general purposes of the Pangea project and emphasised the international cooperation. Concerning the Triassic sediments, the main items of scientific progresses are summarised as follow: Bernecker, M. (Second-order cycle development of the Arabian platform and Hawasina seamounts: Permian and Triassic outcrop data from central Oman), Cordey, F., Baud, A., Béchennec, F., Gorican, S. Krystyn, L. and Robin C. (Permian-Triassic deep water sediments of the Wadi Wasit revisited).

Recent isotope studies were presented by Richoz, S., Atudorei, V., Baud, A. and Marcoux, J. (Upper Permian to lower Triassic carbon isotope record: review and new data in the Oman Mountains, from the shallow platform to the basin) and Richoz, S., Baud, A., Marcoux, J. and Cordey, F. (Lower Triassic carbon isotope stratigraphy of the Sumeini slope deposits (Maqam C, NW Oman).

New data on Permian-Triassic boundary were the subject of a talk by Baud, A., Cordey, F., Krystyn, L.Marcoux, J. and Richoz, S. (The Permian-Triassic boundary in Oman, a review) and of a poster by Krystyn, L., Richoz, S. and Baud, A. (A Unique Permian-Triassic Boundary section from Oman): this is the first discovery of a complete dated Griesbachian coquinite limestone succession in Oman. This facies is unknown in other part of the Tethys.

About Triassic paleoclimates, stratigraphy, magnetic insight and palynofacies, the first presentation has been given by MacDonald, W. and Ellwood, B. on «Magnetic Insights into Permo-Triassic Pangea».

Stratigraphy of Triassic sediments was presented by Bachmann, G.H., Brueckner-Roehling, S., Exner, M., Kedzierski, J. and Szurlies, M. (Sequence Stratigraphy of the Scythian-Anisian Transgression, Triassic Type Region, Germany), by Mandl, G. W. (From Triassic Sea to Cretaceous Orogen - The Austroalpine Sector of the Tethyan Shelf (Eastern Alps, Austria), and by Kozur, H. W. (Ladinian and Carnian palaeogeography of southern Turkey and its importance for the development of the Triassic Tethyan faunal provinces).

Sedimentology, correlations, paleoecology and palynology of the Permian-Triassic boundary interval were the subject of 4 presentations: - Brookfield, M. (Sedimentology of the Permo-Triassic boundary sections in Kashmir, India), - Twitchett, R. J. (High resolution, global correlation of the Permian-Triassic interval), -Twitchett, R. J. and Looy, C. V. (Rapid and synchronous collapse of end-Permian marine and terrestrial ecosystems), - Spina, A., Cirilli, S and Baud, A. (Palynology of the uppermost Permian - basal Triassic successions in the High Arctic (Canada) and comparison with some PTB Gondwanian localities).

All the abstracts of the Pangea Symposium are available on the Web at http://www.geoconfoman.unibe.ch/ and have been published in the last issue of GeoArabia.

The Symposium was followed on Jan. 17 by a 4-day **post-conference Excursion (B01**) on the Permo-Triassic Deposits from Shallow Water to Base of Slope and basin leaded by A. Baud, F. Bechennec, F. Cordey, J. Marcoux, R. Maury, J. le Metour and S. Richoz.

New data on Lower Triassic succession (Member C, Maqam Formation) were presented by S. Richoz and A. Baud in the Wadi Maqam and Wadi Shuayab. It consits of a very thick unit (900m) essentially of platy limestones, calcarenites and calcirudites. It comprises mainly grey-beige calcilutite, laminated and flaggy, interbedded with sparse beds of fine-grained calcarenite in cm beds. Channelizing beds of intraformational calcirudite are also part in this succession which constitutes the great part of the outcrops of the Sumeini Group. The low negative values of the Carbon isotope within this thick Lower Triassic unit contrast with the high positive values found in the underlying Upper Permian Member B (shift of 6 ‰ at the Permian-Triassic transition).

The Global Stratotype of the Permian-Triassic Boundary and the Paleozoic-Mesozoic Events, Changxing, China, August 10-13, 2001

Yin Hongfu[1], Tong Jinnan[2]

[1] China University of Geosciences, Wuhan 430074, China, hfyin@cug.edu.cn, [2] China University of Geosciences, Wuhan 430074, China, jntong@cug.edu.cn

The Paleozoic-Mesozoic transition was the greatest geological turning point during Phanerozoic history, yielding the biggest biotic mass extinction and other extraordinary fatal events. So it has long been a hot topic for geologists and the Permian-Triassic boundary has received considerable attention. After the untiring and arduous effort of Permian-Triassic boundary geologists for decades and of others for over twenty years, the Global Stratotype Section and Point (GSSP) of the Permian-Triassic Boundary (PTB) was finally ratified at the base of Bed 27c of Meishan Section D, Changxing County, Zhejiang Province, South China by the International Union of Geological Sciences (IUGS) in early March 2001. This marks a great progress in the study of Permian-Triassic boundary stratigraphy and geological events. As a result of the studies on the Permian-Triassic boundary and transitional events and geological processes over the world there is now a unitary chronostratigraphic framework.

The international Symposium on the GSSP of the Permian-Triassic Boundary and the Paleozoic-Mesozoic Events was held in Changxing County, Zhejiang Province, China on August 10-13, 2001, chaired by Professor Yin Hongfu, the leader of the Permian-Triassic Boundary Working Group (PTBWG), co-organized by China University of Geosciences, Nanjing Institute of Geology and Paleontology, China Geological Survey and the Government of Changxing County, and co-sponsored by China University of Geosciences, Nanjing Institute of Geology and Paleontology, National Natural Science Foundation of China, China Geological Survey, China National Committee of Stratigraphy, Paleontological Society of China, Land and Resources Bureau of Zhejiang Province, Subcommission of Triassic Stratigraphy (STS), Subcommission of Permian Stratigraphy (SPS) and the Global Sedimentary Geological Program (GSGP). A formal ceremony unveiling the monument marking the PTB GSSP took place on site at Meishan Section D during the symposium. About

Picture 1: The opening of the International Symposium on the GSSP of the Permian-Triassic Boundary and the Paleozoic-Mesozoic Events

60 geologists from 13 countries attended the scientific activities and over 100 other members from the national and local governmental offices and news offices presented the opening and monument ceremonies. The vice-chairman of the International Commission of Stratigraphy (ICS) (Richard Lane), the vice-minister of Ministry of Land and Resources and the director of China National Committee of Stratigraphy (Shou Jiahua), the vice-director of the Head Office of the National Environment Protection (Song Ruixiang), the vice-governor of the Zhejiang Province (Zhang Mengjin) and others were specially invited to present at the symposium and/or ceremonies.

The opening of the symposium (Picture 1) was first held in the downtown of Changxing County during the morning of August 10. Professor Yang Zunyi, 94 years old, chaired the opening and briefly introduced the history of the decision of the GSSP at Meishan. He expressed his excitement and appreciation for the final decision of the PTB GSSP after an extensive, painstaking, and thorough comparison and selection process. He said, "As you know, in the early years the ammonoid *Otoceras* was considered as the index fossil of the Permian-Triassic boundary. In 1986, the conodont *Hindeodus parvus* was proposed to substitute *Otoceras* as the boundary marker, which later obtained the majority approval of the Permian-Triassic Boundary Working Group. In 1993, the PTBWG selected four candidates for the stratotype of the boundary, i.e., Meishan of Zhejiang, Guryul Ravine of Kashmir, Shangsi of Sichuan, and Selong of Tibet. In 1996 nine members of the PTBWG published a formal recommendation to set the Permian-Triassic boundary at the first appearance of *Hindeodus parvus*, Bed 27c of Meishan. From 1999 to 2000, the proposal for Meishan as the GSSP of the Permian-Triassic boundary passed three separate ballots. In March of this year, the IUGS Executive Committee finally ratified that the GSSP of the Permian-Triassic Boundary be defined at the base of Bed 27c, Meishan Section D, Changxing County, Zhejiang Province, China, at the horizon where the conodont *Hindeodus parvus* first appeared." Subsequently, some leaders from the international scientific organizations and from the national and local governmental offices addressed their congratulations to the opening of the symposium.

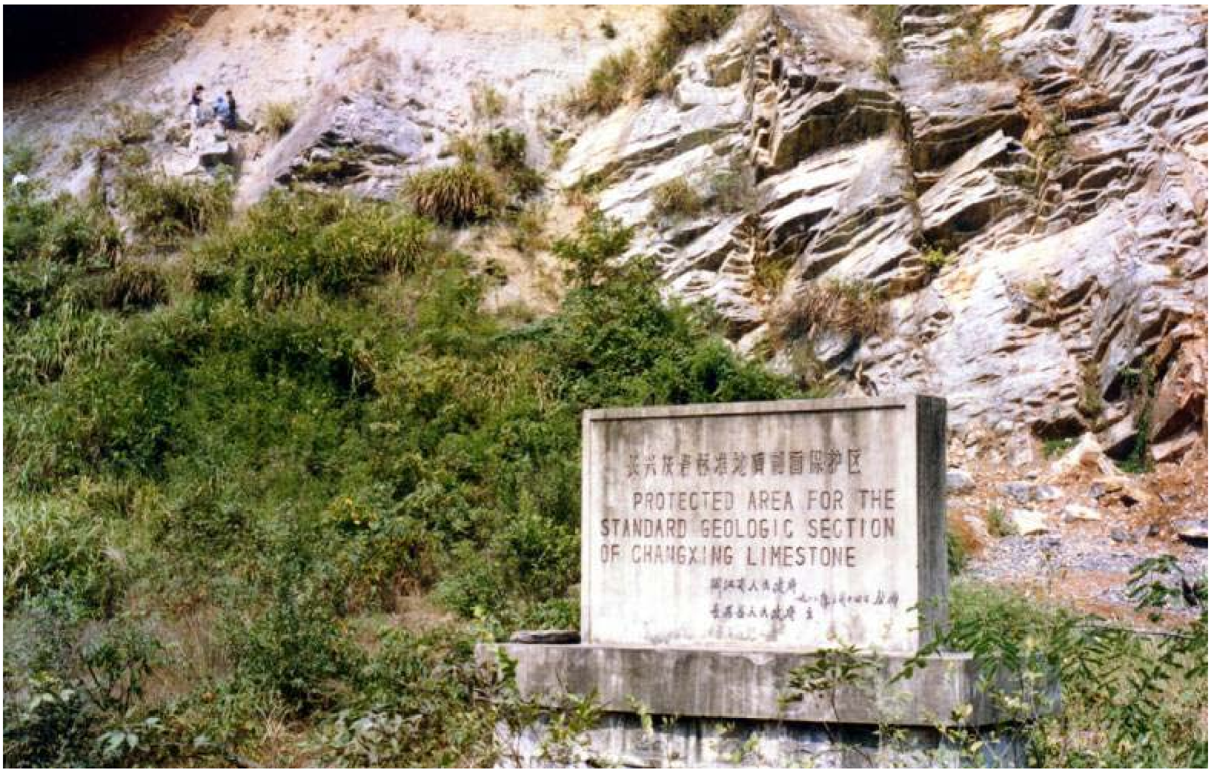
After the opening of the symposium, all conventioneers immediately took buses to Meishan Section D to present the ceremony of unveiling the monument marking the PTB GSSP on site. The monument ceremony was chaired by the leader of the PTBWG, Professor Yin Hongfu. He said, "According to the regulation of the International Commission of Stratigraphy, the type-locality of the GSSP should be open to all scientists for investigation and sampling regardless of their nationality, political attitude, race or religion, and a preservation stele or monument should be established on the site in order to protect the stratotype. The first demand has been satisfied by the document of State Council of China, September 17,1999, which declared the openness of the whole Changxing County, including Meishan area, to foreigners. Now we will fulfill the second demand by establishing and unveiling the protection monument."

Picture 2: The GSSP monument of the Permian-Triassic boundary at Meishan Section D

The chairman of the STS, Dr. Michael Orchard, and the head of the Changxing County declared the importance of the Meishan section and its protection, separately. Richard Lane, Shou Jiahua, Song Ruixiang and Zhang Mengjin together unveiled the monument.

The monument of the PTB GSSP is 9.09 m high and composed of three parts: the base, the body and the top (Picture 2). The body is bipartite. The lower part has two blocks, meaning Dyas in German, now called Permian. The upper part has three long columns, implying Trias in German, now called Triassic. The top consists of a "golden spike" wedging into the rocks and the index fossil of the spike—*Hindeodus parvus*. The carved characters on the column are the Chinese translation of the PTB GSSP and the three organizations in charge of it. The carved characters on the lower body records the main research units, the supporting organizations of the research and the monument. At the

Picture 3 Group photo in front of the GSSP of the Permian-Triassic boundary



Picture 4 The protection stele of the Changxing Limestone

back is a diagram showing the multidisciplinary correlation of the PTB strata. In front of the monument is a marble stone, where carved in Chinese, is a record of the course of the choice of this GSSP. A group photo was taken thereafter in front of the monument for all symposium participants and the official leaders as a souvenir (Picture 3).

To celebrate the completion of the monument and the opening of the symposium, a Commemoration Envelope of the GSSP of the Permian and Triassic Boundary was co-issued by the Philately Company of Zhejiang Province, the Government of Changxing County and the Post-office of Changxing County. A brief ceremony for the first-day cover and the signature followed the opening.

The scientific sessions started from the afternoon of August 10 on. This symposium received and printed 47 abstracts and 33 papers were orally reported during the symposium, including 9 keynotes. Yin Hongfu first summarized the basic geology and achievements of the Meishan section and the GSSP of PTB, and then the scientific sessions went on. The reports and discussions focussed on Permian-Triassic boundary geology, dealing with all aspects related to the boundary and the transition. The contents and achievements of the reports and discussions are roughly summarized below:

1. Boundary chronology: Dr. Roland Mundil reported new ages for the clay beds around the Permian-Triassic boundary of the Meishan section based on the U/Pb dating of zircons. The age of the Permian-Triassic boundary at the GSSP is suggested to be 253 Ma. The method is believed to be more reliable and the result is proven by their research at the Shangsi section. This result, if proved by re-investigations, will cast significant influence on the duration of the Upper Permian, Lower Triassic and the Permian-Triassic crisis.

2. Boundary events: Research on the Permian-Triassic boundary has yielded new evidence. The quantitative statistics on a database of fossils, the discovery of fullerenes (C_{60} and C_{70}), and anomalous sulfur and strontium isotope excursions, and new curves of carbon isotopes, as well as new dating on the boundary strata, compel us to further consider the causes of the great transitional events. A few papers especially suggested an extraterrestrial origin for the mass extinction.

3. Boundary correlation: Many reports dealt with new data at the Permian-Triassic boundary from various regions around the world, including Arctic Canada, Norway, Russia, Japan, Thailand, Iran, Saudi Arabia, Oman, and Vietnam as well as several provinces and Tibet of South China. The new data are correlated to the standard sequence at the Meishan section and support the boundary data as well as demonstrate a unitary boundary strati-

Picture 5 Steps to the base of the Changxing Limestone at Section D

graphic pattern. However, the magnetostratigraphic sequence of the terrestrial Permian-Triassic boundary strata in Xinjiang reported by Dr. John Lyons is clearly different from the marine sequence.

4. Transitional biota: Besides the mass extinction pattern at the Permian-Triassic boundary, the evolutionary processes and lineages of several characteristic taxa were examined, for example, conodont lineages and paleogeographic provincialism, radiolarian extinction at the end of the Permian and recovery in the early Triassic as well as a turnover between the Early and Middle Triassic, the discovery of Triassic vertebrates in Guizhou and their radiation during the Middle Triassic. It is notable that the restudy of *Reduviasporonites* redefines and opposes a disastrous fungal event.

5. Stratigraphy below and above the boundary: Some reports addressed advances in the study of the Lopingian and Changhsingian below the Permian-Triassic boundary and the Lower Triassic above the boundary. The bases of the Wuchiapingian and Changhsingian stages of the Lopingian and the Induan-Olenekian boundary were discussed. Many reports presented important advances in Lopingian and Lower Triassic conodont and ammonoid biostratigraphy, the biostratigraphic correlation between the Boreal and Tethyan sequences, and of new knowledge on the continuation of some stratigraphic sequences in the new biostratigraphic framework.

Meanwhile, studies indicate that the reconstruction of the Permian and Triassic eastern Tethys shows an archipelagic ocean full of islands, remarkably different from previous reconstructions. The paleoclimatic and paleoceanographic interpretations thus have to be quite different from those previously published. A lecture was also presented on Carboniferous conodont events prior to the formation of Pangea and the tectono-stratigraphy surrounding the North American transcontinental arch.

During the symposium, STS and SPS business meetings were conducted and a conodont workshop was organized. The SPS meeting was chaired by the vice-chairman of the SPS, Dr. Clinton Bruce Foster. At the meeting Dr. Charles Henderson, the secretary-general of the SPS, reported on the work of the SPS since the 31st IGC, its plan for the future and on preparations for attending the 32nd IGC. Recent advances and results in the study of the bases of the Lopingian and the Changhsingian were addressed and discussed. It was approved that unnecessary controversies could be avoided and that the Guadalupian-Lopingian boundary should be fixed against time soon.

Picture 6 The bed numbers carved on rocks at the boundary of Section D

The STS meeting was chaired by Dr. Michael Orchard, chairman of the STS. The meeting emphasized the boundaries between the stages within the Triassic. The base of the Triassic (Induan Stage) has been fixed, which provides an excellent example for the other Triassic GSSPs. The base of the Olenekian faces problems in that the stage is from the Boreal biogeographic realm and the proposed candidates of the boundary from the Vladivostok area may not meet the GSSP requirements. Thus it was suggested that the stage be re-selected. South China qualifies for this GSSP. The base of the Anisian is expected to be the second Triassic GSSP in the near future, but the work in Romania should be quickened. The tuff beds around the Lower and Middle Triassic boundary in South China would provide age data for this boundary. The base of the Ladinian has been extensively argued in terms of three different markers. As lots of work has been done at this boundary, it was advised that a vote could be done sooner. However, it is feared that the ballot may not be successful if no predominant selection is achieved before the vote. The base of the Carnian has been studied in Italy and Spiti and some good results have been achieved recently, but the pace of this work should also be quickened. The base of the Norian has seen little work so far, but a new section in North America is quite good for biostratigraphy although the magnetostratigraphy is not reliable due to an overprint. The base of the Rhaetian is to be done in the future.

The conodont workshop was chaired by Drs. Mei Shilong and Charles Henderson. Conodonts become the key fossils in the definition of the boundaries between and within the Permian and Triassic, but the taxonomic position of some conodonts is as yet indeterminate and the classification of conodonts is under dispute. A classification scheme based upon population features was proposed and discussed and it was confirmed to be valuable for Permian and Triassic conodont studies. The conodonts marking the Permian-Triassic boundary and its lineage were reviewed as well.

The mid-symposium field excursion provided all participants an opportunity to closely examine all of the Meishan sections. Section D, where the PTB GSSP is located, is also the location where the entire Changxing Limestone outcrops; it was protected with a stele by the governments early in the 80's (Picture 4). Here, all but the base and top of the Changxing Limestone are in the middle part of the hillside, which causes trouble for observation and investigation. With the cooperation of the local government, the Meishan section has been entirely repaired and protected. The boundaries were especially revealed by the preparation and a series of firm cemented steps extends to the boundaries (Picture 5) and the standard lithostratigraphic bed numbers were carved on the rocks (Picture 6), which is very convenient for observation and for research at the section. Now the boundary strata of Section D (the PTB GSSP) are strictly protected. In the west part, about 80 m from the GSSP, a section is exposed for sampling to meet the needs of researchers. As the case stands, the Permian-Triassic boundary in the Meishan area extends along the hillside and it is exposed within a series of abandoned quarries. For this excursion the local government built a road along the foot of the hill to run through all the sections. Therefore, we could trace the Permian-Triassic boundary westward from Section D to Section A and achieve a complete knowledge on the standard boundary sequence. This would be of great importance for the extension of the PTB GSSP around the world.

For better understanding the PTB GSSP at the Meishan section, the China University of Geosciences professionally designed 24 poster pages showing the major achievements of various studies at the Meishan section and posted them during the symposium. Meanwhile, the China University of Geosciences and the Nanjing Institute of Geology and Paleontology jointly collected and exhibited hundreds of publications on the Permian and Triassic boundary and related studies that were accomplished by both institutions during various stages, as well as some of the most important fossil specimens from the Meishan section. So it provided the best opportunity for extensively understanding the Meishan section and the Permian-Triassic boundary sequence. This formed crucial parts of the symposium together with the field excursions.

The pre-symposium field excursion was executed on August 8-9 and nine participants including the guiders attended this tour to view the regional stratigraphy in the Meishan area. Four sites were scheduled to examine Carboniferous to Triassic sequences and some key boundaries within them, the variation of Changhsingian facies, and the spatial extension of Permian-Triassic boundary strata. From the excursion, the specialists were convinced of the superiority of the Permian-Triassic boundary sequence at Meishan for the regional geologic setting.

The post-symposium field excursion to Chaohu, Anhui Province had 15 attendee, including the chairman of the STS, Dr. Michael Orchard, the vice-chairman of the STS, Prof. Yin Hongfu (vice-chairman of the China National Committee of Stratigraphy), the vice-chairman of the STS, Dr. Yuri Zakharov (leader of the Induan-Olenekian Boundary Working Group), and the secretary-general of the SPS, Dr. Charles Henderson. The excursion had five stops. The first stop dealt with the Carboniferous and Permian boundary with emphasis on the difference between the global and the traditional Chinese Carboniferous-Permian boundaries. The Permian stratigraphic sequence was reviewed as well. The other four stops focussed on the Upper Permian and Lower Triassic. They were especially designed to closely examine the whole Lower Triassic sequence, fossil assemblages, sedimentary facies and key boundaries such as the Permian-Triassic, Induan-Olenekian and Lower and Middle Triassic boundaries. The Induan-Olenekian boundary received considerable attention and discussion. It is believed that the Lower Triassic of Chaohu is quite competent as a potential GSSP for the Induan-Olenekian boundary, because: (1) the Lower Triassic sections have a good geographic condition with excellent traffic and good stratigraphic exposure on the roadsides. The sections are in the suburb of the Chaohu City, only 3 km from the downtown. Chaohu is a medium-sized city of the Anhui Province, 60 km from Hefei, the capital of the Anhui Province, communicated by railway and freeway. Moreover, it is only 90 km from Chaohu to Nanjing, the capital of the Jiangsu Province; (2) the Lower Triassic of Chaohu has abundant fossils. Most of the crucial ammonoids and conodonts have been collected so that the boundary could be clearly defined and correlated. In the meantime, the sections yield rich bivalves and some vertebrates and they are important sites producing rare reptile fossils; and (3) the Lower Triassic sequence at Chaohu is complete. The sedimentary sequences almost could be correlated with those of North America in terms of sequence stratigraphy. The cyclic sediments are ideal for high-resolution cyclostratigraphic study.

Two groups of 14 scientists went to Guizhou for the Permian-Triassic boundary sequences from the marine to continental facies after the symposium in Changxing. One group of five men went alone, as they needed more time to do field work there. The other group of nine attendees went on the scheduled post-symposium field excursion to Guizhou. The viewed sections were far from each other and in different facies so that the excursion was quite long. As it is in a mountainous area in the western Guizhou, the traffic was also slow. At the same time, many parts of the highway are currently under construction due to the national program of developing the west in China, which makes the traffic even slower, so that we had to cancel one previously scheduled stop. The marine Permian-Triassic boundary section in Zhongzhai of the Liuzhi County was examined. The lithology at the boundary is entirely different from that at the Meishan section and mainly composed of clastic rocks. But it contains rich marine fossils similar to those in Meishan. The boundary stratigraphic sequence of clay beds and boundary limestone at the Meishan section was also observed here except that the boundary limestone here contains more arenaceous elements. It is a marine sequence with a different facies (littoral) from the Meishan section, that represent transitional facies from marine to continental, so it was quite attractive and interesting to the visitors.

The observed continental Permian-Triassic boundary sequence is the Zhejue section in the Weining County at the border between the Guizhou and Yunnan provinces. The boundary strata consist entirely of continental sediments yielding mainly plant fossils except for the boundary clay beds, which is intercalated by a medium bed of sandstone to form a three-bed sequence similar to the boundary sequence at the Meishan section. Although the boundary correlation based only upon the three-bed boundary sequence might be quite arbitrary and adventurous, it is convincing that this is an instructive effort.

Acknowledgements

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Report on the field excursion in western Guizhou and eastern Yunnan

Peng Yuanqiao[1,3], Wang Shangyan[2] and Gu Songzhu[1]

[1] Faculty of Earth Science, China University of Geosciences, Wuhan 430074, Hubei, China,
[2] Guizhou Geological Survey, Guiyang 550004, Guizhou, China
[3]corrsp. author: digushi@cug.edu.cn

After the International Symposium on the Global Stratotype Section and Point (GSSP) of the Permian-Triassic boundary (PTB) and the Paleozoic-Mesozoic Events, nine scholars from home and abroad took part in the field excursion on the PTB strata from marine to land in western Guizhou and eastern Yunnan on 14-18 August, 2001. The field excursion was lead by Dr. Peng Yuanqiao (CUG), Dr. Wang Shangyan (GGS) and Dr. Gu Songzhu (CUG). Participants included Dr. Aymon Baud (Geological Museum of Switzerland) and his wife Monique Baud, Dr. Tadeusz Peryt (Polish Geological Institute), Dr. Takeshi Ishibashi (Kyushu University of Japan), Dr. Kunio Kaiho (Tohoko University of Japan) and Dr. Cao Changqun (Nanjing Institute of Geology and Palaeontology, Academia Sinica). This field party examined two kinds of facies of the PTB strata: the marine Permian and Triassic of Liuzhi area, Guizhou and the terrestrial Permian and Triassic of Weining area, Guizhou.

Western Guizhou and eastern Yunnan are in the southwestern part of China, to the south of Sichuan and to the north of Guangxi (Fig.1). The area lies in the east part of Yunnan and Guizhou plateau with the average elevation of 1000 meters. Typical Karst landforms are widely developed in the whole area. Road access is improving through a large-

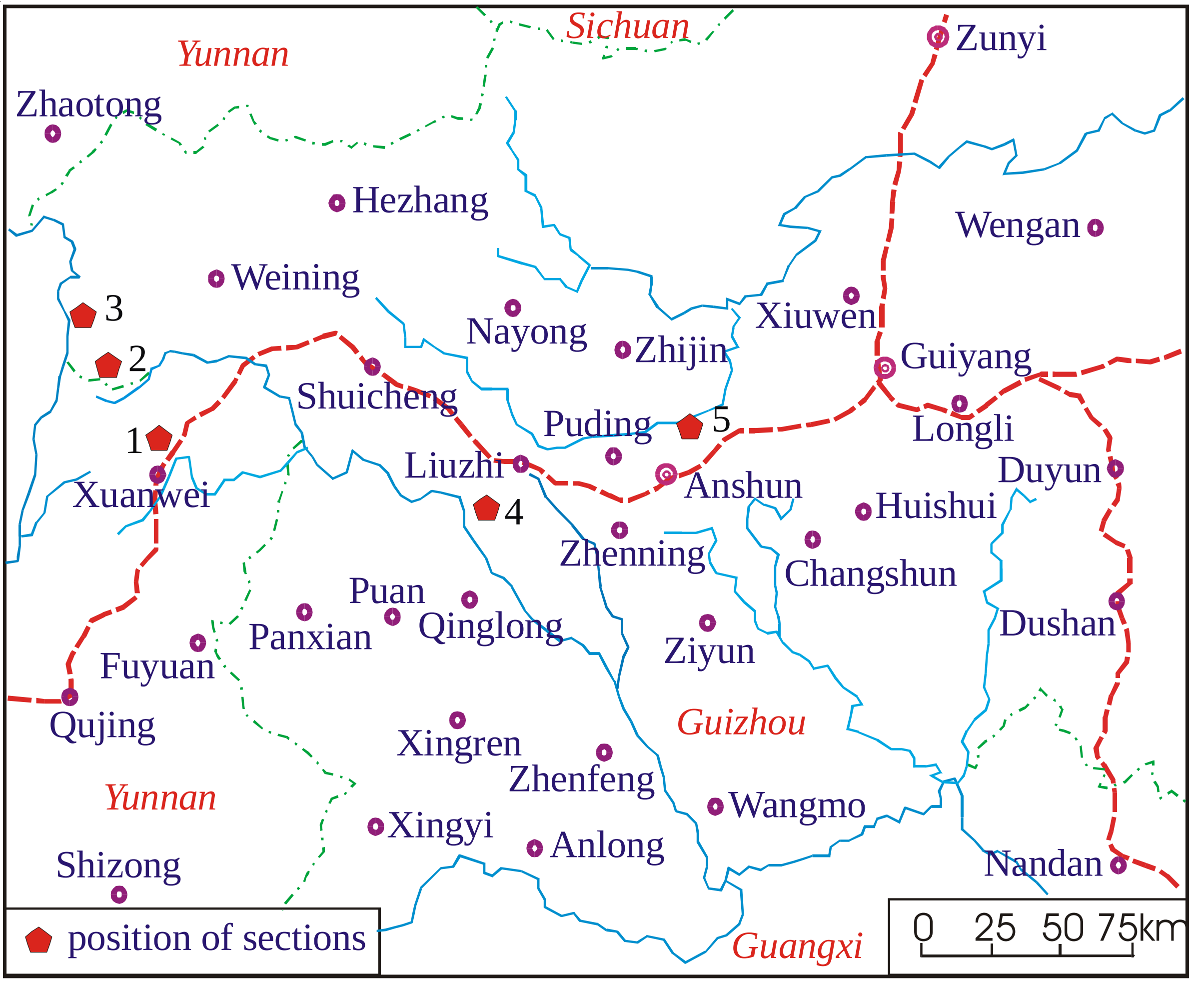

Figure 1 Geographical setting of western Guizhou and eastern Yunnan
1-Laibin section; 2-Zhejue section; 3-Chahe section; 4-Zhongzai section; 5-Jiaozishan section, 1, 2 and 3 are terrestrial PTB sections, 4 is neritic clastic PTB section, 5 is neritic carbonate PTB section;

Picture 1 The Permian-Triassic boundary at Stop 2 (North Pingdingshan Section)

scale Road Refit Project currently in progress.

Two sections were arranged to be surveyed for this five days' field excursion: the marine Zhongzai section, Liuzhi, Guizhou Province and the terrestrial Zhejue section, Weining, Guizhou Province.

Stop 1: Zhongzai section, Liuzhi, Guizhou Province—neritic clastic PTB section

Zhongzai section is located in a road-cut at the north part of Zhongzai village (or Heilaga village), Langdai, Liuzhi County, Guizhou Province. The well exposed Upper Permian and the Lower Triassic succession differ lithologically from the neritic carbonate PTB Meishan section — the Global Stratotype Section and Point (GSSP) of the PTB. The lithologies near the PTB at the Zhonghai section are composed of clastics containing abundant fossils, but the PTB sequence of clay beds and the corresponding boundary limestone (sandstone) is clear. This section possesses shore facies characteristics and should be the key for the high-resolution correlation from marine to land.

Stop 2: Zhejue section, Weining, Guizhou Province—terrestrial PTB section

Zhejue section is located at Gongping village, Zhejue town, Weining County, Guizhou Province. It is cut by national highway 326 from Weining to Xuanwei. The Upper Permian and the Lowermost Triassic are well exposed and consist of terrestrial clastics containing abundant plant fossils. At this section, the PTB is marked by two clay beds with the same structure and event sequence as that of the Meishan section. The main difference between the two sections is that the boundary limestone at the Meishan section is replaced by a sandstone bed at the Zhejue section. Although the high-resolution correlation of the boundary sequence at the two sections needs to be strengthened by further study in biostratigraphy and magnetostratigraphy, it is believed that the Zhejue section could serve as an Accessory Section and Point (ASP) of the PTB. In its favour are: (1) good stratigraphic exposure and accessibility, (2) abundant fossils including plants and palynomorphs, (3) similarity of the stratigraphic set compared with the marine PTB sequence at Meishan section and (4) the boundary clay beds formed by volcanism at Zhejue section that might provide us opportunity to test the direct age for the terrestrial PTB.

Picture 2 The Stratigraphic sequence around the Induan-Olenekian boundary (and sequence surface) at Stop 2 (North Pingdingshan Section)

Picture 3 The Stratigraphic sequence around the Induan-Olenekian boundaryat Stop 3 (West Pingdingshan Section)

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British Triassic Palaeontology: Supplement 26

G. Warrington

Since the completion of the writer's previous supplement (No.25; ALBERTIANA, 25: 48) on British Triassic palaeontology, the following works relating to aspects of that subject have been published or have come to his notice:

Ambrose, K. 2001. The lithostratigraphy of the Blue Lias Formation (Late Rhaetian-Early Sinemurian) in the southern part of the English Midlands. Proceedings of the Geologists' Association, 112: 97-110.

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Contributor's address:

G. Warrington, British Geological Survey, Keyworth, Nottingham NG12 5GG, Great Britain.

New Books

THE RECONSTRUCTION OF LATE PALEOZOIC AND MESOZOIC MARINE ENVIRONMENTS FROM ISOTOPIC DATA (evidence from north Eurasia)

Y.D. ZAKHAROV, N.G. BORISKINA, A.M. POPOV
Vladivostok: Dalnauka, 2001. 112 p.
(in Russian, with English abstract and explanation of figures and tables)
http: //www.fegi.ru/FEGI/reconst/

Some recently discovered events at the Tethys, respectively occuring at (1) early Permian (Artinskian?), (2) Wordian, (3) early Midian, (4) Midian-Dzhulfian transition, (5) early Dorashamian, (6) middle Olenekian, (7) early Anisian, (8) latest Ladinian, (9) late Carnian, (10) early Norian and (11) early Rhaetian intervals are characterized by anomalously high values of $\delta^{13}C$ in organogenic carbonates («carbon-isotope macrorhythms»). We can consider the four brightest Phanerozoic events, which were probably reflected by the greatest phytoplankton heyday and, accordingly, by an intensive photosynthesis: Late Carboniferous ($\delta^{13}C$=6.2‰), Midian-Dzhulfian 6.5-7.3‰), middle Olenekian (6.9‰) and early Aptian (6.8‰).

The geochemical variations appear explainable by high bioproductivity of data on isotopic composition of organic carbonates testfy that the carbon-isotopic anomalies in many periods of the Phanerozoic appreciably are reflection of climatic fluctuation. Their positive maxima during the end of Paleozoic and Mesozoic fell, probably, on warm epochs caused by several factors, main of which seem to be: (1) rise of solar activity, (2) macropulsation of an energy of the sun and (3) number of astronomical variations. About eight solar cycles distinguishing on their duration are known now. Carbon-isotopic macrorhythms of Late Palaeozoic and Mesozoic demonstrated here may testify to the existence of cycles of solar activity (solar macrocycles) by duration from 1.5 up to 12 Ma, less often up to 15-18 Ma.

Based on oxygen-isotope and Ca-Mg analysis of invertebrate shells and limestones in the Tethys the highest Late Paleozoic temperatures in North Hemisphere were obtained for the Midian-Dzhulfian transition (till 27.9°C). In general, at low latitudes temperatures are thought to begin a recurrent warming trend in the Artinskian-Dorashamian, reaching temperature maxima in the Artinskian of Early Permian, early Murgabian and particularly Midian-Dzulfian transition time of Middle Permian, and in the late early Dorashamian (23.8°C) – early late Dorashamian (23.8°-24.2°C) time of the Late Permian, which agrees with a placing of the positive carbon isotope anomalies and taxonomic diversity of Permian invertebrates.

It seems justified to assume that through the course of the early Induan temperature dropped of about three times (twice within the beginning of the Lytophiceras medium Zone and once just at the beginning of the Gyronites Zone, with a visible warming in the middle part of the latter. A short-term fall of temperature at the beginning of the Induan (volcanic winter) soon followed by warm period (greenhouse summer) seem to be caused by eruption of the Siberian Traps. A similar situation apparently occurred at the end of the Cretaceous, when extensive flood basalts, known as Decan Traps, erupted.

Temperatures during early Olenekian seem to be significantly lower than during late Olenekian or late Anisian (8.8°C, 16.2°C and 15.4°C, respectively for Arctic Siberia).

Two main trends can be recognized in Late Cretaceous temperature conditions in the shallow-water Hokkaido-south Sakhalin Basin. (1) In general, a recurrent warming trend is thought to have begun in the Turonian-Campanian, reaching temperature maxima in the early Late Santonian (19.6°C) and perhaps early Campanian. (2) During the Maastrichtian, temperatures dropped sharply (till 7.1°C), with only a slight warming (till 11.2°C) in early Late Maastrichtian. The existence of a Santonian-transition thermal maximum has previously been expected, but is not confirmed by new isotopic results. The influence of some basic factors: drop of temperature, oxygen deficit, enormous sea level fluctuation and volcanic activity seems to be the main reason for the destruction of epicontinental sea ecosystems both at the end of the Permian and the end of the Cretaceous.

For reconstruction of late Palaeozoic and early Mesozoic environments the data from reef distribution seem to be very important, because the reefs consider to be very sensible indicator for marine environment changes. As an example of a prospering reef is that of the end-Permian strata of the Urushtenskaya Suite in North Caucasus. It is known that at the start of the Triassic, reefs disappeared from the face of the earth and a reef formation was not renew in any region of world in both the middle Olenekian climatic optimum (transgression) and the similar condition of the beginning of Middle Triassic. After the Permian-Triassic boundary ecological crisis they have arised in the tropical zone only in Late Triassic (although scleractinian corals made their first appearance in Middle Triassic). Lack of reefs in the low latitudes during the beginning of the Triassic more logically to connect with O_2 deficit of that time as consequence of the anoxic event across the Permian Triassic boundary. The absence of visible signs of organic SiO_2-accumulation just in the Permian-Triassic transition time and the low rates in reconstruction of the radiolarian taxonomic diversity through the Induan and Olenekian to the early Anisian seem to be caused by the same reason.

Future Meetings

Shallow Tethys 6, Budapest, Hungary, 26-31st August, 2002.
See http://pangea.elte.hu/paleo/tethys/

This is the venue for an official STS meeting with a thematic session on “Middle Triassic boundaries”. It is hoped that substantial progress towards agreement on the GSSPs for the O-A, A-L. and L-C boundaries will result from this meeting. Also of interest will be a meeting of IGCP project 458 on Triassic-Jurassic boundary events. A full program of lectures and field trips will accommodate those interested in other Triassic topics.

The STS will also be independently arranging a pre-conference field trip from Italy to Hungary to view GSSP candidates at Bagolino (A-L, Italy), Prati di Stuores (C-N, Italy), and Felsoors (A-L, Hungary). The option of an additional post-meeting field trip to Delsi Caira (O-A, Romania) is possible depending on demand. Space for all these field trips will be limited and priority will be given to voting and working group members. Those interested in these trips should inform the Chair asap.

Paleontological & Bioestratigraphic Congress, Corrientes Province, Argentina, Oct., 2002.

A Triassic Symposium is being organized at this congress by South American colleagues. Contact Andrea Arcucci at email arcucci@satlink.com

Geological Ass. Canada, Vancouver, British Columbia, Canada, 26-28th May, 2003.

This will be a joint meeting of the Geological Association of Canada (GAC), Mineralogical Association of Canada (MAC) and the Society of Economic Geologists (SEG). A thematic session on Upper Triassic standards and correlations will be organized. A field trip to Williston Lake, British Columbia will include a visit to the Carnian-Norian boundary GSSP prospect and several Triassic-Jurassic contacts. In addition, the non-marine auxiliary C-N candidate in the Chinle Group of New Mexico, USA, will be organized by Spencer Lucas..

32nd International Geological Congress, Florence, Italy, August 20-28th, 2004.

“From the Mediterranean toward a Globval Renaissance” is the banner of this IGC. We plan an STS workshop and at least one Symposium topic has been proposed: “Triassic of the Tethys Realm” (M. Gaetani).

BOUNDARY WORKING GROUPS

In order to make quicker progress toward GSSP definition in the Triassic, the Chair, on behalf of the executive, has now created additional boundary working groups (WGs) and nominated some new Chairpersons. In line with ICS recommendation, these WGs are to be more formally constituted and the onus will be upon the Chairs (plus in some cases a secretary) to convene a representative group of experts to nominate and consider GSSP candidates. Their recommendation will form the basis of any subsequent vote undertaken by the STS voting slate so much of the essential scientific work falls upon the members of the WGs.

Whereas Chairs may invite researchers who they know to be active in particular boundary studies, those STS members who feel they have a contribution to make on specific boundaries may write directly to the contact people below and make their interests and views known. It is important that we do not encumber the working groups with numerous peripherally interested persons so please consider carefully your potential contribution. For your information, the recently revised guidelines for GSSP proposals are reproduced below.

P-T*	-	Yin Hongfu
I-O	-	Yuri Zacharov
O-A**	-	Eugen Gradinaru
A-L	-	Aymon Baud
L-C	-	Maurizio Gaetani
C-N	-	Mike Orchard
N-R	-	Leo Krystyn
Non-marine	-	Spencer Lucas

*The P-T boundary GSSP is now fixed at Meishan, China. **There is currently only one candidate for the O-A boundary GSSP (Desli

Caira, Romania) for which the responsible proponent is E. Gradinaru.

Global Boundary Stratotype Section and Point (GSSP)
Guidelines for GSSP proposals

The Global Boundary Stratotype Section and Point is a permanent reference for geological time. The GSSP is a specific point in a stratotype, clearly marked and documented.

1. Stratigraphic rank of boundary

2. Proposed GSSP — geographic & physical geology
    - A. Geographic location
    - B. Geological location
    - C. Location of Level and Specific Point
    - D. Stratigraphic completeness
    - E. Adequate thickness and stratigraphic extent
    - F. Provisions for conservation and protection

3. Primary and Secondary Markers
    - A. Principal correlation event (marker) at GSSP level
    - B. Other stratigraphy — Biostratigraphy, Magnetostratigraphy, Chemical stratigraphy, Sequence stratigraphy, Cycle stratigraphy, Other event stratigraphy, Marine-Land correlation potential, Amenability to geochronometry
    - C. Demonstration of regional and global correlation.
4. Selection process
    - A. Relation of the GSSP to historical usage
    - B. Other candidates and reasons for rejection
    - C. Votes
    - D. Selected publications

5. Other useful sections

STS MEMBERS LIST 2001

Voting members 2001

Yoshiaki Aita, Utsunomiya, JAPAN
aida@cc.utsunomiya-u.ac.jp
Radiolarians in the southern high latitudes, mainly from New Zealand and Russia; P-T boundary succession in New Zealand.

Andrea B. Arcucci, San Luis, ARGENTINA
arcucci@satlink.com
Vertebrate paleontology of the continental Triassic of western Argentina (faunal evolution, taphonomic, stratigraphic, and sedimentological studies).

Darioush Baghbani, Tehran, IRAN
baghbanid@nioc-ripi.org
Biostratigraphy and chronostratigraphy of Triassic Foraminifera, especially the Zagros Basin, SW Iran.

Aymon Baud, Lausanne, SWITZERLAND
Aymon.Baud@sst.unil.ch
Permian-Triassic in Oman and Turkey; Late Permian-Early Triassic physical stratigraphy and palynofacies, and correlation based on carbon isotope curves from carbonates and organic matter; Blind Fiord transgression in the high Canadian Arctic; Anisian-Ladinian WG Chair.

Hugo Bucher, Lyon, FRANCE
Hugo.Bucher@univ-lyon1.fr
Lower Triassic ammonoids, western Guangxi, China; Spiti, North America. Middle Triassic ammonoids of North America.

Hamish Campbell, Dunedin, NEW ZEALAND
H.Campbell@gns.cri.nz
Molluscs (especially bivalves) and brachiopods; Stratigraphy. correlation, terrane relations, and biogeography.

Yoram Eshet, Jerusalem, ISRAEL
yoram@mail.gsi.gov.il
Palynology of the P-T boundary, focused on the „Fungal Spike“ and reconstruction of the floral succession, Israel and the Karoo Basin, South Africa.

Maurizio Gaetani, Milano, ITALY
maurizio.gaetani@unimi.it
Middle Triassic boundaries; Ladinian-Carnian WG Chair.

P. John Hancox, Wits, SOUTH AFRICA
065PJH@cosmos.wits.ac.za
Non-marine Triassic basins of southern and eastern Africa, particularly the Induan-Olenekian and Olenekian-Anisian boundaries.

Dennis Kent, Palisades, U.S.A.
dvk@rci.rutgers.edu
Paleomagnetism of nonmarine (Newark basins, East Greenland, Argana) and marine (esp. Tethys); U. Triassic, astronomically-calibrated geomagnetic polarity time scale and global correlation; magnetostratigraphic correlation of M-U. Triassic Tethyan marine sections (with G. Muttoni) and calibration of biochronologies; marine-nonmarine correlation.

Sandor Kovács, Budapest, HUNGARY
skovacs@IRIS.geobio.elte.hu
Middle-Late Conodont biostratigraphy, Balaton Highland; *Circum-Pannonian terrane maps and Late Triassic environments*; *Triassic correlation, Carpatho-Balkans area (Austria to Greece); Triassic of northeast Hungary; A-L and L-C boundaries.*

Heinz W. Kozur, Budapest, HUNGARY
kozurh@helka.iif.hu
Conodonts, and their calibration with radiolarian zones and marine ostracodes, esp. Tethys; U. Triassic biostratigraphic scales (conodonts, holothurian sclerites, radiolarians, ostracods) in Silicka Brezova; Germanic continental-marine correlation using conchostracans and ostracods.

Leopold Krystyn, Vienna, AUSTRIA
leopold.krystyn@univie.ac.at
Ammonoids and conodonts; Triassic boundary definitions and resolutions. Norian-Rhaetian WG Chair.

Jinling Li, Beijing, CHINA
pljinling@263.net
Marine reptiles from Guizhou, China; Environmental change at the P-T boundary; P-T boundary of the Tianshan section using vertebrates, palynology, paleomagnetism, and geochemistry, and correlation with Dalongkou.

Vladlen R. Lozovsky, Moscow, RUSSIA
vlozovsky@mtu-net.ru
Stratigraphy of continental red beds of the Russian platform and surrounding areas, and the position of the P-T, O-A, and A–L boundaries.

Spencer Lucas, Albuquerque, U.S.A.
SLucas@nmmnh.state.nm.us
Tetrapod-based timescale; tetrapods and stratigraphy in the western United States; Triassic of

northern Mexico; Stratigraphic distribution of tetrapods in the type German Triassic; tetrapod assemblages of the Parana Basin, Brazil; Non-marine WG Chair.

Manfred Menning, Potsdam, GERMANY
menne@gfz-potsdam.de
Magnetostratigraphic reference scale of the Buntsandstein and Keuper (with M. Szurlies); global correlations. German Subcommission for P-T stratigraphy Chair.

Alda Nicora, Milano, ITALY
aldanic@e35.gp.terra.unimi.it
Conodont studies; Middle-Upper Triassic of the southern Alps; Upper Triassic of Sicily, Hydra Island, and Spiti; boundary studies of the O-A boundary of Romania and Greece; A-L of the Southern Alps (with Brack), and L-C of the Himalaya (with Krystyn and Balini).

Michael J. Orchard, Vancouver, CANADA
morchard@nrcan.gc.ca
Conodont biostratigraphy and biochronology in North America; conodont taxonomy, apparatus structure, and evolution; Cordilleran terranes and paleogeography; O-A boundary in Romania (with Nicora); A-L boundary in Nevada (with Bucher); C-N boundary WG Chair; STS Chair.

George D. Stanley, Missoula, U.S.A.
fossil@selway.umt.edufossil@selway.umt.edu

Early Mesozoic reefs; Paleoecology and taxonomy of corals and sponges; Cordilleran tectonics and paleogeography of terranes.

Vijaya, Lucknow, INDIA
bsip@bsip.sirnetd.ernet.in
Lower Triassic palynology, Raniganj Godwana Basin, West Bengal.

Henk Visscher, Utrecht, THE NETHERLANDS
h.visscher@bio.uu.nl
Triassic palynology in chronostratigraphic correlation and classification, Europe; Correlation of Alpine and continental Germanic facies; P-T boundary terrestrial ecosystems (with C. Looy).

Geoffrey Warrington, Nottingham, U.K.
gwar@bgs.ac.uk
Palynology U.K., N. Africa, Middle East; U.K. stratigraphy. STS Secretary. Convenor, Triassic-Jurassic Boundary Working Group.

Wolfgang Weitschat, Hamburg, GERMANY
weitschat@geowiss.uni-hamburg.de
Triassic stratigraphy and ammonoids of Svalbard, Spitsbergen; High paleolatitude correlations.

Hongfu Yin, Hubei, CHINA
hfyin@cug.edu.cnmailto:
Terrestrial stratotype of the P-T boundary, western Guizhou; P-T boundary events; I-O boundary in China; STS Vice-Chair; P-T boundary WG Chair.

Yuri D. Zakharov, Vladivostok, RUSSIA
zakharov@fegi.ru
Uppermost Permian and I-O ammonoids from South Primorye; Paleomagnetic studies in the Abrek Bay; STS vice-Chair; Induan-Olenekian WG Chair.

Corresponding members

Viorel Atudorei, Alburqueque, USA
atudorei@unm.edu
Chemostratigraphy, carbon, sulfur and oxygen stable isotope geochemistry; Triassic sediments, Triassic paleo-oceanography, strontium isotope stratigraphy.

Marco Balini, Milan, ITALY
marco@e35.gp.terra.unimi.it
Ammonoids of the Tethyan realm; Anisian (S. Alps, Hydra, Spiti, Zanskar); L.-C. (S.Alps, Spiti); L. Triassic (Kçira, Albania; Mangyshlak, Kazakhstan); taxonomy, integrated biostratigraphy/ ammonoids-conodonts-pelagic bivalves, biochrono-stratigraphy, palaeobiogeography.

Michael J. Benton, Bristol, ENGLAND
mike.benton@bristol.ac.uk
Vertebrate [primarily reptilian] paleontology, particularly the rhynchosaurs of the UK; Russian and Mongolian faunas (with Shishkin).

Robert B. Blodgett, Corvallis, USA
blodgetr@bcc.orst.edu
Gastropod faunas from para-authochthonous or cratonic North American rocks, including Sonora, Nevada, British Columbia, and east-central Alaska; accreted terrane faunas from western North America.

Peter Brack, Zuerich, SWITZERLAND
brack@erdw.ethz.ch
A-L boundary (with Hans Rieber) at Bagolino, Italy; correlation of S. Alpine successions with the Germanic Muschelkalk; multidisciplinary studies of platform carbonate cycles and the evolution of the platform-basin system; quantifi-

cation of processes in the Middle Triassic.

Nikita Bragin, Moscow, RUSSIA
mailto:bragin@geo.tv-sign.ru
Radiolaria: morphology, taxonomy, biostratigraphy, and palaoegeography; zonal stratigraphy in E. Siberia, E. Mediterranean; high latitude faunas in NE Siberia, their origin and history; geology of deep-water sediments and P/T boundary in these environments.

Kiril Budurov, Sofia, BULGARIA
budurov@geology.bas.bg
Triassic stratigraphy, palaeogeography and palaeogeodynamics of the Balkan Peninsula; Definition of Middle Triassic stages and substages and their boundaries based on conodonts; CAI maps for several Triassic substages.

Galina I. Buryi, Vladivostok, RUSSIA
buryi@mail.ru
Conodonts from Far East Asia (Sikhote-Alin); biostratigraphy of silicious and carbonate formations; conodont affinities and paleobiology.

Elisabeth S. Carter, Portland, U.S.A.
escarter@coinet.com
Dynamics of radiolarian extinction and recovery across the T-J boundary, Queen Charlotte Islands, Baja California, and Japan; radiolarians across the C-N boundary, Queen Charlotte Islands; intercalibration of radiolarian zonation with conodont and ammonoid zones.

Jinghua Chen, Nanjing, CHINA
jhchen@nigpas.ac.cn
Bivalves - biostratigraphy, bioevents, paleobiogeography; Lower Triassic recovery and Middle Triassic bivalve radiation in south China.

Zhengwu Cheng, Beijing, CHINA
ljivpp@263.net
Non-marine P-T boundary at the Dalongkou section of Jimusar and neighbouring areas of Xinjiang; Biostratigraphic and palaeomagnetic studies of the T-J boundary in Lufeng, Yunnan Province.

Chonpan Chonglakmani, Nakhon Ratchasina, THAILAND
chongpan@ccs.sut.ac.th
Stratigraphy, sedimentology, and tectonic evolution of Thailand; systematics of bivalve and ammonoids.

Simonetta Cirilli, Perugia, ITALY
simocir@unipg.it
Sequence-stratigraphy and correlation in the Tethys; Sedimentary organic matter (palynofacies, palynostratigraphy, organic facies) and sedimentary facies; marine ecosystems - stratigraphy, evolution, palaeoclimatology, palaeogeography.

Dang Tran Huyen, Hanoi, VIETNAM
Fauna and stratigraphy of Vietnam.

G. Demathieu, Dijon, FRANCE
Vertebrate ichnotaxonomy, Middle-Upper Triassic, Spain and France.

Jim M. Dickins, Turner, AUSTRALIA
Global climates, faunas, events, and correlations; Burrowing bivalves (with N. Morris); T-J boundary, UK.

Paulian Dumitrica, Bern, SWITZERLAND
c/o Ruth.Dumitrica@bfs.admin.ch
Radiolarian biostratigraphy in Oman, esp. the Zulla Formation (Upper Anisian-Lower Norian); radiolarian taxonomy, Oman, northern Italy, and Romania.

Ashton Embry, Calgary, CANADA
AEmbry@nrcan.gc.ca
Stratigraphy and sedimentology of the Sverdrup Basin, northern Canada; sequence boundaries and global tectonics.

Douglas H. Erwin, Washington, USA
erwin.doug@nmnh.si.edu
Early Triassic biotic recovery; high-resolution geochronology (U/Pb) of the Early Triassic (with Sam Bowring); gastropod systematics and diversity patterns (with Alex Nutzel).

Jean-Claude Gall, Strasbourg, FRANCE
jcgall@illite.u-strasbg.fr
Biological recovery following the Permian mass extinction event, emphasis on strategies developed by the flora and fauna (crustaceans, terrestrial arthropods) to ensure colonization of disturbed habitats; *Contributions of microbial communities to taphonomy and sediment genesis*.

Oscar Gallego, Corrientes, ARGENTINA
ofgallego@hotmail.com
Conchostracans, insects and other continental invertebrates, especially taxonomy of conchostracans; evolution, stratigraphical and paleogeographical distribution of these groups; comparisons between faunas from Gondwana and Laurasia.

Yves Gallet, Paris, FRANCE

gallet@ipgp.jussieu.fr
Magnetostratigraphy of the O/A and C/N boundaries.

Andrzej Gazdzicki, Warszawa, POLAND
gazdzick@twarda.pan.pl
Triassic foraminifera of Tethys (West Carpathians, Himalaya, Papua New Guinea) and the Polish and Spanish Muschelkalk; Rhaetian conodonts from the Tatra Mountains; Early Triassic conodonts from Spitsbergen; Microcoprolites from the Carpathians. Norian-Rhaetian boundary.

Piero Gianolla, Ferrara, ITALY
glr@unife.it
Sequence stratigraphy and paleoclimate of Middle and Upper Triassic successions of Tethys and the correlations with different areas as Arctic and the Germanic basin.

Brian F. Glenister, Iowa City, U.S.A.
brian-glenister@uiowa.edu
Extinction patterns in key Permian biostratigraphic indicators (ammonoids, fusulinaceans, conodonts) as they relate to the P-T extinction and subsequent recovery.

Spela Gorican, Ljubljana, SLOVENIA
spela@alpha.zrc-sazu.si
Ladinian-Carnian Radiolaria from Oman; Middle-Late Triassic Radiolaria from northern Croatia.

Eugen Gradinaru, Bucharest, ROMANIA
egradin@geo.edu.ro
Biostratigraphy (ammonoids, conodonts) and magnetostratigraphy of Desli Caira, Romania; O-A boundary; lithostratigraphy and biostratigraphy of North Dobrogea; Upper Anisian ammonoids of the Brasov and Sasca areas, S. Carpathians.

Bruno R.C. Granier, Abu Dhabi, UAE
bgranier@emirates.net.ae
Algae, taxonomy and stratigraphic range; carbonate sedimentology and stratigraphy.

Jack A. Grant-Mackie, Auckland, NEW ZEALAND
j.grant-mackie@auckland.ac.nz
Palynofloras across our T-J boundary (with Zhang Wang-Ping); paleoibiogeography of Australasia; Mesozoic macrofauna of Misool Island (with Fauzie Hasibuan).

Jean Guex, Lausanne, SWITZERLAND
Jean.Guex@igp.unil.ch
Lower (Spathian) and Upper Triassic (Rhaetian) ammonoids, western USA; T-J boundary.

János Haas, Budapest, HUNGARY
haas@ludens.elte.hu
Sedimentology, Stratigraphy; T-J boundary.

Hans Hagdorn, Ingelfingen, GERMANY
Encrinus@t-online.de
Crinoid faunas - revision and palaeobiology of families Holocrinidae and Traumatocrinidae; palaeoecology of German Muschelkalk and Lower Keuper (e.g. cephalopod and echinoderm taphonomy, reptile palaeobiogeography and stratigraphy); Muschelkalk stratigraphy.

Charles M. Henderson, Calgary, CANADA
henderson@geo.ucalgary.ca
Conodonts and sequence biostratigraphy, western and arctic Canada; L-M Triassic in the subsurface and surface section of western Alberta and northeastern British Columbia; Secretary of the SPS.

Francis Hirsch, Jerusalem, ISRAEL
Francis.Hirsch@mail.gsi.gov.il
Late Triassic conodonts from the Chichibu accretionary belt (with K. Ishida); relationship between Tethys and Circum-Pacific faunal assemblages.

Mark Hounslow, Lancaster, ENGLAND
m.hounslow@lancaster.ac.uk
Magnetostratigraphy of: Lower-Upper Triassic of Svalbard; the proposed T-J GSSP at St Audries Bay; the terrestrial Triassic of the UK and North Sea basin; P-T boundary strata and lower Triassic in eastern Greenland.

Yukio Isozaki, Tokyo, JAPAN
isozaki@chianti.c.u-tokyo.ac.jp
Permo-Triassic boundary mass extinction event in Japan and in China; conodont, radiolarian, and fusulinacean biostratigraphy, and chemostratigraphy of the boundary beds.

Daria Ivanova, Sofia, BULGARIA
dariaiv@geology.bas.bg
Foraminifers, calcareous algae - taxonomy, biostratigraphy, microbiofacies, event stratigraphy, sequence stratigraphy, database, palaeobiogeography, palaeoecology.

Volker Jacobshagen, Berlin, GERMANY
vojac@zedat.fu-berlin.de
Lower Triassic ammonoids, Chios sections (with D. Mertmann).

Marji J. Johns, Victoria, CANADA
johnsm@telus.net

Ichthyolith biostratigraphy, paleoenvironments, sequences, and boundaries of the Middle and Late Triassic of NE British Columbia and Canadian Cordillera.

Hans Kerp, Münster, GERMANY
kerp@uni-muenster.de
Antarctic palynology; Rhaetian floras, particularly seed ferns.

Tatyana V. Klets, Novosibirsk, RUSSIA
fossil@lab.nsu.ru
Conodonts of northeast Asia (North of Siberia and Far East Russia).

Toshio Koike, Yokohama City, JAPAN
koike@ed.ynu.ac.jp
Reconstruction of conodont apparatuses of the Gondolellidae and Ellisonidae in Japan.

Tea Kolar-Jurkovsek, Ljubljana, SLOVENIA
tea.kolar@geo-zs.si
Biostratigraphy of Slovenia with special interest in Smithian, Carnian, and Norian faunas, including the Raibl beds; Conodonts (stratigraphy, CAI) of Croatia.

Galina V. Kotlyar, St. Petersburg, RUSSIA
gkotlyar@mail.wplus.net
Permian brachiopods and the P/T boundary transition.

Wolfram M. Kuerschner, Utrecht, THE NETHERLANDS
w.m.kurschner@bio.uu.nl
Palaeobotany and palynology in the Carnian and Norian of Southern Germany and Austria; Editor of Albertiana.

Jochen Lepper, Hannover, GERMANY
Red Beds of the Germanic Triassic; co-ordinator of Buntsandstein Monograph; Dinocephalian fauna from Zimbabwe.

Jean Marcoux, Paris, FRANCE
marcoux@ipgp.jussieu.fr
Magnetostratigraphy (Austria, Turkey; Saudi Arabia); Paleoenvironments and P-T Pangaea configuration; Neotethyan geodynamic evolution of Oman; Biotic response to mass extinction: the lowermost Triassic microbialites facies; Exotic limestone blocks of Crimea.

Claudia Marsicano, Buenos Aires, ARGENTINA
claumar@gl.fcen.uba.ar
Triassic continental tetrapod faunas, especially temnospondyl amphibians; correlation of continental basins in Argentina; Triassic Stratigraphic Lexicon of Argentina.

Adelaide Mastandrea, Modena, ITALY
mastandrea@unical.it
Late Norian-Rhaetian conodonts from Calabria (Southern Italy); Ladinian-Carnian conodont biostratigraphy from the Dolomites.

Christopher R. McRoberts, Cortland**,** U.S.A.
mcroberts@cortland.edu
Bivalve molluscs - systematics, biochronology and paleoecology; particularly taxic and ecologic diversity through the North American Triassic.

Selam Meço, Tirana, ALBANIA
smeco_2001@yahoo.com
Conodonts and stratigraphy of the deposits of the Korabi Zone, Albania; Conodonts and pelagic Triassic stratigraphy of the Cukali Zone, Albania; Anisian conodonts in Albania.

Dorothy Mertmann, Berlin, GERMANY
mertmann@zedat.fu-berlin.de
Olenekian ammonoids of Chios Island (Greece) from collections of Assereto and Gaetani-Jacobshagen; Sequence-stratigraphy of the Salt Range and Trans Indus Ranges (facies development, biofacies, depositional environments).

Ian Metcalfe, Armidale, AUSTRALIA
imetcalf@metz.une.edu.au
Conodonts from the P-T boundary in China (with Bob Nicoll) - multidisciplinary study of the boundary and mass extinction (marine/ non-marine) integrating isotope geochronology, biostratigraphy, chemostratigraphy, and magnetostratigraphy; faunas from Malaysia and Indonesia, and the tectonic evolution of E and SE Asia.

Jozef Michalik, Bratislava, SLOVAKIA
geolmich@savba.sk
Coprolites from the uppermost Triassic, Western Carpathians; Ladinian brachiopods; Lower Carnian orbital rhythms in laminated Hauptdolomit; T-J boundary studies via sequence stratigraphic eustatic signal in Rhaetian Fatra Fm.

Paolo Mietto, Padova, ITALY
mietto@epidote.dmp.unipd.it
Anisian-Carnian ammonoid (and partially also conodont) biostratigraphy in the Tethys Realm (Southern Alps, Italy), particularly the A-L and L-C boundaries; tetrapod footprints - paleontologyl and biostratigraphy.

Roberto S. Molina Garza, Querétaro, MEXICO
rmolina@unicit.unam.mx
Magnetostratigraphy and correlation of non-marine Triassic sequences, southwest USA - Moenkopi Fm., Chinle Gp., Glen Canyon Gp.; Magnetostratigraphy of non-marine P-T boundary in southeastern New Mexico, and Sonora.

Atle Mrrk, Trondheim, NORWAY
atle.mork@iku.sintef.no
Lower Triassic succession of Svalbard,

Spitsbergen and the Norwegian Shelf; P-T boundary of Svalbard.

Helfried Mostler, Innsbruck, AUSTRIA
helfried.mostler@uibk.ac.at
M. Triassic holothurians, Alpine area; lower M-U. Triassic and T-J boundary radiolarians; M. Triassic siliceous sponges, S. Alps; siliceous sponges (Porifera) of Tethys, especially the T-J boundary; P-T boundary in Sicily and Iran, M. Triassic of Turkey), and U. Triassic of Columbia.

Giovanno Muttoni, Milan, ITALY
giovanni.muttoni1@unimi.it
Magnetostratigraphy aimed at the construction of a Polarity Time Scale; P-T paleogeography from paleomagnetism, esp. Pangea configurations and Tethyan paleogeography; P-T climate analyisis: testing the zonal vs monsoonal pangea climate by means of paleolatitude curves correlated with climatic indicators in rocks.

K. Nakazawa, Kyoto City, JAPAN
Ammonites and bivalves, Spitsbergen; Salt Range; biostratigraphy of Japan.

Norman D. Newell, New York City, U.S.A.
newell@amnh.org
Upper limit of the Paleozoic as revealed by mass extinction and introduction of new Bivalvia; Texan and western American collections from the American Museum of Natural History and the U.S. National Museum.

Robert S. Nicoll, Flynn, AUSTRALIA
bnicoll@goldweb.com.au
Conodonts from the P-T boundary at Meishan and Shangsi, China (with Ian Metcalfe).

Omer Faruk Noyan, Manisa, TURKEY
noyan@nil.com.tr
Conodonts - biostratigraphy, morphogenesis, paleoecology and extinctions.

Gilles S. Odin, Paris, FRANCE
gilodin@ccr.jussieu.fr
Radiometric dating and refinement of the time scale.

Jim Ogg, West Lafayette, U.S.A.
jogg@purdue.edu
Early Triassic magnetic polarity time scale; integrated magnetic-ammonite-sequence scale for Canadian Arctic sections and correlation to a composite magnetostratigraphy and sequence stratigraphy of the Dolomites region. Secretary General of the ISC.

Paul Olsen, Palisades, U.S.A.
polsen@ldeo.columbia.edu
Upper Triassic magnetostratigraphy, Newark basins; Carnian-Norian boundary and correlation between terrestrial and marine successions.

Qiqing Pang, Hebei, CHINA
Continental P-T boundary and Ostracoda, northern China; Lower and Middle Triassic stratigraphy and ostracodes, Henan Province.

Gary Pattemore, Mt. Nebo, AUSTRALIA.
Gymnosperms and stratigraphy, Queensland and other areas of Gondwanaland, e.g. the Molteno Formation of the Karoo Basin in South Africa; habitats and environmental conditions.

Rachel A. Paull, Littleton, U.S.A.
rocdox@worldnet.att.net
P-T boundary to Smithian conodont biostratigraphy and depositional history, Rocky Mountains, eastern Great Basin, and Colorado Plateau of the western USA.

Maria Cristina Perri, Bologna, ITALY
perri@geomin.unibo.it
Permian-Triassic conodonts in the Southern Alps; biostratigraphy and biofacies analysis.

Lyudmila Petrounova, Sofia, BULGARIA
lyudmila@geology.bas.bg
Norian palynomorphs from East Bulgaria; Ladinian-Carnian boundary based on Bulgarian palynomorphs; conodonts.

Jozef Pevny, Bratislava, SLOVAKIA.
c/o bystric@gssr.sk
Anisian-Norian conodonts from pelagic facies in central Slovakia; Middle-Upper Triassic ichthyoliths (with Dr. Salaj).

Renato Posenato, Ferrara, ITALY
psr@unife.it
Brachiopods and molluscs at the P-T boundary of the S. Alps; bivalves of Anisian plant bearing beds of the Dolomites; biostratigraphy/ palaeoecology of M. Carnian benthic mollusc & brachiopod assemblages, Dolomites; palaeoclimatic changes v. the mid Carnian extinction.

Roberto Rettori, ITALY
rrettori@unipg.it
Systematics, biostratigraphy, paleoecology, and evolution of Triassic foraminifers of the Tethyan domain; foraminiferal evolution and extinction across P-T and T-J boundaries; intercalibration of foraminifer ranges with other fossil groups.

Hans Rieber, Zürich, SWITZERLAND
rieber@im.unizh.ch
Ammonoids and other fossils and stratigraphy of the middle Triassic of the Southern Alps; Definition of the A-L boundary (with P. Brack).

John Rigby, Brisbane, AUSTRALIA
j.rigby@qut.edu.au
Megafloras of Gondwanaland; P-T boundary events; tectonic evolution of south east Asia in relationship to distribution of non-marine biotas.

Guido Roghi, Padova, ITALY
guido@geol.unipd.it
Palynological and paleobotanical analysis of Middle and Upper Triassic sequences of the Julian Alps and Dolomites.

Bruce Rubidge, Wits, SOUTH AFRICA
106gar@cosmos.wits.ac.za
Temnospondyl and Therapsid phylogeny; Biostratigaphy and basin analysis of Karoo-aged rocks from southern Africa.

Franco Russo, Consenza, ITALY
f.russo@unical.it
Carbonate diagenesis and biomineralization, especially in the Dolomites; Ladinian/Carnian conodont biostratigraphy of Dolomites; Norian/ Rhaetian sequences in Calabria and in Basilicata.

Michael R. Sandy, Dayton, U.S.A.
Michael.Sandy@notes.udayton.edu
Triassic brachiopod taxonomy, biogeography, and evolution, North America, southern Europe, and Middle East.

Baba Senowbari-Dryan, Erlangen, GERMANY
basendar@pal.uni-erlangen.de
Algae, foraminifers, palynomorphs, and reefs in Iran; systematic paleontology of coralline sponges in Turkey; Norian reefs in Greece; Carnian Inozoid sponges of Hydra, Greece; biotic studies in Austria, Sicily, and Hungary.

Kazem Seyed-Emami, Tehran, IRAN
k.seyedemami@kavosh.net
Stratigraphy and ammonoid biozonation.

Yasunari Shigeta, Tokyo, JAPAN
shigeta@kahaku.go.jp
Systematics, biostratigraphy and evolution of Triassic ammonoids and nautiloids; Induan-Olenekian boundary.

Michael A. Shishkin, Moscow, RUSSIA
schsz@orc.ru
Biostratigraphy of the continental Triassic based on tetrapod evidence; Evolution and biogeography of Triassic tetrapods.

Milos Siblík, Suchdol, CZECH REPUBLIC
inst@gli.cas.cz
Upper Triassic brachiopods, especially Alpine Kössen Beds and the Dachstein Limestone of Hochschwab; Complement to Fossilium Catalogus Austriae: Brachiopoda triadica.

Norman J. Silberling, Lakewood, USA
slbrlng@email.msn.com
Ammonoids and Stratigraphy, USA

Evgeny S. Sobolev, Novosibirsk, RUSSIA
alfalfa@cgi.nsk.su
Rhaetian deposits in Eastern Taimyr; Triassic nautiloids, North Dobrogea (Romania), Primor'ye (Far East), and North Siberia; Lower Anisian ammonoids, Eastern Taimyr; Paleobiogeographic differentiation of nautiloids.

Maureen B. Steiner, Laramie, U.S.A.
magnetic@uwyo.edu
The sequence of magnetic polarity changes near the P-Triassic boundary; Late Carnian through Rhaetian sequence of magnetic reversal changes; comprehensive summary of the Late Permian-Early Triassic magnetic reversal history.

Milan N. Sudar, Belgrade, YUGOSLAVIA
sudar@EUnet.yu
Triassic conodonts and foraminifers; Sedimentological-paleontological investigations of carbonate platform deposits and red nodular limestones in the Yugoslav Dinarides; Ophiolitic melanges; Correlation within the Mediterranean region; boundary resolution.

David Taylor, Portland, USA
blitz124@home.com
Norian-Rhaetian ammonoid biochronology and evolution, Western USA; Early Triassic Thaynes Formation and its ammonoid fauna in Nevada, Idaho and Utah.

Kagan Tekin, Ankara, TURKEY
uktekin@yahoo.com
Biostratigraphy and systematics of late Middle to Late Triassic radiolarians from Turkey.

R.S. Tiwari, Bhopal, INDIA
c/o shailendra_singh_75@yahoo.com
P-T boundary in the nonmarine sequence of the Indian peninsula; Tagging of palynozones with marine datum of Tethyan Himalayan and creation of a palyno-chronological scale for nonmarine Gondwana sequence of India; intra-Gondwanaland correlations.

Jinnan Tong, Hubei, CHINA
jntong@cug.edu.cn
Lower Triassic stratigraphy and paleontology.

E. Timothy Tozer, Vancouver, CANADA
timtozer@nrcan.gc.ca
Canadian ammonoids and global correlations.

John Utting, Calgary, CANADA
JUtting@NRCan.gc.ca
Palynology of the Permian -Triassic boundary and Lower Triassic of Canada.

Carmina Virgili, Barcelona, SPAIN
Triassic of Spain and its relations with Occidental Europe; Continental deposits of the Lower and Middle Triassic; Problems of the P-T boundary in the continental series.

Attila Voros, Budapest, HUNGARY
voros@zoo.zoo.nhmus.hu

Anisian-Ladinian ammonoid stratigraphy, Hungary; A-L boundary.

Bruce Waterhouse, Christchurch, NEW ZEALAND
c/o loris@xtra.co.nz
E. Triassic Claraia from Nepal; Anisian ammonoids from south NZ; mapping M. Triassic in the S. Alps; reinterpreting E.Triassic of NZ as M. Triassic from ammonoids; E.& M. Triassic ammonoid succession, western and central Nepal (7 part Palaeontographica series).

Jobst Wendt, Tübingen, GERMANY
jobst.wendt@uni-tuebingen.de
Carnian mud mounds in Sichuan, China - biostratigraphy, sedimentology, palaeoecology, and diagenesis (stable isotopes) of the mounds and off-mound lithologies.

Paul B. Wignall, Leeds, ENGLAND
P.Wignall@earth.leeds.ac.uk
Boundary studies: P-T boundary in western Canada, E Greenland, S. Tibet; Scythian stage boundaries; T-J boundary in England and S.Tibet.

Zunyi Yang, Beijing, CHINA
zunyi@public.bta.net.cn
Compilation of the Lexicon of the Chinese Triassic System, and the Chinese Triassic System.

Jin Yugan, Nanjing, CHINA
ygjin@public1.ptt.js.cn
Stratigraphy and events of the basal Triassic; Brachiopods from western China.

Ivan Zagorchev, Sofia, BULGARIA
zagor@geology.bas.bg
Triassic stratigraphy, palaeogeography, tectonics and palaeogeodynamics of the Balkan Peninsula.

Ana Maria Zavattieri, Mendoza, ARGENTINA
amz@lab.cricyt.edu.ar
Palynology and biostratigraphy of Triassic Basins of Argentina.

John-Paul Zonneveld, Calgary, CANADA
jzonneve@nrcan.gc.ca
Ichnology and sequence biostratigraphic evolution of the Triassic of western Pangea; in Western Canada: Griesbachian-Dienerian and Ladinian trace fossil assemblages; brachiopod-echinoderm biostromes (Ladinian); coral patch reefs (Carnian); new taxa of lobster (Ladinian).

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Text files can be submitted formatted as *.wpd, *.doc or *.rtf files and illustrations as pixel based graphics (e.g: *.bmp, *.tif, *.gif or *.jpeg) or vector based graphics (e.g: *.ai, *.cdr) that can be directly imported into Adobe PageMaker. Please provide good, clean, flat, printed copies (NOT xerox copies) of any illustrations, which MUST be designed to fit on an A4 page (centered, with at least 2.54 cm wide margins left and right, and 4 cm margins at the top and bottom).

Special attention should be paid to grammar and syntax - linguistic corrections will be minimal. In case of doubt, send your manuscript to a colleague for proof reading. References should be in the format used in the ‘New Triassic Literature’ section in issue 25 of Albertiana. Please write all Journal titles in full length. The use of names of biostratigraphic units should be in accordance with the International Stratigraphic Guide:

The formal name of a biostratigraphic unit should be formed from the names of one, or preferably no more than two, appropriate fossils combined with the appropriate term for the kind of unit in question.”

The writing and printing of fossil names for stratigraphic units should be guided by the rules laid down in the International Code of Zoological Nomenclature and in the International Code of Botanical Nomenclature. The initial letter of generic names should be capitalized; the initial letter of the specific epithets should be in lowercase; taxonomic names of genera and species should be in italics. The initial letter of the unit-term (Biozone, Zone, Assemblage Zone) should be capitalized; for example, Exus albus Assemblage Zone.”

The name of the fossil or fossils chosen to designate a biozone should include the genus name plus the specific epithet and also the subspecies name, if there is one. Thus Exus albus Assemblage Zone is correct. After the first mention, the genus name may be abbreviated to its initial letter if there is no danger of confusion with some other genus beginning with the same letter; for example, Exus albus may be shortened to E. albus. On the other hand, the use of the specific epithet alone, in lowercase or capitalized, in italics or not (albus Assemblage zone, Albus Assemblage zone, albus Assemblage zone, or Albus Assemblage zone), is inadvisable because it can lead to confusion in the case of frequently used species names. However, once the complete name has been cited, and if the use of the specific epithet alone does not cause ambiguous communication, 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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