

# ALBERTIANA



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The primary aim of ALBERTIANA is to promote the interdisciplinary collaboration and understanding among members of the I.U.G.S. Subcommittee 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 is available as PDF at <http://www3.bio.uu.nl/palaeo/Albertiana/Albertiana01.htm>

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**Cover:** The participants of the Upper Triassic Subdivisions, Zonations, and Events, Bad Goisern. see also report on page 15.

## Executive Notes

### From the Chair

Every International Geological Congress represents an important step for the Geologic Community, but the 33 IGC held in Oslo has been of special importance for the renewal of the IUGS and IUGS bodies that have involved several stratigraphers. The new Chairman of the IUGS is Alberto Riccardi from Argentina, a valuable stratigrapher with a long experience in the Jurassic Subcommittee (SJS) and in the Subcommittee on Stratigraphic Classification (ISSC). The general opinion within the ICS is that with the new Chairman the ICS will have a better integration in the IUGS than in the recent past. The ICS itself has renewed its Executive Committee. The new Chairman is Stan Finney (USA), former Vice chairman. Sanchi Peng (China), formerly Chairman of the Subcommittee on Cambrian Stratigraphy is the Vice chairman and Paul Bow (UK) is the new Secretary. Part of the structure of the ICS has been changed and the new Subcommittee on Stratigraphic Information (SSI) has been established. It is led by the very active Jim Ogg (USA) former Secretary of the ICS. The renewal of the ICS is also documented by the complete revision of the ICS website (same address: <http://www.stratigraphy.org>; webmaster: fanjunxuan@gmail.com) that is now almost complete. The site is very informative, for instance with a regularly updated list of incoming events. I invite all of you to visit it.

The Subcommittee on Triassic Stratigraphy has a new Executive Committee. After 8 years of very good and extremely active service Mike Orchard has left the position of Chairman. Mike has done a superb job and I warmly thank him for the great efforts he has done to stimulate studies on the Triassic System. Under his leadership the GSSPs of the Ladinian and of the Carnian stages have been ratified and the number of the Triassic GSSP has increased from 1 to 3, with a rate of 200%. This rate is unique within all the Subcommittees of the ICS and for this reason the STS is considered one of the most efficient subcommittees of the ICS.

Mike has also led the IGCP 467, one of the most successful IGCPs of the last years. He has been able to involve and motivate a wide community of participants, who on the other hand reacted very positively. The great success of this project is documented by the number of international meetings and workshops held in several countries and in areas usually regarded as remote like Himalaya and Svalbard. The wide participation to this project is also shown by the number of thick abstract books edited for the official meetings. Of special interest are the issues 40 and 41 of the New Mexico Museum of Natural History and Science, with about 650 pages and Albertiana 36, with a good 200 pages, the thickest Albertiana ever printed. I would like to express Mike the special thanks of all the STS for the opportunity he has given us to meet and discuss on the Triassic.

It is now the time of the new Executives and I take the op-

portunity of this introduction to Albertiana 37 to acknowledge all the members of the STS who have trusted me and the new Vice chairmen Mark Hounslow (UK) and Tong Jinnan (China). With your contribution and the support of Chris McRoberts (USA) our very active Secretary I hope to be able to guide the STS to the completion of the Triassic scale by the 34 IGC, Brisbane 2012. I ask all the members to keep in mind this goal and to continue their work with accuracy, seriousness and dedication as they have done in the past, notwithstanding the difficulties connected to the incoming global economic recession. I ask especially the STS people involved into the Task groups to work in a closer connections with the other members. The cooperation always provides better results than the competition and allows the presentation of really up to date proposals with the most comprehensive documentation especially as regard the correlatability. I emphasize two reasons for a closer cooperation. The first is practical and the second is scientific. Cooperation is especially necessary when the financial resources are becoming scarce. The second reason, perhaps more important than the world economic contingency, is the quality control on the GSSP proposals. I already introduced the problem during the business meeting of the STS in Albuquerque (May 2007) and I want here to quickly resume it. The check of GSSP proposals is now much more strict than in the past and at present the GSSP proposals voted by the Subcommittees are not blindly approved by the ICS or IUGS. The proposals are reviewed, commented and they can be even rejected if the correlatability is not considered as well documented. Just to give you an hot example, the GSSP proposal for the Eemian Stage (Upper Pleistocene), approved with light majority by the ICS just before the Oslo Congress, has been rejected by IUGS in September 2008 with a shocking list of 8 major problems.

I understand that the general pressure and responsibility over the members of the Task groups is becoming harder so I would like to end my introduction to Albertiana 37 with two positive news. I have already mentioned the GSSP of the Carnian Stage. The proposal to define the boundary at Prati di Stuoeres/Stuoeres Wiesen (Italy) with the First Occurrence of the ammonoid *Daxatina canadensis* has been ratified by the IUGS last June and you will read the final report of the Ladinian/Carnian Task group in the next pages of this issue of Albertiana.

Last but not least, there is a new IGCP that is of interest for the Triassic scientific community. The new IGCP 572 "Restoration of marine ecosystems following the Permian-Triassic mass extinction: Lessons for the present" is just started (2008) and looks like to be a very interesting framework for discussions on the Early Triassic. The Project is headed by Z. Q. Chen, R. J. Twitchett, J. Tong, M. L. Fraiser, S. Crasquin, S. Kershaw, T. Algeo & K. Grice and will end in 2012. My best wishes to the leaders and the participants for a fruitful exchange of knowledge and for a very close cooperation.

*Marco Ballini*

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## From the Secretary ICS Subcommittee on Triassic Stratigraphy

### Minutes of the business meeting of the STS Bad Goisern, Austria, October 1, 2008

#### PRESENT

Marco Balini, Paulian Dumitrica, Eugen Gradinaru, Janos Haas, Alexandre Hungerbühler, Tatyana Klets, Alyona Kopylova, Heinz Kozur, Leopold Krystyn, Marco Levera, Michele Mazza, Christopher McRoberts, Alda Nicora, József Palfy, Werner Piller, Manuel Rigo, Katrin Ruckwied, Milos Siblik, Ugur Kagan Tekin, Max Urlichs, Axel Von Hillebrand.

#### AGENDA

1. Welcome and general STS remarks
2. Review of present state of Triassic GSSPs
3. Report of recent activities within the Jurassic Subcommittee (by J. Palfy)
4. Future Meetings
5. Other discussion and announcements
6. Closing remarks

#### ITEM 1.

Chairman opened the meeting at 10:50 and welcomed participants to the STS business meeting. Chairman thanked Krystyn for organizing the meeting and others who provided their support and hospitality including the Austrian IGCP Committee, Geologisches Bundesanstalt, and the town of Bad Goisern. Chairman noted changes in the STS executive following votes from the earlier in the year and were instituted at the IGC meeting in Oslo. The chair gave a warm thanks to outgoing chair Michael Orchard for his excellent leadership of the STS for the past eight years.

Balini also announced new executive for the ICS and IUGS as follows: Stanley Finney as incoming ICS chair and Paul Bown as incoming ISC secretary, Alberto Riccardi as incoming IUGS chair

#### ITEM 2.

The chair provided a PowerPoint presentation on the status of current and pending GSSP with oral reports.

The chair reviewed the completed Triassic GSSPs including the base-Induan (Meishan, China) which was ratified in 2001 and the base-Ladinian (Bagolino, Italy) which was ratified in 2005. The chair announced that the base-Carnian GSSP defined by the FO of the ammonoid *Daxatina canadensis* at Prati di Stores was passed by the ICS and

ratified by the IUGS in June 2008. The chair thanked the proposal authors and task group chair Maurizio Gaetani for their efforts in seeing this proposal through. A brief discussion ensued regarding the generally positive comments from the ICS on the base-Carnian proposal and their desire to see more quality proposals with strong documentation of regional and global correlations.

These announcements were followed by a status report on the progress towards the base-Anisian GSSP. The chair acknowledged there are currently two proposals, both using the Deşli Caira section in Romania. The proposal by Gradinaru and others) using the FO of the conodont *Chiosella timorensis* which is well correlated to other sections. Gradinaru remarked that there are still some parts of the proposal that need to be completed including securing protective status for the site. Kozur commented that most would agree that *C. timorensis* was an excellent choice and provided the best means for correlation. The chair thanked Gradinaru for progress made on the proposal and encouraged him to expedite collaborations on the ammonoid fauna and correlations and proceed with the final proposal. The chair acknowledged a second proposal recently published in Albertiana for the base Anisian GSSP also at Deşli Caira (Romania) by Hounslow and others using the base of Magnetozone MT1n. Given that the principal proposers were not present, there was no comment on this proposal.

The chair reviewed the status of the base-Norian GSSP, and noted that there are two active proposals: one at Pizzo Mondello (Sicily) and second at Black Bear Ridge (north-eastern British Columbia). McRoberts reported that work continues at Black Bear Ridge with significant progress on the taxonomy of halobiid bivalves (McRoberts) and conodonts (Orchard). Publications were in preparation and should be forthcoming within the next few months. Nicora and Balini acknowledged that work on Pizzo Mondello progresses at rapid pace with significant results presented at this meeting on conodonts (Mazza and Rigo) and halobiid bivalves (Levera and McRoberts). Balini and Nicora commented that specific defining datum for Pizzo Mondello will be selected shortly once the taxonomic work is complete. Nicora emphasized that the two candidate sections (Pizzo Mondello and Black Bear Ridge) were complimentary and that there should be cooperation between the two groups. McRoberts and Krystyn agreed. Klets commented that correlation of conodonts from the Tethys to the Boreal Realm during this interval were difficult. Haas also emphasized that the two candidate proposals were from relatively deep-water successions and that efforts should be made to correlate them to shallow-water facies, perhaps utilizing cyclostratigraphy. Kozur further commented on the abundance of species in open nomenclature and his desire to see determinate species assignments for all GSSP proposals.

Leo Krystyn presented an oral report on the status of the base-Rhaetian GSSP processes. Krystyn noted the preliminary outcome of voting on the base-Norian GSSP and that task group members were in favor of the first appearance of the conodont *Misikella posthernsteini* within the fos-

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siliferous Hallstatt Formation at Steinbergkogel (Austria). Participants who were able to visit the candidate GSSP at Steinbergkogel on the previous day were in agreement that this datum and section represents the best possible choice among other alternatives. Krystyn further noted that the palynomorph record from Steinbergkogel is lacking, but there are good correlation datums with shelly faunas including ammonoids. It was also noted that correlation between the Steinbergkogel section and the deeper-water sections of the Zlambach Formation was good. Krystyn announced that the final proposal is in preparation and will be shortly put to a vote within the task group

**ITEM 3.**

Jozsef Palfy made a short report on the status of the base-Hettangian (Triassic/Jurassic boundary) GSSP and its bearing on the activities of the Triassic Subcommittee. Palfy indicated that the base-Hettangian proposal by von Hillebrandt and others using the first occurrence of *Psiloceras* cf. *P. spelae* from the Kuhjoch section in the Karwendel Mountains of Austria has achieved a majority vote within the task group. Hillibrandt commented on the status of the defining taxon and reported that it was a subspecies of *Psiloceras spelae* and could be compared with the poorly preserved type material from Nevada and Chile. The full proposal will be currently being revised and will be presented to the entire Jurassic Subcommittee at a later date.

**ITEM 4.**

The chairman proposed the next meeting of the STS be held in Sicily (Pizzo Mondello which candidate for base-Carnian GSSP) in late 2009 or early 2010 and solicited discussion. It was generally agreed that the proposed meeting was appropriate and discussion focused around potential dates. Balini announced that final decision on the date will be made in consultation with the STS executive and take into account member obligations and academic schedules.

Kozur announced a forthcoming meeting to focus on the Middle Triassic Muschelkalk to be held late in 2009 and hosted by Dr. G. Bachmann and the University Halle. Further information regarding this meeting would be forthcoming.

It was noted that the 8th International Congress on The Jurassic System will be held in August 2010, Sichuan, China. More information on this meeting can be found on the website of IGCP-506 website: <http://www.nigpas.ac.cn/IGCP506/>.

**ITEM 5.**

The chair announced that there is currently only one active Triassic-related International Geological Correlation Programme project: IGCP 572: Restoration of Marine Ecosystems following the Permian-Triassic Mass Extinction. Those wishing to participate in activities of this project are encouraged to contact project leaders (<http://www.igcp572.segs.uwa.edu.au/>)

McRoberts announced that activity on the STS website (<http://paleo.cortland.edu/sts/>) was high with over 8,000 hits this past year. Of particular note was that the website now has active links to individual pdf papers included within two volumes of the Global Triassic Meeting held in Albuquerque New Mexico and published by the New Mexico Museum of Science.

Krystyn suggested that following establishment of primary stage GSSPs for the Triassic that future work should be focused on events taking place at substage boundaries. A brief discussion ensued on the merits defining substage boundaries of and other activities pursuant to the STS charter. Of particular note were brief discussions on the Carnian pluvial event and a Julian/Tuvalain extinction event and the extinction events at the lower/middle Norian boundary and the Norian/Rhaetian boundary. These were all deemed worthy of investigation, but conclusive results on the pattern, magnitude and potential causes must wait further research activity by STS members.

Krystyn announced that a list of participants for the meeting would be distributed electronically after the field conference. Krystyn also invited participants to consider submitting manuscripts based on meeting abstracts/presentations to a volume. These would be published rapidly by the Geological survey of Austria.

**ITEM 6.**

Chairman asked if there was any other business to be discussed and no further points were raised. Chairman thanked those present for their participation and declared the meeting closed at 12:15

Duly submitted,

Christopher McRoberts  
STS Secretary

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**In Memoriam**

**Jean Philippe Marcoux (1940-2008)**

Aymon Baud \*

*\*Parc de la Rouvraie 28, CH-1018 Lausanne,  
Switzerland*



1. Jean Marcoux, 1984

Our friend Jean Marcoux passed away on 17 June 2008 after a three-month battle against cancer in Orsay, France. His death interrupted a Professor lifetime of passionate geological researches and fieldwork, of estimate teacher and community activities. Jean is survived by his wife Noëlle, by their daughter Céline and son François, and three grandchildren.

Jean is born during the war on 8 October 1940 in Marseille, France, to well-educated parents. Both were teachers and *agrégé de Lettres Classiques*. He spent his early childhood in Marseille and in his grandmother's countryside house near Gemenos where he acquires a taste of observation and a fondness for Natural Sciences and entomology. In 1951 his family moved to Paris where he starts his secondary schools. Enthusiast of climbing and mountaineering, he followed mountain instructor courses and spent all his holidays between the Provence and the high Alps, in a family house at Le Monétier les Bains near Briançon.

He started Geology at Paris VI University and after one year moved to Paris XI University at Orsay in the new geological laboratory of the Professor Jan Houghton Brunn, followed by his fiancée Noëlle Mercier who became Mrs. Marcoux, his wife, in 1966. He was enlisted 18 months (1965-66) in the French army during his studies. He succeeded his University degree (French diploma DEA) in 1969, got an assistant position and started in Brunn's

laboratory a PhD thesis (French "Thèse d'Etat") on "The anatomy of the Antalya nappes in SW Turkey" after being introduced in the field by R. Lefèvre. He started his thesis in western Taurus together with four other Brunn's students, Jean-François Dumont, Olivier Monod, André Poisson, and Marcel Gutnic.

From 1969 to 1976, he spent each year from 1 to 3 months in the field, mapping the geology of up to the equivalent of 20 sheets in 1:25'000 scale in agreement and with the assistance of the Mineral Research and Exploration Institute (MTA) in Ankara. During this time he not only discovered and mapped 9 superposed nappes of different ages, but also learnt Turkish of the countryside. He could speak so fluently peasant dialect that he often staggered Turkish people with his speech and appearance. Even, arriving in the evening with three French colleagues in a remote South Turkey small hotel, Jean asked for room. We all received nice rooms but as the Innkeeper strongly believed that Jean was our Turkish driver, he gave him a "cupboard room"! Turkey was as his second homeland and he got deep friendships with Turkish colleagues, among them Celal Sengör who friendly called Jean with the Turkish nickname of *Marko Pasha*.

Working on shallow to deep water thrust units of the Taurus Mountains, Jean reconstructed a model of the Neotethys Southern margin and, with his colleagues and friends J.P. Brun, J.P. Burg and E. Ricou, he was able to prove, by shear zone and microtectonic studies the Southward emplacement of the Ophiolite and Nappe system and consequently the northern position of the Neotethys Ocean in regard of the Taurus.

Discovering in Turkey a great variety of Triassic sediments from restricted shallow water to deep volcano-sedimentary facies, Jean focused very early his interest in the Triassic stratigraphy and took part to the IGCP project No 4 "Triassic of the Tethys realm" led by Prof. Zapfe from Vienna. He participated to the first symposium in 1973 and presented a note on "Alpine type" Triassic of the upper Antalya Nappes (Western Taurides, Turkey)". During this workshop, he met Leopold Krystyn and from that time started a long and scientifically very fruitful friendship.

From 1981 to 1984 Jean Marcoux was *maître-assistant* at Reims University and from 1984 to 1989 *maître de conférences Ière classe* at Paris VII (Jussieu) University.

In 1980 he became member of the Subcommittee on Triassic Stratigraphy (STS) and in 1982 member of the STS Working Group on Permian-Triassic Boundary and participated to numerous Triassic congress (Bergamo meeting, 1979; Bratislava 1980; Sarajevo, 1981; Brescia 2005), taking opportunities to work with Eastern colleagues in Eastern Slovakia and Montenegro, despite the presence of Russian "officials".

In 1984 we attended together to the fieldtrip on the Triassic of the Verkoyansk Mountains in East Siberia, just before the Moscow International Geological Congress. Led by A. Dagens and Archipov, we had opportunity to fly by plane to Kandigar and then by helicopter to the Permo-Triassic





2. Jean Marcoux (second to the left between V. Jacobshagen and B. Bataille) witnessing a discussion between T. Tozer and A. Dagens on a new basal Triassic ammonoid collection from Setorym Creek (1984, East Siberia).

section of Setorym Creek. Jean and I enjoyed making outcrop photos but also taking East Siberia forbidden pictures from the air and we are still thankful to our real geologists Russian colleagues who refused to report it to the accompanying KGB “scientist”.

For 1986, Jean and I decided to organize, with L. Krystyn, O. Monod and C. Sengör, a STS fieldworkshop in Istanbul and in Kemer (Turkey). Jean and I went to Kemer Gorge in October 1985 to prepare the Field guidebook. This workshop was very successful and about twenty STS Members participated with great interest. Just after, Jean invited me to publish a paper on “The Permo-Triassic boundary in the Antalya Nappes (western Taurides, Turkey)”.

From 1977 to 1985, due to his huge knowledge on Tethys geology and all his contribution to Geosciences, Jean was invited to follow six expeditions of French Research Groups in Ladakh Himalaya and in Tibet and he participated, as co-author, to not less than twenty high ranked papers. September 30, 1987, he presented his “Thèse d’Etat” entitled *Histoire et Topologie de la Néotéthys, contribution à partir d’exemples de la Turquie et de l’Himalaya-Tibet* at the Pierre et Marie Curie University in Paris and received the highest honors.

Three months later, Jean and I participated to the IGCP Project 199 field workshop on the Permo-Triassic sections of the Salt Ranges (Pakistan). We organized a postmeetings fieldwork in Indian Kashmir. We took the opportunity to sample successfully the Palgham and the Guryul Ravine sections. Six month later, all this area fell to terrorism and imposed curfew.

In summer 1988, Jean started with his colleagues J. Besse,

Y. Gallet and L. Krystyn a very successful research program in Southern Turkey on Triassic magnetostratigraphy. His broad knowledge of well-calibrated Triassic profiles had significant impact for their success.

The same year he was appointed for the ODP researches on Leg 123 (NW Australia margin) and he participated to the main reports and publications. A year later he became full Professor in Geology at the Paris VII University. He was teaching at different student degrees, from general geology for beginners to geology of the Earth and paleogeography for Master students. Convinced of the importance of the field approach for the students, he devoted himself up to one month in total each year for field camp in Normandy or Languedoc and field trip through the Alps.

For the Tethys research Program managed by J. Dercourt and starting in 1989, Jean was in charge of the Triassic paleogeographical and paleoenvironmental maps working group (Anisian and Norian maps) and help me greatly on my charge of the Permian map (Murgabian) working group. To complete our data, we organized together fieldwork on the Permian Basin (W Texas), on the West Timor Triassic and we start researches on Permian and Triassic units in the Sultanate of Oman. During 4 years, Jean and I organized numerous meetings of our working groups. Jean furnished a huge effort in drawing and publishing maps, explanatory notes and articles (see publication list).

In 1991, Jean and J. Guex helped me to lead the International Symposium of the Subcommittee on Triassic Stratigraphy. He was active during this Symposium in Lausanne and he participated to the editorial Committee of the Proceeding edited in 1994.



3-Discussion between Jean and Leo during the 1986 field-workshop in Kemer (Antalya area, south Turkey).



5-Jean just achieved to drill a core for paleomagnetic studies in the lower Triassic limestone of Wadi Musjah (January 1995, Oman)



4-Jean sitting on the top of the Zewan Formation, Guryul Ravine section (India, Dec. 1987)



6-Jean staying on the right during the explanations of L. Krystyn keeping a guidebook, with our friend F. Béchenec on the left. Baid outcrop, first stop of the Pangea fieldtrip A1, Oman Mountains, January 2001.





7-Jean (in the middle) has a close look to the map I am showing to him and to H. Masson (right): a stop during the student of Lausanne excursion in Oman, January 2002



9-Jean and Noëlle at the Interrad official Dinner, Wellington N.Z. March 2006



8-Jean, geologist and photograph in the Spiti Valley (July 2004)



10-Jean showing the cataclasite, a so-called "sedimentary basement" of Oman Exotic according to a recent paper (see text above), March 2007.

In 1993, Jean was elevated *Professeur de 1ère classe* at Paris VII University.

From 1992 to 2007, he organized field works in Turkey and participated as co-signatory to important papers on the Triassic magnetostratigraphy (first author Y. Gallet). In 1995, he participated also to Paleomagnetic studies in Saudi Arabia and supervised the PhD work of H. Théveniaut.

During the summer of 1997, within the Peri-Tethys Program, Jean and I went together to Simferopol (Ukraine), for fieldworks on Permian and Triassic blocs in Crimea, led by G. Kotlyar, and both we take part to the published report.

A team of Lausanne and Bern Universities invited him, in early 1989, to work on Oman exotics with the financial support of the Tethys program. From that time, Jean has been very active on Permian and Triassic researches in Oman, participating actively in Congress (1990; 2001; 2005) with talks and co-organization of fieldtrips. He was adviser of PhD students from Lausanne: A. Pilleveit on Oman Exotic and S. Richoz on PT boundary. Each winter, from 1995 to 2002 Jean and I organized 2-3 weeks of field studies on Permian and Triassic, working with French colleagues from BRGM, with colleagues from Milano, from Lyon and sometimes, L. Krystyn join us. For High-school teachers and university students, he co-organized and guided excursions in Oman, conveying very impressively his knowledge. In March 2007, Jean and I organized seven days of fieldworks to check some key part of his research program on "Gaps in the Mesozoic carbonate of the Oman Exotic". We also surveyed the new Sint road north of the Jebel Kaur (see picture below) and were outraged by a newly built theory on the Exotic basement published by a PhD researcher in geology, theory that apparently skipped a scrupulous field watching. Jean had still a lot of work that he wanted to continue there.

He was also very engaged in France and became Chief Editor of the *Bulletin de la Société géologique de France* from 1997 to 1999 and his scientific contribution to Geosciences earned him the prestigious *Prix Fontannes* of the Geological Society of France in 1999.

After two cycles of researches in Turkey (1969-1986: its own researches; 1988-1998: the Triassic magnetostratigraphy with Y. Gallet, J. Besse and L. Krystyn), Jean went again from the year 2000 to the study of the Permian-Triassic boundary interval in the Western Taurus and we worked together. His broad knowledge allows S. Richoz to find together with N. Ozgul new PT sections in Alanya and Tashkent area and contributed to the success of his PhD. In 2002, he also organized successful fieldworks on the Çuruk dag section for Paleontologists from Paris (S. Crasquin) and from Milano (L. Angiolini and A. Nicora) and participated as co-author to the five papers, results of these researches. He was always ready to help colleagues to have access to data or to get field permits to work (e.g. D. Botjer and S. Pruss for the study of the Permian-Triassic transition of the area)

In September 2003 he prepared, with D. Vaslet from BRGM and colleagues from Isparta University, fieldworks on Permian and Permian-Triassic transition of the Hazro section. He was happy to visit again, after 25 years, the Eastern part of Turkey. Since 2003, Jean advised also Master and PhD students (e.g. P. Moix) from Lausanne, on the Paleozoic of the Taurus (Mersin Area, Lycean nappes).

In June 2004, Jean participated with Noëlle to the STS meeting in Manali (India) and to the Triassic field workshop in Spiti organized by L. Krystyn, M. Balini, O.N. Bhargava and D.M. Banerjee. After the meeting, getting the opportunity to visit the Lahul, Spiti and Kinnaur Valleys, Jean and I organized an unforgettable ten days trip with our wives and a couple of friends. We repeat such a great journey at the end of the Triassic and Interrad Conference of Wellington (New Zealand, March 2006) and we were filled by the friendships among the participants and by the wonder of both the North and South Islands.

In September 2007, Jean invited me to participate to fieldworks on Paleozoic of south coast of Turkey and we even discovered new Permian Triassic boundary outcrops, East of Gazipaça. We also visited P. Moix on its PhD fields on the Paleozoic of the Lycean nappes. During this time, Jean started suffering and had difficulties in physical efforts, but he did not know the reasons.

Last April, when a cancer was finally detected and became very painful, Jean was not able to return to the field, as he planned to start studies on the Permian and the Triassic sections with S. Crasquin's and A. Nicora's new PhD students. He asked me to stand in for him and he gave us all documents and advises. During our fieldworks on Jean's well-known sections, we all had his illness in the mind and when coming back we told him our deep gratitude and the success of the new paleontological field studies. Getting caught by his sudden death only few days later, we all have been devastated and our thoughts and one's condolences went to his wife Noëlle, and to all his family.

Excellent teacher, Jean Marcoux first was a field geologist who could feel comfortable in sedimentology as in tectonic, in magnetostratigraphy as in paleontology. He had an easy communication and got well with his colleagues and always wanted to share his enthusiasm and encyclopedic knowledge. He was always ready to do something for his friends, for his colleagues and helped many young geologists who wanted to start a scientific career.

His scientific production is important and of high quality, well oriented on field facts and data and convincing conclusions, outside temporary trends or model wheel. He brought a new knowledge on the Triassic of South Turkey and participated to the Triassic magnetic inversion story developed by Y. Gallet team with J. Besse and L. Krystyn. He was the main actor of the Triassic paleogeographical and paleoenvironmental maps of the Tethys Atlas but his important contribution was not recognized, as it should have been.

Jean was a modest scientist often staying in the back but however being author or co-author of about hundred high

quality publications and about 140 abstracts or short notes. He leaved common researches in work. We will achieve some of them to his memory.

For Albertiana readers, I refer below his papers concerning Triassic time and sediments.

Within these few pages, I have shown only a small part of Jean's life, his researches concerning the Triassic time p.p. and in particular the events and projects which I had the chance to participate or to organize with him, but here are no detailed reports or account on his successful researches in Ladakh, Tibet, Korea, Japan, Vietnam, Thailand and Iran, nor on his detailed researches with his colleagues and friends from Paris VII University and from the Paris "Institut de Physique du Globe (IPG)".

Other aspects of Jean's live with the development of his Turkish researches have been friendly related by Celal Sengör in Turkish Journal of Earth Sciences, vol. 17, p. 637-652 with a list of his publications

*Jean, tu es parti trop tôt, nous avions tant de projets,  
tu laisses un grand vide, mais nous poursuivrons ton  
œuvre.*

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*Thanks to Sylvain Richoz who helped me to improve and shorten the text.*

## In Memoriam

### Kiril Budurov



Dear colleagues,

It is a sad duty to inform you that our colleague and friend Kiril Budurov passed away this morning at the age of 73.

Professor Budurov was a renowned expert in the fields of conodont palaeontology and Triassic stratigraphy of the Balkan Peninsula. He had worked in the field in Austria, Syria, India and other countries, and made important contributions, especially in Triassic geology. His last extensive work has been dedicated to the Triassic geology of Bulgaria within the frame of a monograph on the “Geology of Bulgaria” as well as to a revision of Triassic conodont taxa. Unfortunately, the last work will remain unfinished . . .

Ivan Zargochev

## Past Meetings

### Upper Triassic Subdivisions, Zonations and Events: Meeting Report

Christopher McRoberts

From September 28<sup>th</sup> to October 3<sup>rd</sup> 2008, the Geological Survey of Austria, the University of Vienna, and the Austrian Academy of Sciences sponsored an international field conference on **Upper Triassic Subdivisions, Zonations, and Events** in the historic town of Bad Goisern in Austria's Salzkammergut. The field conference organized by L. Krystyn and G. Mandl was also sponsored by the Subcommittee on Triassic Stratigraphy (STS) and former IGCP Project 467 Triassic Time and Correlations and hosted by the town of Bad Goisern. Thirty-two scientists attended coming from 11 countries including: Austria, Germany, Hungary, Italy, The Netherlands, Turkey, Romania, Russia, Slovakia, Switzerland, and the USA. The meeting integrated field trips to classic Upper Triassic localities in the Austrian Salzkammergut and a technical session with both oral and poster presentations. The technical sessions were conducted within Bad Goisern's modern Town Hall and participants enjoyed local hospitality, and had ample opportunity to sample local dishes and drink.

The meeting was dedicated to three individuals: E. von Mojsisovics (1839-1907), H. Zapfe (1913-1996), and E.T. Tozer. These individuals have all made tremendous contributions on Triassic ammonoids and biochronology and to our understanding of the geology and complex stratigraphic relationships of the Triassic of the Austrian Salzkammergut.

Key scientific results presented at the meeting include advances in biochronology, chemostratigraphy, paleobiogeography, and regional and global correlations of the Upper Triassic. Kozur presented a correlation of the marine and continental Triassic using conchostracans. Tekin and Goncoulgu provided a useful summary on the Middle—Upper Triassic radiolarian occurrences of Turkey. Several presentations dealt with Carnian—Norian succession from the base-Carnian GSSP candidate at Pizzo Mondello Italy including an overview of integrated biochronology, magnetostratigraphy, and geochemistry of the interval (Balini and others), a detailed taxonomy and phylogeny of conodont apparatus' (Mazza and Rigo), and the halobiid bivalve succession (Laveran and McRoberts). Several important presentations were made on Upper Triassic including an overview of the Carnian-Rhaetian carbon isotope record (Ricoz and others), brachiopods from the Northern Calcareous Alps (Siblik), and Rhaetian bivalves (McRoberts). Leo Krystyn provided a new integrated biozonation of upper Triassic ammonoids and conodonts

that was complemented by the results on the distribution of arcestid ammonoids around the Norian—Rhaetian boundary (Cwik) and taxonomy and biochronology of heteromorphic ammonoids from the Rhaetian of Austria (Maslo). The Rhaetian stage and its base was the focus of several presentations including Rigo and others who presented new findings on the conodont succession in the Lombardian Alps. The Triassic—Jurassic boundary was the focus of two presentations including new data on the foraminifera and ostracode faunas of Northern Calcareous Alps (von Hillebrandt and Urlichs) and a revision of U-Pb ages from the boundary in western Canada (Palfy and others).

Following an informative introduction to the geological history of the Dachstein—Hallstatt—Salzkammergut region by H. Lobitzer and G. Mandl, participants visited localities examined including Steinbergkogel, the proposed GSSP for the base-Rhaetian, and nearby Sommerakogel where fossiliferous successions within Hallstatt Limestone spanned the upper Norian through lower Rhaetian. A second excursion, under beautifully blue skies, led by Janos Haas, was made to examine classic Lofer cycles on the Dachstein Plateau at Krippenstein. A third excursion was made to the Gosaukamm platform margin to study the transitional relationships between the platform margin reefal facies and the basin pelagic sequence. Side excursions were made to the historic town of Hallstatt and to the private collector/fossil shop Gapp, where participants took advantage of examining and purchasing beautifully preserved and prepared Hallstatt fossils.

A business meeting of the STS was held on 1 October (see report by McRoberts this issue).

The field guide and abstracts volume of the meeting are published by the Geological Survey of Austria as:

Krystyn, L. and Mandl, G. W. (eds.). 2008. Upper Triassic Subdivisions, Zonations and Events: Meeting of the late IGCP 467 and STS, September 28th - October 2nd 2008, Bad Goisern (Upper Austria): Abstracts and Excursion-Guide. *Berichte der Geologischen Bundesanstalt*, vol. 76, 116 p.





**Figure 1** Group photo of meeting participants, Bad Goisern, October 1, 2008.



**Figure 2:** Leo Krystyn at base-Rhaetian GSSP candidate Steinbergkogel



# 5th International Triassic Workshop, Hungary Alpine and Germanic Triassic facies areas of Hungary

September 7–12, 2008

Tadeusz Ptaszyński, Warszawa, Poland

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The Fifth International Triassic Field Workshop on the Triassic took place between September 8–12, 2008 in Hungary, in the central part of the Carpathian Basin. The Workshop was attended by participants from six countries and organized by the Hungarian colleagues T. Budai, J. Haas, G. Konrád, H. Kozur and K. Sebe. Participants obtained a field guide book compiled by T. Budai et al. (2008) containing information on the regional geology and on the profiles visited.

The Pelso Mega-Unit, having South Alpine affinities, traverses Transdanubia in NE–SW direction. The Tisza Mega-Unit can be outlined to the south of the Mid-Hungarian Fault Zone. The unit shows a Germanic type succession of Permian and Triassic continental and shallow marine deposits, but also some South Alpine affinities. The first two days of excursions were devoted to the Transdanubian Range Unit in the Balaton Highland. Overnight accommodation was in the guesthouse of the “Balaton Geopark” in Csopak near Balatonfüred.

The geological trips in the Bakony Hills, north of Lake Balaton, started with the fluvial conglomerates and sandstones of the Balatonfelvidék Formation (Middle and Upper Permian) above a Variscan basement of metamorphic rocks (exposed at Alsóörs). The formation is overlain by the marine Nádaskút Dolomite Member (Köveskál Formation) and the Arács Marl Formation, the latter built predominantly of marls with siltstone and “gastropod oolite” intercalations with some *Lingula* and *Claraia*. The sandstone-dolomite boundary corresponds approximately with the German Zechstein-Buntsandstein boundary. The Permian-Triassic boundary is in the lower part of the succession of the marine Nádaskút Dolomite Member (Fig. 1). The marine Olenekian is represented by the Csopak Marl Formation containing a rich marine fauna of bivalves, gastropods, crinoids and ammonites (*Tirolites cassianus*, *Dalmanites morlaccus*, *Dinarites*). This formation starts with the Hidegkút Dolomite Member (observed in the town of Felsőörs at the base of an impressive 800 year old Romanesque church). The upper part of the Csopak marls shows a trend of decreasing fauna diversity with a gradual transition towards the dolomites of the Aszófő Formation (Lower Anisian) deposited in sabkha and la-

goonal environments.

Early Anisian Iszkahegy Limestone Formation, almost vertical due to tectonics, crops out in the Szentekereszt Hill. The limestones with marl interlayers contain ostracods, bivalves, foraminifers and echinoderms. The succession exposed at Forrás Hill near Felsőörs is one of the most important Middle Triassic key sections in the region. The profile starts with the Megyehegy Dolomite Formation that is followed by the Felsőörs Limestone Formation (Middle Anisian) consisting of slightly dolomitic, cherty, argillaceous limestones with marls, rich in fossils including ammonites and conodonts. The upper part of this formation contains a rich Upper Illyrian ammonite fauna. Higher up there occur several metres of thick tuffs, which prevail in the Vászoly Formation. The tuffs yielded an important radiometric date of some 241 Ma. Limestone intercalations contain an ammonite association of the Reitzei Zone. Sedimentation of limestones resumes in the succeeding Buchenstein Formation. The upper part of this formation contains ammonites indicating the Curionii Zone at the base of the Ladinian. In Szentkirályszabadja, Middle Anisian shallow marine dolomites with Dasycladaceae are overlain, after a short but remarkable gap, by basinal ammonite-bearing carbonates of the Vászoly Formation. This hiatus can be correlated with the Riechthofen event of the Southern Alps. The relationship of the Late Ladinian platform and basinal succession can be observed in the Berek Hills near Hajmáskér, where Budaörs Dolomite is overlain by red limestones with tuff intercalations of the Buchenstein Formation (Ladinian). This formation is, in turn, overlain by turbiditic limestones with marls (Berekhegy Member) and by the Budaörs Dolomite of Ladinian/Carnian age.

On the Balaton Highland, the Early Carnian Füred Limestone Formation develops gradually from the underlying Budaörs Formation. Within the Lower Carnian a significant change in the lithofacies took place. The Veszprém Marl Formation, built up of thinly bedded, laminated clay marls, in the middle part contains the pelagic, cherty Nosztor Limestone Member (Late Julian). The following Late Carnian carbonates, as observed in the Nosztor valley road cut in Csopak, start with bituminous, hypersaline Sándorhegy Limestone covered by marls containing bivalves and ostracods; the upper part consists of shallow marine limestones containing *Cornucardia*, *Megalodus*, sponge spicules, crinoids and benthic foraminifera. Higher up there occur limestones and marls containing brachiopods, echinoderms, benthic foraminifera, dasycladacean algae and oncooids of Early Tuvallian age. The section ends with the Main Dolomite, above a zone with reddish, argillaceous mudstones with breccias caused by a hiatus and subaerial erosion between the two formations. The lower part of the about 1000 m thick Late Carnian (Late Tuvallian) to Norian Main Dolomite in an abandoned quarry near Veszprém was the youngest Triassic formation visited

The next two days were dedicated to the Triassic of the Mecsek Mountains near the City of Pécs. Southern Transdanubia was an area of continental sedimentation starting in the Late Carboniferous. The Late Permian lacustrine



**Figure 1.** Balatonfüred railway cut. Red siltstones and sandstones of the Balatonfelvidék Formation overlain by marine yellowish-grey siltstones, sandstones and sandy dolomites of the Nádaskút Dolomite Member (Köveskál Fm). The lithological boundary corresponds to the Zechstein-Buntsandstein boundary of Germany; the Permian-Triassic boundary is a few metres higher up. Photo: T. Ptaszyński.

Boda Claystone passes into the fluvial Kővágószőlős Sandstone Formation; the Permian-Triassic boundary is in its uppermost part. The formation is unconformably overlain by some 250 m of conglomerates and sandstones of the continental Jakabhegy Formation that has a close Buntsandstein affinity. Microflora found in lacustrine (or tidal flat) deposits of the upper Jakabhegy Formation indicates Spathian to Lower Anisian age. A typical terrigenous succession of latest Permian to early Triassic age was demonstrated with cores.

Lower Anisian siltstones and marls of the Patacs Formation represent early Middle Triassic sedimentation in the region with *Lingula* sp., *Costatoria costata*, *Euestheria albertii* and sporomorph assemblages containing *Triadispora crassa* and *Stellapollenites thiergartii*. Both the Patacs Formation and the succeeding Hetvehely Formation (that originated in a sabkha environment) have close affinities to the Germanic Röt.

After a marine transgression, carbonate sedimentation resembles that of the Lower Muschelkalk in the Germanic Basin and Israel/Jordan. The Viganvár and Lapis formations are separated by the shallow marine Rókahegy Dolomite with characteristic stromatolitic buildups. The fully marine Lapis Limestone Formation (Bithynian to Early Pelsonian) is developed in Lower Muschelkalk facies and, together with the dark grey Zuhánya Limestone Formation (Pelsonian to Ilyrian), is exploited in the huge

Bükkösd quarry. Those limestones are overlain by Ladinian dolomites of which the Kán Dolomite Member is well exposed in the Kán valley. The Kán Dolomite may be a dolomitized variety of the Kozár Limestone (Late Ilyrian to ?Early Ladinian), a member of the Csukma Formation overlying the Zuhánya Limestone in the nearby Pécs area. Large parts of the Ladinian are missing because of a hiatus. The up to 15 m thick Mánfa Formation consists of kaolinitic-sideritic white or green claystones that may be related to this gap. Depending on location, an oncoidal limestone of the Kisrét Member of the Kantavár Calcareous Marl Formation overlies unconformably the Zuhánya Limestone, Kozár Limestone or Kán Dolomite.

The Kantavár Calcareous Marl Formation is of lacustrine origin. The lower part of this formation is built up of thick-bedded, laminated limestones containing the ostracod *Darwinula liassica*, Charophyta, gastropods and vertebrate bones. Upwards the clay content increases and a coalified flora with *Equisetites* occurs. Those deposits gradually evolve into the up to 600 m thick Karolinavölgy Formation whose lower part starts at the base of the Carnian and contains sandstones similar to the Germanic Schilfsandstein. The Carnian/Norian boundary is marked by the *Ovalipollis ovalis*, while *Triancoraesporites ancorae*, found in its upper part, is characteristic of the Rhaetian. The upper boundary of the formation is drawn at the first coal seam of the following Mecsek Coal Formation; the Triassic/Jurassic boundary is drawn within the Mecsek





**Figure 2.** Workshop participants at Bükkösd quarry. Photo courtesy of E. Gradinaru.

Coal Formation. The Karolinavölgy and Mecsek Coal formations are both similar to the Alpine coal-bearing Rhaeto-Liassic Gresten facies.

Field guide. 1–50.

The 5th Workshop was very well organized by the Hungarian colleagues with highly interesting field trips and scientific discussions. Additionally, one had opportunity for some sightseeing and the sampling local culinary specialities and wines. Also there was beautiful summer weather – which is even more difficult to organise.

### Participants

Organisers/Guides: Tamás Budai, Geological Institute of Hungary; János Haas, Hungarian Academy of Sciences; Gyula Konrád, Pécs University; Heinz Kozur, Budapest; Krisztina Sebe, Pécs University;

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Josef Paul, Universität Göttingen; Tadeusz Ptasiński, Warszawa.

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## Scientific Reports

# Correlation of the Induan-Olenekian boundary beds in the Tethys and Boreal realm: evidence from conodont and ammonoid fossils

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**Abstract** - According to traditional point of view, the base of the Olenekian in the Boreal realm is located at the base of the Hedenstroemia hedenstroemi Zone. Representatives of Hedenstroemiidae are known from Arctic Sibeia, Arctic Canada, South Primorye, South China, Himalayas, and Idaho. Hedenstroemia Beds in Siberia are represented by Hedenstroemia (Hedenstroemia) hedenstroemi and Lepiskites kolymensis zones. The most important ammonoid genus to distinguish the Induan-Olenekian boundary in the Boreal realm seem to be Lepiskites associated with conodont Neospathodus waageni, wide distributed in the Tethys.

## Introduction

Stratotype of the lower stage of the Lower Triassic has been proposed by Kiparisova and Popow (1956, 1964) to be established in Salt Range, Indus River, indicated in Russian maps as *Ind*, therefore it was named in Russian as *Indskij* (Induan). This name is using more than 50 years. A concrete section in the Indus River basin has not been mentioned by them.

According to mentioned workers (Kiparisova and Popow, 1956, 1964), the body stratotype for the upper stage of the Lower Triassic (Olenekian) is situated at the lower reaches of the Olenek River in Arctic Siberia (more exact survey is absent). They had in view, apparently, first of all the famous Mengilyakh section with abundant ammonoids, firstly described by Mojsisovics (1886, 1888), but it may be offered only as a stratotype for the Upper Olenekian, because of lacking the lower part of the Olenekian there (Lazurkin and Korchinskaya, 1963; Zakharov, 1996). As a stratotype for the Lower Olenekian the Buur-Nyykabyt section was proposed (Zakharov, 1996). Ammonoids in Arctic Siberia were investigated after Mojsisovics investigation by Popow (1958), Dagys and Ermakova (Dagys, 1984; Dagys and Kazakov, 1984; Dagys and Kurushin, 1985; Dagys and Ermakova, 1988, 1990, 1993) and Zakharov et al. (1987): conodonts were described by Dagys (1984).

Recently several candidates for the Global stratotype section and point for the Induan-Olenekian boundary have been offered: Tri Kamnya Cape and Abrek Bay sections in South Primorye (Zakharov, 1996; Zakharov et al., 2000), West Pingdingshan section in South China (Tong et al., 2004) and Mud (Muth) section in Spiti, Himalayas (Krystyn et al., 2005, 2007). There were two most prominent official proposals (Tong et al., 2004; Krystyn et al., 2007), according to which the base of the Olenekian in conodont terms is marked by the FAD of *Neospathodus*

*waageni* sensu lato. The Induan-Olenekian Task Force voting, recently organized by one of authors (Zakharov), gave preference to the latter.

The aim of our presentation is to make some comments on this topic and give our version to correlate the Induan-Olenekian Boundary (IOB) beds of the Tethys and Boreal realm.

## Tethys

### *Chaohu (South China)*

In the West Pingdingshan section, investigated in most detail, IOB is indicated at the base of Subbed 24-16 (Tong et al., 2004). The lowermost part of the *Neospathodus waageni* Zone in Chaohu contains typical Induan conodont species – *N. cristagalli* and *N. dieneri*, associated with typical Olenekian conodont and ammonoid species. In this paper we indicate the mentioned interval as *Stage A*. The upper part of the *Neospathodus waageni* Zone, indicated by us here as *Stage B*, is characterized by lack of Induan-type conodonts.

In the Lower Olenekian of Chaohu, the two ammonoid zones (*Flemingites-Euflemingites* and *Anasibirites*) can be certainly recognized on the basis of relatively well-preserved *Euflemingites tsotengensis* Chao from the North Pingdingshan section and *Anasibirites kwangshianus* Chao from the West Pingdingshan and South Majiashan sections (Fig. 1). However, location of the lower boundary of the *Flemingites-Euflemingites* Zone in the Chaohu area can not be determined strictly because of pure preservation of ammonoids from the Induan-Olenekian boundary transition, about 4-5 m thick.



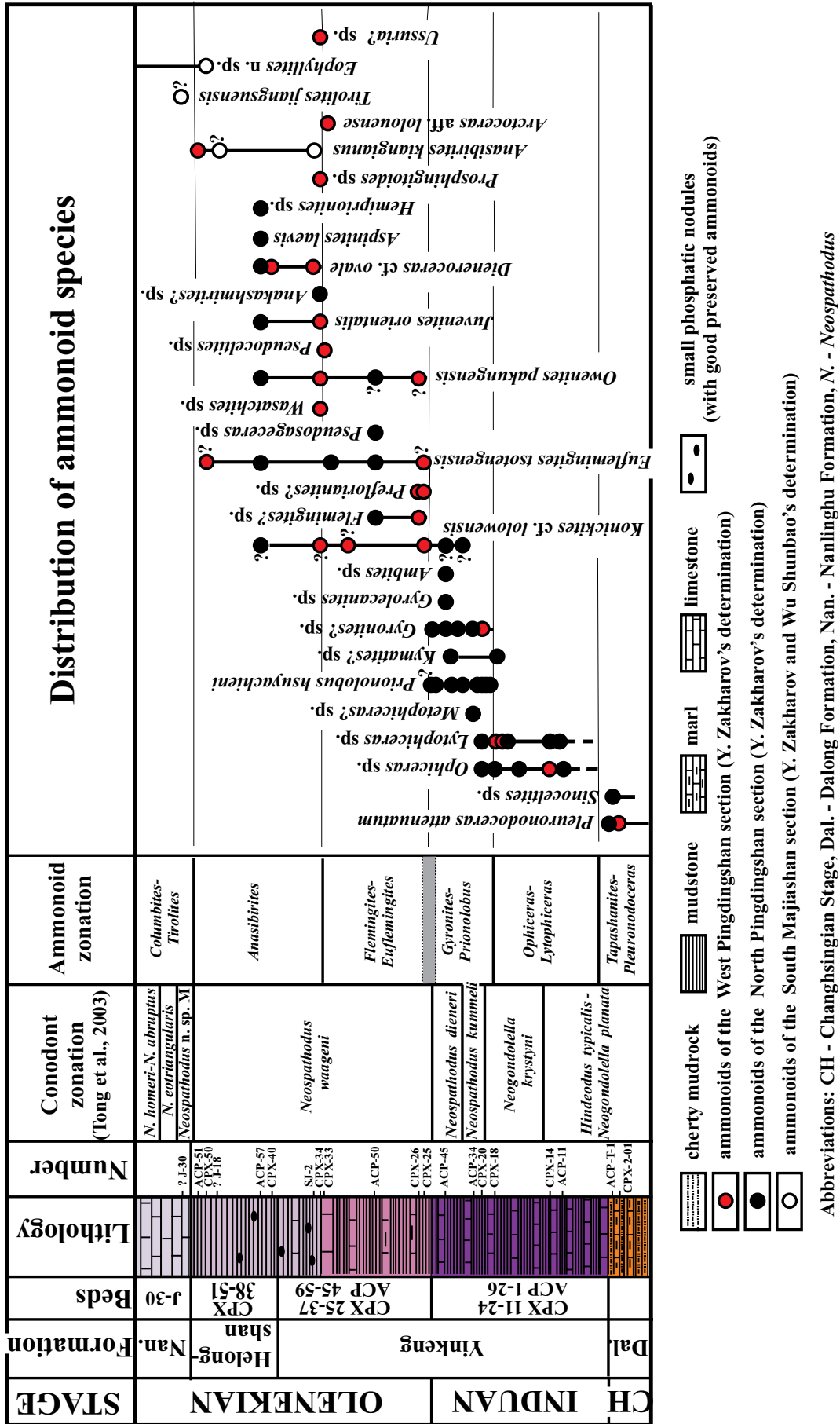


Figure 1. Vertical range and zonation of ammonoids in the IOB in the Chaochu area, South China (West Pingdingshan, North Pingdingshan and South Majiashan).

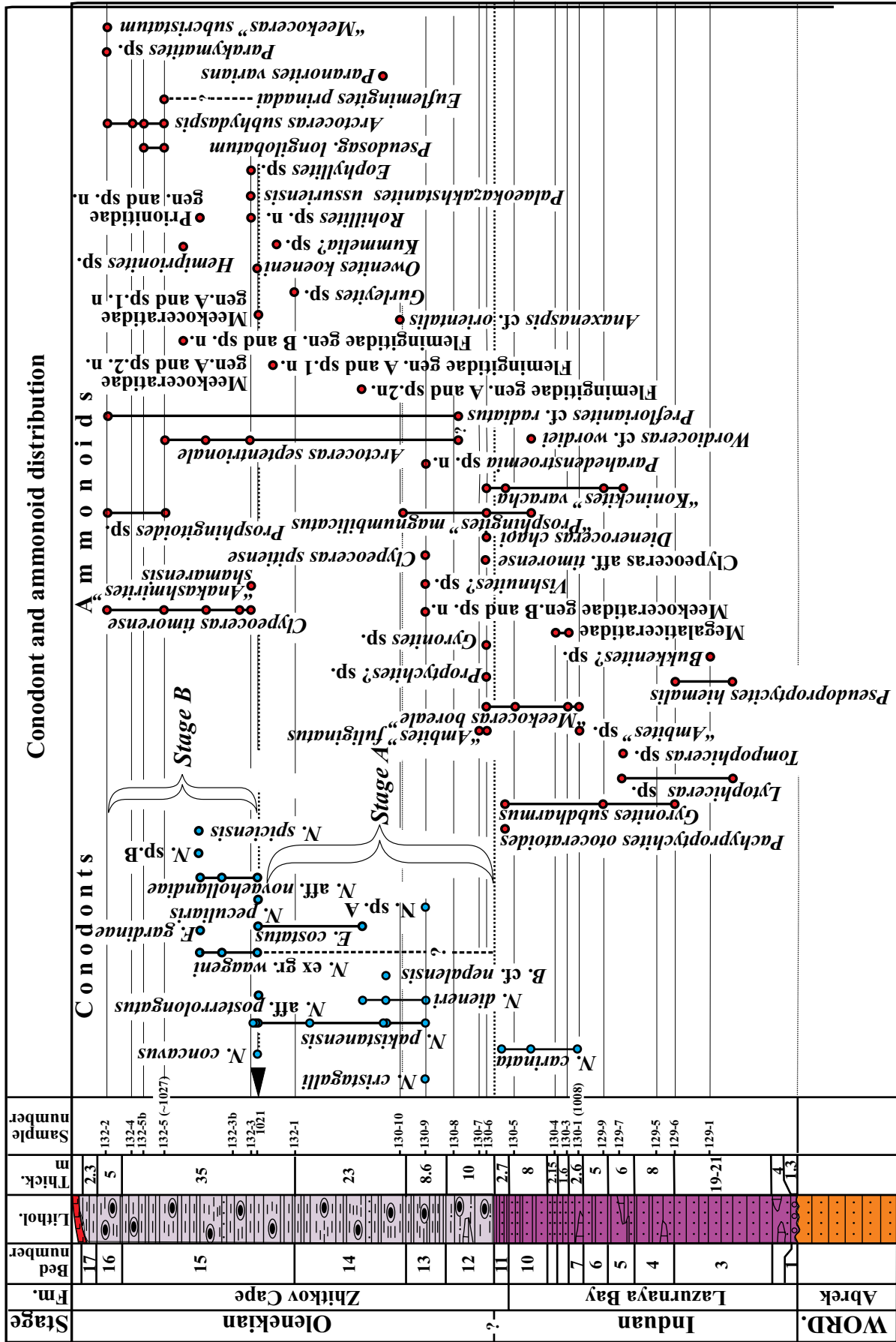
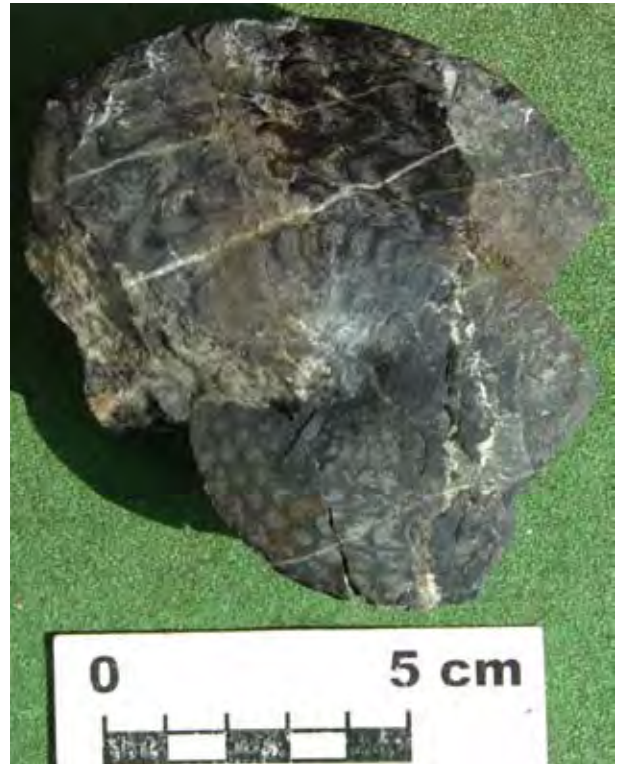


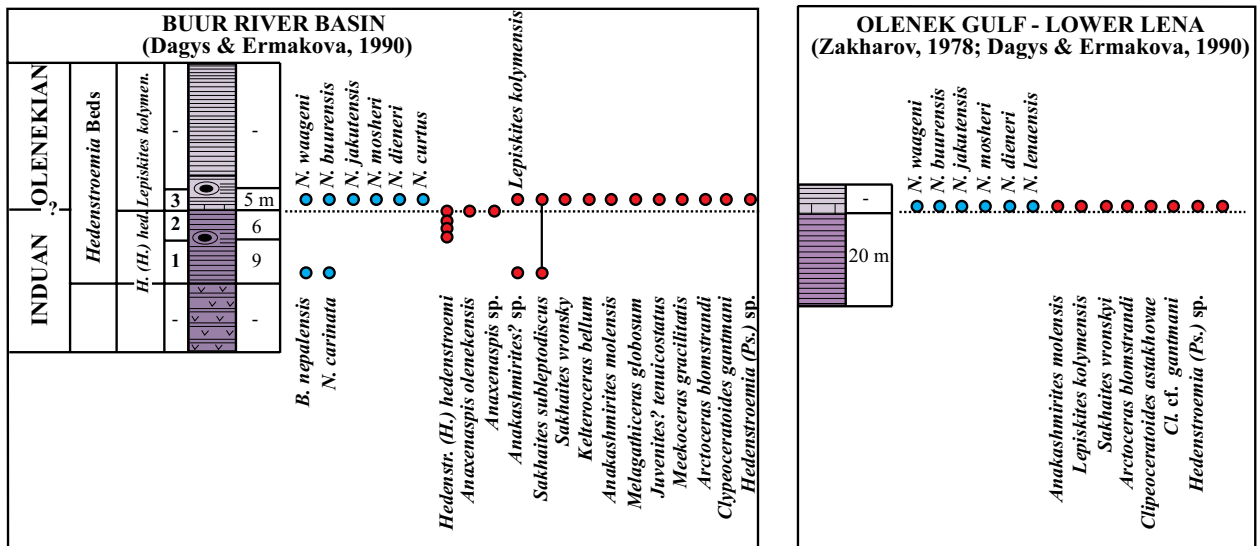
Figure 2. Vertical range and zonation of conodonts and ammonoids in the IOB in Abrek Bay, South Primorye.



**Figure 3.** *Hedenstroemia* (*Pseudohedenstroemia*) *tscherskii* Popow, sample 256-2-8 (Y.D. Zakharov's coll.); *Lepiskites kolymensis* Zone; Kenyelichi River, Kolyma River basin, north Russia Far East.



**Figure 4.** *Hedenstroemia* (*Pseudohedenstroemia*) *tscherskii* Popow, sample 255-19a (Y.D. Zakharov's coll.); *Lepiskites kolymensis* Zone; Kenyelichi River, Kolyma River basin, north Russia Far East.



**Figure 5.** Vertical range and zonation of conodonts and ammonoids in the IOB in Arctic Siberia.

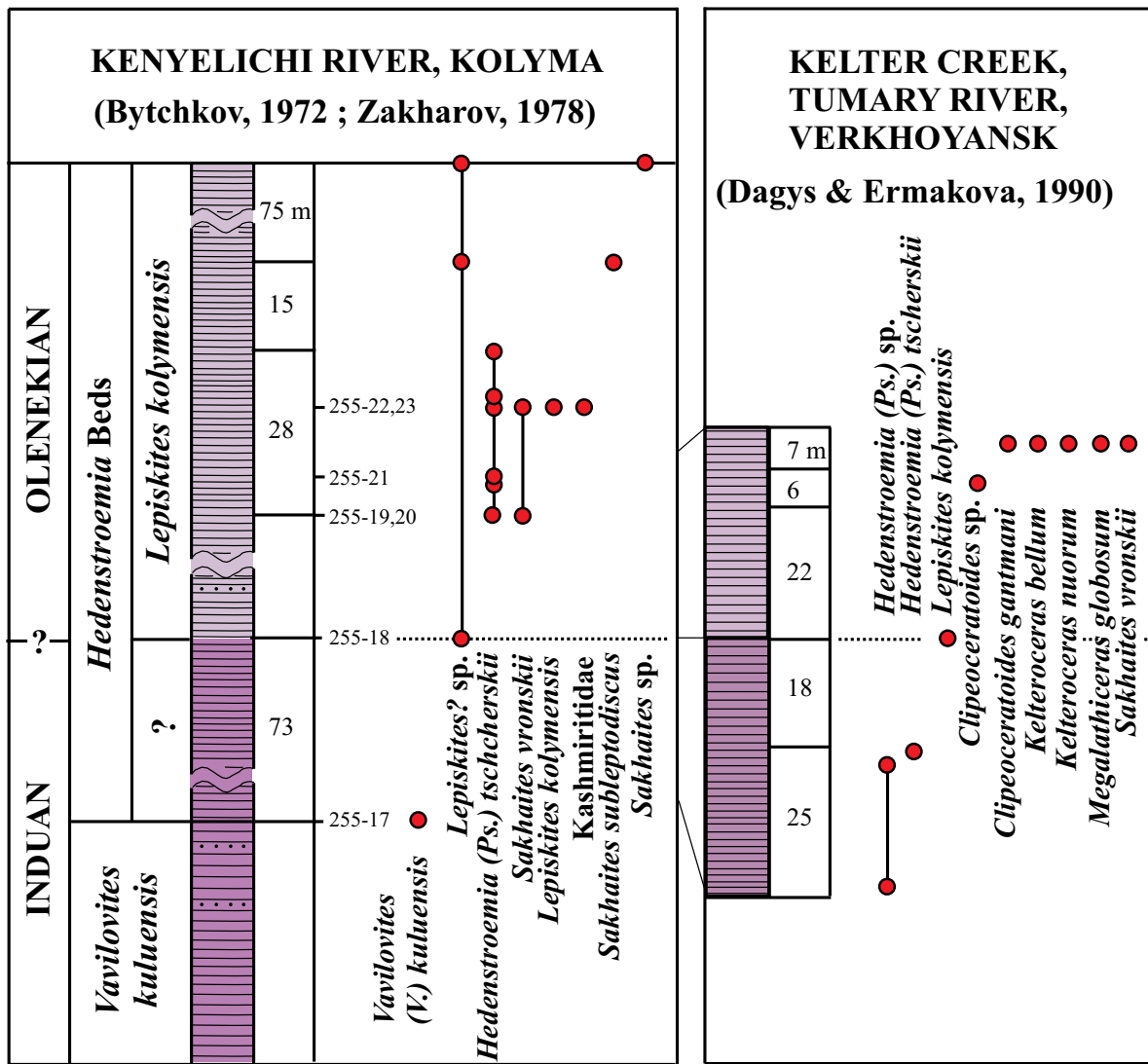


Figure 6. Vertical range and zonation of ammonoids in the IOB at the Kolyma and Verkhoyansk areas.

STAGE	TETHYS				BOREAL REALM						
	SPITI (Krystyn et al., 2007; with minor correction)		CHAOHU (Tong et al., 2003; with minor correction)		SOUTH PRIMORYE (Zakharov, 1968, 1978, 1997; Buryi, 1979; Markevich and Zakharov, 2004; Shigeta et al., 2009, in press)		SIBERIA (Dagys, 1984; Zakharov, 1978; Dagys & Ermakova, 1990; with correction)				
OLENEKIAN	<i>Wasatchites-Anasibirites</i>		<i>N. milleri</i>	<i>Anasibirites</i>	<i>Anasibirites nevolini</i>		<i>N. milleri</i>	<i>Anawasatchites tardus</i>	<i>N. milleri</i>		
	<i>Owenites Euflemingites-Fl.</i>		<i>N. spitiensis</i>	<i>Flemingites-Eufleming.</i>	<i>N. waageni</i>	<i>Hedenstr. (Pseudoh.) bosphoren.</i>	<i>Eufleming. prinadai</i>	<i>N. ex gr. waageni</i>	<i>Hedenstroemia Beds</i>	<i>Lepiskites kolymensis</i>	<i>N. bicuspidatus</i>
	<i>Rohillites rohilla</i>	<i>B. mandh. B. griesb. R. n. sp. 1</i>	<i>N. waageni s. str.</i>								<i>N. waageni s. l.</i>
<i>Meekoceras? vercherei</i>	<i>B. nepalen.</i>	<i>N. waageni</i>	<i>N. dieneri</i>	<i>Gyronites subdharmus</i>	<i>N. carinata</i>	<i>N. nepalen.</i>					
<i>Gyronites frequense</i>	<i>N. cristagalli</i>	<i>Prionolobus-Gyronites</i>	<i>N. kummeli</i>			<i>Vavilovites</i>					

Figure 7. Correlation of the Upper Induan and Lower Olenekian in the Tethys and Boreal realm.



*Spiti (Himalayas)*

A last study of the Lower Triassic in the Mud area has evidenced a distinct Induan-Olenekian sequence boundary between subbeds 12E and 13A (Krystyn et al., 2007). According to the recommendation of the Subcommission on Triassic stratigraphy, Krystyn indicates the base of the Olenekian in the section MO4 of Mud at the base of Subbed 13A-3. At least subbeds 13A-3 and !3-B in the lower part of the Olenekian, as well as the *Stage A* of the *Neospathodus waageni* Zone in West Pingdingshan, contain some typical Induan conodont species (e.g. *N. cristagalli* and *N. dieneri*) associated with Olenekian conodonts, including *Ns. waageni* s.l.

It seems for us that there is a close correspondence between the mentioned sections located in Chaohu and Spiti. It is very important because the both of them have some defects: lack of the palaeomagnetic record for the Mud section and the absence of the full ammonoid control for the West Pingdingshan section. But these sections mutually add each other, which must be used in future works.

*South Primorye.*

Induan and early Olenekian ammonoid successions of South Primorye have been investigated in Tri Kamnya Cape, Golyj Cape, Yuzhnorechensk Settlement, SMID Quarry, and Ajax Bay (Kiparisova, 1961; Zakharov, 1968, 1978, 1997; Markevich and Zakharov, 2004), but most abundant Induan-Olenekian conodont succession were discovered and investigated in the Abrek Bay section (Shigeta et al., 2009, in press). However, because the FAD of *N. waageni* in Abrek Bay has not been determined yet, there are two versions concerning location of the Induan-Olenekian boundary there. One author of the present paper (Zakharov) correlates beds 12-14 of the section with the lower part of the *N. waageni* Zone (*Stage A*) of the Chaohu and Mud areas because they also characterized by some Olenekian ammonoids (e.g. *Parahedenstroemia*, *Arctoceras*, *Anaxenaspis*, *Dieneroceras*, *Gurleyites*, and *Preflorianites*), associated with Induan-type conodonts (Fig. 2). The most part of Bed 15, in contrary, is characterized by lack of Induan-type conodonts (*Stage B*). Other authors of the present paper incline in favour of location of the Induan-Olenekian boundary in the Abrek Bay section between the stages A and B, where Induan-type conodonts entirely disappear and where Olenekian *Rohillites* were discovered.

**Boreal realm**

According to traditional point of view, the base of the Olenekian in the Boreal realm is located at the base of the *Hedenstroemia hedenstroemi* Zone. Representatives of *Hedenstroemia hedenstroemi* (Keyserling) are known only from restricted localities (Buur River basin and Kotelny Island in Arctic Siberia).

First hedenstroemiid ammonoid (*Hedenstroemia hedenstroemi* (Keyserling)) was found by M. Hedenstroem in Kotelny Island in Arctic Siberia and was described by Keyserling (1845). Next finding was made by A. Middendorff in the Olenek River basin, possibly in the Buur-

Nyykabyt section, and described by Mojsisovics (1888) as *Meekoceras* nov. f. ind. ex aff. *Meekoceras hedenstroemi* (Keyserling). Later it was redescribed by Diener (1897) as *Hedenstroemia mojsisovicsi* Diener, which seem to be synonym of the *Hedenstroemia hedenstroemi* (Keyserling). Hedenstroemiid ammonoid with flat venter originated from the Mud section, Himalayas, firstly named as *Hedenstroemia mojsisovicsi*, was renamed by Spath (1934) as *Hedenstroemia himalayica*. Later it was offered by Kummel (Arkell et al., 1957) to be the type species of his new *Pseudohedenstroemia* genus.

I agree with Dagys and Ermakova (1990) that hedenstroemiid ammonoids are very abundant in the Kolyma area and Siberia, but not diversified there (they seem to be represented only by two/three species: *H. hedenstroemi* (Keyserling) and *H. tscherskii* (Popow) (Figs. 3 and 4). In our opinion, they are representatives of the same genus (*Hedenstroemia*) but different subgenera (*Hedenstroemia* and *Pseudohedenstroemia*). The venter of the *H. (Pseudohedenstroemia) tscherskii* changes in its ontogenesis from rounded to concave and narrow flattened, but the venter of the *H. (Hedenstroemia) hedenstroemi* changes from rounded to concave, flattened and narrow rounded. In Arctic Canada, known hedenstroemiid ammonoids, characterized by the narrow flattened venter, seem to be representatives of subgenus *Pseudohedenstroemia*.

*Arctic Siberia*

In the Buur River basin *Hedenstroemia* Beds are represented by *Hedenstroemia (H.) hedenstroemi* and *Lepeskites kolymensis* zones (Dagys and Ermakova (1990). Conodonts *N. waageni* are known only from the *Lepeskites kolymensis* Zone. In the Olenek-lower Lena area *N. waageni* was met also in association with *Lepeskites kolymensis* (Fig. 5). In basal beds of the *Lepeskites kolymensis* Zone in the both sections, typical Induan conodonts (*N. dieneri*) were discovered together with *N. waageni*, therefore we have every reason to correlate these beds with *Stage A* of the *N. waageni* Zone in the Chaohu section, beds 12-14 in the Abrek section and subbeds 13A-3 and !3-B in the Mud section.

*Kolyma and Verkhoyansk areas*

*Lepeskites kolymensis* Zone in the Kenyelichi River section (Kolyma River basin) is characterized by *Lepeskites kolymensis* (Popow), *Hedenstroemia (Pseudohedenstroemia) tscherskii* Popow, *Sakhaites subleptodiscus* (Popow), *S. vronskii* (Popow), representatives of *Kelterites* and *Kashmiritidae* (Fig. 6). Similar ammonoid association has been discovered also in the *Lepeskites kolymensis* Zone of the Verkhoyansk area (Dagys and Ermakova, 1990).

**Conclusions**

In both the Tethys and the Boreal realm I/O boundary coincides, apparently, with the FADs of conodont *N. waageni*. In this stage of our knowledge, new information allow us to correlate the lower part of the basal Olenekian *Rohillites rohilla* Zone in Spiti (Tethys) with the lower part of the *Lepeskites kolymensis* Zone in Siberia (Boreal realm) and

basal beds of the *Hedenstroemia bosphorensis* Zone (*Gyronites separatus* Beds) of South Primorye (Fig. 7).

The first hedenstroemiid ammonoids (*Hedenstroemia* (*H. hedenstroemi*)) originated, apparently, in Arctic Siberia (possibly in the Late Induan). Representatives of *Pseudohedenstroemia*, originated in that area some later, seem to be distributed in middle latitudes of the both hemispheres during Early Induan time.

## Acknowledgments

We are very grateful to Dr. G.I. Buryi (Russian Academy of Sciences, Vladivostok) for her determination of first conodont (*N. carinata*) from the Abrek Bay section, South Primorye.

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## Triassic Ammonoid Succession in South Primorye: 4. Stratigraphical and Palaeobiogeographical significance of flemingitids

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**Abstract** – A review of a new data on stratigraphical distribution of flemingitid ammonoids in the Lower Triassic of South Primorye (Seryj-Tri Kamnya Capes, SMID Quarry, Tobizin Cape, Golyj Cape and Abrek Bay sections) is given. Stratigraphical and palaeogeographical significance of flemingitids is briefly discussed.

### Introduction

Early Olenekian flemingitid ammonoids from South Primorye (Tri Kamnya Cape) were firstly studied by Kiparisova (1954, 1961), who identified them as *Flemingites prynadai* Kiparisova and *Flemingites* sp. Later Zakharov (1968) described some other fossils (e.g. *Flemingites tobisinensis* Zakharov from the Tobizin Cape (Russian Island) and Tri Kamnya Cape (western Ussuri Gulf) *F. radiatus* Waagen, *F. aff. glaber* Waagen, *Flemingites* sp., and *Euflemingites* sp. from the Tri Kamnya Cape, *Euflemingites?* sp from the Seryj Cape (eastern Ussuri Gulf) and also a large shell from Ajax Bay, Russian Island, originally identified as *Flemingites flemingianus* (Koninck), but later shown by

him as *Arctoceras*. One form from eastern Ussuri Gulf was identified by N.K. Zharnikova as *Flemingites prynadai* Kiparisova (Buryi, 1979).

The aim of this paper is to show some new data on stratigraphical distribution of flemingitid ammonoids in South Primorye.

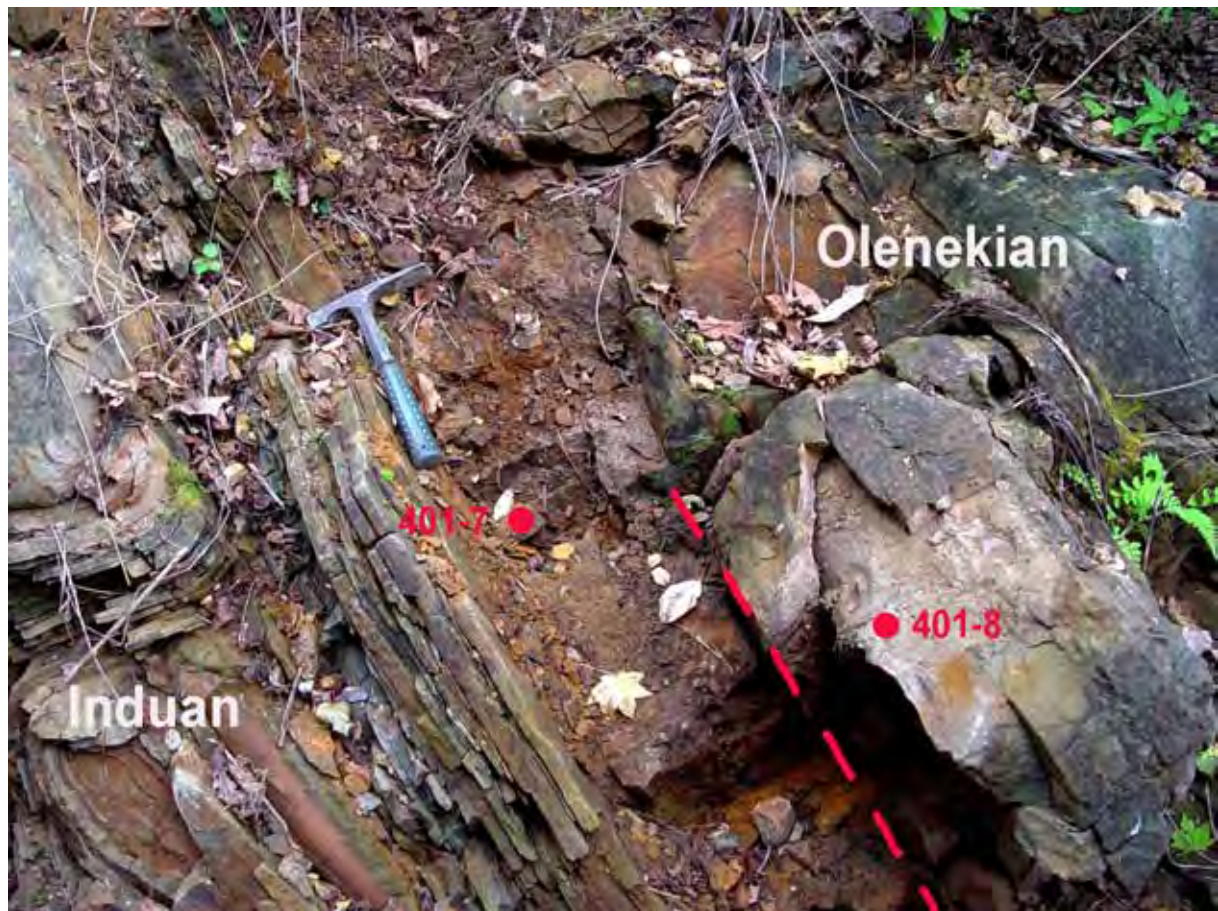
### Seryj-Tri Kamnya Cape

In the Seryj-Tri Kamnya Capes section in South Primorye, the Induan stage is represented by two zones: *Glyptophiceras ussuriense* and *Gyronites subdharmus* (Fig. 1). The latter is overlaid by the Early Olenekian *Hedenstroemia bosphorensis* Zone, consisting of two members in this



Figure 1. Seryj Cape, western Ussuri Gulf, Sea of Japan.





**Figure 2.** Location of earliest Olenekian *Hedenstroemia* (*Pseudohedenstroemia*) *bosphorensis* (Zakharov) (401-8), *Gyronites separatus* Beds of the *Hedenstroemia bosphorensis* Zone; Kontaktny Creek, western Ussuri Gulf.



**Figure 3.** Oryel Cliff, western Ussuri Gulf.





**Figure 4.** Location of “*Meekoceras*” cf. *subcristatum* Kiparisova and *Gyronites separatus* Kiparisova at the base of the Olenekian in Oryel Cliff.

section: *Gyronites separatus* Beds (11 m thick) (figs. 2-4) and overlying *Euflemingites prynadai* Beds (about 70 m thick). *Gyronites separatus* Beds are characterized by *Hedenstroemia* (*Pseudohedenstroemia*) *bosphorensis* (Zakharov), *Parahedenstroemia* sp., *Gyronites separatus* Kiparisova, *G. aff. planissimus* Spath, *Ambites* sp. indet. and “*Meekoceras*” cf. *subcristatum* Kiparisova.

Tri Kamnya Cape is one of sections in South Primorye, where *Euflemingites prinadai* (Kiparisova), important stratigraphical index (Fig. 5), was found in many stratigraphical levels within 70-meter sequence of the *Euflemingites prinadai* Beds (Fig. 6). Its representatives, represented by full shells or their fragments with characteristic spiral sculpture, were discovered sometimes in association with *Flemingites* and other early Olenekian ammonoids (Fig. 7).

#### SMID Quarry

At SMID quarry near Artyom town, a single full shell (Fig. 8), identified as *Euflemingites* sp. n., has been found in talus, originating apparently from the layer of the *Hedenstroemia bosphorensis* Zone located just below the *Anasibirites nevolini* Zone (Fig. 9), but fragments of *Euflemingites* shells in this section distribute within all 60-meter sequence of the *Hedenstroemia bosphorensis* Zone, characterized by *Arctoceras*, *Dieneroceras*, *Anaxenaspis*, *Parussuria*, *Owenites*, *Prionolobus*, *Prosphingitoides*, and *Kashmirites*, typical for the Lower Olenekian.

#### Golyj Cape

Lower Triassic sediments well expose at the Golyj Cape area (Fig. 10), at the same time only a single fragment of *Euflemingites* shell have been found there in association with ammonoids *Hedenstroemia*, *Parussuria*, *Metussuria*, *Tellerites*, *Arctoceras*, *Prosphingitoides*, *Juvenites*, *Owenites*, *Prionolobus*, *Inyoites*, *Hemiprionites* and *Gurleyites*?, and conodonts *Neospathodus zharnikovae*, *Furnishius triserierratus*, *Hadrodontina subsymmetrica*, *Ellisonia triassica*, *E. cf. meissneri*, *Hindeodella triassica*, and *H. nevadensis* (Buryi, 1979).

#### Tobizin Cape

In the south-eastern part of the Tobisin Cape, where only the upper *Anasibirites nevolini* and lower *Tirolites-Anasibirites* zones are known in the the large cliff (Fig 11), a large evolute ammonoid shell was found in block of calcareous sandstone-coquina, originated from the *Anasibirites nevolini* Zone. This fossil, collected 740 m southwest of Point 57 (Markevich and Zakharov, 2004, Fig. 4), was originally described as a holotype of *Flemingites tobizinensis* Zakharov (1968), however, it considers to be *Guangxiceras tobizinense* (Zakharov) now.

#### Abrek Bay

A single representative of *Euflemingites* (*E. prinadai*) has been found in the upper part of the quarry (Zhitkov Cape Formation, *Hedenstroemia bosphorensis* Zone, the upper



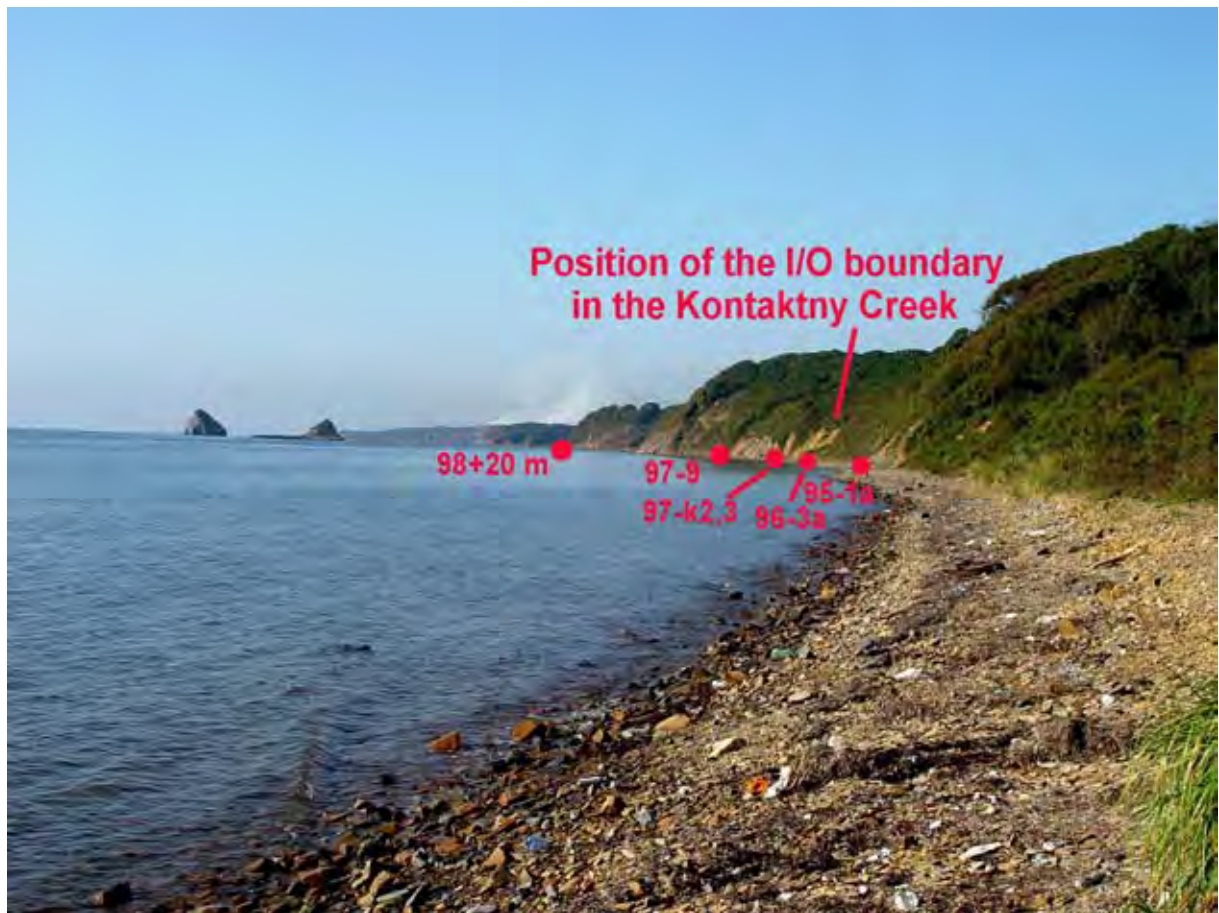


Figure 5. Location of *Euflemingites* in the Tri Kamnya Cape section; western Ussuri Gulf.



Figure 6. Location of *Euflemingites* and *Flemingites* in the Tri Kamnya Cape section; western Ussuri Gulf.





**Figure 7.** *Euflemingites prinadai* (Kiparisova); *Euflemingites prinadai* Beds of the *Hedenstroemia* (*Pseudohedenstroemia*) *bosphorensis* Zone; Tri Kamnya Cape area; western Ussuri Gulf.



**Figure 8.** *Euflemingites* sp. n.; SMID quarry, Artyom, South Primorye.



**Figure 9.** Ammonoid association in the *Euflemingites prinadai* Beds of the *Hedenstroemia bosphorensis* Zone; SMID quarry, Artyom, South Primorye.



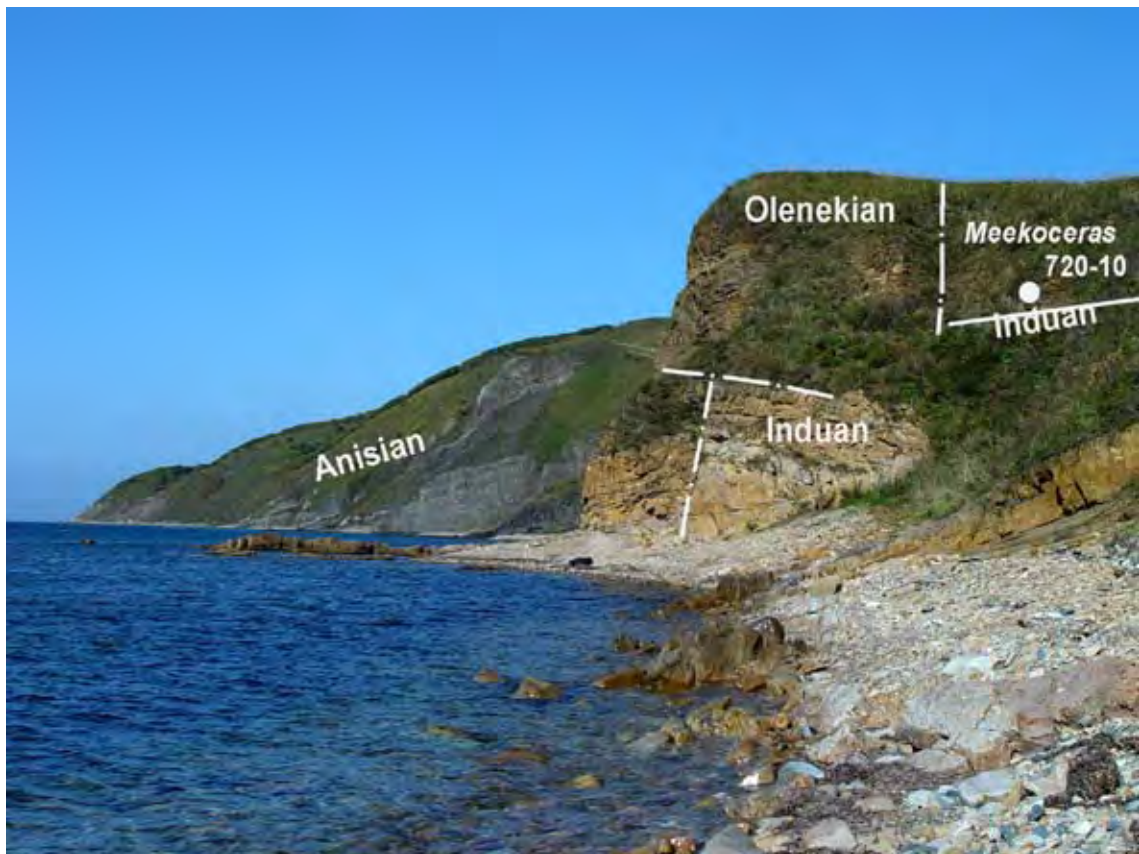
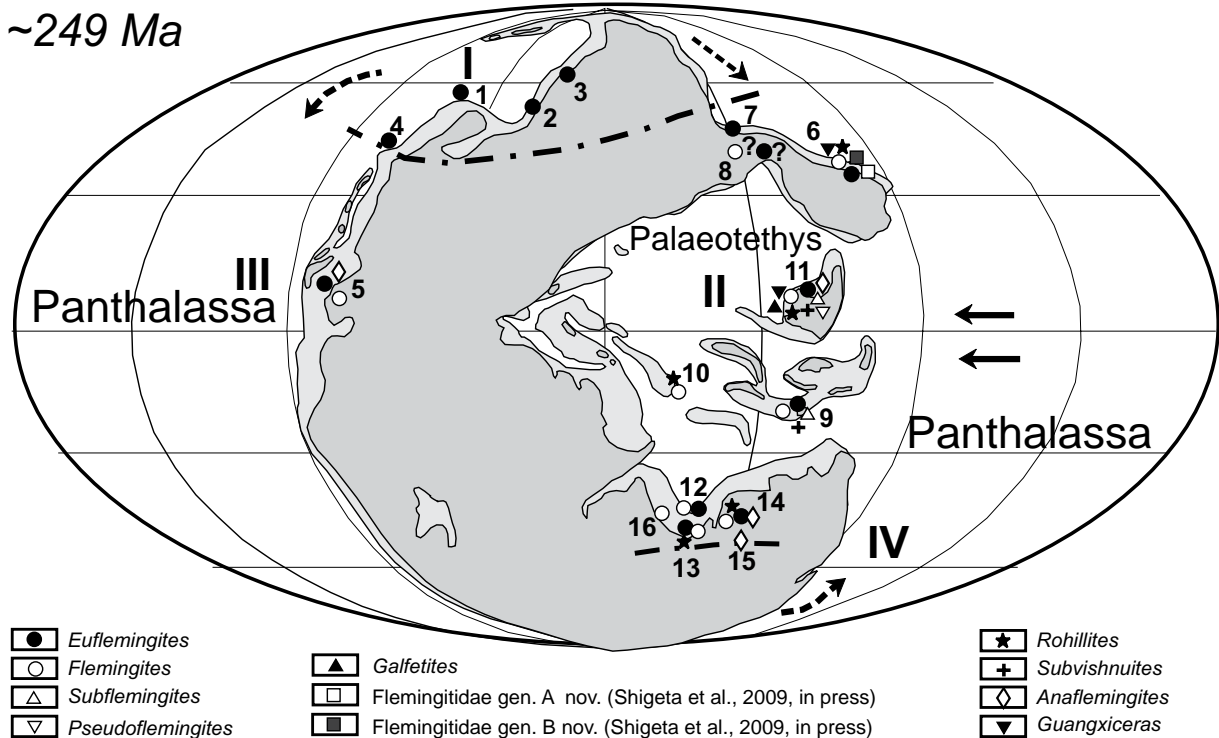


Figure 10. Lower-Middle Triassic at Goly (Kom-Pikho-Sakho) Cape area, eastern Ussuri Gulf.



Figure 11. Location of *Guangxiceras tobizinense* (Zakharov) in the Tobizin Cape, Russian Island.



**Figure 12.** Palaeogeographical map showing the distribution of flemingitid ammonoids during the late Early Olenekian (base map after Ziegler et al. 1999). Realms: I – Boreal, II – Tethyan Palaeoequatorial, III - American Palaeoequatorial, IV – Gondwanan. 1 - ArcticCanada (Tozer 1961, 1994); 2 –Svalbard (Mørk et al. 1999); 3 – Verkhojansk area (Dagys and Ermakova, 1990); 4 – British Columbia (Tozer, 1994); 5 – Idaho (Smith 1932); 6 - South Primorye (Kiparisova, 1961, Zakharov, 1968, 1997; Shigeta et al., 2009, in press); 7 – Khabarovsk area (Okuneva, 1990); 8 – Mongolia (Ehiro et al., 2006); 9 – Timor (Welter, 1922); 10 – Afganistan (Collignon, 1973); 11 – South China (Chao, 1959; Tong et al., 2004; Brayard and Bucher, 2008); 12 – Salt Range (Waagen, 1895); 13 – Spiti (Krafft and Diener, 1909, Diener, 1897); 14 – Nepal (Kummel, 1970; Waterhouse, 1996); 15 – Tibet (Waterhouse, 1996); 16 – Madagascar (Collignon, 1933).

part of Bed 15 - *Arctoceras subhydaspis* beds (see Zakharov et al., 2009, Fig. 2 this volume). Other flemingitids in this section, represented by new species and genera (Shigeta et al., 2009, in press), has been found somewhat lower, in the middle part of Beds 15, where *Hemiprionites* sp. and *Clypeoceras timorensis* were discovered, and the *Anaxenaspis* bearing part of Bed 14, which overlies Bed 13, characterized by such typical early Olenekian ammonoids as *Parahedenstroemia* sp. and *Inyoites* sp. (= “Vishnuites?” sp. (Shigeta et al., 2009, in press).

**Correlation**

The three ammonoid zones are recognized in the lower part of the Olenekian in the Mud section: *Rohillites rohilla*, *Euflemingites-Flemingites*, and *Owenites* (Krystyn et al., 2007), showing separated distribution of *Rohillites* and other flemingitids there. However, in Guangxi *Rohillites* was recently discovered in the lower part of *Owenites koeneni* beds (Brayard and Bucher, 2008). In South Primorye reliable *Rohillites* (Shigeta et al., 2009, in press) and typical late Early Olenekian *Owenites* locate between the beds containing new flemingitid genera below and *Euflemingites* above. However, there is no information on distribution of the latter in the section, because only a single *E. prinadai* shell is known there. Nevertheless, judging from data on ammonoids from Guangxi (Brayard and Bucher, 2008) and additional information from South Primorye, the Himalayan *Rohillites rohilla* seems to be the oldest representative of the genus *Rohillites*.

Taking into account our doubt concerning specific belongings of Canadian hedenstroemiid ammonoids (Tozer, 1994), we offer to correlate the upper part of the *Hedenstroemia bosphorensis* Zone (*Euflemingites prinadai* beds) of South Primorye with the *Euflemingites romundari* Zone in Arctic Canada and British Columbia (Tozer, 1994), the upper part of the *Lepiskites kolymensis* Zone in Siberia (Dagys and Ermakova, 1990), *Rohillites rohilla* (upper part), *Euflemingites-Flemingites* and *Owenites* zones in the Himalayas (Krystyn et al., 2007), *Flemingites-Euflemingites* Zone in Chaohu (Tong et al., 2004) and *Flemingites rursiradiatus*, and *Owenites koeneni* beds in Guangxi (Brayard and Bucher, 2008).

**Geographical differentiation of flemingitid ammonoids**

Known data shows, that only representative of a single flemingitid ammonoid genus (*Euflemingites*) were distributed in both tropical-subtropical and warm-temperate climatic zones in the late Early Olenekian. However, other flemingitid taxa (*Flemingites*, *Subflemingites*, *Rohillites*, *Subvishnuites*, *Anaflemingites*, *Pseudoflemingites*, *Galfetites*, *Guangxiceras*, Flemingitidae gen. nov. A, and Flemingitidae gen. nov. B (Fig. 12) were distributed only in the tropical-subtropical climatic zone. Shevyrev (1986) considered *Preflorianites*, *Preflorianitoides*, and *Anaxenaspis* to be flemingitid ammonoids;

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## GSSP of the Carnian Stage defined

### Maurizio Gaetani, on behalf of the ad hoc Task Group

The 6 of June 2008 the International Union of Geological Sciences ratified the selection of the GSSP for the Carnian Stage. Usually these formal approvals are done during the International Geological Congresses, but this approval preceded the Oslo Congress, held on August 2008. The GSSP of the Carnian Stage has been definitively assessed in the section of Prati di Stuores/Stuores Wiesen in Northern Italy, at the bed SW4, with the First Occurrence of the ammonoid *Daxatina canadensis*. It was the end of a long research and procedure.

The beginning may be traced back to the 1994, when I asked Carmen Broglio Loriga to lead an Italian Working Group to search for a suitable locality in the eastern Southern Alps, where to define the GSSP of the Carnian. It should be mentioned that historical localities as Stuores and Raibl were quoted by Mojsisovics et al. (1895) as reference localities for their Carnian Stage. Both are now in Italy, at their time within the boundaries of the Austro-Hungarian Empire. Carmen did a good job gathering a group of scientists that not only started to analyze the two classical localities, but also evaluated other localities in Southern Alps, in order to check for the best potential GSSP.

This stage of research was finalized in the papers by Broglio Loriga et al. (1998 a, b, 1999), in which the locality of Prati di Stuores/Stuores Wiesen resulted the best in the Southern Alps and was proposed as GSSP candidate. Notwithstanding the high sedimentation rate, ammonoids appear fairly well distributed, whilst conodonts are scarce, and significant bivalves like *Halobia* have a meagre documentation. Additionally, the range of foraminifers and crinoids was provided as well as palinology, magnetostratigraphy, and sequence stratigraphy. A first visit to Stuores of STS members was paid in July 1998. The novelty of the proposal was the formal suggestion to draw the boundary with the first occurrence of the ammonoid *Daxatina*, which lies below the first occurrence of *Trachyceras*, especially *Trachyceras aon*, which historically was considered as the base of the Carnian (Ulrichs 1974, 1994; Krystyn 1978). The conodont *M. polygnathiformis*, whose first occurrence was used by conodont workers to define the base of the Carnian (i.e. Kovacs et al., 1991) was not found in the sections 1 and 1a, but only in the overlying section 2, associated with *Trachyceras aon*.

The pros points of Stuores appeared to be mainly the fairly good distribution of ammonoids and the possibility of magnetostratigraphy, as well accessibility and from the historical point of view the coincidence with the Cordevolian strato-type, whilst the cons were the insufficient conodont and bivalve documentation.

Previously, in the same 1998, Gallet et al. published their results on the section of Mayerling in Austria. Conodonts are sufficiently distributed and magnetostratigraphy may be measured; however ammonoids and significant bivalves

are missing.

These results open the search for other candidates and also the attempt by Italian researchers to fulfil the feeble points of Stuores. Outside Europe, researchers focused on Spiti, India and in the South Canyon (New Pass Range) area in Nevada, USA. In the meantime, at the Veszprém meeting of the STS in September 2002, Mike Orchard asked me to lead an ad hoc Task Group. Members were from Austria, Canada, Hungary, Italy, Russia, Slovenia, and Turkey. Some actively participated, other not.

In the Himalaya, the valley of Spiti is a classic area for the stratigraphy of the Triassic. Marco Balini and Leo Krystyn did several trips to Spiti in cooperation with Indian scientists, especially O.N. Barghava and D.M. Banerjee (Balini et al., 1998, 2001, Balini et al., 2004). Eventually, Barghava, Balini, and Krystyn led the excursion to Spiti for the WG in July 2004, which was attended by some 22 scientists (Krystyn et al., 2004, Bhargava et al. 2004). They found between Guling and Muth, several sections. The best appeared to be Guling 1 and Muth 3, in which documentation of ammonoids, conodonts, and bivalves are good. The boundary is situated in the lowermost part of the Chomule Fm. with the entry of *M. polygnathiformis* recorded in the middle part of the range of *Frankites* and rather below the FO of *Daxatina*. Magnetostratigraphy is hampered by the later heating that affected the whole area, and another cons appears to be the fairly low sedimentation rate, with the suspect that some minor gaps are present through the section.

The area of South Canyon in the New Pass Range (Nevada), type of the *Trachyceras desatoyense* Zone of the earliest Carnian in the north-American scale was investigated mostly in the field by M. Balini and J. Jenks from Salt Lake City (Balini & Jenks, 2007; Balini et al., 2007; Balini, 2008). The sections have not always favourable exposure, and some trenches were excavated. Ammonoids are well spread (Balini & Jenks, 2007), as well conodonts (Orchard & Balini, 2007) and bivalves (McRoberts in Balini et al., 2007). Magnetostratigraphy is hampered by the Cretaceous nearby intrusions. Members of the Task Group had the opportunity to visit the section during the Albuquerque Symposium (May 2007). The new investigations lead to identify *Frankites*, *Daxatina* and *M. polygnathiformis* and *Daonella* gr. *elegans* rather below the FO of *Trachyceras*.

In the meantime, Italian researchers improved the documentation on Stuores. Taxonomy of ammonoids improved (Mietto et al., 2004; 2008) and additional conodont occurrences were identified, even if documentation remained meagre. However, very important was eventually the finding of *M. polygnathiformis* just above the first bed (SW4) with *Daxatina*. It resulted an updated proposal of



GSSP at Stuoeres (Mietto et al., 2007a) and its correlation potential was discussed at Albuquerque Symposium (Mietto et al., 2007b).

The Albuquerque Symposium was a turning point towards the solution. With the visit to the South Canyon, scientists and members of the STS had the opportunity to visit the last of the three best areas and sections investigated to define the boundary. The new data both on Stuoeres and South Canyon were shown, as well as new data for conodonts on the critical interval in British Columbia (Orchard, 2007). A meeting of the Task Group and of the STS was devoted to discuss the issue. It appeared that the entry of *M. polygnathiformis* was not considered as sufficiently affordable to define the base of the Carnian, whilst the FO of *Daxatina canadensis* appeared to be the best tool for correlation. The general picture of the faunal evolution between Tethys, Nevada and British Columbia appeared sufficiently assessed. People attending the meeting considered that basic and sufficient information was gathered to arrive to a decision on the definition of the GSSP. The base of the Carnian is drawn with the FO of the ammonoid *Daxatina canadensis* and the FO of *P. polygnathiformis* is a proxy, usually slightly preceding the entry of *Daxatina*. Other palaeobiological events and physical events may be correlated to this boundary. They unanimously suggested to select Prati di Stuoeres/Wiesen as GSSP of the Carnian.

In November-December 2007 a formal vote was obtained by the Task Group members, with the following result 13 Yes, 0 No, 0 abstention; 5 No answer.

This voting was delivered to M. Orchard, Chairman of the STS, and in January 2008 the Secretary C. Mc Roberts sent out a formal vote amongst the Voting Members, which gave these results: 21 Yes, 0 no, 0 abstention and 4 no answer. Having obtained more than the 60% of positive answers, all the documents were sent to the ICS for final approval. The ICS asked for more information on some specific points in March, especially concerning the conodont occurrence, the potential of correlation and magnetostratigraphy. This was a very interesting issue, because the ICS adopted a kind of “quality control” on the proposal, previously not so strict at least as for other already approved Triassic GSSPs. Answer and additional information to make more robust the proposal were provided and eventually in April the ICS approved with reservation the GSSP of the Carnian defined at the section of Stuoeres, with these results: 80% Yes, 20% Abstain (and 3 no answer). Final ratification by IUGS was obtained June 6, 2008.

Is thus everything OK? I guess that improvements are still necessary, both in biostratigraphy in Dolomites in order to have nearby auxiliary sections with not so high sedimentation rate and more conodonts. Improvements in magnetostratigraphy correlation and isotope stratigraphy seems to be also an important future target. Therefore we may consider that the adopted solution is at present the best possible, but improvements are still possible and likely.

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# Late Triassic biostratigraphic constraints in the Imagna Valley (western Bergamasc Alps, Italy)

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Keywords: Late Triassic, Rhaetian, Bergamasc Alps, western Southern Alps, conodont

## Introduction

In the Lombardy Basin, the last Triassic depositional system, deposited after the crisis of the Dolomia Principale carbonate platform, consists of a subtidal mixed shale-carbonate (up to decameter thick) cycles represented by the Argillite di Riva di Solto and the Zu Limestone formations followed by the Hettangian Malanotte and Albenza (*Conchodon Dolomite Auctorum*) Formations. Since the middle of the 1800s several litho-biostratigraphic works on the upper Triassic-lower Jurassic succession of the Bergamasc Alps (western Southern Alps) have been carried out (i.e. Stoppani, 1857; Kronecker, 1910; Anelli, 1949; Bertuletti, 1962; Allasinaz, 1962; Gnaccolini, 1965; Gaetani, 1970; Fantini Sestini and Motta, 1984; Lakew, 1990; Jadoul, 1994; McRoberts, 1994; Cirilli et al., 2000; Galli, 2002; Jadoul et al., 2004; Galli et al., 2005; 2007). However, the absence of conodont/ammonoid constraints and the low biostratigraphic resolution of the other taxa, led to several misunderstood interpretations. For instance, Allasinaz (1962) based his biostratigraphic investigation on bivalves fauna and indicated the base of the Hettangian in the *Grenzbivalvenbank* (Kronecker, 1910; Rossi Ronchetti and Brena, 1953) that is a very rich fossiliferous bank containing echinoids, bivalves and corals, located at the base of the Sedrina Limestone Formation, just above the *Conchodon Dolomite Auctorum*. Gnaccolini (1965), instead, reviewed the Lombardian stratigraphy recognizing three units (the Argillite di Riva di Solto, the Zu Limestone and the *Conchodon Dolomite*) and he considered them as Rhaetian in age. According to Allasinaz (1962), Gaetani (1970) and McRoberts (1994) confirmed the base of the Sedrina Limestone as early Hettangian, basing on a faunistic assemblage of *Chlamys*-bed.

In the last two decades the biostratigraphy of these units has been instead focused on benthic foraminifers and palynomorphs which attributed a latest Norian-Rhaetian age to the Zu Limestone Fm. (Lakew, 1990; Jadoul et al., 1994; 2004). Based on the palynological composition and isotopic analyses, the base of the Hettangian stage has been located in the lower portion of the Malanotte Formation (Cirilli et al., 2000; Galli et al., 2005; 2007). Thus, the overlying *Conchodon Dolomite*, recently stratigraphically reviewed and now renamed as Albenza Formation (Jadoul and Galli, 2008) is Hettangian in age.

In this paper, we present new conodont biostratigraphic

data useful to constrain the timing and thus the evolution of the Late Triassic depositional system in the Bergamasc Alps.

## Geological setting

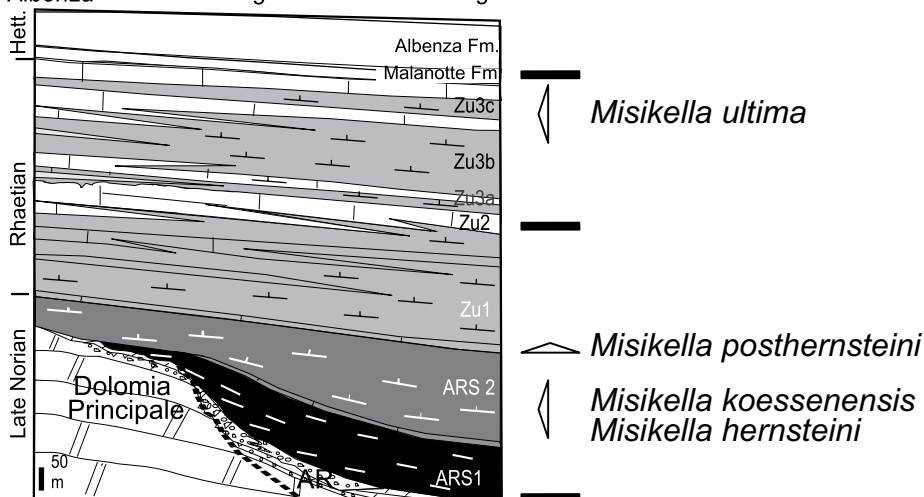
The evolution of a passive margin due to the opening of the Alpine Tethys is well recorded in the Norian-Early Jurassic stratigraphic succession of the western Bergamasc Alps (western Southern Alps) (Bertotti et al., 1993; Jadoul et al., 2004 and references therein). During the late Norian, a system of a mixed shale-carbonate depositional environments replaced that of the Dolomia Principale platform and of its intraplatform basins (Jadoul et al., 1994; 2004). The upper Triassic succession consists of Argillite di Riva di Solto (ARS) and Zu Limestone (Zu) formations (Figure 1). The main feature of the Argillite di Riva di Solto in respect to the overlying Zu Limestone Formation is the presence of abundant dark laminated shales, rich in organic matter. In the Argillite di Riva di Solto it is possible to distinguish a lower portion (ARS1) which is composed by asymmetric cycles of marls and rare limestones showing a carbonate content increasing upwards and an upper portion (ARS2) which is instead characterized by micritic bioturbated limestones, often rich in fossils (mainly bivalves) alternated by marls or marly limestones and laminated shales. The passage between the Argillite di Riva di Solto and the overlying Zu Limestone Formation is transitional and is characterized by ~100 m of dark shales in which the calcareous intercalations are more frequent upwards.

The Zu Limestone Formation is instead characterized by a mixed carbonate shale sedimentation in which the carbonate micritic component is dominant. It is represented by dark grey limestones, sometimes marly, intercalated by marls or marly shales, unusually dark in color. Coral banks are also present. The Zu Limestone Formation has been subdivided into three members (Zu1, Zu2 and Zu3) basing on their lithological features (Galli et al., 2007).

The Zu1 member (200-400 m thick) is very similar to the lower Argillite di Riva di Solto (ARS1) but with less dark shales and more calcareous components and it is organized in cycles with marls, marly and micritic limestones. Strata are rich in thin-shelled bivalves and locally parallel and rarely cross laminated packstones are present.

The Zu2 member (up to 100 m thick) is characterized by carbonate shallowing upwards cycles with bioturbated

Albenza Southern Imagna V. Northern Imagna V.



Keywords:

- AR Aralalta Group
- ARS1 Argillite di Riva di Solto - lower
- ARS2 Argillite di Riva di Solto - upper
- Zu1 Zu Limestones - lower member
- Zu2 Zu Limestones - middle member
- Zu3 Zu Limestones - upper member  
(a, b, c = lithofacies)

- barren
- △ appearance
- ◇ occurrence

**Figure 1.** Late Triassic/earliest Jurassic stratigraphic sketch of the western Bergamasc Alps with the occurrences of the major conodont species.

wackestones at the base and intrabioclastic and/or oolitic intercalations at the top. Locally coral patch reef are developed.

The Zu3 member (120-200 m thick) is represented by marls, marly and micritic limestones arranged in asymmetric cycles with thin iron-oxide crusts at the top and evaporitic facies within marly horizons. Bioturbated wackestones or packstones with benthic foraminifers, sponges, corals and incrusting organism are recorded.

The Zu Limestone Formation passes upwards into the Hettangian transgressive, thinly-bedded, open subtidal micritic limestones of the Malanotte Formation (Galli et al., 2007).

**Conodont investigations**

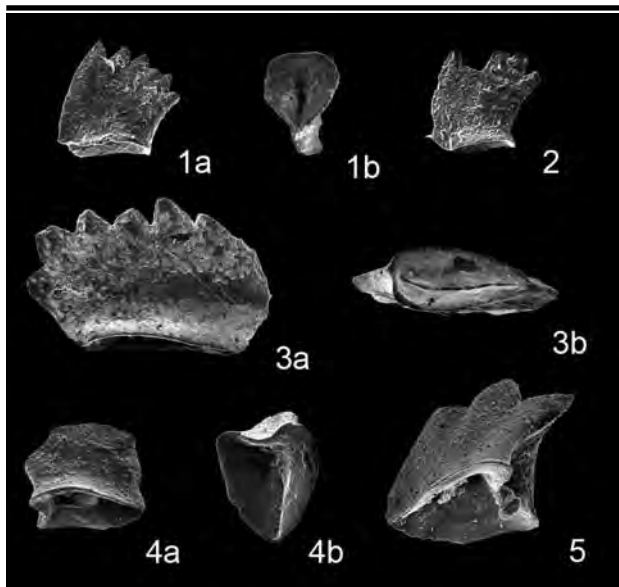
We present here the preliminary conodont biostratigraphic data of the Bergamasc Alps (western Southern Alps, Italy) (Figure 1, 2). A useful conodont fauna composed of *Misikella hernsteini* and *Misikella koessenensis* has been collected from the base of the upper Argillite di Riva di Solto (ARS2), restricting thus the age to Sevatian 2 (latest Norian) (Kozur and Mock, 1991; Moix et al., 2007). Even if rare, *Misikella koessenensis* can be found in the latest

Sevatian (Moix et al., 2007).

A major dataset has been collected for the Zu limestone Formation, in particular on the Zu1 member. In the transitional interval between the Argillite di Riva di Solto and the Zu Limestone Formation only species *Misikella hernsteini* occurs, along with *Misikella koessenensis*. This fauna is the same collected from the underlying Argillite di Riva di Solto (ARS2). At the base of the Zu1 member, and thus the base of the Zu Limestone Formation, *Misikella posthernsteini* occurs. Conodont investigations has been also carried out at the top of the Zu1 member where a fauna composed by *Misikella hernsteini*, *Misikella posthernsteini* and *Misikella koessenensis* occurs together with a new conodont species here called *Misikella* n. sp. A. The base of the Zu2 member has been also investigated for conodont biostratigraphy, but the samples resulted barren as expected. The upper Zu Limestone Formation (Zu3 member) yielded only a species of *Misikella ultima* which has been collected from the last calcareous layer, just below the net contact to the overlying Malanotte Formation which is Hettangian in age basing on palynomorphs and isotopic data (Cirilli et al., 2000; Galli et al., 2005; 2007).

The first occurrence (FO) of *Misikella posthernsteini* is commonly used to define the base of the Rhaetian (Kozur





**Figure 2.** SEM micrographs of conodonts: 1 a, b) *Misikella koessenensis*, Zu Limestone Fm., Zu 1 member, Brumano section, sample J 270; 2) *Misikella koessenensis*, Zu Limestone Fm., Zu 1 member, Brumano section, sample J 279; 3 a, b) *Misikella hernsteini*, Zu Limestone Fm., Zu 1 member, Costa Imagna section, sample J 18c; 4 a, b) *Misikella posthernsteini*; Zu Limestone Fm., Zu 1 member, Brumano section, sample J 276; 5) *Misikella posthernsteini* Kozur and Mock, Zu Limestone Fm., Zu 1 member, Costa Imagna section, sample J 22a.

and Mock, 1991) and it has been recently calibrated with the FO of *Paracochloceras suessi*, an ammonoid largely used to define the base of the Rhaetian stage (Krystyn et al., 2007).

Furthermore, Kozur and Mock (1991) recognized the upper Rhaetian with the appearance of *Misikella ultima*, never found from Jurassic strata. Basing on conodont data, the whole Zu Limestone Formation is Rhaetian in age.

## Conclusions

In the Lombardy Basin, the last Triassic depositional system, developed after the crisis of the Dolomia Principale carbonate platform, consists of a subtidal mixed shale-carbonate cycles. This thick and heterogeneous succession was deposited in inherited restricted basins (Argillite di Riva di Solto) followed by the development of distal up to proximal carbonate/terrigenous ramps (Zu Limestone Formation). A rich conodont fauna collected from the Zu1, Zu2 and Zu3 members allowed to constrain the whole Zu Limestone Formation to the Rhaetian stage.

The obtained data set lead to reconsider and relocate the previous stratigraphic boundaries. In fact, the top of the Dolomia Principale was usually considered at the transition between the middle and the late Norian, the Argillite di Riva di Solto and the lower Zu Limestone (Zu1 member) were retained as late Norian and the middle to upper Zu Limestone (Zu2-Zu3 members) was traditionally attributed

to the Rhaetian. These results have significant implications for the sedimentation rates and the duration of the Rhaetian stage.

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## New Rhaetian base and brachiopod fauna

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**Abstract** On the strength of accessible data, remarkable changes in the Upper Triassic brachiopod assemblages can be observed at the boundary between *quinquepunctatus* and *reticulatus* Zones. This corresponds to the FOD of *M. posthernsteini* and to the option 2 of the discussed Rhaetian base (see Figure 1). At that time the bulk of the Kössen brachiopod fauna appeared and is thus of Rhaetian age (new base).

With regard to proposed new base of Rhaetian, the attention should be focused in the next future on gaining more accurate data of FAD of brachiopods species occurring near the N/R boundary, based on accompanying conodont and ammonite fauna.

According to the recommendation of the Subcommittee on Triassic Stratigraphy the base of the Rhaetian Stage (Norian/Rhaetian boundary) should be defined by means of conodonts. The respective proposals were published quite recently by Krystyn et al. (2007a, 2007b) and Steinbergkogel in Austria became up to now the only GSSP candidate. Consequently, a short review of the character of the brachiopod fauna near the Norian/Rhaetian boundary is desirable.

There are 3 options suggested for the Norian/Rhaetian boundary in the mentioned proposals: 1) FO of *Misikella hernsteini*, 2) FAD of *Misikella posthernsteini* and 3) FO of *Vandaites*. With respect to the new proposals of the N/R boundary it should be necessary to revalue the stratigraphical distribution of the respective brachiopod species. However, the authors often presented their various views on the Norian and Rhaetian boundary and this may cause difficulties in stratigraphical evaluation of the brachiopod

fauna given in their faunal lists. Their information of the Upper Norian or Sevatian occurrences could represent now also partially or wholly Lower Rhaetian (new base).

The Uppermost Triassic brachiopod fauna is well known in the Northern Calcareous Alps, and is the most common and variable in the Kössen Formation („Kössen Beds“). It was studied in the past by a series of authors (e.g. by Suess, 1854, Zugmayer, 1880, Pearson, 1977, and its distribution in different facies by Golebiowski, 1990 etc.). The Rhaetian Zlambach fauna was described by Zapfe (1967). The Kössen brachiopods were considered Rhaetian but some of them were reported also from the Norian (Sevatian). According to Pearson (1970, 1977) *Austriellula cornigera* was the only species restricted to the Rhaetian (*Choristoceras marshi* Zone). This statement was impugned by Urlichs (1972) who had found the leading Norian ammonite *Rhabdoceras suessi* above *A. cornigera* in the Weissloferbach section. Krystyn (1990) wrote that “there is also no doubt

		ammonoid zones		conodont zones
Rhaetian options	[3] L. Rhaetian	<i>“Choristoceras “ haueri</i>	<i>Vandaites stuerzenbaumi</i>	<i>M. hernsteini - M. posthernsteini</i>
	2 Sevat. 2	<i>Paracochloceras suessi</i>	<i>Sagenites reticulatus</i>	<i>“E.” bidentata - M. posthernsteini</i>
	1			<i>“E.” bid. - M. h.</i>
Norian	Sevatian 1	<i>Metasibirites spinescens</i>	<i>Sagenites quinquepunctatus</i>	<i>“Epigondolella” bidentata</i>

**Figure 1.** Correlation of ammonoid and conodont zones based on Steinbergkogel data (adapted from Krystyn et al., 2007a).

that practically all Kössen brachiopod genera with exception of Ager's bellowed *Austrirhynchia* do occur in the Norian". Pearson (1970, 1977) summarized the Kössen brachiopods occurrences in the Norian (*suessi* or even *Himavatites columbianus* Zones) in the NCA, in Caucasus, Crimea, East Bulgaria and Stratenska hornatina Mts. (incl. famous Bittner's locality Drnava), what was later called in question by Dagys & Dagys (1994).

New scheme divides existing Upper Norian – Sevatian into Sevatian 1 with *Sagenites quinquepunctatus* below and Sevatian 2 with *Sagenites reticulatus* above (see Figure 1). Important changes in the composition of the ammonite, pelecypod and brachiopod faunas between *quinquepunctatus* and *reticulatus* Subzones were ascertained already by Dagys (1988). That all meant for him the N/R boundary, connected with disappearance of *Halorella* and *Halorelloidea*, and with appearance of Kössen brachiopods like *Austrirhynchia*, *Laballa*, *Zugmayerella* etc. The same opinion was repeated by Dagys & Dagys (1994). According to them, the change in the brachiopod fauna at the boundary *reticulatus* Zone x *Vandaites stuerzenbaumi* Zone is unclear and most probably unimportant, while the Rhaetian starting at bottom of *reticulatus* Zone could be ascertained worldwide. This view was followed later e. g. by Hallam (2002). Dagys & Dagys (1994) offered also an interesting information that the data on the so-called „Norian-Rhaetian“ brachiopod assemblages in the Caucasus, Crimea, Pamir, West Carpathians etc., given earlier by Dagys (1963) were caused by the overestimating of the stratigraphical value of the accompanying leiostracan ammonites. Thus some occurrences of the Kössen brachiopods in the mentioned regions were erroneously considered Norian or Norian/Rhaetian. The brachiopod assemblages in the *quinqueplicatus* Zone are different from those in the younger zones, and this was confirmed also by the recent studies in the alpine Kössen Beds. According to Kozur (2003, p. 70) is the Norian/Rhaetian boundary connected with the FAD of *Misikella posthernsteini*, which is at or very close to the base of *Cochloceras suessi* Zone. In his opinion Norian brachiopods like *Halorella*, *Halorelloidea*, *Crurirhynchia*, *Camerothyris* and *Pexidella* disappeared and the Rhaetian ones like *Austrirhynchia cornigera*, *Oxycolpella oxycolpos*, *Rhaetina pyriformis*, *Laballa suessi* and *Zugmayerella koessenensis* succeeded to their position. However, according to Kozur the brachiopod appearance was at those days not satisfactorily correlated with ammonites and conodonts.

Golebiowski's detailed studies of the Kössen Formation (1990, 1991) in the Tirolicum and Bajuvaricum showed that the characteristic brachiopod fauna appeared in his Unit 2 (and partially Unit 3) of the Hochalm Member (*reticulatus* Zone), containing FOD of *Misikella posthernsteini*. This Golebiowski's "Rhaetina – Biofacies" with monotypical occurrences of *Rhaetina gregaria* is followed upwards by "Zugmayerella – Biofacies", "Fissirhynchia – Biofacies" and finally by "Oxycolpella – Biofacies" ("Oxycolpellenkalk") at the top of the Kössen Formation (*Choristoceras marshi* Zone).

The proposed candidate GSSP Steinbergkogel near Hallstatt has not yielded many brachiopod species. Bittner (1890) mentioned or described from the local grey "Hallstätterkalk" *Halorella pedata*, *Waldheimia dualina*, *Juvavella Suessii*, *Spirigera deslongchampsii* and *Rhynchonella Mojsisovicsii*, and from the "Weisser Crinoidenkalk" (local neptunian dike) *Juvavella Suessii*, *Rhynchonella Geyeri*, *Rhynchonella nux*, *Koninckina blandula*, *?Koninckella norica*, *Amphiclina ambigua* and *Spirigera Deslongchampsii*. All mentioned species were held then as Norian in age. Not well proved at Steinbergkogel were *Spirigera oxycolpos* and *Spirigera pachyrhyncha*. Later collections in the grey limestone yielded *Camerothyris ramsaueri* (Suess). According to Tozer (1980) the grey limestones at Steinbergkogel correspond to *Cochloceras amoenum* Zone [= upper *suessi* Zone] and white crinoidal limestones to *Choristoceras crickmayi* Zone [= *marshi* Zone].

### Age of some selected Upper Triassic brachiopod localities

#### Norian:

JENNER – Zankl (1962); according to Krystyn (pers. comm. 2008) *Halorella amphitoma* starts in the Uppermost Laciian and is common in the Middle Norian.

HOCHSCHWAB – Early Norian age documented by *Epigondolella triangularis* (Budurov) yielded *Fissirhynchia fissicostata*, *Zugmayerella koessenensis*, *Laballa suessi*, *Sinuocosta emmrichi* and *Rhaetina pyriformis* (Siblík & Bryda, 2005):

TAUBENSTEIN – Norian (Spengler, 1919), (Krystyn, pers. comm. 2008).

#### Rhaetian (new scale):

HERNSTEIN p. p. – Krystyn (pers. comm. 2008).

KENDLBACHGRABEN – Lower and Upper Rhaetian (Gaździcki, Kozur & Mock, 1979); *crickmayi* Zone (Tozer, 1980); *marshi* Zone (Krystyn, 1987).

WEISSLOFERBACH - KÖSSEN – *crickmayi* Zone (Tozer, 1980); *marshi* Zone (Krystyn, 1987).

MÜHLTAL – *amoenum* Zone (Tozer, 1980); Rhaetian (Krystyn, pers. comm., 2008).

GOSAUSEE – Norian (Kittl & Spengler, 1916); Rhaetian: according to Krystyn (pers. comm., 2008) *Halorella* occurs above the Lower Rhaetian Dachstein Reef Limestone.

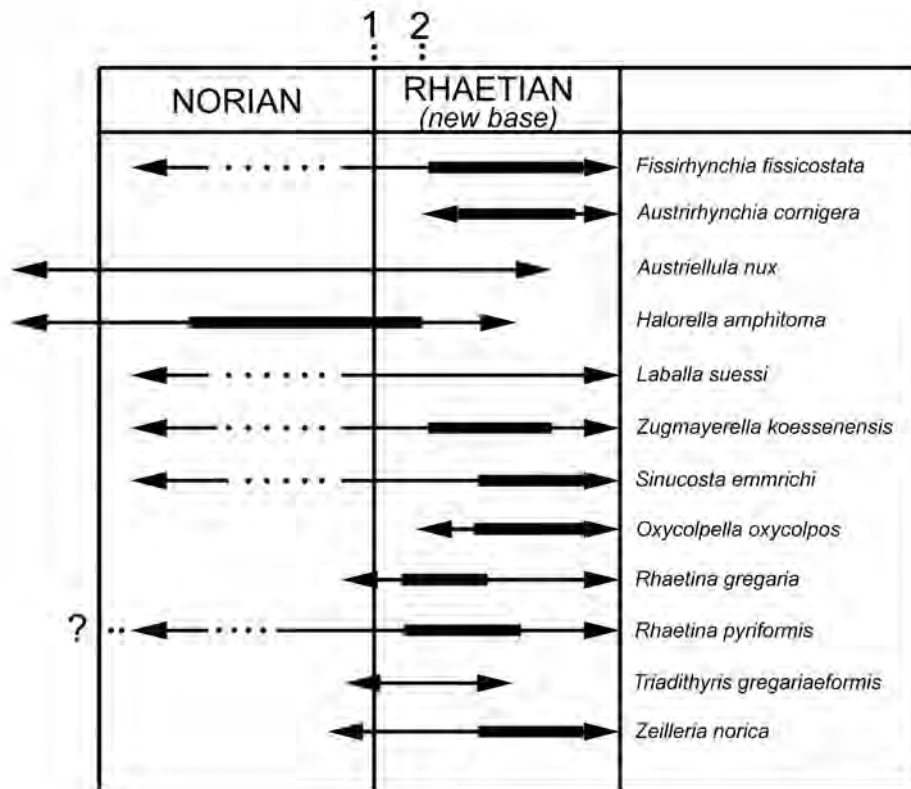
LUPPITSCH - *Pedata*-Schichten – Rhaetian (Krystyn, pers. comm. 2008), *Halorella* occurs together with *M. posthernsteini*.

KLEINER ZLAMBACH – *Vandaites stuerzenbaumi* and *Choristoceras marshi* Zones (Krystyn, 1987).

FISCHERWIESE - Zlambach Marls – Rhaetian (Zapfe, 1967); Lower Rhaetian (Gaździcki, Kozur & Mock, 1979).

STEINBERGKOGEL - grey Hallstatt Limestone: *amoenum*





**Figure 2.** Approximate stratigraphical ranges of some important Upper Triassic brachiopod species (based mostly on the literary data).

Zone = upper *suessi* Zone (Tozer, 1980); *Cochloceras* Beds (Krystyn, pers. comm., 2008). white crinoid limestones: *crickmayi* Zone = *marshi* Zone (Tozer, 1980); *stuerzenbaumi* Zone (Krystyn, 1987)

DRNAVA (Slovakia) – Rhaetian (Gazdzicki, Kozur & Mock, 1979 with history of previous research); *crickmayi* Zone (Tozer, 1980); *stuerzenbaumi* Zone (Krystyn, 1987).

CAUCASUS, TURKEY – occurrence of *Halorella amphitoma*: SE Turkey – Uppermost Carnian (Krystyn & Siblík, unpublished); Terziler - ? Rhaetian (Ager et al., 1978).

PAMIR – Postmonotis Beds (Dagys, 1990), (Dagys & Dagys, 1994), (Krystyn, pers.comm. 2008).

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## British Triassic palaeontology: supplement 33

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Since the completion of the writer's previous supplement (No.32; ALBERTIANA, 35: 91) on British Triassic palaeontology, the following works relating to aspects of that subject have appeared or come to his notice.

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## Future Meetings



### IGCP 572 “Permian-Triassic Ecosystems” (2008-2012) and her activities in 2009

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#### **The IGCP 572 “Permo-Triassic ecosystems” (2008-2012)**

As reflected in widespread public concern, modern marine ecosystems are fragile and defaunation events occur frequently in modern oceans and over the past decades and centuries, probably due to natural and/or anthropogenic disturbances, including for example global warming, oxygen depletion and toxic chemical pollution [18]. Looking into the past, life on Earth has undergone at least five major mass extinctions in the past 550 million years [26]. The sixth mass extinction, and potentially the worst, is now said to be in progress. Despite widespread upheaval, marine ecosystems have recovered from every Phanerozoic catastrophe. These pre-historical biotic crises are natural global experiments that provide lessons for us in effective ecological management; not only in predicting the possible impact of defaunation events on the marine ecosystems, but also, perhaps, in revealing ways to help accelerate the post-event restoration of the devastated ecosystems. In this regard, we, together with more than 130 researchers from 26 countries around the world, proposed the IGCP 572 to study a severe extinction event that occurred during the Permian-Triassic (P/Tr) global warming event (~252 million years ago). By analyzing the post-extinction reconstruction of marine ecosystems in the Early Triassic we hope to determine how marine ecosystems recover after global-scale natural crises.

As the greatest mass extinction of Earth life in the past 550 million years, the P/Tr extinction resulted in dramatic elimination of >90% marine species and >70% land life ([5]). The possible causes including: increased carbon dioxide concentrations and global marine anoxia, hypercapnia (CO<sub>2</sub> poisoning), a bolide impact, rapid global warming, and plume-induced volcanic eruption, may have triggered this catastrophe ([31], [8-12], [14-16]). Some of these triggers (i.e. global warming) are observed

in the present. Thus, the proposed study has tremendous relevance to today’s concerns regarding the extent to which human activity has influenced the loss of marine habitats and species.

Our objective in understanding the biotic response to the past crisis should be to develop a general understanding of the recovery mechanisms of marine ecosystems following the P/Tr crisis in global scale from the low-palaeolatitude regions (e.g. South China) to the high palaeolatitude regions (e.g. Greenland, New Zealand) [25]. The ultimate aim of the IGCP 572 is to provide insights to help manage the current defaunation event and subsequent recovery of marine ecosystems. Specifically we aim to:

1. utilize stratigraphically important fossil groups (e.g. conodonts, ammonoids) to establish robust biostratigraphic frameworks for the Early Triassic sequences worldwide, to enable accurate, high-resolution global correlation;
2. elucidate the recovery patterns of various fossil groups (e.g. brachiopods, bivalves, echinoderms, foraminifers etc.) by conducting phylogenetic analyses to help minimize sampling biases, and thus determining the true timing of recovery of various clades;
3. utilize palaeoecological, palaeontological (body and trace fossils), and sedimentological information to fully document marine communities throughout the recovery interval in a variety of environments from shallow to deep habitats and tropical to temperate climate zones, and construct a novel database of global P/Tr ecosystem types;

4. analyze community structures (e.g. alpha diversity, richness, dominance, tiering, biotic guilds), and to test and further refine a global palaeoecological recovery model recently proposed [28-29] and forming the basis of part of this project;
5. assess the roles of the so-called disaster taxa, Lazarus taxa and refugia in the recovery communities, and determine the relationships between microbial (stromatolites, thrombolites, calcimicrobia) structures and metazoa within a single community and between microbialite and metazoan communities;
6. utilize geochemical signatures (carbon, oxygen and sulfur isotopes, and biomarkers) as independent indicators of environmental and climate changes during the recovery stages in different habitats and climate zones;
7. reveal catastrophic events recorded in the Early Triassic successions and elucidate their relationships with those triggering the P/Tr mass extinction as well as effects on the Early Triassic ecosystems by integrating geochemical, palaeontological and sedimentological data;
8. elucidate the factors controlling the recovery rates of benthic communities in various habitats and climate zones, determine what are the similarities and differences in the response of the marine ecosystem to biotic crises at different scales, and assess climate effects on the restoration of a defaunated marine ecosystem.

The P/Tr mass extinction not only caused the largest crash in global biodiversity since the Cambrian explosion, but also dramatically redirected the course of subsequent biotic evolution. Consequently, it is largely responsible for much of the structure of marine ecosystems today [2]. In fact, some triggers of the P/Tr extinction event such as oceanic anoxia, influx of hydrogen sulfide, global warming and plume-induced volcanic eruption still influenced the Early Triassic oceans millions of years after the event itself. As a result, deleterious environmental conditions prevailed throughout much of the Early Triassic ([15], [6], [3]). Various palaeoecological and

sedimentary features such as the presence of disaster taxa including stromatolite mats, wrinkle structures, and seafloor calcium carbonate precipitates ([20-21], [27]), as well as lack of reefs built by colonial metazoans in shallow water, testify to the processes and effects of environmental degradation. Other aspects of stratigraphic record, as well as evidence from stable isotopes, also indicate that environmental conditions that would cause significant biotic stress existed during this time. Startling fluctuations in the records of several stable isotope systems through this interval also indicate a reorganization of the global carbon reservoir, indicating that the Early Triassic was a time of unusual environmental change [17]. Increased levels of CO<sub>2</sub> accompanied by a decrease in atmospheric O<sub>2</sub> level in the Early Triassic atmosphere led to global warming and oceanic anoxia ([7], [1], [14]). These widespread deleterious oceanic and climate conditions almost certainly influenced the timing and shape of the recovery following the P/Tr extinction [32].

However, the above conclusions are derived from studies of theoretical modelling or detailed field studies from western US, northern Italy and a few other regions [29]; few comprehensive Triassic recovery studies have been conducted in other parts of the world. Although the importance of palaeoecology in biotic mass extinction studies has been addressed by several recent studies ([3], [17]), there are, so far, two influential palaeoecological studies concerning ecologic recovery from the P/Tr crisis ([23]). In South China, the P/Tr successions are extensively exposed and well constrained by multiple fossil groups. In this region almost all types of depositional setting (i.e. nearshore, open platform, ramp to offshore basin) seen in modern tropical oceans were present in the P/Tr transitions. Unfortunately, the Early Triassic recovery of ecosystems in this region still remains poorly constrained, despite several past efforts ([15], [17-19]). No recovery data have been reported from the remaining regions proposed in this project (i.e., Japan, Russian Far East, southern Tibet, elsewhere in Asia, western Australia, New Zealand, Greenland-Spitsbergen), although the studies concerning the P/Tr extinction event have been published ([25], [7]). These regions were also located at different climate

zones from low-latitude tropic to high-latitude cold zone. Thus, the data from the above regions are crucial to success in formulating a global recovery model.

Quantifying biotic recovery is not easy [28]. One established model describing biotic extinction and subsequent recovery, proposed by Kauffman and Erwin [13], is based on the application of theoretical concepts of survivorship to the fossil record. In particular, taxa in the extinction aftermath were interpreted as having survived by virtue of one or other survival mechanism, based on characteristics of their stratigraphic range. However, this model is heavily reliant on interpretations based on literal reading of the stratigraphic ranges of fossil taxa and has incurred criticism of some aspects [28]. Alternatively, based on detailed palaeoecological studies of the recovery communities, one of the proposers (Twitchett) formulated a novel recovery model that attempts to quantify recovery rates and process using empirical, palaeoecological data only [28-29]. This model will be further tested and refined/rejected/replaced during the proposed project.

To achieve the above eight aims, this five-year IGCP project (2008-2012) will undertake the following ten studies:

1. Global latest Permian to Middle Triassic biostratigraphy [Aim 1];
2. Recovery pattern of fossil groups and Preservation and sampling biases [Aim 2];
3. Recovery model of palaeo-communities [Aims 3, 4, 7];
4. Community ecologic analysis [Aims 3, 4, 5];
5. Early Triassic microbial community [Aims 3, 5, 7];
6. Collapse and re-building of P/Tr reefs [Aims 4, 7];
7. Palaeophysiology of P/Tr mass extinction and its aftermath [Aims 4, 7];
8. Biomarker studies of the P/Tr successions [Aims 6, 7];
9. Isotopic geochemistry of the P/Tr transition [Aims 6, 7];
10. Restoration traits of marine ecosystems and comparison with modern defaunation event [Aim 8].

More detailed descriptions of these studies see project website [<http://www.igcp572.org>]. Briefly, the IGCP 572

is an ideal vehicle to bring together colleagues working on the P-Tr sequences of the world, with high quality research facilities and spectacular fossil records to address a truly global problem. In the past, several IGCP projects (i.e., 335, 359, 467) have been conducted by several generations of geologists to enhance our understanding of the P/Tr mass extinction and subsequent recovery. However, many issues of this ecologic crisis and subsequent prolonged recovery have remained little understood. Thus, studies of these issues have enjoyed a surge in scientific interest of the past 10-15 years that shows no sign of abating. In addition, these eight goals listed above will be achieved primarily by collaborative fieldwork in key Early Triassic successions in >10 different countries over five years (2018-2012) and related laboratory work in over 20 different countries. The results of our project, which are to be published in four edited books and special volumes, in international peer-reviewed journals, in annual symposium proceedings and on the World Wide Web, will advance scientific understanding of the interactions between the biosphere and geosphere and lead to a better understanding of ancient defaunation events. The firm support and active involvement in this project of most top scientists in this field from around the world will lead to unique training opportunities for postgraduate students from a range of countries (Argentina, Austria, Australia, Canada, China, Japan, France, Germany, Iran, India, Switzerland, UK, USA) as well as professionals from developing and developed regions alike. As a result, the IGCP 572 will provide a friendly platform for participants to communicate their own research results and also bring together global experts, and research facilities to solve a truly global-scale problem. The competitive track records of the proposers underscore this project's high chance of academic success as well as its potential to achieve significant societal benefits in the form of knowledge sharing and enhanced scientific cooperation between nations.

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## Co-leaders of the IGCP 572:

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Richard J. Twitchett (University of Plymouth, UK; e-mail: [richard.twitchett@plymouth.ac.uk](mailto:richard.twitchett@plymouth.ac.uk));

Jinnan Tong (China University of Geosciences, China; e-mail: [jntong@cug.edu.cn](mailto:jntong@cug.edu.cn));

Margret L. Fraiser (University of Wisconsin-Milwaukee, USA; e-mail: [mfraiser@uwm.edu](mailto:mfraiser@uwm.edu));

Sylvie Crasquin (Université Pierre et Marie Curie, France; e-mail: [sylvie.crasquin@upmc.fr](mailto:sylvie.crasquin@upmc.fr));

Steve Kershaw (Brunel University, U.K; e-mail: [stephen.kershaw@brunel.ac.uk](mailto:stephen.kershaw@brunel.ac.uk));

Thomas J. Algeo (University of Cincinnati, USA; e-mail: [thomas.algeo@uc.edu](mailto:thomas.algeo@uc.edu));

Kliti Grice (Curtin University of Technology, Australia; e-mail: [K.Grice@curtin.edu.au](mailto:K.Grice@curtin.edu.au)).

## IGCP 572 activities in 2009

1. IGCP 572 is sponsoring a session at the 9th North American Paleontological Convention titled "IGCP 572: Recovery of ecosystems after the Permian-Triassic mass extinction". The 9th NAPC will be held in June 21-26, 2009 at the [University of Cincinnati](http://www.cincinnati.ohio.edu), Cincinnati, USA. A small amount of money is available from IGCP 572 (Permian-Triassic Ecosystems) to help defray meeting costs for project members. If you are interested in applying for funds from the IGCP, please contact both meeting conveners: Margret L. Fraiser ([mfraiser@uwm.edu](mailto:mfraiser@uwm.edu)) and Richard J.

Twitchett ([richard.twitchett@plymouth.ac.uk](mailto:richard.twitchett@plymouth.ac.uk)) by February 12, 2009. The amount awarded will depend on the number of applicants, geography of applicants, and stated need for funds.

2. IGCP 572 is also sponsoring a session at the “International Conference for Evolution of Tethys from Palaeozoic to Mesozoic” at Angara, Turkey and organizing an annual field excursion in southern Turkey in August 31 to September, 6, 2009.

Conveners: Sylvie Crasquin, Steve Kershaw, Aymon Baud.

A small grant is available from IGCP 572 (Permian-Triassic Ecosystems) to help defray meeting costs for project members. If you are interested in applying for funds from the IGCP, please contact either Sylvie Crasquin ([sylvie.crasquin@upmc.fr](mailto:sylvie.crasquin@upmc.fr)) or Steve Kershaw ([stephen.kershaw@brunel.ac.uk](mailto:stephen.kershaw@brunel.ac.uk)) or Aymon Baud ([aymon.baud@unil.ch](mailto:aymon.baud@unil.ch)) as soon as possible.

3. IGCP 572 will sponsor a thematic session for the “Permian-Triassic mass extinction and recovery” at the 10<sup>th</sup> Palaeontological Society of China Congress & 25<sup>th</sup> Chinese Palaeontological Convention, October 11-15, 2009, Nanjing, China.

Conveners: Jinnan Tong, Zhong Qiang Chen.

IGCP 572 Chinese working group will also organize 1-2 field excursions to investigate the Permian-Triassic boundary and Lower Triassic successions in South China after the convention. If you are interested in attending this meeting and field excursion, please contact Prof. Jinnan Tong as soon as possible (e-mail: [jntong@cug.edu.cn](mailto:jntong@cug.edu.cn)).

#### **2010 Third annual field workshop** in Oman

This fieldworkshop will offer to the participants the opportunity to visit the magnificent outcrops of the Oman Mountains, that provide unparalleled access **to Permian to Triassic Tethyan platform carbonate, continental slope and abyssal plain deposits**

**Schedule** : start of February 2010,

One and half day of Conference in Muscat and four and half days of fieldtrip and workshop

**For further info contact** Michaela Bernecker [michaela.bernecker@gutech.edu.om](mailto:michaela.bernecker@gutech.edu.om)





## 6<sup>th</sup> International Triassic Field Workshop (Pan-European Correlation of the Triassic)

### Triassic of Southwest Germany

175<sup>th</sup> Anniversary of the Foundation of the Triassic System by  
FRIEDRICH VON ALBERTI  
September 7–11, 2009, Tübingen and Ingelfingen

### 1<sup>st</sup> Circular

THOMAS AIGNER<sup>1</sup>, HANS HAGDORN<sup>2</sup>, EDGAR NITSCH<sup>3</sup> & THEO SIMON<sup>3</sup>  
GERHARD H. BACHMANN (Co-ordinator)<sup>4</sup>

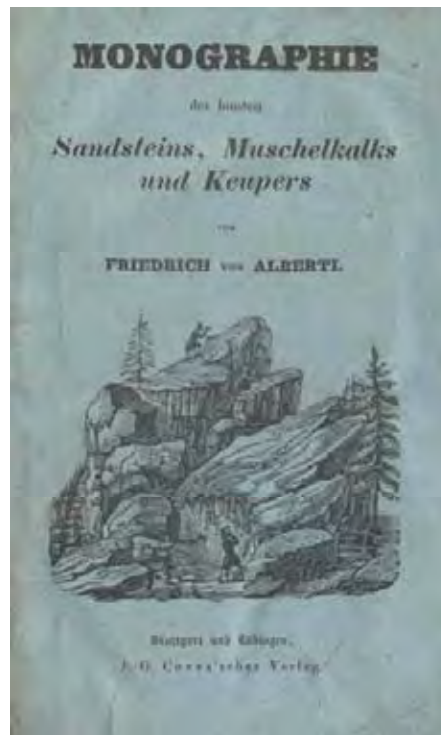
<sup>1</sup>Institut für Geowissenschaften, Universität Tübingen, <sup>2</sup>Muschelkalkmuseum Ingelfingen,

<sup>3</sup>Landesamt für Geologie, Rohstoffe und Bergbau Baden-Württemberg, Freiburg i. Br.

<sup>4</sup>Martin-Luther-Universität Halle-Wittenberg, Halle (Saale)

In 1834, FRIEDRICH VON ALBERTI, Royal Württembergian Salt Mining Director, founded the Triassic System in his monograph:

*Beitrag zu einer Monographie des Bunten Sandsteins, Muschelkalks und Keupers  
und die Verbindung dieser Gebilde zu einer Formation*



The 6<sup>th</sup> International Triassic Field Workshop commemorates VON ALBERTI's pioneering work and presents an introduction to the type area of the Germanic Triassic for an international audience with field trips to representative outcrops. This workshop builds upon earlier international Triassic workshops held in England (2004), Central Germany (2005), Eastern France (2006), Western Poland (2007), and Hungary (2008).

## Preliminary Programme

### Monday, September 7, 2009

**Arrival at Tübingen:** Tübingen is easily reached by car from exit 28 Herrenberg of Autobahn A81 Stuttgart–Singen, or by train. Tübingen is approximately 20 km SW of Stuttgart-Echterdingen airport and can be reached by train or bus shuttle.

Please make your **hotel reservations** as soon as possible. In Tübingen we recommend the following hotels in which a limited number of rooms are reserved under the **keyword “Alberti-Tagung” until May 15**. Prices are per room and night including breakfast. The hotels are in walking distance to the Institut für Geowissenschaften.

- **Hotel Hospiz**, Neckarhalde, 72070 Tübingen, Tel.: 07071-9240; Fax: 07071-9024 200, E-Mail: [hotel.hospiz.tuebingen@t-online.de](mailto:hotel.hospiz.tuebingen@t-online.de)  
Single rooms: € 70–85, double rooms: € 105–115
- **Hotel Katharina**, Lessingweg 2, 72076 Tübingen, Tel.: 07071-96 500, Fax: 07071-610 882, E-Mail: [info@hotel-katharina-garni.de](mailto:info@hotel-katharina-garni.de)  
Single rooms: € 67–77, double rooms: € 115–127
- **Hotel Meteora**, Weizsäckerstr. 1, 72074 Tübingen, Tel.: 07071-22735, Fax: 07071-27920, email: [info@hotel-meteora.de](mailto:info@hotel-meteora.de)  
Single rooms: € 33–52, double rooms: € 83 (some of the less expensive single rooms may have no private shower/WC)

For additional hotels in Tübingen see: [www.hotel.de/tuebingen](http://www.hotel.de/tuebingen)

Please make sure to ask for hotels near the Institut für Geowissenschaften.

Institut für Geowissenschaften der Universität Tübingen, Sigwartstr. 11

- |         |   |
|---------|---|
| 18.00 h | Welcome by Prof. Dr. RALPH WATZEL, Regierungspräsidium Baden-Württemberg, Landesamt für Geologie, Rohstoffe und Bergbau       |
| 18.15 h | Prof. Dr. GERHARD H. BACHMANN, Halle (Saale): Introduction to the classic Germanic Triassic of the Southwest German type area |
| 19.00 h | Prof. Dr. THOMAS AIGNER: The Muschelkalk as an analogue for oil and gas reservoirs: new integrated modelling studies          |
| 20.00 h | Reception at the Museum. Württembergian wines and pretzel snacks  |

**Field Trips**

Guides: T. AIGNER, H. HAGDORN, E. NITSCH, T. SIMON

**Tuesday, September 8, 2009**

**Buntsandstein and Muschelkalk (Early – Middle Triassic) in Central Württemberg**

- Lower and Middle Buntsandstein; Induan – Olenekian: cliffs and road cuts along forest trail around Reutiner Berg near Alpirsbach
- Buntsandstein/Muschelkalk boundary (Röt and Freudenstadt formations); early Anisian: abandoned quarry near Freudenstadt-Glatten
- Lower Muschelkalk (Freudenstadt Formation / Wellendolomit); Anisian: abandoned clay pit near Freudenstadt-Dietersweiler
- Upper Muschelkalk (Trochitenkalk, Meißner and Rottweil formations), Lower Keuper (Erfurt Formation); late Anisian – early Ladinian: active quarry near Frommenhausen

20.00 h Dr. ROBERT WEEMS, USGS, Reston VA: Correlations among the Newark Supergroup and the Germanic Basin

Overnight in Tübingen

**Wednesday, September 9, 2009**

**Keuper (Late Triassic) in Central Württemberg**

- Middle Keuper (Grabfeld Formation / Gipskeuper); latest Ladinian: gypsum pit Entringen
- Middle Keuper (Stuttgart Formation / Schilfsandstein); Carnian: abandoned sandstone quarries near Wendelsheim
- Middle Keuper (Weser Formation / Bunte Mergel), Löwenstein Formation ~ Stubensandstein); Norian: abandoned quarries near Kayh
- Upper Keuper and Triassic-Jurassic boundary; Rhaetian: active sandstone quarry near Tübingen-Pfrondorf

Transfer to Ingelfingen (approximately 135 km, approx. 2 h).

20.00 h Muschelkalkmuseum. Reception by Mayor MICHAEL BAUER

Overnight in Ingelfingen.

Please make your **hotel reservation** as soon as possible. In Ingelfingen we recommend the following hotel in which a limited number of rooms are reserved under the **keyword “Alberti-Tagung” until May 15**. Prices are per room and night including breakfast.

- **Hotel Nicklass**, Künzelsauer Str. 1, 74653 Ingelfingen, Tel.: 07940-91010, Fax: 07940-910199, email [info@haus-nicklass.de](mailto:info@haus-nicklass.de)  
Single rooms: € 54,50, double rooms € 84,50

For additional hotels and pensions in Ingelfingen see:  
[www.meinestadt.de/ingelfingen/tourismus/markt/unterkunft](http://www.meinestadt.de/ingelfingen/tourismus/markt/unterkunft)

**Thursday, September 10, 2009**

**Buntsandstein and Muschelkalk (Middle Triassic) in Northern Württemberg**

- Upper Muschelkalk (Trochitenkalk and Meißner formations); Anisian, Ladinian: abandoned quarry at Künzelsau-Garnberg
- Upper Muschelkalk (Quaderkalk Formation); early Ladinian: active quarry near Krensheim
- Lower and Middle Muschelkalk (Jena, Karlstadt, Heilbronn, and Diemel formations); Anisian: active quarry near Werbach on River Tauber
- Upper Buntsandstein (Plattensandstein and Rötton formations); earliest Anisian: Homburg on River Main

20.00 h      Kulturforum Schwarzer Hof, Ingelfingen  
                 Dr. WOLFGANG HANSCH, Naturhistorisches Museum Heilbronn  
                 FRIEDRICH VON ALBERTI – his life and work

Overnight in Ingelfingen

**Friday, September 11, 2009**

**Muschelkalk and Keuper (Middle Triassic) in Northern Württemberg**

- Lower Keuper (Erfurt Formation); Ladinian: active quarry with vertebrate lagerstätten near Vellberg-Eschenau
- Lower Keuper (Erfurt Formation); Ladinian: abandoned stone quarry near Crailsheim-Fallteich
- Upper Muschelkalk (Trochitenkalk and Meißner formations); Anisian, Ladinian: active quarry near Satteldorf-Neidenfels

14.00 h      Restaurant Wacker, Gröningen. Lunch and Final Discussion.

Transfer to Crailsheim Railway Station

## **Additional Programme**

### **September 12, 2009**

Participants who are interested in studying Muschelkalk and Lower Keuper invertebrates, vertebrates, or trace fossils in the **Muschelkalkmuseum Ingelfingen** are welcome. Exhibits and collections will be open for them. Please indicate your interest in the registration form.

### **September 12–13, 2009**

It is planned that a small group of participants will leave the Workshop on the afternoon of September 11 and drive some 450 km (6 h) north to Halle (Saale). September 12–13 will be dedicated to the well exposed Upper Permian/Lower Triassic **Buntsandstein near Halle**, its cyclicity and conchostracan biostratigraphy (Guides: H. W. KOZUR, G. H. BACHMANN). On September 14 participants will return to their destinations by car, by train or by plane from the nearby Leipzig/Halle airport.

We hope to be able to provide free transport with private cars to Halle and also during the field trip; otherwise, depending on the number of participants, we may ask for a contribution. Participants will have to pay their accommodation (single rooms € 65, double rooms € 85 per room and night including breakfast) plus their food and drinks. Please indicate on the registration form if you are definitely interested in participating in the additional field trip.

## **Additional information**

### **General information. Tübingen and Ingelfingen parts of Workshop (September 7–12):**

[encrinus@hagdorn-ingelfingen.de](mailto:encrinus@hagdorn-ingelfingen.de)

### **Halle (Saale) part of Workshop (September 12–13):**

[gerhard.bachmann@geo.uni-halle.de](mailto:gerhard.bachmann@geo.uni-halle.de)

### **Workshop Website of the Subkommission für Perm-Trias-Stratigraphie (will be opened in the next few weeks):**

<http://www.stratigraphie.de/perm-trias/>

**Transport** will be arranged by private cars and possibly some mini-buses.

Please make **hotel reservations** yourself! We recommend early accommodation reservations be made, preferably in the above mentioned hotels. Please consider that capacities in hotels in Tübingen and Ingelfingen are limited.

For those who will arrive by plane and/or by train, we will help to arrange their transport during the field trip. **Please use the attached form for registration.**



**6<sup>th</sup> International Triassic Field Workshop**  
(Pan-European Correlation of the Triassic)  
**Triassic of Southwest Germany**  
175<sup>th</sup> Anniversary of the Foundation of the Triassic System by  
FRIEDRICH VON ALBERTI  
September 7 – 11, 2009, Tübingen and Ingelfingen

## Registration Form

..... Name	..... First Name
..... Institution	..... Street
..... City, Postal Code	..... Country
..... Telephone	..... Email

- I will participate (definite registration)
- I will provisionally participate (please keep me informed)
- I will arrive by car and can take with me up to ..... participants during the field trips
- I will arrive by public transportation
- I am interested in an additional day for studying specimens in the Muschelkalkmuseum Ingelfingen, September 12, 2009
- I am definitely interested in participating in the additional Buntsandstein field trip to Halle (Saale), September 12–13, 2009
- I will participate with my car and can take with me up to ..... participants during the Buntsandstein field trip

Please fill in and return this registration form before April, 15, 2009 to

Dr. Hans Hagdorn  
Muschelkalkmuseum Ingelfingen  
Schloss-Str. 11  
D-74653 Ingelfingen  
Germany  
Phone: +49 - (0)7940 - 59500  
Email: [encrinus@hagdorn-ingelfingen.de](mailto:encrinus@hagdorn-ingelfingen.de)



1<sup>st</sup> circular



In Memory of Pr. Jean Marcoux  
Second IGCP 572  
Annual field workshop  
Antalya, Southern Turkey



3<sup>rd</sup>-6<sup>th</sup> September 2009

**Organisers:**

Erdal Kosun, Sylvie Crasquin, Aymon Baud, Steve Kershaw, Sylvain Richoz

**General informations:**

The Field workshop aims to investigate the recovery of ecosystems following the end-Permian mass extinction through analyses of the rock and fossil records via studies of biostratigraphy, palaeontology, palaeoecology, sedimentology, geochemistry and biogeochemistry.

One day meeting is organized at the Engineering faculty Akdeniz University in Antalya where Aymon Baud will introduce the field trip. We propose to have open discussions addressing issues such as recovery patterns of various fossil groups, reconstruction of global P-Tr oceanic and climatic conditions, outline of the P/Tr ecosystem types, and correlation of various data within a global stratigraphic framework. Different topics will be introduced by a short talk and will be followed by a casual discussion with participation of all of us. We propose here some topics. *All propositions are welcome!*

- Microbialites and depositional environments: introduction by S. Kershaw
- Microbialites and associated fauna: introduction by S. Crasquin
- Recovery of benthic fauna: introduction by Z.Q. Chen
- Recovery of pelagic fauna: introduction by ??
- Influence of palaeogeographic location on recovery: introduction by ??
- .....

**The fieldtrip** will offer participants the unique opportunity to visit the magnificent outcrops of the Taurus Mountains that provide unparalleled access to Permian to Triassic Tethyan platform carbonate. This fieldwork will be dedicated to the Memory of Jean Marcoux, who studied and mapped in great detail the geology of the area and promoted Permian and Triassic studies.

**Potential participants:** Members of the IGCP 572 Program, Members of the International Subcommissions on Permian or Triassic Stratigraphy. The number of participants is limited to 20 due to safety reasons. The acceptance will be done in order of registration and payment.

**Tentative fieldtrip organization and schedule (departure and return in Antalya):**

**Sept. 2th:** evening: arrival of the participants at Antalya, overnight in Antalya.

**Sept. 3th:** meeting at Engeneering Faculty of Akdeniz University in Antalya. Introduction to the fieldwork (A. Baud) and proposed talks on Permian-Triassic transition in Turkey, recent advance. End of afternoon, minibuses will bring the participants to Gul Mountain hotel going through Kemer and Kemer Gorge up. (1h30 drive). Overnight at Gul Mountain hotel.

**Sept. 4:** Fieldwork on Permian-Triassic transition at the Cürük Dag section. Back in the evening to Antalya, overnight Antalya.

**Sept. 5,** departure to Alanya - Demirtash, (2h30 drive) fieldwork on the Demirtash section in the afternoon. Overnight in Gazipaça.

**Sept. 6,** fieldwork on the Oznurtepe section in the morning.  
The afternoon the minibuses will bring back the participants to Antalya (Airport or hotel) End of the fieldwork

**Tentative Costs** of the 4 days fieldwork: 600€ (departure and return Antalya). This includes transportations, accommodations, meals and guidebook. Travels to Antalya and drinks are not included!

**Registration** before June 15<sup>th</sup>, 2009:

Please note the number of participants is limited to 20 (due to safety measures). The admissions will be done by order of registration and payment.

*Please note: before June 15<sup>th</sup> that all refunds will incur a 25% charge  
No registration and no refund after June 15<sup>th</sup>*

**Payment before June 15th:**

Complete the form available on web site <http://sgfr.free.fr/seance/marcoux/> ....  
And send it back to Société Géologique de France

Circular is available on website <http://sgfr.free.fr/seance/marcoux/> .....

**IGCP 572 website:** <http://www.igcp572.org>

## GUIDELINES FOR THE SUBMISSION OF MANUSCRIPTS TO ALBERTIANA

Albertiana is published twice a year. Contributions should be sent to the editor. In order to facilitate the production of this newsletter and reduce typing errors, authors are kindly requested to submit their contributions electronically, preferably by email. Those who are unable to submit a manuscript in electronic format are kindly requested to send flat (unfolded), clearly typed manuscripts in a 12-point typeface (sans serif) with single line spacing.

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

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.

## **Subcommission on Triassic Stratigraphy**

*STS Chairman*

*Prof. Marco Balini, Dipartimento di Scienze della Terra "Ardito Desio" Università degli Studi di Milano Via  
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*Vice Chairman*

*Dr. Ying Hongfu, Office of the President, China University of Geosciences, Yujiashan, Wuhan, Hubei, 430074,  
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**Deadline for the next ALBERTIANA issue (38) is the 30<sup>th</sup> of  
September 2009.**