# Annual Report* of IGCP Project No. 467

*The information in this report will also be used for publication in 'Geological Correlation' (please feel free to attach any additional information you may consider relevant to the assessment of your project).

IGCP project short title: **Triassic Time and Trans-Panthalassan correlations**

Duration and status: Year 2 of 5

---

**Project leader**:


1. Name: M. J. Orchard
   Address: Geiological Survey of Canada, 101-605 Robson St., Vancouver, BC, V6B 5J3
   Tel.: 604-666-0409
   Fax: 604-666-1124
   e-mail: morchard@nrcan.gc.ca


**Regional co-leaders/ representatives:**

2. L. Krystyn, Vienna, Austria - Europe
3. J. Tong, Wuhan, China - China
4. S. Lucas, Albuqueque, USA – non-marine
5. H. Campbell, Dunedin, New Zealand – southern hemisphere
6. F. Hirsch, Naruto, Japan - Middle East
7. K. Ishida, Tokushima, Japan – SE Asia
8. Y. Zacharov, Vladivostok, Russia - Russia

---

Project Secretary: M. J. Orchard, as above

---

Date of submission of report:

Friday, December 12, 2003

Signature of project leader:

**Please use the following headlines to report the present status and scientific achievements of your**

**project (write N/A where not applicable) and explain abbreviations you use in your report.**

**1. Website address(es) related to the project**

Primary IGCP 467 site: http://paleo.cortland.edu/IGCP467/index.html

Albertiana/ Subcommission on Triassic Stratigraphy site:
http://www.bio.uu.nl/~palaeo/Albertiana/Albertiana01.htm

http://imbi.uwc.ac.za/courses/ifaa/petralga/index.htm

2. **Summary of major past achievements of the project**

**The inaugural workshop** of IGCP 467 was on the theme of the emerging multielement taxonomy of Triassic conodonts which the project leader is spearheading. Multielement analysis leads to an understanding of evolutionary relationships in the conodont group, which in turn improves biochronology and leads to a refined Triassic time scale.

The base of the **Induan**, and of the Triassic is the only defined Triassic GSSP yet the P-T boundary continued to attract considerable attention (Krull et al.). In Canada, medium to high latitude palynomorph assemblages of the Griesbachian contain a distinctive Triassic flora and significant amounts of newly recognized, mainly Devonian spores reworked from exposed Devonian strata during the Griesbachian transgression (Utting et al., 2003). Similar palynomorph assemblages occur in the Lower Triassic rocks of other circum-polar regions such as Alaska and East Greenland.

The multidisciplinary **Nanpanjiang Basin Project** in South China focussed on detailed conodont biostratigraphy, carbon isotopes, and magnetostratigraphy of long sections that span the entire Lower Triassic. A spectral analysis study was undertaken to investigate Milankovitch climate signals in Olenekian strata (Yang & Lehrmann, 2003). A detailed conodont biostratigraphic study of the Olenekian-Anisian boundary sections was initiated in collaboration with the project leader. A radiometric age of 247 Ma was reported from a tuff near the boundary.

A candidate for defining the base of the Lower Triassic **Olenekia**n Stage was identified by Chinese collaborators at Chaohu, Anhui Province (Chinese working group, 2003). Intensive sampling was undertaken for macro- and micro- paleontology, magnetostratigraphy, and isotope geochemistry. Besides a diverse collection of ammonoids, samples taken for conodont study proved to be very productive.

Studies in the high latitudes have established a conodont biostratigraphy for the **Boreal Lower Triassic** of North-Eastern Asia (Klets) and improved our knowledge of Tethys-Boreal correlation. An account of the conodonts and ammonoids from the Far East Primorye region was provided (Zacharov et al., 2002); a monograph on the Lower Triassic invertebrates is being prepared.

During the Hungary meeting, new data on the stratigraphy, conodont and foraminiferid biostratigraphy, magnetostratigraphy, and carbon isotope geochemistry of the **Olenekian-Anisian** boundary interval at Desli Caira in Dobrogea, Romania was presented. It was determined that the appearance of a defining conodont, a significant change in the ammonoid fauna, and the peak of a negative C isotope anomaly were synchronous (Piros et al., 2002). The ammonoid succession from equivalent strata in Canada (Bucher, 2002) and Greece (Mertmann & Jacobshagen, 2003) was

published.

A candidate section for the **Anisian-Ladinian** stage boundary type section at Felsoors was visited during the Hungarian workshop in 2002. Details of the ammonoid (Voros, 2002) and conodont successions and new isotopic ages derived from tuffs (240-41 Ma) were discussed and compared with the data from Bagolino, Italy, a second GSSP candidate. There is no agreement on the best ammonoid datum to serve as a global standard. Nevertheless, the A-L working group agreed on a firm schedule for a formal vote on the position of this stage boundary.

Correlation within the widespread Middle Triassic **carbonate platforms** should be enhanced by the increasing use of dasyclad algae. These appear widespread and stratigraphically restricted (Bucor & Enos, 2001). Documentation of Triassic taxa is underway (Granier & Grgasovic, 2000; http://imbi.uwc.ac.za/courses/ifaa/petralga/index.htm).

Work on the **Ladinian-Carnian** (M-U Triassic) boundary interval resulted in a proposal for a type section at Stuores, Italy with the FAD of the ammonoid Daxatina as the base of the Carnian. Compared with intercalibrated ammonoid, conodont and pelagic bivalve data from Spiti (Himalayas), there are major inconsistences in the ranges of stratigraphic guide species (Krystyn & Balini). In North America, an important section for this interval was identified at New Pass in Nevada. Consequently, fieldwork was undertaken by a multidisciplinary Canada-USA-Italy team during October 2002 and several suite of ammonoid, bivalve, conodont, and geochemical samples collected from Nevada, Idaho, and Utah. An absolute age estimate for this boundary (237 Ma) in Hungary was presented (Palfy et al., 2003).

A **Tethys working group** comprising scientists working in palaeontology, palynology, sedimentology, palaeomagnetics, and isotope geochemistry was formed. It comprise 15 people from seven countries (Austria, France, Germany, India, Italy, Netherlands, Slovakia, Switzerland). Field studies have been undertaken on the best marine boundary sections in the central and eastern Tethys (Austria, Turkey, Himalayas).

A Middle East group (Israel, Jordan, Syria, Cyprus), completed a multi-authored 2-volume book on the Geological Framework of the Levant, (eds. J.Hall et al.). Due in 2004, it contains various chapters concerning the Triassic, particularly, the state of the art of biostratigraphy in the **Sephardic Realm**, including relevant information concerning stage boundaries. An account of the Triassic in Iran also appeared (Seyed-Emami, 2003).

The **Upper Triassic Numeric Time Scale** has been in a state of flux because of uncertainties about the correlation between magnetostratigraphic scales in Tethyan marine sections and non-marine profiles of the astronomically tuned continental Newark sequence of eastern North America (Gallet et al., 2003). This dates the probable Carnian-Norian boundary (base of Newark E7 zone) as 227 Ma, considerably older than previously determined through palynostratigraphy and vertebrate biostratigraphy linkages (~ Newark E15, @215 Ma). The age of the Norian-Rhaetian boundary remains is more problematic because of the lack of a Tethyan Rhaetian magnetostratigraphy. At the moment, there are no absolute age dates in marine strata between the base of Carnian and the top of Triassic that can help resolve these problems. However, two areas in North America were were identified as potentail sites for sampling

**Carnian—Norian boundary** GSSP candidate sections have been sampled in Sicily (Pizzo

Mondello) and Turkey for magneto- and biostratigraphy. A detailed magneto-biochronology has been obtained and a high-resolution cross-correlation of the sections has been achieved and published (Krystyn & Gallet, 2002). Similar work was also carred out in Slovakia (Channel et al., 2002).

Black Bear Ridge, in BC, Canada became the focus for North American multidisciplinary studies around the Carnian-Norian boundary. Preliminary ammonoid, conodont, bivalve, and ichytholith successions were established (Orchard et al., 2001) and tied to a sequence stratigraphic framework. Geochemical samples were taken for carbon isotopes.

Late Triassic marine **ichthyolith biostratratigraphy** ofers a new tool that is being applied in northeastern B.C., Canada. Their importance in tracking transgression and regression cycles within the Late Triassic Peace River Embayment was highlighted (Johns & Barnes). An updated ichthyolith elasmobranch (shark) and new actinopterygian (bony fish) taxonomy is underway. The potential for correlating with the non-marine fish chronology received some attention.

The task force studying the **Norian-Rhaetian boundary** identified key sections in Canada and Austria. The Tethyan key sections in Austria (Salzkammergut) have been sampled for magnetostratigraphy and palynology to provide constraints for a better stratigraphic understanding and correlation of the time-equivalent vast nonmarine sedimentary sequences in Eurasia and North America as well as to find the best applicable horizon for a boundary placement. The application of Late Triassic foraminifera as environmental and paleogeographic indicators also became clear. In North Canada, sections on Williston Lake and Queen Charlotte Islands were sampled for ammonoids, conodonts and radiolarians; the latter area promises to provide important integrated zonations.

In the **non-marine realm**, work continued on identifying a terrestrial P-T boundary and a proposal was produced for a GSSP (Yin et al., 2003). A Triassic numeric timescale based on the Germanic Trias was published in 2002 (Deutsche Stratigraphische Kommission). Orbitally forced cycles of long (0.4 Ma) and short (0.1 Ma) excentricity were used to calibrate the complete Triassic succession. This cyclostratigraphy resulted in the recognition of large gaps within the Keuper, and an estimate that the Permian-Triassic boundary is only 120 ka younger than the Zechstein-Buntsandstein boundary (Szurlies et al. 2003). Conchostracan biostratigraphy played some part in Germanic correlations and there is good potential to use these fossils in England.

Elsewhere in Europe, work on Ladinian and Carnian palynomorphs in the southern Alps, Northern Calcareous Alps, and Hungary, and paleobotanical analysis (plants, cuticle, amber) of some Carnian sites in Southern Alps was undertaken (Hotchuli et al., 2003).

## 3. Achievements of the project this year

A landmark study on **Triassic multielement conodonts** is now in press in the conference proceedings of ECOS8. It includes a wholly new suprageneric classification of the key Triassic conodont indices (Orchard).

Zhao Laishi, a doctoral student from Wuhan University in China, came to Vancouver for 3 months to study the Lower Triassic conodont collections from Chaohu. Several new taxa were differentiated and a new conodont zonation developed (Zhang & Orchard). Meanwhile, study of the ammonoid biostratigraphy and the magnetostratigraphy were largely completed. A proposal to

designate the locality as the GSSP for the **base Olenekian** was prepared. This identifies the FAD of the conodont *Neospathodus waageni* as the defining index. It corresponds to the base of the *Flemingites-Euflemingites* ammonoid zone and falls within a brief zone of normal magnetic polarity (Tong et al., 2003).

A **conodont workshop** in Italy focused on the definition and stratigraphic range of the conodont *Chiosella timorensis* which had been proposed as the index fossil for the **base Anisian** (=Lower-Middle Triassic boundary). After much discussion over a microscope, there was unanimous agreement on the suitability of the conodont for defining the GSSP at Desli Caira in Romania.. A magnetostratigraphic profile for the section was also presented (in Brack, Schlager et al., 2093). Additional isotopic dates of about 247 Ma from around this boundary in China were obtained through the Nanpanjiang Basin Project.

Largely reproducible U-Pb-ages of zircons from volcaniclastic layers at similar stratigraphic levels in Middle Triassic sedimentary successions of the Southern Alps and Hungary (Palfy et al., 2003) have now been obtained by three independent research groups. New age results from both the primary Italian (Brack, Reiber et al,., 2003) and Hungarian (Voros et a;l., 2003) candidate sections for the **Anisian - Ladinian** GSSP confirm previous ones but are not compatible with the interpretation based on spectral analysis of basic cycles in the platform interior succession at Latemar as controlled by Earth's precession. The experts of cycle analysis promised to thoroughly test alternatives such as a basic cycle of as yet unclear significance being modulated by orbital parameters (in Brack, Schlager et al., 2003).

A third candidate for a Anisian-Ladinian boundary GSSP was proposed at the base of the Avisiatum Zone at Bagolino (Mietto et al., 2003), and all three proposals were published with comments in *Albertiana* vol. 28. Final arguments for the placement of the boundary were made by the proponents during the St Christina meeting. Since then, there has been a vote on the 3 options and the third option was eliminated. A vote is underway to select one of the remaining two as the GSSP.

The **Upper Triassic numeric time scale was enhanced by** new data from the non-marine Chinle Group in southwestern USA. Dates of 211.1 +/- 0.7 Ma and (lower in the section) 220.9 +/- 0.9 Ma were obtained from the University of British Columbia isotope laboratory. These dates come from strata with a magnetostratigraphic profile that can be correlated with the Newark scale in eastern North America and can therefore be used to test the accuracy of age estimates based on cyclostratigraphy. Orbital control of platform carbonate cycles of Upper Triassic age seems to be largely accepted for the long record of lacustrine cycles of the Newark cores whereas other cycles in terrestrial sediments of the UK seem not to show evidence for Milankovitch-type control (in Brack, Schlager et al., 2003).

Isotopic samples were also collected from volcanic rocks interstratified with fossiliferous marine sediments in SE Alaska and Queen Charlottes Islands: they are now being processed with results expected early in 2004. Resulting data will be vital in Upper Triassic chronology.

A **conodont workshop** in Vancouver focussed on Upper Triassic conodont faunas and their taxonomy and distribution. Conodont collections from **Carnian-Norian** boundary beds at Black Bear Ridge in British Columbia (Orchard et al., 2001), and from Sicily (Nicora, Muttoni) formed the basis for discussion. Key researchers from Canada, Austria, Hungary and the USA came to a consensus on some crucial taxonomic, nomenclatural, and biogeographic aspects of the group, which will likely serve as definitive indices for Upper Triassic stages. This should lead to a global biochronology that

can bring much greater precision to dating and correlating Late Triassic strata. The Canadian conodont successions are far superior to those of Sicily in both abundance and diversity: new taxa will form the basis of a new biochronology in preparation.

A preliminary geochemical investigation of both Turkish and Alaskan sections demonstrate a significant carbon isotope shift within the boundary interval: this has to be further investigated both for its correlation potential (and the causal background.). A radiolarian study has been started in Oman for a more precise correlation of Tethyan and Panthalassa deep water boundary successions.

The pattern of **extinction in the Late Triassic** and at the **Triassic/Jurassic boundary** were the focus for researchers on radiolarians), ammonoids, conodonts, bivalves, and non-marine tetrapod faunas at the Vancouver meeting. The most striking example of sudden extinction at the T-J boundary is in turnover in radiolarian faunas, with more gradual declines occurring during the Late Triassic in the other groups, notwithstanding the final extinction of conodonts at the boundary. The relationship of these changes to major volcanism and bolide impact (Manicouagan) remains obscure because of the lack of absolute age constraints within the Upper Triassic (GAC, 2003).

The task force on **base Rhaetian** were active in the Tethyan region. A multidisciplinary documentation of the time interval is being prepared: it includes bio- (incl. palynology), magneto- and chemostratigraphic data from several sections.

Progress in **non-marine Triassic** correlations were achieved in North and South America. A revival of interest in Brazilian, Argentinian and Chilean nonmarine Triassic strata saw several publications upgrading the distribution of fossil vertebrate and palynomorphs in these rocks (Heckert & Lucas, 2002). Similar work continued in North America, especially in the western United States (Lucas, 2002, 2003). A monograph on nonmarine Triassic chronology and correlation is in press (Elsevier).

In the UK, magnetostratigtraphic studies continued (Hounslow & McIntosh, 2003). In India, the research emphasis was on the vertebrate palaeontology, palynology, and geochemistry of continental Gondwana (Sarvar et al., 2003). Plans are well advanced to convene a workshop on the marine Triassic of the Himalayas.

**Trans-Panthalassan correlations** were improved through a month-long tour of Triassic localities and research centres in Japan undertaken by the leader during November 2003. This afforded an opportunity to discuss the IGCP467 with Japanese researchers, and to learn more about terrane stratigraphy and faunal provinciality in Triassic conodont faunas.

A southeast Asia group are attempting to establish an up to date inventory of Triassic fossils. They have focussed on mélange outcrops in SW Japan, in the Mino-Tamba, Mikabu, and Chichibu belts, where carbonate blocks derived from oceanic plateaus are contained within chert and shale matrix (e.g. Hirsch & Ishida, 2002). There are remarkable parallels with some terranes (e.g. Cache Creek) in British Columbia (Sano & Orchard, 2003) although details of the stratigraphy are less well known in BC . In the Chichibu superbelt, depositional hiatuses relate to post-Aegean and Early Carnian emersions, Lower-Middle Norian condensation, and Late Norian-Rhaetian drowning. Faunistically, the Japanese Upper Triassic faunas (Ishida & Hirsch, 2001) contain far more Tethyan elements than those in Canada. Correlations with China were also made (Chen et al., 2003)

A Japan-Thailand "Shan Thai" working group were active in the Mae Sot and Umphang areas of Tak Province, northwestern Thailand. Their study intends to determine time constraints of the orogenic activity that led to the assemblage of the allochtonous elements forming the Shan-Thai

basement. Preliminary results of the current paleontological investigation, particularly on radiolarians and conodonts, include refinement of the age of the Triassic turbidite series, acidic tuffs, and polymict breccia.

The Monbusho Project produced more data from New Zealand (Grant Mackie & Aita, 2003; Hori et al., 2003). This work contributes directly to our understanding of terranes in the southern hemisphere ands facilitates their comparison with those to the north. Related work in Timor was of direct relevance to the hydrocarbon industry (da Costa Monteiro et al., 2003).

Studies of biostratigraphy and faunal affinities in the Upper Triassic western North American terranes generated new data on the Cache Creek, Baker, Wallowa, San Hip-lito, Alexander, and Eastern Klamath terranes. Conodont fauna of the first four have Tethyan affinity and the second two are of Pacific affinity; and conodont-radiolarian fauna from Baja, Mexico is mixed.

*3.1. Countries involved in the project (*indicates active this year)*

*Albania, Argentina, *Australia, *Austria, *Bulgaria, *Canada, *China, Czech Republic, *England, *France, *Germany, *Hungary, *India, *Italy, *Japan, *Netherlands, *New Zealand, Poland, *Romania, *Russia, *Slovakia, *Slovenia, South Africa, *Switzerland, *Thailand, *Turkey, *U.S.A..

*3.2. General scientific achievements (including societal benefits)*

- A multielement taxonomy for Triassic conodonts leading to a more resolved biochronology.
- New numeric ages for base Anisian (247 Ma), base Ladinian (240 Ma), and base Carnian (237 Ma). Samples with potential for base Norian and Rhaetian ages collected.
- Cyclostratigraphic calibration of the Triassic yields some anomalies when compared with absolute ages: there may be unrecognized sub-Milankovich cycles.
- Definitions for the base of the Olenekian and Anisian stages are provisionally agreed, and GSSPs identified.
- Candidates for the base of the Ladinian and Carnian stages are described and their potential as GSSP is under review.
- Carnian-Norian boundary GSSP candidates have been outlined, and much new data in preparation, including a new conodont zonation for the boundary interval.
- Advances in new paleontological tools both for marine and nonmarine correlation: ichthyoliths, conchostracans, dasyclad algae..
- Improved knowledge of the Triassic stratigraphy, history, and paleogeography of circum-Pacific Terranes in western North America, southeast Asia, and Australasia.

*3.3. List of meetings with approximate attendance and number of countries*

**Triassic Conodont Workshop**, 23rd June, 2002. Part of the 8th International Symposium on Conodonts held in Europe (ECOS 8), 21st – 25th June, 2002, Florence and Albi, France. This meeting, convened at short notice as a formal part of ECOS 8, represented the inaugural meeting of IGCP 467. About 20 conodont researchers from Canada, USA, Russia, England, Germany, Spain, Poland.

**Field workshop on Middle Triassic boundaries,** 5th - 8th September, 2002, Veszprum, Hungary. Including a field excursion in Balaton Uplands to view the Anisian-Ladinian GSSP candidate at Felsoors and key sites for the Ladinian-Carnian boundary. 41 Triassic experts representing 18 countries participated.

**Third International Congress on "Environmental Micropalaeontology, Microbiology, Meiobenthology** (EMMM'2002), 1st-6th Sept., 2002, Vienna, Austria.
39 countries were represented at this meeting on "Applications of micro- and meioorganisms to environmental problems" during which examples from throughout the geological column were presented. IGCP 467 was represented by Dr. V. Vuks from the Russian Geological Research Institute (VSEGEI) in St.-Petersburg, Russia.

**Field workshop on the Ladinian-Carnian boundary.** New Pass, Nevada, USA. October 2002.
Seven geologists from the USA, Canada, and Italy.

**Conodont workshop** on Upper Triassic taxonomy and correlation between Europe and North America. 23th-25th May, 2003. Vancouver, BC.
Four Triassic conodont researchers from Canada, USA, Hungary and Austria.

**GAC-MAC-SEG Joint Annual Meeting**, 26th-28th May, 2003; Vancouver, BC, Canada.
Special session on "Extinction events, faunal turnovers, and natural boundaries within and around the Late Triassic" co-sponsored with IGCP project 458 (*Triassic-Jurassic boundary* events). The session comprised 15 oral and 5 poster presentations on subjects relating to Triassic biochronology, diversity and extinction analyses. About 50 scientists from 7 countries.

**Triassic geochronology and cyclostratigraphy**, a field symposium, Sept. 11th-16th, 2003. St. Christina, Val Gardena, Italy. Focus on Secada core research and Middle Triassic time scales. Field trip to the Seceda (drilling location and outcrops), and the Latemar carbonate platform. 58 scientists from 14 countries attended the symposium. The technical sessions comprised 21 oral and 18 poster presentations on geochronology, stratigraphy and sedimentology of the Triassic. Special emphasis was given to age dating, depositional rhythms and the question of orbital cycles of the Triassic

**Conodont workshop** on the **Olenekian-Anisian** boundary. Sept. 13th, 2003. St. Christina, Val Gardena, Italy. A conodont workshop on the subject of basal Anisian indices for correlation was held: 5 scientists from 5 countries.

3.4. *Educational, training or capacity building activities*

The leader advised or directed these graduate students:
Zhao Laishi, a Doctoral student from Wuhan University in China: Lower Triassic conodonts.
Tetsuji Onoue, a Doctoral student from Fukuoka University in Japan: Triassic terrane studies.
Tyler Beatty, a Masters student from Simon Fraser University, Canada: Triassic terrane studies.
Erik Katva, a Masters student from Montana University, USA: Triassic terrane studies. Also presented

lectures and discussed research with numerous Canadian and Japanese students.

3.5. *Participation of scientists from developing countries*

The following individuals received travel and or accommodation subsidy for meetings in 2002-2003: Meco from *Albania;* Ivanova & Petrounova from *Bulgaria*; Tong, Yin from *China;* Siblik from *Czech. Republic;* Aljinovic from *Croatia*; Kozur, Oravecz, Szabo, & Palfy from *Hungary*; Gradinaru from *Romania*; Lovosky, Shevyrev, Shishkin, and Vuks from *Russia*; Szulc from *Poland*; Kolar-Jurkovsek from *Slovenia*; Marquez-Aliga from *Spain*. Other recipients came from Canada, USA, UK, Italy, Austria

There are currently National Working Group representatives from *India* (T.C. Lahiri) and *Turkey* (K. Tekin). See also section 3.1.

*3.6. List of most important publications (including maps)*


- Brack, P.; Maurer, F. (eds.). 2003. *Triassic geochronology and cyclostratigraphy - a field symposium, Dolomites, Italy: Field trip to Seceda, September 14, 2003.* 21 pp.
- Brack, P.; Rieber, H.; Nicora, A. 2003. The Global Stratigraphic Section and Point (GSSP) of the base of the Ladinian Stage (Middle Triassic). *Albertiana*, 28, pp. 13-25.
- Brack, P.; Schlager, W.; Stefani, M. (eds.). 2003. *Triassic geochronology and cyclostratigraphy - a field symposium, Dolomites, Italy, September 11-13.* Programme and Abstracts, 50 pp.
- Bucher, H. 2002. Early Anisian (Middle Triassic) ammnonoid biostratigraphy of northeastern British Columbia. *Eclogae Geologicae Helvetiae*, 95, pp. 277-287.
- Bucor, I.I.; Enos, P. 2001. Middle Triassic dasyclad algae from Guizhou, China. *Micropaleontology*, New York, 47(4), pp. 317-338.
- Channel, J.E.T., Kozur, H.W., Mock, R., & Aubrecht, R. 2002. Carnian-Norian condont biostratigraphy and magnetostratigraphy at Silicaka Brezova (Slovakia): correlation to other Tethyamn sections and to the Newark Basin. Palaeogeography, Palaeoclimatology, Palaeoecology, 191, pp. 65-109.
- Chen, J.H.; Cao, M.Z.; Komatsu, T. 2003. Upper Triassic fauna in Japan and its correlation with that of China. *Science Technology and Engineering*, 3(1), pp. 39-42.

ıdies on the Lower Triassic of Chaohu, Anhui Province, China. *Albertiana*, 27, pp. 20-25.

- da Costa Monteiro, F.; Grant-Mackie, J. A.; Ricketts, B.; Woods, B. 2003. Some Late Triassic rocks in Timor Leste. *Opportunities & Challenges for Oil & Gas & Mining Sectors in Timor-Leste, Dili, 5 -7 March 2003,* 31 pp.
- Deutsche Stratigraphische Kommission (ed.). 2002. *Stratigraphische Tabelle von Deutschland 2002*. GeoForschungsZentrum, Potsdam.
- GAC. 2003. *On the edge: Earth science at North America's western margin.* Geological Association of Canada, Mineralogical Association of Canada, and Society of Economic Geologists Joint Annual Meeting, Vancouver, May 25-28, 2003, 28, 45 pp.

ɛ Upper Triassic numerical time scale from cross-correlation between Tethyan marine sections and the continental Newark sequence. *Earth and Planetary Science Letters*,

212, pp. 255-261.
- Grainer, B.; Grgasovic, T. 2000. Les Algues Dasycladales du Permien et du Trias. Nouvelle tentative d'inventaire bibliographique, g.ographique et stratigraphique. *Geologia Croatica*, Zagreb, 53(1), pp. 1-197.
- Grant-Mackie, J. A.; Aita, Y. 2002. Progress in paleontological studies of New Zealand Late Paleozoic-Mesozoic terranes. *Abstracts with Programmes, 151th Regional Meeting, Palaeontological Society of Japan, Kagoshima, Jan. 26, 27, 2002,* p. 37.
- Heckert, A.B.; Lucas, S.G. 2002. South American occurrences of the Adamanian (Late Triassic: latest Carnian) index taxon *Stagonolepis* (Archosauria: Aetosauria) and their biochronological significance. *Journal of Paleontology*, 76, pp. 852-863.
- Hirsch, F.; Ishida, K.2002. The Izanami Plateau: Pre-accretionary origin of Japan's low latitude Triassic pelagic carbonates. *Eclogae Geologicae Helvetiae,* Basel, 95, pp. 43-55.
- Hochuli P., and Roghi G., Palynology and organic matter of the Middle Triassic of the Seceda- and Val Gola sections, (Dolomites, Italy). Santa Cristina
- Hori, R. S.; Campbell, J. D.; Grant-Mackie, J. A. 2003. Triassic Radiolaria from Kaka Point structural belt, Otago, New Zealand. *Journal of the Royal Society of New Zealand*, 33, pp. 39-55.
- Hounslow, M.W.; McIntosh, G. 2003. Magnetostratigraphy of the Sherwood Sandstone Group (Lower and Middle Triassic), south Devon, U.K: detailed correlation of the marine and non-marine Anisian. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 193(2), pp. 325-348.
- Ishida, K.; Hirsch, F. 2001. Taxonomy and faunal affinity of Late Carnian- Rhaetian conodonts in the southern Chichibu Belt, Shikoku, SW Japan. *Rivista Italiana di Paleontologia E Stratigrafia*, 107, pp. 227-250.
- Johns, M.J.; Barnes, C.R. In press. Facies and ichthyolith assemblages in transgression/regression sequences of the Baldonnel and Pardonet formations at Pink Mountain, Trutch map-area (94G), northeastern British Columbia. Bulletin of Canadian Petroleum Geology.
- Kozur, H.W. 2003. Integrated ammonoid, conodont and radiolarian zonation of the Triassic and some remarks to stage/substage subdivision and the numeric age of the Triassic stages. *Albertiana*, 28, pp. 57-74.
- Krull, E.S.; Lehrmann, D.J.; Druke, D.; Kessel, B.; Yu, Y.Y.; Li, R. in press. Stable carbon isotope stratigraphy across the Permian-Triassic boundary in shallow marine carbonate platforms, Nanpanjiang Basin, South China. *Palaeogeography, Palaeoclimatology, Palaeoecology*.
- Krystyn, L.; Gallet, Y. 2002. Towards a Tethyan Carnian-Norian boundary GSSP. *Albertiana*, 27, pp. 12-19.
- Krystyn, L.; Gallet, Y.; Besse, J.; Marcoux, J. 2002. Integrated Upper Carnian to Lower Norian biochronology and implications for the Upper Triassic magnetic polarity time scale. *Earth and Planetary Science Letters*, 203, pp. 343-351.
- Lucas, S.G. 2003. Triassic tetrapod footprint biostratigraphy and biochronology. *Albertiana*, 28, pp. 75-84.
- Lucas, S.G.; Huber, P. 2003. Vertebrate biostratigraphy and biochronology of the nonmarine Late Triassic. In: P.M. Letourneau and P.E. Olsen (eds.), *The Great Rift Valleys of Pangea in Eastern North America*, Vol. 2, Sedimentology, Stratigraphy, and Paleontology, Columbia University Press, New York, pp. 143-191.
- Lucas, S.G.; Schoch, R.R. 2002. Triassic temnospondyl biostratigraphy, biochronology and correlation of the German Buntsandstein and North American Moenkopi Formation. *Lethaia*, 35, pp. 97-106.

- Márquez-Aliaga, A.; Ros, S. 2003. Associations of bivalves of Iberian Peninsula (SPAIN): Ladinian. *Albertiana*, 28, pp. 85-89.
- Mertmann, D.; Jacobshagen, V. 2003. Upper Olenekian (Spathian) ammonoids from Chios (Lower Triassic, Greece): Taxonomy and stratigraphic position.- *Riv. Ital. Paleont. Strat.,* Milano.
- Mietto, P.; Manfrin, S.; Preto, N.; Gianolla, P.; Krystyn, L.; Roghi, G. 2003. Proposal of the Global Stratigraphic Section and Point (GSSP) for the base of the Ladinian Stage (Middle Triassic). *Albertiana*, 28, pp. 26-34.
- Orchard, M.J. In press. Multielement conodont apparatuses of Triassic Gondolelloidea. *Palaeontology*.
- Orchard, M.J.; E.T. Tozer, E.T.; Zonneveld, J.-P. 2003. Some preliminary observations on the association of ammonoids and conodonts about the Ladinian -Carnian boundary in North America. *Albertiana*, 27, pp. 8-11.
- Orchard, M.J.; Zonneveld, J.P.; Johns, M.J.; McRoberts, C.A.; Sandy, M.R.; Tozer, E.T.; Carrelli, G.G. 2001. Fossil succession and sequence stratigraphy of the Upper Triassic and Black Bear Ridge, northeast B.C., and a GSSP prospect for the Caniam-Norian boundary. *Albertiana*, 25, pp.10-22.
- Pálfy, J.; Parrish, R. R.; David, K.; Vörös, A. 2003. Mid-Triassic integrated U–Pb geochronology and ammonoid biochronology from the Balaton Highland (Hungary). *Journal of the Geological Society, London*, 160, pp. 271–284.
- Piros, O. (ed.). 2002. STS/IGCP 467 Field meeting. *Abstract and field guide*, Veszprum, Hungary, 86 pp.
- Sano, H.; Orchard, M.J. 2003. Mixed conodont-bearing cave deposits filling Middle Carboniferous limestone of Pope succession, Cache Creek Complex, central British Columbia, Canada. *Facies*.
- Sarkar, A.; Yoshioka, H.; Ebihara, M.; Naraoka, H. 2003. Geochemical and organic carbon isotope studies across the continental Permo-Triassic boundary of Raniganj Basin, eastern India. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 191.
- Seyed-Emami, K. 2003. Triassic in Iran. *Facies*, 48, pp. 91-106.
- Szurlies, M.; Bachmann, G.H.; Menning, M.; Nowaczyk, N.R.; Käding, K.-C. 2003. Magnetostratigraphy and high-resolution lithostratigraphy of the Permian-Triassic boundary interval in Central Germany. Earth Planetary Science Letters, 212, pp. 263-278.
- Tong Jinnan; Zacharov, Y.D.; Orchard, M.J.; Yin, H.; Hansen, H. 2003. A candidate for the Induan-Olenekian boundary Stratotype in the Tethyan Region. Science in China.
- Utting, J.; MacNaughton, R.B.; Zonneveld, J.-P. 2003. Palynostratigraphy and thermal maturity of Lower Triassic rocks in Yukon, N.W.T., British Columbia, Alberta and the Sverdrup Basin, Nunavut.
- Vörös, A. 2002. Paleoenvironmental distribution of some Middle Triassic ammonoid genera in the Balaton Highland (Hungary). *Abhandlungen der Geologischen Bundesanstalt*, 57, pp. 479-490.
- Vörös, A.; Budai, T.; Haas, J.; Kovács, S.; Kozur, H.; Pálfy, J. 2003. GSSP (Global Boundary Stratotype Section and Point) proposal for the base of Ladinian (Triassic). *Albertiana*, 28, pp. 35-47.
- Lehrmann, D. L. 2003. Testing milankovitch climatic signals in Lower Triassic (Olenekian) peritidal carbonate successions, Nanpanjiang Basin, South China. Palaeogeography, Palaeoclimatology, Palaeoecology. 201(3-4), pp. 283-306.
- Yin, H.; Wang, S.; Yang, F. 2003. A candidate for a terrestrial Permian-Triassic boundary stratotype. *Albertiana*, 28, pp. 92.

- Zakharov, Y.D.; Shigeta, Y.; Popov, A.M.; Buryi, G.I.; Oleinikov, A.V.; Dorukhovskaya, E.A.; Mikhalik, T.M. 2002. Triassic ammonoid succession in South Primorye: 1 Lower Olenekian *Hedenstroemia Bosphorensis* and *Anasibirites Nevolini* zones. *Albertiana*, 27, pp. 42-64.

*3.7. Activities involving other IGCP projects or the IUGS*

**Subcommission on Triassic Stratigraphy**: co-sponsor of meetings and workshops in Hungary (2002), Canada (2003), and Italy (2003). Involvement in GSSP task groups.

**IGCP Project 458:** Triassic/ Jurassic Boundary Events. Co-sponsor of special session at the Geological Association of Canada annual meeting in Vancouver, BC, Canada. May 2003.

**Nanpanjiang Basin Project:** A China-USA-Canada collaboration on an integrated biostratigraphy and chronostratigraphy of Triassic sections in Guizhou and Guangxi Provinces, South China.

**Monbusho Project and Interrad Group:** A Japan-New Zealand collaboration of 13 Universities studying Southern High Latitude Radiolarian Faunas. Joint meeting planned for 1996 in New Zealand.

**Secada working group**: 15 scientists in 5 countries studying the mid Triassic core from the Secada boring in Bolzano/Bozen, Italy. Co-sponsored meeting in the Dolomites, 2003.

**"Shan Thai" working group**: A team of seven scientists from Japan and Thailand studying the paleontology, stratigraphy, and tectonic evolution of Tak Province, northwesternThailand.

## 4. Activities planned

*4.1. General goals*

- To establish and stabilize an improved Triassic Time Scale with global applicability through the intercalibration of multiple fossil chronologies, magnetostratigraphic polarity profiles, and geochemical anomalies, within a sequence stratigraphic +/-cyclostratigraphic framework.
- Populate the Time Scale with numeric ages.
- To improve correlations between marine and non-marine Triassic.
- Through the use of the time scale, establish correlations and similarities between circum-Pacific terranes and thereby understand more about the Triassic paleogeography and tectonic evolution of Panthalassa.

*4.2. Specific meetings and field trips (please indicate participation from developing countries)*

**June 25-July 10, 2004. Field workshop on Triassic Time. Spiti-Himalayas, India**.
Organized by Austrian and Italian co-workers with the official support of the state of Himajal Pradesh government and the Geological Survey of India. 2-day working session with the main emphasis on Triassic stage boundaries; 8-day bus/jeep tour to examine famous Triassic sections at Muth, Kuling and surroundings areas.

**August 20-28, 2004. International Geological Congress. Florence, Italy.**. Several symposia and a workshop proposed by, or involving IGCP 467 participants:

T-04-02. Permian-Lower Triassic events
T-04-03. Triassic-Jurassic boundary events
G-05-09. Tethys reconstruction
G22-06. Triassic in Tethys Realm
DWO-09. Upper Triassic chronology.

**May 23-25, 2005. Triassic Chronostratigraphy and Biotic Recovery**. **Wuhan, China**. Co-sponsored by National Natural Science Foundation of China and the China National Committee of Stratigraphy.

**March, 2006. Circum-Panthalassa Triassic Faunas and Sequences. Wellington, New Zealand.** Joint meeting with the International Association of Radiolarian workers (INTERAD).

**August, 2006. The Boreal Triassic. Longyearbyen, Svalbard, Arctic Norway**.

**May, 2007. The Global Triassic. Albuquerque, USA**.