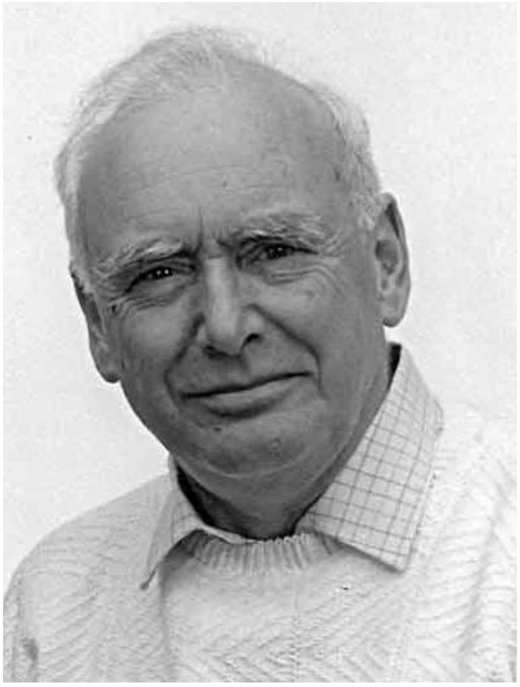
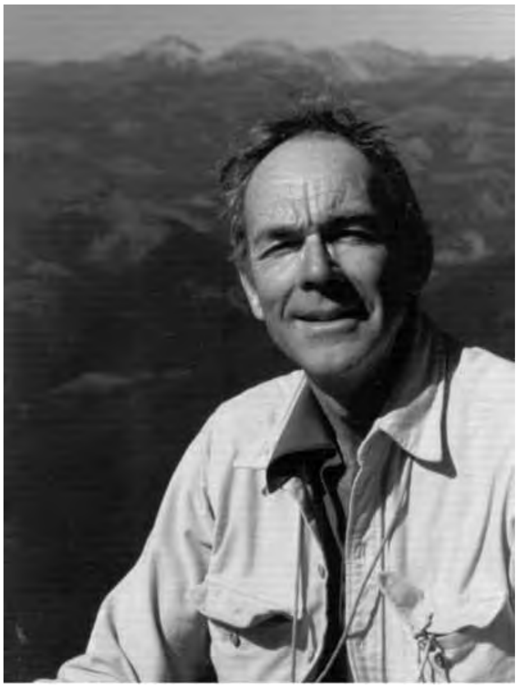
ALBERTIANA





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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. Subcommission on Triassic stratigraphy. Within this scope ALBERTIANA serves as the newsletter for the announcement of general information and as a platform for discussion of developments in the field of Triassic stratigraphy. ALBERTIANA is available as PDF at the STS website. Please send your mansucript to w.m.kuerschner@geo.uio.no.

Executive Notes

From the Chair

As the front cover implies, this issue of Albertiana conveys a significant but sad commentary. During the past two years, the entire STS membership has been saddened by the successive passing of three pillars of the Triassic scientific community. Sandor (Sani) Kovacs, Edward Timothy (Tim)Tozer and Norman (Norm) J. Silberling together are responsible for decades of groundbreaking research involving Triassic stratigraphy and paleontology, and ever since the STS was first formed in early 1970s, they have been among its most active members. Tim and Norm are widely recognized for their introduction of the North American Triassic chronostratigraphic scale in the 1960's, which incidentally, is much better defined than its Tethyan counterpart. The four-stage Early Triassic framework of this scale is still in world-wide use today. Although Tim reduced his activity after his retirement, Norm, despite health problems that severely limitied his physical activities in later years, remained in contact with the scientific community via e-mail. He maintained an active interest in new developments in the Triassic world and on numerous occasions, he provided support to workers in the field through his knowledge and his extensive and meticulous collection of field notes assembled over the years. Sani's sudden unexpected passing has been a shocking for those of us who knew him, because of his rather young age. Sani contributions to Triassic conodont taxonomy and biostratigraphy as well as to regional stratigraphy of Hungary and surrounding Carpatho-Balkan-Dinaric ranges are really outstanding.

Since Tim, Norm and Sani were at various times active members of several working groups of the STS, it is only proper that this issue be dedicated to them. In addition, we intend to further memorialize them in the future by dedicating certain meetings, field trips or workshops in their honor.

Last year in Vancouver, Mike Orchard organized a special session of the Canadian Paleontological Conference (J.W. Haggart & P L. Smith Eds.) dedicated to the memory of Tim Tozer. This event was well-attended and oral presentations were given by 15 participants. You will find the program and the abstracts of that session in this issue of Albertiana. Specific initiatives to memorialize Norman Silberling and Sandor Kovacs are in progress and information regarding these activities will be provided through the STS website and the STS mailing list.

During the editing of this issue of Albertiana, two other Triassic colleagues suddenly passed away. First, Paola De Capoa (Napoli, Italy) died on January 1st, 2012 of a heart attack. Paola was an Upper Triassic bivalve specialist and was very active from the late 1960s to the early 1980s. Her most important contributions include bivalve taxonomy and biostratigraphy of the Upper Triassic "cherty limestone" of Southern Italy and Dinarids.

Lorenz Keim met a tragic death while skiing in the Alps on February 5, 2012 when he and his brother-in-law were buried by an avalanche. Lorenz was a young, active and open-minded stratigrapher of the Innsbruck school, well known to all geologists working in the Dolomites. Lorenz joined the STS in November, 2011 together with about thirty other young Corresponding members. He was very enthusiastic about this opportunity, and it is really sad that he was not able to contribute directly to STS life as he hoped to do.

From the Secretary

Results of the STS vote on the Executive

May 23, 2012

Following IUGS and ICS statues, a new slate for the 2012-2016 STS Executive is required. Following an email solicitation to the voting membership of the STS, the candidates below were nominated. Balloting was conducted by email over a three-week period (1-21 May). Of the 25 voting members, valid ballots were received from 23 members within the specified time giving a response rate of 92%.

Results for the balloting for the STS executive for 2012-2016 are as follows:

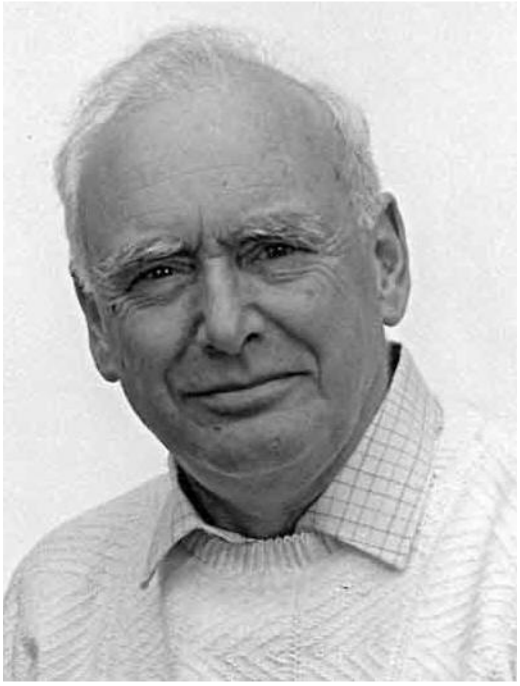
	Yes	No	Abstain	% (affirmative)
Marco Balini (Chair)	22	0	1	96%
Mark Hounslow (Vice Chair)	21	2	1	87%
Jinnan Tong (Vice Chair)	14	2	2	83%
Christopher McRoberts (Secretary)	21	0	2	91%

All candidates have been elected to a second 4-year term 2012-2016. The newly elected executive will begin their terms at the 34rd International Geologic Congress (Brisbane), August 2012)

Duly submitted,

Christopher McRoberts
STS Secretary

Orbituaries



EDWARD TIMOTHY TOZER

1928-2010

Dr. Edward Timothy Tozer, B.A. (Kings College, Cambridge, 1948), Ph.D. (U. of Toronto, 1952) died on 26 December 2010 in Vancouver, British Columbia, at the age of 82 years. Born in Potters Bar, Hertfordshire, England on 13 January 1928, Tim (as he was known to his colleagues) was relocated with his two siblings during the war to Sarnia, Ontario, where he completed high school. In 1944, he returned to England and a year later began studying geology at Kings College, Cambridge. After graduation, Tim returned to Canada as sessional lecturer at the University of Western Ontario (1948-1952) whilst undertaking PhD studies at the University of Toronto. During these early years in Canada, Tim worked with the Geological Survey of Canada as a summer field assistant for various scientists, including the famous RJW Douglas, who recognized Tim's geological prowess and enabled him to conduct his own independent research. In 1952, Tim began his full-time life-long association with the Geological Survey of Canada.

Tim's early research in Canada focussed on non-marine molluscs, but his interest became firmly focussed on the Triassic System (~250-200 million years ago) after meeting his mentor Frank McLearn, a leading authority on the Triassic and its ammonoids who retired the year Tim joined the survey. In 1953, Tim undertook fieldwork in Yukon and British Columbia, but it was as an Arctic geologist that he came into his own. Tim was a pioneer in the modern era of exploration in the Arctic Archipelago. He was the first to conduct geological studies from the joint Canada-US weather station at Mould Bay, the westernmost of a network of stations built to monitor weather and radio signals shortly after Winston Churchill's famous "Iron Curtain" speech in 1946 when he expressed concerns about Stalin's intentions in the high Arctic. In 1954, Tim, then 26 years old, began an arduous 6 months of field work in the western Arctic, first using sled dogs in temperatures of minus 35 degrees, and later on foot. In the following year, Tim was attached to Operation Franklin, a major air-borne mapping operation that resulted in the interpretation of the geology of more than 260,000 square kilometres of the Arctic Archipelago. During 1958, Tim and his colleague Ray Thorsteinsson pioneered the use of light aircraft on over-sized low pressure tires to complete the mapping of the islands. It was an extraordinary success and after flying 300 hours in a single engine Piper "Super Cub", they had mapped an area comparable to the size of Vancouver Island and had ushered in a new era of transportation for research in Arctic terrains.

During 10 years of Arctic exploration, Tim assembled hundreds of Triassic ammonoid collections from the Sverdrup Basin. He then turned his attention to British Columbia, and in 1960, he undertook a hair-raising expedition on the mighty Liard River: he later spoke about entire uprooted trees floating past his simple raft 'like battleships'. In 1964, he visited the Peace River Valley to build on McLearn's legacy and shortly thereafter he began his long association with his American counterpart Norm Silberling, with whom he developed an ammonoid-based chronology for the Triassic. By 1967, Tim produced his classic publication, *A Standard for Triassic Time*, which thrust him into global prominence.

Tim then began to travel the world to visit all the important localities for Triassic ammonoids, and all the important collections assembled before and during the 20th century. While studying those collections and meeting all the key Triassic specialists in the world, he mastered his subject and had become a key player himself. His fascination with the personalities of 19th century Triassic studies gave Tim's research a depth that few achieve – a view of the people behind the science. His scholarly masterpiece – the so-called 'pink book' for which a GSC 'Miscellaneous Series' publication was created, lays out the unfolding drama of *The Triassic and its ammonoids: The Evolution of a Time Scale*. By the early 1990s, Tim had described, classified, and explained the age relationships of all the 256 genera of Triassic ammonoids known from Arctic and Western Canada. More than 130 publications showcased his extraordinary scholarship and his global comprehension of the Triassic System and elevated him to a high pinnacle of achievement and leadership in the history of Triassic studies. His monumental 1994 monograph on *Canadian Triassic ammonoid faunas*, the largest paleontological volume ever produced by the GSC (663 pages including 148 fossil plates), revised and laid out the taxonomic foundation for his global correlation standard.

Tim's research excellence was recognized many times by his contemporaries: Medal of Merit of the Alberta Society of Petroleum Geologists, 1962; election to the Royal Society of Canada, 1966; Royal Geographical Society Medal, 1969; Willet G. Miller Medal, 1979; and the Queen Elizabeth II Golden Jubilee Medal, 2002. In 1989, Tim received the Elkanah Billings Medal, awarded by the Geological Association of Canada for lifetime achievement in paleontological research, and in 1993 he was made a Member of the Order of Canada for contributions "to our knowledge of the stratigraphy and structure of the Arctic Islands and the physical and biological state of our earth during the Triassic Period". The extraordinary high regard in which Tim is held by scientists around the world is clearly displayed by comments submitted to a guestbook that was made available when his bereavement was announced.

Tim was an unpretentious soul. He loved the camaraderie of the field camps where, over the decades numerous companions would relish his stories and yarns. A kind and generous man, yet strong in defence of his hard fought knowledge and opinions, he was never mean-spirited, and his dialogue was always laced with chuckles, hearty laughter and often praise for his 'opponent's' achievements. Pre-deceased by Ruth, his wife of almost 50 years, he leaves behind a son Paul, and daughter Sally. A scholarship has been established at the University of Toronto in Tim's name (https://donate.utoronto.ca/geology).

Michael Orchard and Walter Nassichuk

A bibliography form Tim Tozer was published in:

Lucas, Spencer, G., and Orchard, Michael J. 2007. Dedication to Norman J. Silberling and E. Timothy Tozer. *New Mexico Museum of Natural History and Science, Bulletin 41: 1-12.*

The following are some of his key papers on biochronology, taxonomy, paleobiogeography, and the history of Triassic studies.

Tozer, E.T., 1967. A standard for Triassic time: Geological Survey of Canada, Bulletin 156, 103 p.

Tozer, E.T., 1981, Triassic Ammonoidea: Classification, evolution and relationship with Permian and Jurassic forms: Systematics Association, Special Volume 18, p.65- 100.

Tozer, E.T., 1981, Triassic Ammonoidea: Geographic and stratigraphic distribution: Systematics Association, Special Volume 18, p. 397-431.

Tozer, E.T., 1982, Marine Triassic faunas of North America; their significance for assessing plate and terrane movements: Geologische Rundschau, v. 71(3), p.1077-1104.

Tozer, E.T., 1984, The Trias and its ammonoids: The evolution of a time scale: Geological Survey of Canada, Miscellaneous Report 35, 171 p.

Tozer, E.T., 1994, Canadian Triassic ammonoid faunas: Geological Survey of Canada, Bulletin 467, 663 p.

Edward Timothy Tozer 1928-2010

In Memory,

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

Good bye Tim,

During near 20 years we have shared the Subcommission on Triassic Stratigraphy (STS) adventures, meetings and field workshops. From 1973 in Vienna where I first met you during the "Triassic of the Tethys realm" conference, you were our Master.

Later, I met you again at the Bergamo Triassic meeting organized in memory of R. Assereto and J. Pisa (1979) and in 1981, at the Sarajevo Triassic conference and fieldtrip.

In 1982 you invited me in your home in Ottawa and after Triassic business, I remember you speaking about your famous "Halobia two" sailing boat.

I kept great souvenir of our geological adventures with helicopter in Verkoyansk Mountains (East Siberia), just before the 1984 Moscow International Geological Congress and in particular your passionate discussions on basal Triassic Ammonoids at Setorym Creek with our missed Russian colleague A. Dagys (photo 1).

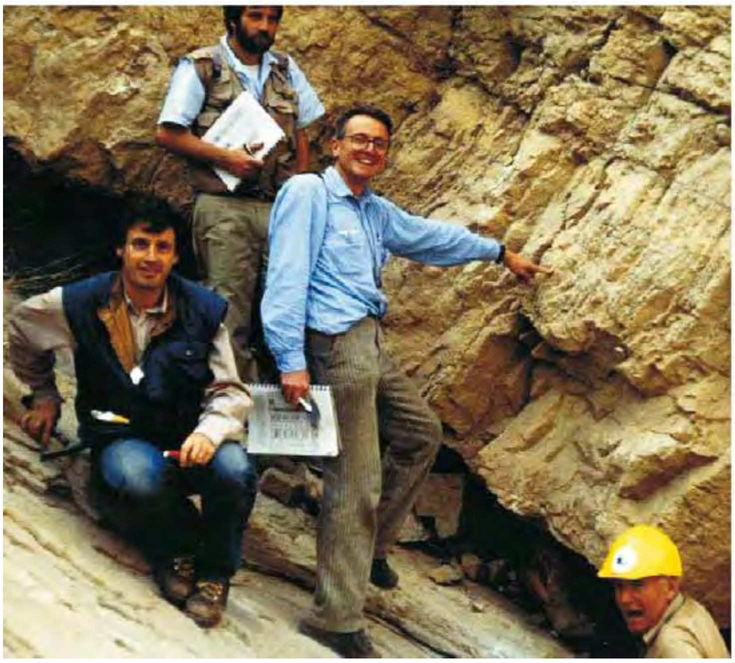
Photo 1 -left: part of the group brought by helicopter at Setorym Creek in the Verkoyansk Mountains, July 1984; -right: Tim on the *Otoceras concavum* beds at Setorim Creek with Yu. Arkhipov (right) and A. Dagys

Soon after printing you sent me your new “pink book” *The Triassic and its ammonoids: The Evolution of a Time Scale* with a friendly dedication. I read it “d’un trait” as tale story but with real nineteen and early twenty centuries paleontologists, geologists and stratigraphers true of life -a sweeping historical epic of a time scale never outshone.

In 1986 you came to the Istanbul STS Conference I organized with J. Marcoux, L. Krystyn and C. Sengör and to our field workshop in the Antalya Mountains. You valued the stratigraphical studies, climbed the Çuruk Dagh and also enjoyed, as I, the Kemer ice-creams!

December 1987, you don’t miss the IGCP 109 field workshop to the Salt Range in

Pakistan, a lower Triassic “must” for Stratigraphers (photo 2).



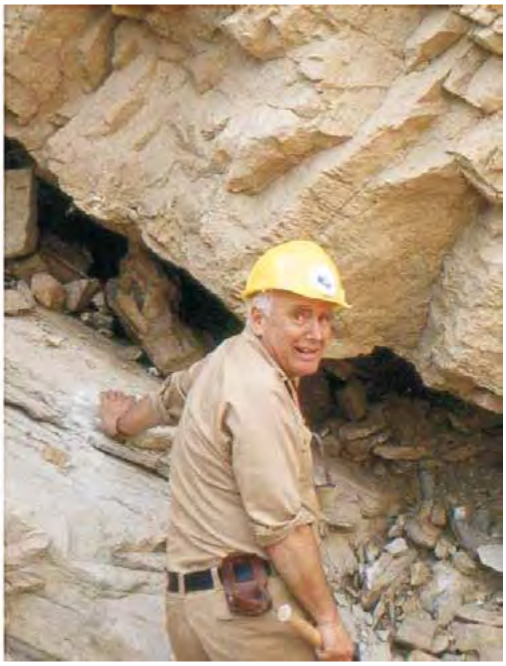


Photo 2, December 1987, the Permian-Triassic boundary at Nammal Gorge (Salt Range, Pakistan). -Left: Tim (yellow hard hat) unhappy with the boundary shown by M. Gaetani with A. Baud; -right: Tim happy with the hand on his believed boundary

Following the IGCP meeting, you take the unique opportunity to go with our small group for visiting the famous Triassic sections of Palgham and Guryul Ravine in Indian Kashmir

We all appreciated the impressive geology but six months later, all this area fell to terrorism and imposed curfew.

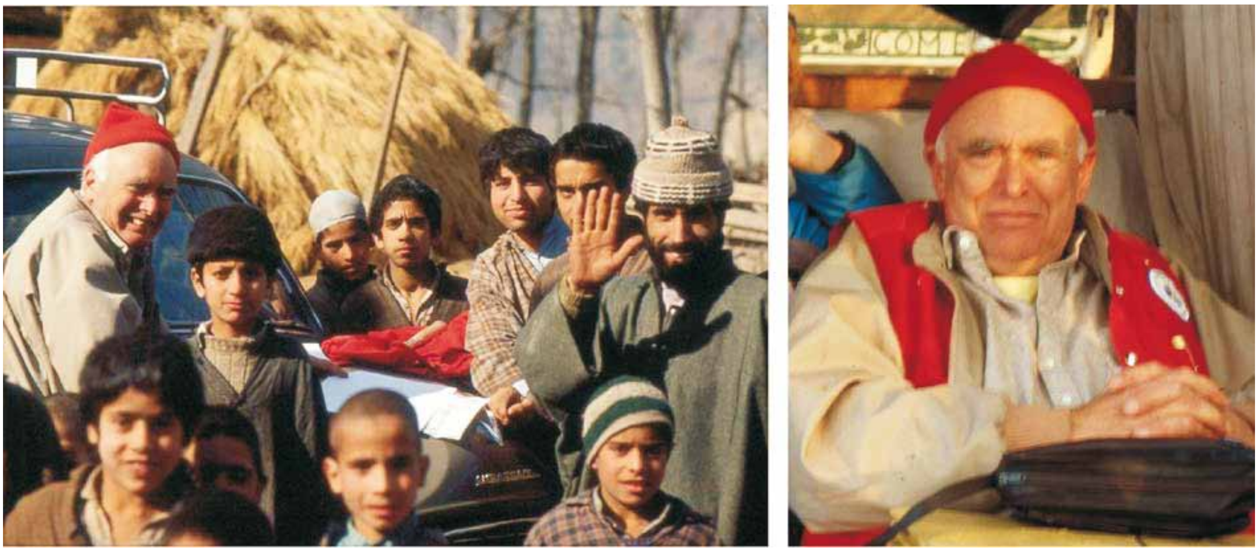


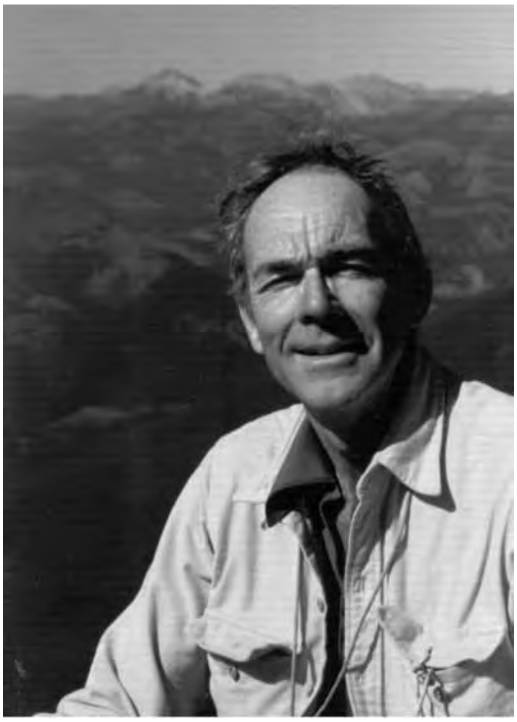
Photo 3 -left, Srinagar (Kashmir), December 1987: smiling Tim surrounded by young Kashmiri people swapped his yellow hard hat for a red hat; -right: Tim is getting a rest in the houseboat after field excursion.

Our last meeting was twenty years ago in Lausanne (1991) and you came with enthusiasm at this International Symposium of the Subcommission on Triassic Stratigraphy I organized with J. Guex and you visited for the first time our Triassic sections of the Prealps

Photo 4, October 1991, in the St-Triphon quarry (Anisian, Prealps of Western Switzerland): debate between Tim and his good friends and colleagues A. Days and W. Weitschat.

Remember You, Tim, our Triassic Master, I will fondly, Aymon

Aymon Baud , former chairman (1989-1996) of the Subcommission on Triassic Stratigraphy (STS),



NORMAN J. SILBERLING
1928-2011

On 27 September 2011, Norm Silberling passed away in his sleep from heart failure. His passing marks the end of one of the most significant efforts of the 20th Century to refine the Triassic timescale.

More than 40 years ago, in 1968, Norm Silberling and Tim Tozer published one of the classic mileposts along the path to a global Triassic timescale. Titled "Biostratigraphic classification of the marine Triassic in North America" (Geological Society of America, Special Paper 110), this work built heavily on the pioneeering efforts of Frank McLearn (1885-1964) in British Columbia, and Siemon Muller (1900-1970) in Nevada, who had deciphered much of the ammonoid succession in the American Cordillera. Nevertheless, it was Norm and Tim's masterful synthesis that established a standard Triassic ammonite zonation that has been tested and elaborated for decades and is still central to many aspects of the ongoing work on the Triassic timescale.

Born 28 November 1928 in Oakland, California, Norm Silberling grew up and was educated in northern California, ultimately receiving a Ph.D. in geology from Stanford University in 1957. Norm was a student of the legendary Si Mueller, who followed James Perrin Smith (Mueller's thesis advisor) in developing the phenomenal record of Triassic ammonoids known from Nevada. Before finishing his Ph.D., Norm saw service in the Korean War, where he was awarded two combat stars. After the Ph.D., his professional career began on the faculty of Stanford University, and then he moved in the 1970s to work for the U. S. Geological Survey, first in Menlo Park, California, then in Washington, D. C., and finally in Denver, Colorado, where he retired in the mid-1990s.

During Norm's scientific career he was never far from Nevada, though both Alaska and, ultimately, New Zealand, also became field areas. From the 1950s through the 1970s, Norm's research evolved from ammonoid biostratigraphy to regional stratigraphy and ultimately into tectonics. Indeed, Norm was one of the key players in developing an understanding of what are variously called suspect (or allochthonous, or accreted or displaced) terranes, particularly based on his Alaskan work. His application of the terrane concept to the geology of western Nevada revolutionzed our understanding of the Meszoic geological history of the Great Basin. Indeed, it is fair to say that Norm's contributions to tectonics are at least equal in importance to his work on Triassic biostratigraphy.

Thus, Norm Silberling really had two careers as an earth scientist and contributed more to both than most contribute to a single career. He truly stands as one of the twentieth century's most important Triassic ammonite biostratigraphers, one of its most perceptive tectonicists and one of the most accomplished students of the geological history of western North America.

I first worked with Norm in Sonora, Mexico, during the mid-1990s. Together, we collected the first Early Triassic ammonites found in Mexico, and Norm brought great clarity and wise caution to interpretation of the structural morass of the Caborca terrane from which lesser observers have mostly conjured tectonic fantasy. I can truly say that Norm was a fine gentleman and a gentle soul—soft spoken and well spoken, but with a penetrating intellect and vast experience that made him one the most valuable field collaborators of my career.

Norm and I kept in touch over the years, and Norm had his hand in the Triassic timescale till virtually the end of his life. Thus, in Geological Society Special Publication 334, "The Triassic Timescale," published in 2010, which I edited, I turned to Norm for much reviewing of various articles. Sharp as a tack, ever on top of the Triassic timescale and the conceptual and methodological issues that surround it, Norm's detailed reviews caused much ink (toner) to move. The quality of several of the contributions to that volume owe much to Norm Silberling. He, truly, was one the great knights errant of the Triassic timescale.--

Spencer G. Lucas

In Memoriam Sándor Kovács

In September 23, 2010 Sándor Kovács has left us unexpectedly. He was an outstanding personality of the Hungarian geology who was the initiator of several international co-operations, projects and who has close contact with a great number of colleagues all over the world. He was an active member of the Triassic Subcommission of the International Stratigraphic Commission for a long time and he has internationally respected publications on Triassic stratigraphic and paleogeographic topics.

He was born in Tamási, a village in the central part of Transdanubia. After the elementary schools, he attended the József Szabó Geological High School in Budapest where he obtained his first knowledge on the earth sciences and got an impetus for his entire life: the appreciation of the rocks and fossils.

Since 1970 he continued his studies on the University of Szeged and graduated as geologist and geographer. He met with Professor Kálmán Balogh, head of the Geological and Paleontological Department over there and became his favourite student. Than their career were joined. In 1975, after obtaining his diploma, he became an assistant at the department of Professor Balogh. In addition to the teaching he made his thesis work on the fossil-rich Triassic formations of the Aggtelek Hills and he defended his dissertation of internationally outstanding level in 1977. Meantime he learned the methods of the investigation of the Conodonts and he got soon an internationally acknowledged expert of this field.

In 1977 Professor Balogh retired and returned to the Hungarian Geological Institute to assist the geological mapping project of Northern Hungary initiated at that time. Sándor Kovács followed him and became the fellow of the Geological Institute. Between 1978–87 he has a crucial role in the study of the Triassic of the Aggtelek and Rudabánya Hills and the Paleozoic formations of the Uppony and Szendrő Hills. Based on investigation of conodonts he elaborated a new stratigraphic model for the Paleozoic of Northern Hungary. In addition to these works, he wrote a particularly important paper on the problematic of the Tisisa inclusively its plate tectonic interpretation and put up the possibility of the long-distance displacement of certain elements of the basement of the Pannonian Basin. He was very active in the international scientific communication in this period of his life. He took part in the work of the Triassic Subcommission of the International Stratigraphic Commission for a long time, worked as a secretary of the Triassic Conodont Working Group and undertook tasks in several project of the International Correlation Program.

In 1987, for invitation of Professor József Fülöp he became the member of the staff of the Geological Research Group of the Hungarian Academy of Sciences at the Eötvös Loránd University. At that time works for compilation of the Paleozoic volumes of Geology of Hungary were already in an intense stage and his knowledge and tireless activity were indispensable. Accordingly he concentrated his efforts to the Paleozoic conodont-stratigraphy. However, he published highly appreciated papers on the metamorphosis indicator role of the conodonts, the submarine slope sediments in Northern Hungary and moreover on the evaluation of the oceanic remnants in the whole Carpathian-Pannonian region. In the 1990-ies he got acquainted with the terrane concept and he was one of the firsts who called the attention to the applicability of this concept for geodynamic interpretation of the heterogeneous basement of the Pannonian Basin. Proving of this thesis was the most important scientific problem for him till the end of his life. This effort led him to extend his relationships with the colleagues working in central and southern Europe, the organization of comparative studies for the Alpine, Carpathian, Dinaridic and Hellenidic regions and to initiate the compilation of the Circum-Pannonian terrane map series.

As far as the comparative studies are concerned, correlation of the Paleozoicum of the Szendrő and Uppony Hills, North Hungary with that in the Carnic Alps, Southern Alps, and Graz Basin brought essential results which became fundamental elements of the Paleozoic terrane maps and publications dealing with this topic. Comparison of the Paleozoic to Triassic sequences of the Bükk Mts, North Hungary with some units in the Dinarides was also of outstanding importance. In the last decade he afforded enormous energy to the investigation of the displaced remnants of the Noetethys Ocean occur in North Hungary comparing them to the ophiolite mélange zones exposed over large areas in the Dinarides and Hellenides. Results of these studies were incorporated into several papers and the Mesozoic sheets of the terrane maps.

In addition to the research, the teaching was also accompanied Sándor Kovács's career. He took part in the education of the students already at the Szeged University. Since 1987 he continuously took part in the education of the geologists at the Eötvös Loránd University, Budapest. He shared his wide and deep knowledge with the students on the geology of Hungary and the Alpine, Carpathian and Dinaridic regions. He assisted the talented and diligent young people and involved them into most thrilling topics.

Sándor Kovács's life was inseparable from his work. He took all scientific problems, debates too much to heart. His unexpected death cut through his career, he could not complete a lot of tasks what he wanted. But in spite of this, what he made, what he put onto the table is really of outstanding value and remained permanent marks on the geology of Hungary and the surrounding regions. We preserve the memory of his likable and nice personality.

Sándor Kovács' most important publications about Triassic topics

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Kovács, S., (l977): New conodonts from the North Hungarian Triassic , Acta Miner. Petr. Szeged, 23, l, p. 77-90, 1 figs., 8 pls., Szeged.

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Correlation of the Induan-Olenekian boundary transition

(Report on the IOBWG activity in 2011)

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Main results

Main bio- and chemostratigraphical results on the Induan-Olenekian transition of the Himalayas (Spiti, India), Salt Range (Nammal, Pakistan), South Tibet (Tulong), Nevada (Candelaria Hills, USA), and South Primorye (Artyom area and Abrek Bay, Russia) were recently reported by Ware et al. (2011) and Zakharov et al. (2011) at the 21st Canadian Paleontology Conference, which took place in Vancouver, and published by Brüchwiller et al. (2010a,b), Orchard (2010), Ware et al. (2011), and Zakharov (Zakharov, 2010; Zakharov et al., 2010). Some important known results of the Switcerland Group, reported by Ware et al. (2011), are in press now.

Switzerland group

1. New findings of ammonoids in the Mud (Spiti, Himalayas) allow to recognize four ammonoids beds (*Ambites lilangense, Fuchsites markhami, Kingites lens,* and *Prionolobus rotundatus*) in the Dienerian and the twelve ones in the Smithian (*Flemingites bhargavai,* Kashmiritidae gen. nov. A, *Vercherites* cf. *pulchrum, Rohillites rohilla, Flemingites* Beds, *Brayardites compressus, Nammalites pilatoides, Pseudoceltites multuplivatus, Nyalamites angustecostatus, Wasatchites distractus, Subvishnuites posterus,* and *Glyptophiceras sinuatum*) (Brühwiler et al., 2010b). The base of the Olenekian is indicated now at the base of the *Flemingites bhargavai* beds, where *Ns. waageni* sensu lato first occur (Orchard, 2010). This level locates about 1 m below the place, where the base of Olenekian was recognized by Krystyn et al. (2007) in their first variant.

2. Intensive sampling of the Early Triassic successions at the Nammal, Chiddru and Zalach localities in the Salt Range shows that the Induan-Olenekoan boundary there is within the Ceratite Marls (e.g., Ware et al., 2011) and that ammonoid and conodont beds of the Salt Range correlate perfectly well with those of Spiti (Brühwiler et al., 2010a). From the twelve ammonoid beds known in the Smithian of the Salt Rage the seven ones, including the basal *Flemingites bhargavai* beds, are present in the Mud section in Spiti. As it follows from authors' note (Ware et al., 2011), among all potential candidates, the Nammal section, yielded high resolution palaeontological (including palynological) and C-isotope records, provides by far the most complete GSSP for the base of the Olenekian stage.

3. The twelve new ammonoid genera from the Smithian of Spiti (*Mudiceras, Vercherites, Nyalamites, Tulongites, Hermannites, Brayardites, Nammalites, Escarguelites, Nuetzelia Truempyceras, Steckites,* and *Shigataceras* (Brühwiler et al., 2010a) have been described.

4. The seven beds with ammonoids (*Kashmirites* sp. indet., *Brayardites compressus, Nammalites pilatoides, Pseudoceltites multiplicatus, Nyalamites angusticostatus, Wasatchites districtus,* and *Glyptophiceras sinuatum*) have been recognized by the Switzerland group (Brühwiler et al., 2010a) within the Smithian in Tulong (South Tibet), five from them are present in both the Mud and the Nammal sections. Five new ammonoid genera (*Brayardites, Nammalites*, *Nyalamites, Shigetaceras,* and *Tulongites*) and several new species have been described on the basis ammonoids mainly from this locality (Brühwiler et al., 2010a).

5. The new genus *Mullericeras* have been described on the basis of ammonoids, discovered in the Induan-Olenekian transition of the Candelaria Hills, Nevada (Ware et al., 2011).

6. $\delta^{13}C_{org}$. and $\delta^{13}C_{carb}$. data have been obtaind fom the Nammal and Chitta-Landu sections, Salt Range (Hermann et al., 2011), showing that increase of $\delta^{13}C$ coincides with the Induan-Olenekian faunal turnover there.

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Fig. 1. Abrek section: Induan (Dienerian) sequences (A.M. Popov's photo).

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B. Russian-Japanese group

Some materials on the Induan-Olenekian transition of South Primorye (Russian Far East) have been published (Zakharov et al., 2010, 2011) or are in press now (e.g., Smyshlyaeva, Zakharov, 2011). Besides, field works were organized in South Primorye (May-June 2011) by the Russian-Japanese group, represented by Y. Shigeta, Y.D. Zakharov, A.M. Popov, and O.P. Smyshlyaeva,. As a results, the following main evidences have been obtained:

1. In the Dienerian *Gyronites subdharmus* Zone (Figs. 1 and 2) of the Abrek section in South Primorye the next three members can be previously recognized: "*Pseudoproptychites" hiemalis, Dunedinites magnumbilicatus,* and *Pachyproptychites otoceratoides* (Fig. 3). The *Gyronites subdharmus* Zone in South Primorye corresponds apparently to the *Prionolobus rotundatus* beds in the Himalayas and Salt Rang and the *Prionolobus-Gyronites* Zone in Chaohu (Fig. 4).

2. The new Smithian ammonoid genus (*Ussurijuvenites*) and a couple of its new species from the Artyom area in South Primorye have been described (Smyshlyaeva, Zakharov, 2011).

3. Early Smithian *"Hedenstroemia" bosphorensis* Zone in both the Abrek and the Tri Kamnya Cape sections in South Primorye consists of the *Ussuriflemingites abrekensis* (= "*Gyronites separatus*") and the *Euflemingites prynadai* beds (e.g., Zakharov et al., 2010). The Induan-Olenekian boundary in the Abrek section is determined by the first appearence of the flemingitid ammonoid *Ussuriflemingites abrekensis,* recently discovered just near the base of the Zhitkov Formation of the mentioned section, together with fish remains (Figs. 5 and 6).

4. Within the earliest Olenekian *Ussuriflemingites abrekensis* beds in Abrek the two horizons (*Parahedenstroemia kiparisovae* and *Paranorites varians*) can be preliminarily recognized (Fig. 7), which correspond possibly the lower and upper parts of the *Flemingites bhargavai* beds in Spiti and the Salt Range, respectively (Fig. 4). The lower part of the *Euflemingites prynadai* beds exposed in Abrek, belongs to the *Shamaraites shamarensis* (below) and the *Brayardites* (?) *subhydaspis* (above) horizons. The former corresponds apparently to the *Shamaraites rursiradiatus* in the Salt Range and the lower part of the Flemingites?-*Euflemingites tsotengensis* beds in Chaohu, but the latter to the interval from the *Xenodiscoides perplicatus* to *Brayardites compressus* horizons.

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Fig. 2. Abrek section: The uppermost part of the Induan (A.M. Popov's photo).

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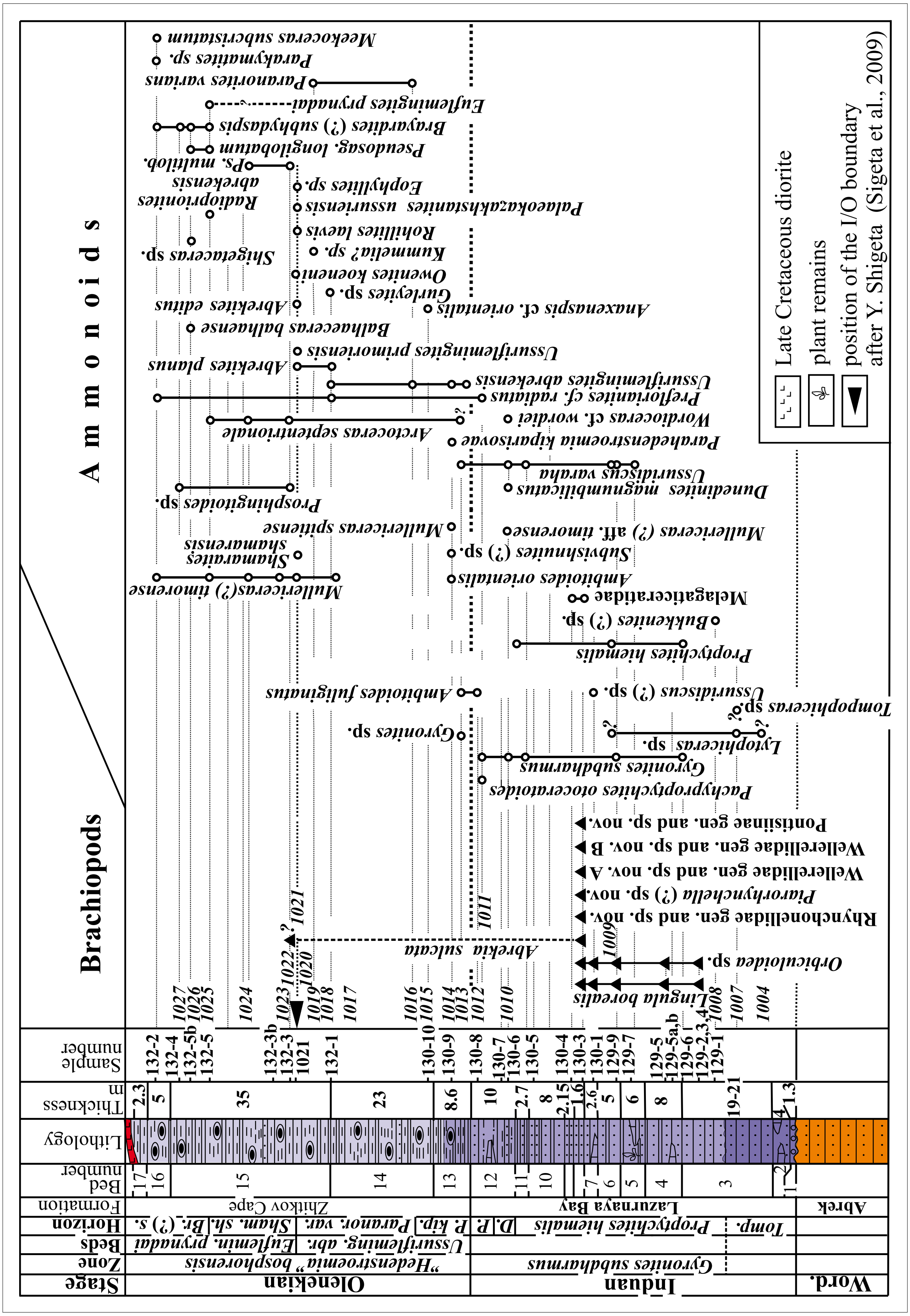

Fig. 3. The ranging of Induan and early Olenekian (Smithian) ammonoids and brachiopods in the Abrek section. *Tomp. – Tompophiceras ussuriense* Zone. Horizons: *D – Dunedinites magnumbilicatus, P – Pachyproptychites otoceratoides, P.kip. – Parahedenstroemia kiparisovae, Paranor.var. – Paranorites varians, Sham.sh. – Shamaraites shamarensis, Br.* (?) *s – Brayardites* (?) *subhydaspis*.

Stage	Substage	Conodont zone (Krystin et al., 2007; Orchard, 2007)	Ammonoid zone (beds, horizons): Spiti, Himalayas (Krystin et al., 2007; Brühwiler et al., 2010, 2011a)	Ammonoid zone (beds, horizons): Salt Range, Pakistan (Bruhwiler et al., 2011b)	Ammonoid zone (beds, horizons): South Primorye (Shigeta vet al., 2009; this study)	Ammonoid zone (beds, horizons): Chaohu, (Tong et al, 2003; this study)
Olenekian	Smithian	*Scythogondolella milleri*	*Glyptophiceras sinuatum*	*Glyptophiceras sinuatum*	*Anasibirites nevolini*	*Anasibirites kiangianus*
			Subvishnuites posterus	-		
			Wasatchites distractus	*Wasatchites distractus*		
		Neospathodus spitiensis	*Nyalamites angustecostatus*	*Nyalamites angustecostatus*	*"Hedenstroemia" bosphorensis*; *Euflemingites prynadai*; -	*Flemingites* (?) - *Euflemingites tsotengensis*
			Pseudoceltites multiplicatus	*Pseudoceltites multiplicatus*		
			Nammalites pilatoides: *Tuempyceras*	*Nammalites pilatoides*		
			Nammalites pilatoides: *Escarguelites*			
			Brayardites compresus	*Brayardites compresus*	*Brayardites* (?) *subhydaspis*	
			Flemingites Beds	*Flemingites flemingianus*		
		Neospathodus waageni	*Rohillites rohilla*	-		
			-	*Radioceras evolvens*		
			Vercherites cf. *pulchrum*	*Flemingites nanus*		
			-	*Xenodiscoides perplicatus*		
			Kashmiritidae gen. nov. A	*Shamaraites rursiradiatus*	*Shamaraites shamarensis*	
			Flemingites bhargavai	*Flemingites bhargavai*	*Ussurifle-mingites abrekensis*; *Paranorites varians*; *Parahedenstroemia kiparisovae*	?
Induan	Dienerian	*Sweetospathodus kummeli*	*Prionolobus rotundatus*	*Prionolobus rotundatus*	*Gyronites subdharmus*; *Pachyproptychites otoceratoides*; *Dunedinites magnumbilicatus*; *Proptychites hiemalis*	*Prionolobus - Gyronites*

Fig. 4. Overview of the upper Dienerian and Smithian buiostratigraphy of the Himalayas (Krystyn et al., 2007; Brühwiler et al., 2010b), Salt Range (e.g., Ware et al., 2011), Chaohu (Tong et al., 2004) and South Primorye. The arrow indicates of the IOB location in Krystyn's et al. (2007) sense.

Fig. 5. The assumed location of the IOB in the Abrek section (near the base of the Zhitkov Formation) (A.M. Popov's photo).

Fig. 6. Fish skull from the base of the Olenekian in the Abrek section (A.M. Popov's photo).

Fig. 7. Early Smithian *Ussuriflemingites abrekensis* beds (*Parahedenstroemia kiparisovae* and *Paranorites varians* horizons) in the Abrek section (A.M. Popov's photo).

Report on the second IGCP 572 field workshop, Feb. 20-26, 2010, in the Sultanate of Oman

By Aymon Baud[1] and Michaela Bernecker[2]

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Following the report on the very successful first IGCP 572 field workshop, Sept. 2-6, 2009, in Antalya, southern Turkey given in Albertiana 38 p. 14, we are reporting here our second field workshop organized five months later, Feb. 20-26, 2010, in the Sultanate of Oman, also dedicated to the Memory of Jean Marcoux, with a reminder of his entire scientific career and his works on the Permian and Triassic of Oman.

A one-day meeting, Feb. 21, has been organized at the GUtech campus (Muscat area) by Michaela Bernecker.

The participants and invited scientists (about 50) were welcomed by the Rector of GUtech, Prof. Dr. Burkhard Rauhut.

Following a short presentation of the IGCP 572 Program by its leader Zhong Qiang Chen, Aymon Baud presented an introduction to the field trip, with the main topics to be discussed on the Permian-Triassic transition outcrops.

Thomas Aigner gave the Keynote lecture: "Outcrop Characterization of the Khuff Formation from Production- to Exploration-scale". Zhong Qiang Chen gave a talk on "Permian-Triassic mass extinction and subsequent recovery: an ecosystem's perspective" and Oliver Weidlich with co-authors presented: "a review of the Permian-Triassic Boundary in the Middle East".

After coffee break we had the following talks:

-"End of gigantism in tropical seas by cooling: End-Guadalupian (Permian) extinction of the photosymbiotic tropical trio" by Yukio Isozaki and Dunja Aljinovic;

- "An unusually well preserved mollusk fauna from the earliest Triassic of South China: A unique window into the early survival phase after the end-Permian mass extinction event" by Michael Hautmann and co authors;

- "Ostracods (Crustacea) and Permian –Triassic boundary events" by Sylvie Crasquin.

After lunch, the afternoon session comprised 7 talks:

- "A Permian-Triassic carbonate sequence in southwestern Tibet, China and implications of dramatic environmental changes across the Permian-Triassic boundary in the oceanic setting in Neotethys" by Shu-zhong Shen, Yi-chun Zhang, Chang-qun Cao and Charles Henderson.

- "End-Permian mass extinction and boundary microbialite in Upper Yangtze Region" by Xinchun Liu, Xiaozheng Chen, Wei Wang, Zhuoting Liao, Yue Wang and Yuping QI.

- "Early and Middle Triassic recovery of the carbonate biofactory in the Western Tethys domain by Joachim Szulc.

- "Deep water records of the Latest Permian Extinction from NW Pangea and the Tethys: Buchanan Lake versus Buday'ah" by Stephen Grasby, Benoit Beauchamp and Aymon Baud.

- "The Middle Permian succession at Wadi Wasit Section, Oman" by Charles Henderson, Alda Nicora and Aymon Baud.

- "Deep water Permian-Triassic successions from Tethys:

Photo 1: Welcome to the participants at the GUtech meeting room by the Rector of GUtech, Prof. Dr. Burkhard Rauhut

Photo 2: Conference at the GUtech meeting room.

Oman Buday'ah revisited" by Aymon Baud, Benoit Beauchamp, Fabrice Cordey, Stephen Grasby, Charles Henderson, Leopold Krystyn, Jean Marcoux, Alda Nicora and Sylvain Richoz.

- "Upper Permian to Lower Triassic carbon isotope record in the Oman Mountains: An overview from the shallow platform to the basin" by Sylvain Richoz, Aymon Baud, Leopold Krystyn, Jean Marcoux and Micha Horacek.

The talks were concluded by a round table discussion followed by a 5 posters session

- "The Permian-Triassic sedimentary sequences in the External Dinarides (Croatia)" by Dunja Aljinovic and Yukio Isozaki

- "Carbon isotopic composition of the basinal carbonates of the Upper Permian Zechstein Limestone (Ca1) in West Poland" by Tadeusz Marek Peryt and Stanislaw Halas

- "Carbon and oxygen stable isotope composition of fish teeth from Lower Triassic of Spitsbergen as an environmental proxy" by Blazej Blazejowski, Andrzej Gaździcki and Krzysztof Malkowski.

- "Complex colonisation patterns of benthic communities in the immediate aftermath of the end-Permian mass extinction: New data from the Dolomites" by Richard Hofmann, Michael Hautmann, Nicolas Goudemand, Martin Wasmer, and Hugo Bucher.

- "Lower Triassic of the Julian Alps: first record of a fossil amphibian in Slovenia" by Tea Kolar-Jurkovšek, Spencer G. Lucas & Bogdan Jurkovšek.

The great official dinner closed this successful first day.

The four and a half day field workshop excursion offered to the 27 participants the opportunity to visit the magnificent outcrops of the Oman Mountains that provide unparalleled access to the Permian-Triassic transition units along the Gondwana margin of the Tethys, from shallow carbonate platform, Tilted block margin, continental slope and abyssal plain deposits.

It started on Feb. 22 with a half day trip on Permian Triassic boundary of the metamorphic autochtonous unit at Wadi Aday, close to Muscat, and leaded by *Oliver Weidlich and Michaela Bernecker*. This very interesting outcrop shows that this part of the Oman margin act as a high where the basal Triassic dolomites has been removed by erosion (basal Mahil unconformity, Weidlich and Bernecker, 2011).

For the second day, Feb. 22, leaded by *Aymon Baud and Sylvain Richoz,* the participants moved to the Saiq Plateau locality. Situated on the southern flank of the Djebel Akdhar antiform, around the mountain village of Saiq at the altitude of 2000m (about 100km SW of Muscat), it is one of the best exposure of the Permian-Triassic transition of the Oman Autochthonous and the type area of the Permian Saiq Formation.

The 3 stops of the day were situated below and at an aban-

Photo 3: Explanations on the Wadi Aday uppermost Permian surface outcrop by Oliver Weidlich (up-center, red backpack).

doned quarry (coordinates: N23°10' 00'' E 57° 39' 50'').

The first one was situated at the top of the Member B (=B4) of the Saiq Formation where the Permian-Triassic transition light dolomitic mudstone are overlying the dark bioclastic dolostone with rugose corals colony of *Wentzelella*-type. Climbing along the Induan Member C of the Saiq Formation the participants had opportunity to discuss the new data brought by the Late Griesbachian conodont recovered by C. Henderson and A. Nicora at the top of C1 Member and the overlying unconformity – erosional surface at the base of the 14m thick lithoclastic dolorudstone (C2). The lithoclasts accumulation is due to rapid lithification and tectonic instability with bloc tilting. At the last stop in the abandoned quarry we examined the oolitic dolograinstone with hardground at the top of the Saiq Formation and the green, brown and red clay mudstone with desiccation cracks at the base of the Mahil Formation (Olenekian).

On the way back, the opportunity to look at the Middle Permian spectacular giant bivalve *Alatoconchida* sp. level were given to the interested participants.

For the third day, Feb. 23, leaded by *L. Krystyn, S. Richoz, A. Baud and C. Henderson,* the participants went to the locality of Wadi Wasit, about 80 km south of Muscat, that provides one of the best and the most extensive exposures of Permian and Triassic deep-water sediments in the allochthon of the Hawasina window. There, the Permian to Lower Triassic Al Jil Formation consists of a 250m thick Middle Permian volcano-sedimentary sequence of pillow basalt with 4 main intercalations, 10 to 30m thick, of cherts, of volcanic breccias, of calcareous gravity flow deposits with Lower and Middle Permian shallow shelf or reef boulders and of cephalopod red lime wackestones. After a stratigraphic gap of nearly 10 My, the Lower Triassic record begins with breccias of Dienerian age followed by platy limestones of Late Dienerian to Smithian age, dated at different places by conodonts.

The breccias sandwiched between Permian turbiditic and Lower Triassic platy limestones, are of variable thickness and are very widespread. They are channelized, clast-supported debris flows deposits, which cut deeply into the underlying calcareous or volcanic rocks of Middle Permian age.

The Wasit block is a unique geological archive that contains evidence of an extraordinarily rapid faunal recovery after the P-Tr crisis with, at the same time, an increase of $\delta^{13}C_{carb}$ isotope values from +1.2‰ in the basal Triassic transgression to 3.1‰ at the end of the Griesbachian (signifying probably an increase in productivity?) as presented by *Sylvain Richoz*.

It contains also the most diverse Griesbachian assemblage known to date, which has a community structure not normally recorded in pre-Spathian (Early Triassic) rocks and which was living under well oxygenated conditions.

This shows us that where conditions of oxygenation and productivity are favorable, a diverse fauna will be recorded.

The fourth day, February 25, leaded by *A. Baud, with explanations of S. Richoz, B. Beauchamp, S. Grasby, C. Henderson* and *L. Krystyn, the* participants went to the Buday'ah area, about 150km west of Muscat. The object was to examine the Middle Permian to Lower Triassic Buday'ah section of oceanic sediments belonging to the south margin of the Tethys. This locality (coord.: N 23° 44' 43'' E 56° 54' 21'') is among the very few places of real Tethyan Permian radiolarites.

Photo 4: Group photo in front of the Saiq village.

Photo 5: Explanation of the geology of the Saiq Plateau by the leaders: Sylvain Richoz (left) with E. Isozaki, and Aymon Baud (center of right photo) with part of the group.

Photo 6: Leopold Krystyn (right), Aymon Baud, Benoit Beauchamp and Charles Henderson sitting on the Wasit block.

The first stop looked at the truncated substratum of the sedimentary succession that consists of pillow basalts erupted in the Hawasina basin far away from the continent, from truly oceanic settings, but located near hot spots and the next stops examined the oceanic successions. In the discussion we compared our Tethyan oceanic section with published Panthalassa sections, showing that all localities display radiolarian cherts as the dominant type strata in the lower Late Permian. Up section, successions graded into "boundary shales" and/or black shales of various thicknesses. Conodonts indicate that the Permian-Triassic boundary succession occurs in the first platy lime mudstone beds above a Changhsingian siliceous to calcareous shale unit. The platy lime mudstone beds include an Upper Griesbachian bloom of calcite filled spheres (radiolarians?) that marks a potential world-wide event. New conodonts indicate an early Olenekian age for overlying grey papery limestone that are devoid of both macrofossils and trace fossils indicating that recovery from the Late Permian extinction has not yet progressed within this deep-water environment.

At the end of the day, our Chinese and part of our Polish colleagues leaved us to go back to the airport and we continue our trip to overnight in the Emirates near Hatta. We were sorry that our Slovenian and Croatian colleagues were not allowed to enter in the Emirates.

The last day, February 26, starting from the Emirates near Hatta the participants went to the entrance of Wadi Maqam belonging to the Oman territory (coord.: N 24°46'30" E 55°51'43"), to look at the Permian-Triassic transition in the Sumeini area with the leaders of the day: *S. Richoz, A. Baud, B. Beauchamp, S. Grasby, C. Henderson and L. Krystyn*.

The lower part of the Sumeini Group represented by a thick sequence slope carbonate deposits is included in the Maqam Formation (Middle Permian to Lower Jurassic), further subdivided into 6 members, A, B, C, D, E and F.

The top part of the B Member and the transition to C Member records the end Permian events. Different types of Permian-Triassic transition outcrops were shown at stop 1 and 2 where the participants had the opportunity to sample the most complete uppermost Permian succession with late Changhsingian conodont, followed by the thickest boundary shales (up to 3m) of the area. The conodont *H. parvus* has been recovered at the base of the overlying papery and platy limestones.

Sylvain Richoz presented his detailed Carbon isotope curve based on the conodont biochronology of *Leopold Krystyn*. Information on the new Chemostratigraphic data were given by *Stephen Grasby* and *Benoit Beauchamp,* showing a significant drop in total carbon content suggesting disruption of carbonate sedimentation associated with

Photo 7: Wasit block: silicified basal Triassic bivalves and brachiopodes (wide 4cm).

the extinction event. After lunch the participants moved to the close Wadi Shuyab to look at the upper part of the very thick (up to 900m) Smithian platy limestones and shales succession with the spectacular development of the ichnofauna.

After samples collecting and lively last discussion, all the participants warmly thanked the organizers, Michaela Bernecker and Aymon Baud, for their deep involvement in this great field workshop and conference.

Some of the participants came back to Muscat, others went to Dubai Airport and some stay for achieving important field studies.

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Photo 8: Part of the participants looking on the Olenekian papery limestone.

Photo 9: Sylvain Richoz (right), Leopold Krystyn (middle) and Aymon Baud (left) explaining the very thick Smithian platy limestones and shales succession.

Triassic Ammonoid Succession in South Primorye: 6. Melagathiceratid ammonoids (inner shell structure, phylogeny, stratigraphical and palaeobiogeographical importance)

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Abstract. The first data on the inner shell structure of early Olenekian melagathiceratid ammonoids (Ptychitina) are reported. Melagathiceratid ammonoids are characterised by the typical Palaeozoic type of the inner shell-structure (ventral position of the siphuncle and retrochoanitic type of septal necks in all of the ontogenetic stages we observed). Similar inner shell structure have been documented for ammonoids of other conservative lineages of the suborder Ptychitina (Paranannitinae and Prosphingitinae), but their retrochoanitic necks are transformed into modified retrochoanitic necks in earlier ontogenetic stages. However, the marked ontogenetic acceleration in septal neck-siphuncular complex of ammonoids took place in the progressive lineage Ussurijuvenites-Owenites–Parapopanoceras–Ptychites. One of the characteristic features in the ammonoid shells of this lineage is a near ventral or near central position of the siphuncle in early ontogenetic stages. It seems likely that the suborder Ptychitina derived from the Permian Paraceltitina, possibly Changhsingian Liuchengoceratidae.

Introduction

The family Melagathiceratidae has been proposed by Tozer (1961, 1971, 1994). He considered it consisting of three genera: *Melagathiceras* Tozer (1971), *Juvenites* Smith (1927), and *Thermalites* Smith (1927), which are predominantly spherocones with changeable periphery and simple ceratitic (five-lobed) suture line. Representatives of the family Melagathiceratidae were globally distributed in the Early Triassic and therefore they are of great stratigraphical and palaeobiogeographical importance.

The aim of our paper, contained the first data on inner shell structure of melagatthid ammonoids, is to prove a better understanding of phylogeny of the suborder Ptychitina as well as the position of the family Melagathiceratidae within this suborder on the basis of published and original data on the inner shell structure.

Material and methods

Original materials (19 samples of ammonoid *Ussurijuvenites* and some biostratigraphical data) used for our investigation were obtained from the lower Olenekian (Smithian) of the Artyom area, South Primorye. To investigate the inner ammonoid shell structure a stereomicroscope Discovery V12 (Zeiss) at the Far Eastern Geological Institute (Analytical Center) was used.

Results

Biostratigraphical occurrences of melagothiceratid ammonoids in South Primorye

Till recently, among megalacerathid ammonoids from South Primorye the next species were recognized: (1) *Juvenites dieneri* (Hyatt et Smith) from the "*Hedenstroemia" bosphorensis* Zone of Balka Cape at Russian Island (Kiparisova, 1961); (2) *Juvenites* sp. from the "*Hedenstroemia" bosphorensis* and *Anasibirites nevolini* zones of Ayax and Paris bays (Zakharov et al., 2004); (3); *J.* aff. *sinuosus* (Kiparisova) from the "*Hedenstroemia*" *bosphorensis* Zone of the eastern Ussuri Gulf and upper Kamenushka River (Kiparisova, 1961); (4) *Juvenites simplex* (Chao) from the "*Hedenstroemia*" *bosphorensis* Zone of the eastern Ussuri Gulf, left bank of the Artyomovka River and Ayax Bay (Zakharov, 1968). Recently, *Ussurijuvenites popovi* Smyshlyaeva and Zakharov and *U. artyomensis* Smyshlyaeva and Zakharov were described from the Smithian *Euflemingites prynadai* Beds of the SMID quarry at the Artyom environs (Smyshlyaeva and Zakharov, 2011) (Fig. 1). Both species, associated with *Arctoceras, Prosphingitoides, Dieneroceras, Owenites* and *Anaxenaspis*, were found in the upper part of the *Euflemingites prynadai* beds, just below the *Anasibirites nevolini* Zone (Figs. 2 and 3), characterised mainly by *Anasibirites, Wasatchites, Kashmirites,* and *Churkites.*.

Inner shell structure of *Ussurijuvenites artyomensis*

The first information on inner shell structure of melagathiceratid ammonoids have been obtained, using *Ussurijuvenites artyomensis* (Figs.4 and 5)). Its initial chamber (protoconch) globe-shaped, comparatively large (up to 0.50 mm in diameter), caecum globular (up to 0.12 mm in diameter), with a short (about 0.07 mm) so-called prosiphon (fixator) (Fig. 6). The living chamber of ammonitella, reached of 0.75 mm in diameter, is short ($\alpha = 275^{o}$). Siphuncle is characterised by its ventral location within the all investigated ontogenetic stages (first four whorls). All septal necks within these onthogenetic stages are retrochoanitic (Fig. 7). The number of hydrostatic

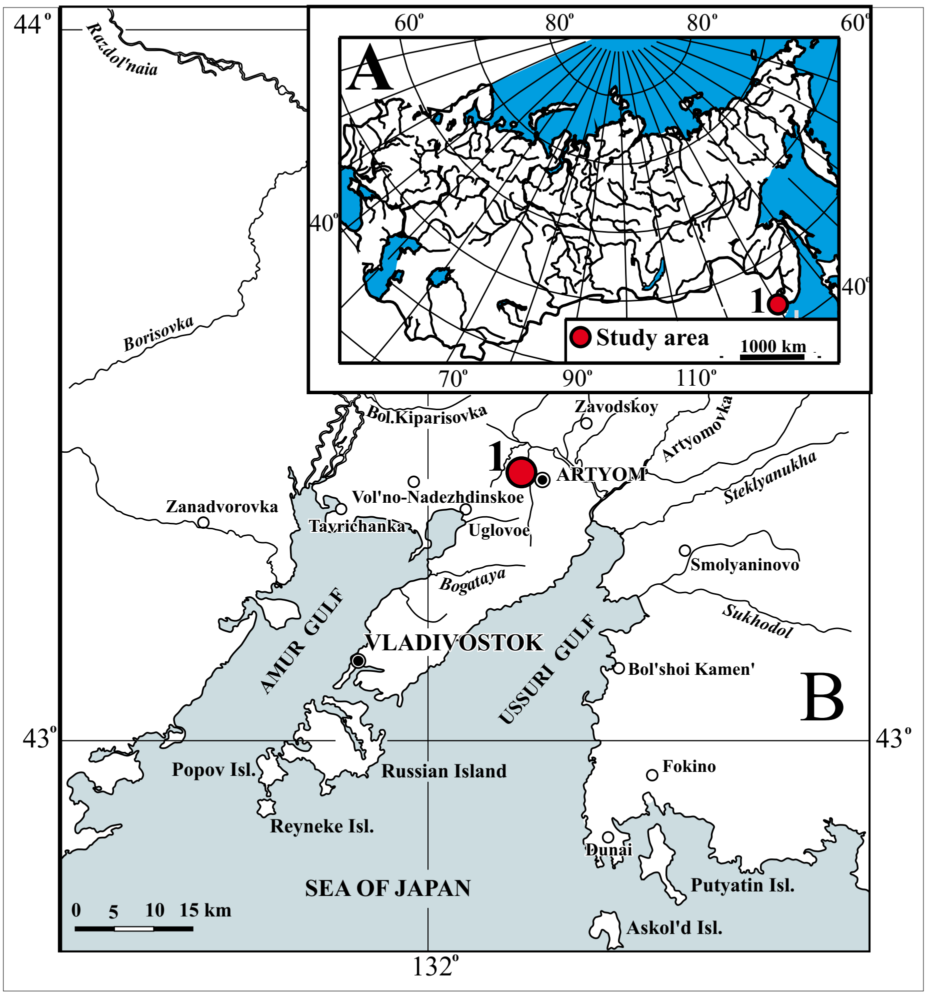

Fig. 1. Location of the investigated section (SMID quarry, Artyom) in South Primorye.

cameras within a whorl is about 6-7 (they are elongated at least within the first four whorls, and the prominence in most of septa is directed adorally).

Discussion

Inner shell-structure in ammonoids of the suborder Ptychitina (an overview)

There is information on the inner shell structure of ten genera of the suborder Ptychitina now: *Juvenites, Parananites, Proshingitoides, Prosphingites, Owenites* (Zakharov, 1978), *Ussurijuvenites (*Smyshlyaeva and Zakharov, 2011*), Stenopopanoceras, Parapopanoceras*, *Ptychites*, *Arctoptychites,* and *Aristoptychites* (Vavilov, 1992).

Judging from these data, *Ussurijuvenites* (Melagathiceratidae) seems to be one of most primitive members of the suborder Ptychitina, characterised by the typical Palaeozoic type of the ammonoid inner shell-structure (ventral position of a siphuncle in the earliest ontogenetic stage and retrochoanitic type of septal necks in all ontogenetic stages observed). We have not full information on this topic concerning *Juvenites*, but it is known (Zakharov, 1978) that it is characterised by smaller size of the protoconch (0.38 mm in diameter).

In the Paranannitidae (*Paranannites, Prosphingitoides,* and *Prosphingites*) retrochoanitic necks, in contrast, were replaced by modified retrochoanitic necks (this transformation occurs between 4th and 5th whorls) during ontogeny (Fig. 8), and position of a siphuncle in the earliest ontogenetic stage became subventral (Fig. 9). Both retrochoanitic and modified retrochoanitic septal necks have been recognized also in the Popanoceratidae (*Stenopopanoceras* and *Parapoponoceras*) and Ptychitidae (*Aristoptychites* and *Ptychites*), but this transformation occurs in the earlier ontogenetic stages (between 1st and 3rd whorls), and position of the siphuncle in the early ontogenetic stages fluctuates from subventral to central (Figs. 8 and 9).

The chief attraction of *Owenites* resides in its original inner shell structure, characterised by retrochoanitic septal necks at least in all of the ontogenetic stages observed (between 4rd and 6th whorls), but with subcentral position of the siphuncle in some early ontogenetic stages (between 2nd and 6th whorls), like in *Arcestes* (Arcestina)) (Figs. 8 and 9).

The position of the Melagathiceratidae within the suborder Ptychitina

According to our original point of view, considered some evidences on the inner shell structure, the evolution of the suborder Ptychitina followed five divergent trends, reflecting in its phylogeny. `We offer to appreciate the four

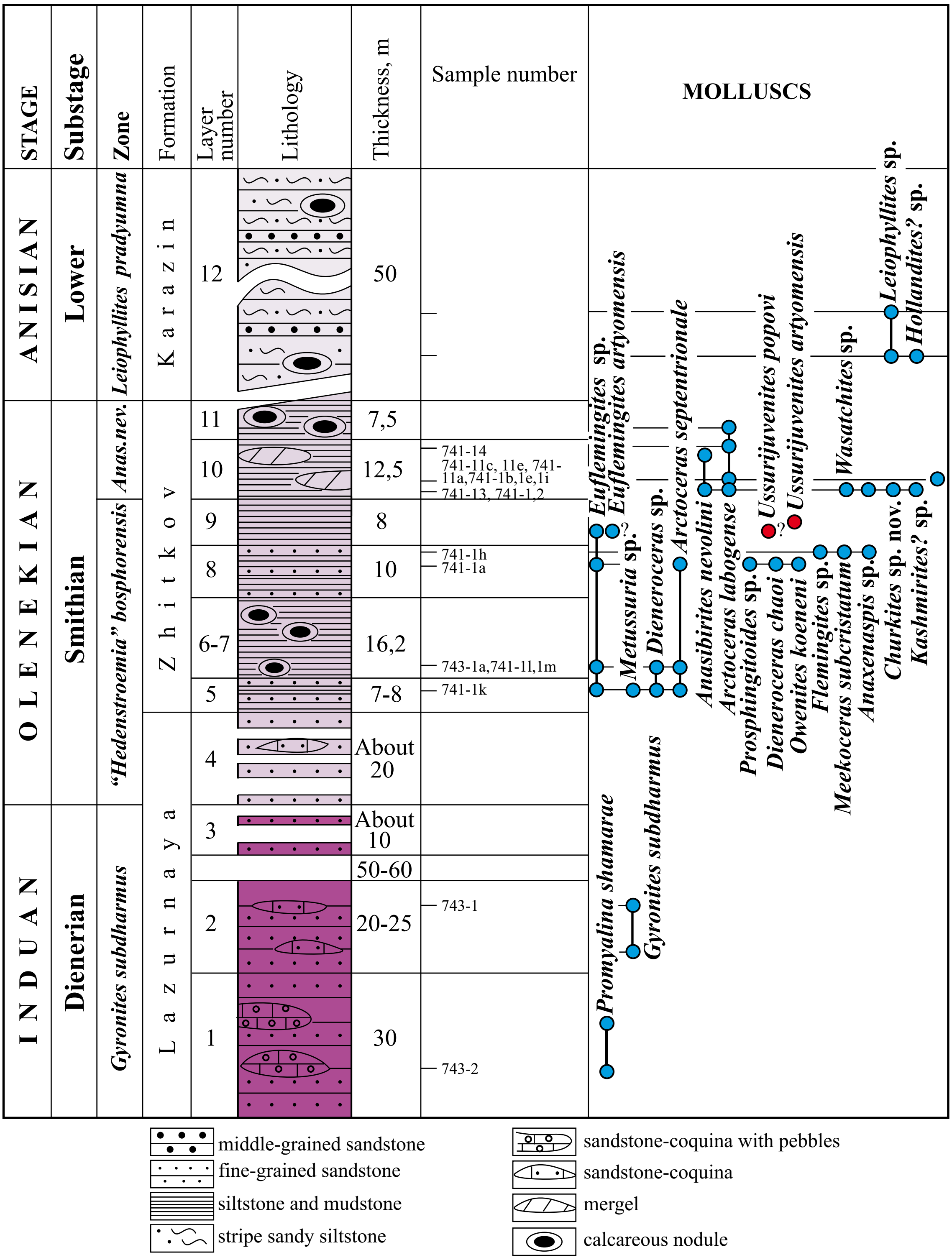

Fig. 2. Observed stratigraphic distribution of molluscs in the Triassic, SMID quarry section.

Fig. 3. The *Ussurijuvenites* locality at the Artyom area, South Primorye (A.M. Popov's photo).

conservative lineages: (1) *Prejuvenites* (Ptychitoidea fam. nov.) – *Ussurijuvenites - Melagathiceras* (Melagathiceratidae), (2) *Ussurijuvenites – Paranannites* (Paranannitinae), (3) *Ussurijuvenites – Proshingitoides – Prosphingites* (Prosphingitinae), and (4) *Proshingitoides – Zhitkovites* (Prosphingitinae), but the single progressive one (*Ussurijuvenites - Owenites* (Owenitidae) – *Parapopanoceras* (Parapopanoceratidae) – *Ptychites* (Ptychitidae)), characterised by most marked terminal addition in evolution of septal necks (Fig. 8) and significant deviation in position of the siphuncular tube in some ontogenetic stages (Figs. 9 and 10).

According to our previous suggestion (Zakharov et al., 2011), only four ammonoid taxa (Episageceratidae, Xenodiscidae, Dzhulfitidae, and Otoceratoidea) survived the end-Permian mass extinction. However, our new morphological analysis shows that ammonoids of the suborder Ptychitina possibly originated from the late Wuchiapingian Liuchengoceratidae (Paraceltitina) (Zhao et al., 1978), characterised by goniatitic suture line, similar with those of some primitive representatives of *Ussurijuvenites* from the Smithian and *Prejuvenites* (Waterhouse, 1996) from the Dienerian. This evidence allows us to assume that some other ammonoid linages (e.g., Liuchengoceratidae-Ptychitoidea) could have potentially crossed the Permian-Triassic boundary.

Geographic differentiation of melagathiceratid ammonoids

In this stage of our knowledge, 25 species of five genera of middle Smithian melagathiceratid ammonoids have been discovered, most of them were found in the low and middle palaeolatitudes, and only 32% of these species are occur in the Boreal realm. Many melagathiceratid ammonoids, such as *Juvenites* and *Thermalites,* are cosmopolitan elements on generic level, being common in low, middle and high palaeolatitudes. Among melagathiceratid ammonoid endemics of the Boreal realm on generic level only forms of *Melagathiceras* are known (*M. crasum* (Tozer)*, M. globosum* (Popow)*,* and *M. depressum* (Smith)) (Dagys, Ermakova, 1990; Tozer, 1994), however one of them (*M. depressum*) has been discovered in the middle latitudes of North America also (Fig. 11). Other melagathiceratid ammonoid genera (*Jinaceras* and *Ussurijuvenites*) are common for only a few low- and middle-latitude regions. These data are in agreement with evidences (Brayard et al., 2006), reflected the quick resumption of increasing trend in latitudinal gradient of ammonoid taxonomic richness during middle Smithian times.

Conclusions

1. The evolution of the suborder Ptychitina followed several divergent trends. Becides the some conservative lineages – *Ptychites*), characterised by marked terminal addition in evolution of septal necks and significant deviation in position of the siphuncle in early ontogenetic stages, seems to be obvious.

2. Melagathiceratid ammonoids, primitive representatives of the suborder Ptychitina, are characterised by the typical

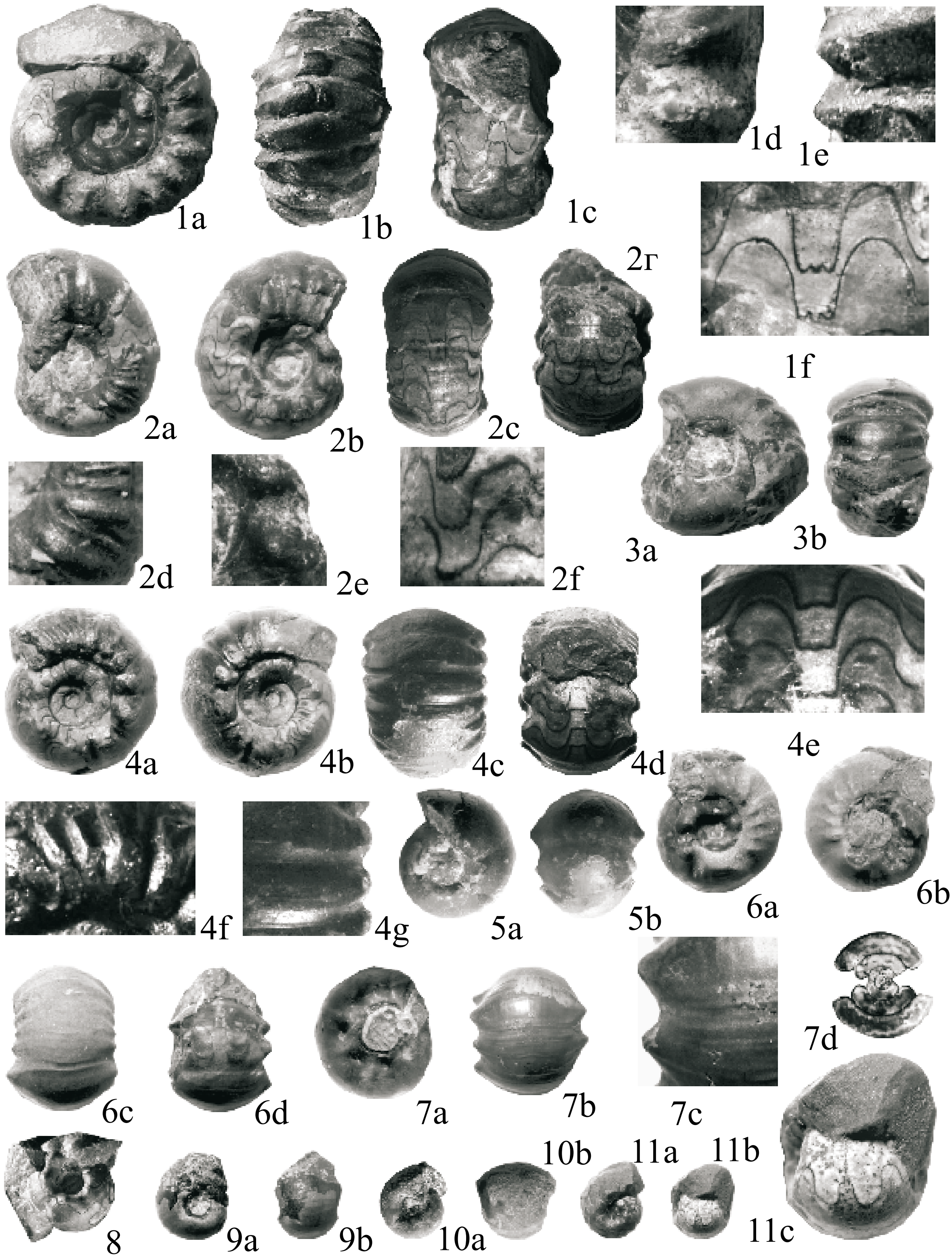

Fig. 4. Smithian *Ussurijuvenites* from South Primorye: 1-3 – *U. popovi* Smyshlyaeva and Zakharov; 4-11 -. *U. artyomensis* Smyshlyaeva and Zakharov.

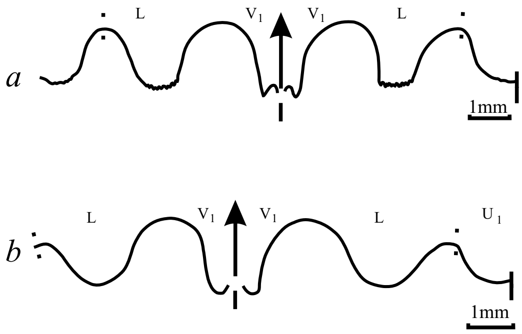

Fig. 5. Suturelines of *Ussurijuvenites popovi* Smyshlyaeva and Zakharov (a) and *U. artyomensis* Smyshlyaeva and Zakharov (b).

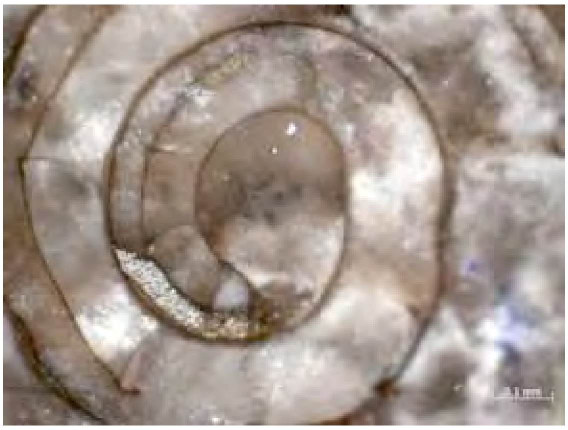

Fig. 6. The inner shell structure of *Ussurijuvenites artyomensis* Smyshlyaeva and Zakharov (protoconch and ammonitella).

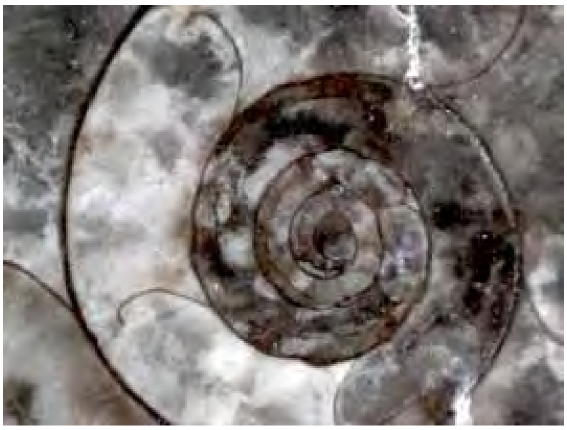

Fig. 7. The inner shell structure of *Ussurijuvenites artyomensis* Smyshlyaeva and Zakharov (retrachoanitic septal necks).

Palaeozoic type of the inner shell-structure. It seems likely that the Ptychitina derived from the Permian Paraceltitina, possibly Changhsingian Liuchengoceratidae. This illustrates that in addition to the four known ammonoid taxa, survived the end-Permian mass extinction, some other ammonoid lineages (e.g., Liuchengoceratidae-Ptychitoidea) could have potentially crossed the Permian-Triassic boundary.

3. Many early Smithian melagathiceratid ammonoids, such as *Juvenites* and *Thermalites,* are cosmopolitan elements. Among melagathiceratid ammonoid endemics of the Boreal realm only forms of *Melagathiceras* is known (three species), however one of them has been discovered also in the middle latitudes of North America. Other melagathiceratid ammonoids (*Jinaceras* and *Ussurijuvenites*) are common for only a few low- and middle-latitude regions, reflecting more or less pronounced geographical differentiation of ammonoid faunas during the Smithian.

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C. Progressive lineage *Ussurijuvenites-Owenites-Parapopanoceras-Ptychites*							
Family	**Species**	**Septal necks**					
Ptychitidae	*Ptychites trochlaeformis*			M	M		
	Aristoptychites kolymensis	R M	M				
Popanoceratidae	*Parapopanoceras medium*		M	M	M	M	M
	Parapopanoceras janaensis	R	M	M	M	M	M
	Parapopanoceras asseretoi	R	M	M	M	M	M
	Stenopopanoceras mirabile	R	R	R	M	M	M
Owenitidae	*Owenites koeneni*		R?	R?	R	R	R
Melagathiceratidae	*Ussurijuvenites artyomensis*	R	R	R	R	R?	R?
		I	II	III	IV	V	VI

Whorls →

B. Conservative lineage *Ussurijuvenites - Prosphingitoides - Prosphingites*							
Family (subfamily)	**Species**	**Septal necks**					
Paranannitidae (Prosphingitinae)	*Prosphingites czekanowskii*	R	R	R	M	M	M?
	Prosphingitoides hexagonalis	R?	R	R	R	M	M
Melagathiceratidae	*Ussurijuvenites artyomensis*	R	R	R	R	R?	R?
		I	II	III	IV	V	VI

Whorls →

A. Conservative lineage *Ussurijuvenites - Paranannites*							
Family (subfamily)	**Species**	**Septal necks**					
Paranannitidae (Paranannitinae)	*Paranannites aspenensis*	R?	R	R	M?	M	M
Melagathiceratidae	*Ussurijuvenites artyomensis*	R	R	R	R	R?	R?
		I	II	III	IV	V	VI

Terminal additional in evolution — **Whorls** →

Fig. 8. Terminal addition in evolution of septal necks in different lineages of the suborder Ptychitina (Zakharov, 1978; Vavilov, 1992; this study). Septal necks: R – retrochoanitic, M – modified retrochoanitic.

Suborder	Family	Species	Position of the siphuncle					
Arcestina	Arcestidae	*Arcestes* sp.			SD	C	C-SV	V?
Ptychitina	Ptychitidae	*Aristoptychites kruzini*	C-SV	SV-V	V	V	V	V
		Aristoptychites euglyphus	V	V	V	V	V	V
		Aristoptychites kolymensis	V	V	V	V	V	V
	Parapopanoceratidae	*Parapopanoceras medium*	C-SV	SV-V	V	V	V	V
		Parapopanoceras asseretoi	C	SV	V	V	V	V
		Parapopanoceras janaensis	SV	V	V	V	V	V
		Stenopopanoceras mirabile	SV?	V	V	V	V	V
	Owenitidae	*Owenites koeneni*	SV	SC	SC	SC	SC	SC
	Paranannitidae (Prosphingitinae)	*Prosphingites czekanowskii*	SV-V	V	V	V	V?	V?
		Prosphingitoides ovalis	SV-V					
	Paranannitidae (Paranannitinae)	*Paranannites aspensis*	SV-V	V	V	V		
	Melagathiceratidae	*Ussurijuvenites artyomensis*	V	V	V	V		

Fig. 9. Main tendency in deviation of the siphuncle from its original ventral position in some species of the suborder Ptychitina (Zakharov, 1978; Vavilov, 1992; this study). Position of the siphuncle: V – ventral, SV – subventral, C – central, SC – subcentral, SD – subdorsal.

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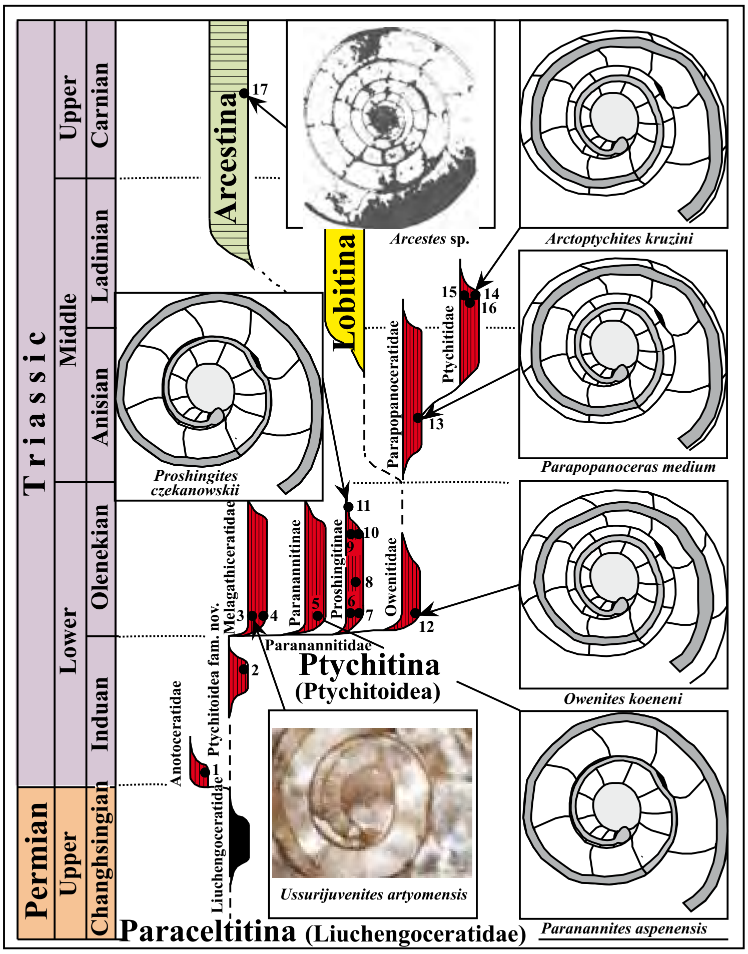

Fig. 10. The phylogenetic tree of the suborder Ptychitina. 1 – *Anotoceras*, 2 – *Prejuvenites*, 3 – *Ussurijuvenites*, 4 – *Juvenites*, 5 – *Paranannites*, 6 – *Isculitoides*, 7 – *Popovites*, 8 - *Proshingitoides*, 9 – *Pseudoprosphingites*, 10 – *Zhitkovites*, 11 – *Prosphingites*, 12 – *Owenites*, 13 – *Parapopanoceras*, 14 – *Arctoptychites*, 15 – *Ptychites*, 16 – *Aristoptychites*, 17 – *Arcestes*.

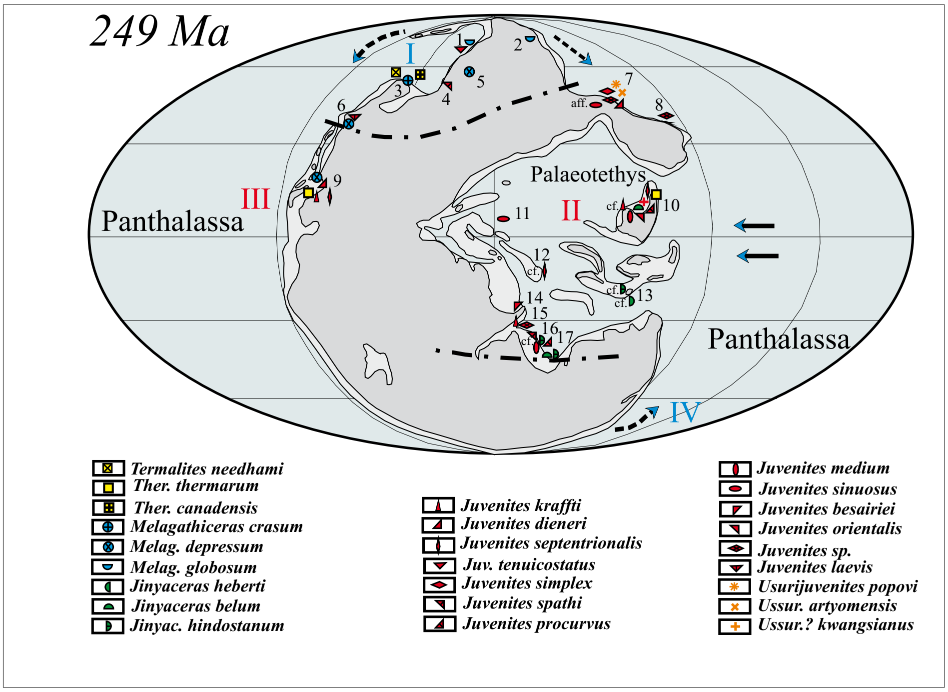

Fig. 11. Geographical distribution of melagathiceratid ammonoid species during the Smithian. 1 – Arctic Siberia (Dagys and Ermakova, 1990), 2 – Kolyma (Bytchkov, 1972), 3 – Arctic Canada (Tozer, 1994), 4 - Svalbard (Brayard and Bucher, 2008), 5 – Verkhoyansk (Dagys and Ermakova, 1990), 6 – British Columbia (Tozer, 1994), 7 – South Primorye (Kiparisova, 1961; Zakharov, 1968; Smyshlyaeva and Zakharov, 2011), 8 – Kitakami (Kummel and Steele, 1962), 9 – Idaho and Nevada (Kummel and Steele, 1962), 10 – South China (Chao, 1959; Brayard et al., 2006), 11 – North Caucasus (Kiparisova, 1947), 12 – Afganistan (Kummel, 1968), 13 – Timor (Kummel and Steele, 1962), 14 – Madagascar (Kummel and Steele, 1962), 15 – Salt Range (Brühwiler et al., 2011b), 16 – Himalayas (Brühwiler et al., 2011a), South Tibet (Brayard and Bucher, 2008).

Abstracts and short papers presented at the special session: Studies on the Triassic in Commemoration of Edward Timothy Tozer

The Annual Meeting of the Paleontology Division of the Geological Association of Canada.

University of British Columbia, August 19th-22nd, 2011 Vancouver, British Columbia

Chairs: Mike Orchard and Marco Balini

Towards the definition of the Carnian/Norian boundary: new data on ammonoids and conodonts from central Nevada

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The Berlin-Ichthyosaur State Park in central Nevada is a very important locality for the understanding of the Carnian-Norian boundary (CNB) in North America. Rich ammonoid faunas from this site within the Luning Formation were studied by Silberling (1959) and provided support for the definition of the Schucherti and Macrolobatus zones of the latest Carnian, which are here overlain by well preserved faunas of the earliest Norian Kerri Zone. Despite its importance, no further investigations have been done at this site during the last 50 years. Here

we present the preliminary data of a new bed-by-bed sampling for ammonoids and conodonts carried out in West Union Canyon during October 2010.

The eastern side of the canyon provides the best record of the Macrolobatus Zone, which is represented by several beds yielding ammonoids of the Tropites group, together with Anatropites div. sp. Conodont faunas from both these and higher beds are dominated by ornate 'metapolygnthids' that would formerly have been collectively referred to Metapolygnathus primitius, a species long known to straddle the CNB. Within this lower part of the section, they resemble forms that have been separated as Metapolygnathus mersinensis. Slightly higher, forms close to 'Epigondolella' orchardi and a single 'Orchardella' n. sp. occur. This association can be correlated with the latest Carnian in British Columbia.

Higher in the section, the ammonoid fauna shows a sudden change and is dominated by Tropithisbites. Few tens of metres above, but slightly below the first occurrence of Norian ammonoids Guembelites jandianus and Stikinoceras, two new species of conodonts (Gen et sp. nov. A and B) appear that also occur close to the favoured Carnian/Norian boundary at Black Bear Ridge, British Columbia. Stratigraphically higher collections continue to be dominated by forms close to M. mersinensis and 'E.' orchardi.

The best exposure of the Kerri Zone is on the western side of the West Union Canyon. Ammonoids, dominated by Guembelites and Stikinoceras div. sp., have been collected from several fossil-bearing levels. Conodont faunas replicate those of the east section.

The collected ammonoids fit perfectly well with the faunas described by Silberling in 1959, but they differ somewhat from coeval faunas of the Tethys and Canada. The genus Gonionotites, very common in the Tethys and British Columbia, is for the moment unknown in Nevada. More in general, the Upper Carnian faunas are dominated by Tropitidae, while Juvavitidae are lacking.

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Radiolarians and conodonts across the Carnian-Norian boundary in Haida Gwaii, British Columbia

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The early Mesozoic radiolarian succession in Haida Gwaii is unrivalled in terms of both abundance, excellent preservation of the faunas, and because of their common co-occurrence with conodonts and macrofossils, which permits the intercalibration of fossil zonations.

Radiolarians from stratigraphic sections at Sadler Point (uppermost Carnian to lower Norian) and Frederick Island (lower Norian), plus collections from selected localities included to better constrain the upper Carnian interval, were studied to assess the character of faunas through the interval likely to embrace the as yet undefined Carnian-Norian Boundary (CNB). The faunas are diverse and contain over 130 species. These include species that are widely known in other areas of the world as well as many new undescribed species. The faunas compare most closely with those from central Oregon (Blome, 1984; Yeh, 1989) and Baja California (Pessagno et al. (1979), but many species described from Japan, Timor, the Philippines, the Northern Calcareous Alps and Tethys (i.e., Cypress, Greece, Sicily, and Turkey) are also common to abundant. Many of the conodonts from Haida Gwaii are also known from Black Bear Ridge in northeastern British Columbia and thereby permit recognition of conodont faunas differentiated by Orchard (2007, 2010). However, there are also some Tethyan species unknown in the interior.

The pattern of radiolarian change across the CNB interval is characterized by the appearance of new species, there being very few extinctions. The oldest faunas co-occur with Carnian ammonoids of the Welleri Zone and conodonts originally assigned to the lower Metapolygnathus nodosus Zone (Orchard, 1991). This distinctive fauna occurs widely throughout Haida Gwaii and most of its species range upward across the CNB interval. The composition of younger radiolarian faunas changes gradually through the samueli to primitius conodont zones (equivalent to Faunas 1-6 of Orchard, 2010), which are broadly equivalent to the Macrolobatus ammonoid Zone. The FAD of Kahlerosphaera kermerensis adentatus Tekin, a species formerly regarded as early Norian, occurs in the upper part of this interval. A major increase in diversity occurs around the beginning of Fauna 7 (of Orchard, 2010), wherein the favoured CNB lies, with the first appearance of over 34 radiolarian species including Corum speciosum Blome, Loffa mulleri Pessagno, Icrioma deweveri Tekin, Sarla curvatus (Tekin), Spinosicapsa? akayi (Tekin), and Veghia sulovensis Kozur & Mock. The FAD of a further 15 species, including Dumitricasphaera elegans Tekin, Hetalum parvus (Tekin), Kozuricyrtium carinatus (Tekin), and Pachus longinquus Blome occurs slightly higher in association the Metapolygnathus parvus group. Together this 'faunal bloom' marks the FAD of genera Catoma, Loffa, Pachus, and

Renzium, and over half of the constituent species have been regarded as first appearing in the Norian. Further but lesser radiation occurs at higher stratigraphic levels through the 'Epigondolella' orchardi and Epigondolella quadrata zones.

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Absolute ages for the Norian stage: a contribution from southern British Columbia, Canada

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Direct absolute age calibration for the Upper Triassic is largely unavailable and age estimates have relied on magnetostratigraphic correlation between Tethyan marine successions and the Newark nonmarine succession, and summations of cyclostratigraphic periodicities derived from the latter. On that basis, a broad range of ages have been suggested e.g. the base of the Norian at ~216 Ma or ~227 Ma, and that of the Rhaetian at ~204 or ~210 Ma. Rare chronometric ages presently provide a base Carnian age at ~236 Ma, an age of ~231 Ma within the upper Carnian, and a top Rhaetian at ~201 Ma.

Upper Triassic strata of the Nicola Group in the Merritt area, 200 km east of Vancouver, form part of the southwestern margin of the Quesnel Terrane, a subduction-generated magmatic arc that stretches northwesterly throughout the British Columbia Cordillera. Two sections -Castillion Creek and (9 km to the northeast) Iron Mountain - consist of broadly similar strata of bedded, feldspar-rich siltstone-sandstone, minor mudstone, and limestone, and interlayered volcanic rocks of contrasting compositions including mafic lava flows and comparatively thin felsic ash-lapilli interbeds.

At Castillion Creek highway exposure, 400+ m of calcareous siltstones and scarce impure carbonates alternate with feldspathic fine clastic beds, siliceous exhalites, and primarily mafic lava flows. Numerous steeply inclined normal faults and a few south-verging contraction faults have produced small offsets in the parallel-layered rocks. A rare rhyolitic ash-tuff layer, locally up to 20 cm thick, marks the base of conformably overlying sedimentary strata and yielded a robust U-Pb age of 224.52 ± 0.22 Ma. Limestone that depositionally overlies this tuff produced an early middle Norian conodont assemblage consisting of Epigondolella spiculata and E. tozeri.

At Iron Mountain, a preliminary U-Pb age of 223.81 ± 0.78 Ma was determined from dacitic crystal-ash tuff overlain by an internally conformable 60 m section composed of limestone, lesser dacitic fragmental volcanic, and feldspar-bearing sandstone beds. Carbonate beds yield the conodonts Epigondolella quadrata and E. triangularis, diagnostic for the upper lower Norian. Waterlain rhyolitic ash-forming prominent white bands in siltstone at the top of the measured section with the potential to bracket the conodont fauna unfortunately failed to produce zircons.

Together, the two U-Pb dates imply that the lower-middle Norian boundary interval lies at ~224

Ma. The more robust one from Castillion Creek places a maximum age on the spiculata conodont Zone (equivalent to lower Columbianus ammonoid Zone in northeastern British Columbia) of the early middle Norian, although biogeographic and stratigraphic arguments may used to suggest that the zircons date a slightly older interval. The less robust but similar U-Pb age from Iron Mountain lies beneath fauna of the upper lower Norian triangularis conodont Zone (equivalent to the Dawsoni-Magnus ammonoid zones), but may fall within that zone. Although neither location yet provide tightly bracketed fauna or zircons, these dates appear consistent with an older base-Norian (~227 Ma) and imply the latest estimates of the L-M Norian boundary at ~216 Ma are too young.

Tozer's arctic legacy: an update on the recognition of the Permian-Triassic boundary (PTB) in the Sverdrup basin, Canadian Arctic Archipelago

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The fact that we continue to use the informal substages Griesbachian, Dienerian, Smithian, and Spathian is testament to Tim Tozer's Arctic legacy in Triassic biostratigraphy and that his ammonoid zonation remains the standard after more than 40 years. The type-section for the Griesbachian is at Griesbach Creek, Axel Heiberg Island, where a succession of ammonoids including Otoceras concavum, O. boreale, and Ophiceras commune characterize what Tim determined to be the basal Triassic. This succession unconformably overlies the Lower Permian Great Bear Cape Formation. Ammonoids are abundant, but unfortunately conodonts that would be important for testing the ratified PTB defined by the FAD of Hindeodus parvus at Meishan, China, are absent at this location. Fortunately, conodonts and ammonoids have been found together elsewhere in the Sverdrup Basin on Ellesmere Island. At Otto Fiord, the Blind Fiord Formation disconformably overlies the Middle Permian Degerbols Formation. The Otoceras concavum, O. boreale, Ophiceras commune ammonoid succession has been recovered at this section, associated with Late Permian and Early Triassic conodonts that correlate the PTB within the Otoceras boreale zone. The best conodont position for the boundary is the FO of Clarkina taylorae, 18 m above the base of the Blind Fiord. Hindeodus parvus is rare, but an occurrence at 31 m indicates the parvus zone and proximity to the PTB. Near the shores of Blind Fiord, the Blind Fiord Formation sits conformably on the Late Permian Black Stripe Formation where a carbon isotopic record and Late Permian conodonts including Clarkina hauschkei and C. cf. changxingensis indicate that the Arctic Late Permian extinction preceded the Tethyan event by about 200 Kyrs. Tozer was very focussed on the PTB and extinction and would hopefully be pleased to know that the Arctic succession is now playing a prominent role in understanding the dynamics of Earth's greatest extinction.

Dienerian (Early Triassic) ammonoids from the Candelaria Formation (west-central Nevada, USA) and their significance for paleobiogeography and paleoceanography

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Well-preserved Early Dienerian ammonoids, long known from the Candelaria Formation in the Candelaria Hills, have been studied in detail and illustrated for the first time. Although the previously documented correlation of this fauna with the mid-high paleolatitude Proptychites candidus Zone of Canada is valid, in reality it more closely resembles the Tethyan ammonoid faunas, thus demonstrating the occurrence of a certain degree of equatorial faunal exchange between opposite sides of the Panthalassic Ocean as well as the onset of provincialism, which contrasts with the cosmopolitan Griesbachian faunas. Taxonomic analysis of the fauna leads to the recognition of ten species, which include two new species and one new genus, and also shows a close correlation with the Early Dienerian Ambites fauna from the base of the Ceratite Marls in the Salt Range (Pakistan) and the base of the "Meekoceras" beds of Spiti, the classic Himalayan section. The discovery of a few slightly older Early Dienerian ammonoids within the underlying Claraia beds, which contain Claraia stachei, confirms that this taxon straddles the Griesbachian-Dienerian boundary. Considerable evidence within the fossiliferous lower part of the Candelaria Formation points to the existence of a discrete anoxic episode in the equatorial region of the North American continental margin. This event, precisely dated by the Early Dienerian ammonoid fauna, corresponds with coeval anoxic or dysoxic events reported from several Tethyan localities.

Middle and Upper Triassic Ichthyolith successions: Pink Mountain, Trutch, and Halfway River map-areas (94g, 94b), northeastern British Columbia

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Upper Triassic ichthyoliths (fish teeth and scales) are diverse and common in platform to nearshore environments of the Baldonnel and Pardonet formations, northeastern British Columbia. Fifteen offshore to nearshore ichthyolith assemblages are recognized, correlated with ammonoid and conodont biostratigraphies, and their occurrence studied in detail through transgressive/regressive phases at Pink Mountain. Ichthyolith abundance and diversity is greatest in the upper shoaling phase of a sequence and may be concentrated in deposits above sequence boundaries. Flooding surfaces are commonly organic-rich, may coarsen upwards, contain lags, and be overlain by carbonates that tend to be dolomitized eastward in the Peace River Embayment. Many ichthyolith-rich beds have distinctive gamma ray signatures. A significant change in ichthyoliths occurred across the Baldonnel/Pardonet boundary during the Carnian/Norian transition.

The ichthyolith database includes >160 samples from Pink Mountain and >600 Middle and Upper Triassic samples from 20 other locations in the Trutch and Halfway River map-areas. Middle and Upper Triassic ichthyolith assemblages of the Liard, Charlie Lake, Baldonnel, and Pardonet formations are correlated over much of the Trutch and Halfway River map-areas and tend to track facies changes.

Sedimentary record of a late Triassic impact event in an ancient pacific pelagic site: Manicouagan impact ejecta?

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We present evidence for an impact event (microspherules, nickel-rich spinels, and anomalous concentrations of platinum-group elements) from a deep-sea claystone layer in an Upper Triassic bedded chert succession of the Sakahogi section, Inuyama area, central Japan. The strata were deposited in a deep Paleo-Pacific (Panthalassa) basin. The claystone contains anomalously high contents of iridium, up to 40 ppb, comparable to the levels found at the Cretaceous/Paleogene boundary (e.g. 36 ppb at Stevens Klint, Denmark). Radiolarian and conodont biostratigraphy indicate that the chert succession is middle to late Norian in age. The radiolarian fossils show no

39 evidence of a mass extinction event across the impact layer. Of the 14 radiolarian species identified within the claystone, only one species disappears within this layer.

Although there are no radiometric age data for the middle to late Norian, it has been assigned an age range of 216.4-209.8 Ma based on biostratigraphy and the astronomically tuned geomagnetic polarity time-scale (Hüsing et al., 2011). The Manicouagan impact structure (Canada) would appear to be related to deposition of the ejecta deposit described in the present study, because 1) the age of crater formation (215.5 Ma) is within the range of the age of the chert succession, and 2) the Manicouagan impact was large enough to produce a global distribution of ballistic ejecta within ~30° paleolatitude of the crater. Our results suggest that distal ejecta layers, possibly linked to the Manicouagan impact, will be found at other middle to late Norian sites worldwide. The application of an event-stratigraphic approach at such sites is required to confirm the distribution of ejecta and constrain the location of the source crater for the ejecta deposits.

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Multiple conodont lineages across the Carnian-Norian boundary in North America: new taxonomy and biochronology

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At Black Bear Ridge on the perimeter of Williston Lake in northeast British Columbia, a prospective GSSP for the Upper Triassic Carnian–Norian boundary (CNB), continuously outcropping strata have yielded important ammonoids, bivalves, a carbon isotope anomaly, and a remarkable succession of abundant and diverse conodont faunas, many of which are new.

Nine conodont faunas are differentiated within an interval that broadly encompasses the Macrolobatus and Kerri ammonoid zones. These include conodont zones named for samueli, primitius, orchardi, and quadrata, as well as currently unnamed intervals. Within a few metres of strata (Faunas 6-8 of Orchard, 2010), identified as embracing the preferred CNB, multiple conodont event datums are recognized. These are mostly linked to rapid and progressive morphogenesis in reconstructed lineages prior to a major faunal turnover. These events include: FAD of Gen nov. A sp. nov. A + Gen nov. C sp. nov. A; FAD of 'Epigondolella' orchardi; FAD of Metapolygnathus parvus s.s.; FAD of M. ex gr. parvus-echinatus + FAD of Gen nov. B sp. nov. A; LAD of multiple unornamented 'metapolygnathids;' and FAD of common Norigondolella.

The tentatively named parvus-echinatus group appears to represent the evolutionary end-members of several lineages of 'metapolygnathids': they are relatively small elements characterized by strongly reduced platforms, long blades, and pits located beneath the junction of the two. Gen nov. A and B are ornate elements formerly regarded as variants of Epigondolella primitius Mosher and subsequently assigned to Metapolygnathus on the basis of their anteriorly situated pit. They are characterized by, respectively, pointed and markedly asymmetric platforms. Elements with generally rectangular platforms (including primitius and orchardi) are also assigned to a new genus. Within all of these, as well as those with strongly reduced platforms ("Orchardella?"), successions of species show progressive development of discrete and sharp anterior nodes, carina variation, and anterior migration of the pit. The genus Epigondolella is retained for E. quadrata and younger Norian species, whereas Carniepigondolella is restricted to older Carnian forms.

Newly recognized and reclassified conodont taxa within a phyletic framework provide multiple indices for a refined biochronology and for boundary definition or proxy.

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The Induan/Olenekian boundary: new data from the Spiti valley (India) and the Salt Range (Pakistan)

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To improve our understanding of the biotic recovery in the aftermath of the Permian/Triassic mass extinction, a reliable high resolution biochronological frame of the Early Triassic period is crucial. Here we focus on the boundary between the Induan and Olenekian based on new, rich ammonoid and conodont collections from Mud (Spiti Valley, India), a GSSP candidate for the Induan-Olenekian Boundary (Krystyn et al., 2007a, b). Our results demonstrate that some ammonoid taxa of typical Smithian affinities (namely Flemingitidae and Kashmiritidae) appear about 1 m below the previously defined boundary (in bed 10 instead of bed 13 of Krystyn et al., 2007a, b; Brühwiler et al., 2010). New conodont data confirm these results. The documented faunal turnover is associated with a facies change (from dark shales with early diagenetic calcareous concretions to massive, bioturbated limestone beds).

The Salt Range (Pakistan) constitutes another classical locality for Early Triassic ammonoids. Extensive new collections of ammonoids and conodonts from the Nammal section allowed us to refine the biochronological scheme in this area. For both ammonoids and conodonts we recognize the same sequence of faunal associations as in Mud. In the Salt Range, the Induan-Olenekian faunal turnover coincides with an increase of o13Corg of ca. 6‰ and with a sequence boundary (Hermann et al., 2011). In this expanded stratigraphical series the boundary falls within the Ceratite Marls without any significant facies change. The section also yields high resolution palynological and C-isotope records. Among all potential candidates, Nammal provides by far the most complete GSSP for the Induan-Olenekian boundary.

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The Early Triassic family Melagathiceratidae Tozer: the position within the suborder Ptychitina (Ammonoidea)

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The first detailed data on the inner shell structure of early Olenekian melagathiceratid ammonoids (Ptychitina) are reported. Our observations on this topic and suture lines concerning ammonoids of the suborder Ptychitina suggest that it can be distributed into five lineages: the four conservative evolutionary branches (1. Prejuvenites (Ptychitoidea fam. nov.) – Melagathiceratidae gen. nov. - Melagathiceras (Melagathiceratidae); 2. Prejuvenites (Ptychitoidea fam. nov.) – Paranannites (Paranannitidae); 3. Prejuvenites (Ptychitoidea fam. nov.) – Proshingitoides (Prosphingitinae) – Prosphingites (Prosphingitinae); and 4. Proshingitoides – Zhitkovites (Prosphingitinae)), but the single progressive lineage (Owenites (Owenitidae) – Parapopanoceras (Parapopanoceratidae) – Ptychites (Ptychitidae)). Melagathiceratid ammonoids are characterized by the typical Palaeozoic type of the inner shell-structure (ventral position of a siphuncle and retrochoanitic type of septal necks in all of the ontogenetic stages we observed (up to four whorls)). Similar inner shell structure have been documented for ammonoids of the second (Paranannitinae) and third (Prosphingitinae) conservative lineages, but their retrochoanitic necks are transformed into modified retrochoanitic necks between four and five whorls. However, the marked ontogenetic acceleration in septal neck-siphuncular complex of ammonoids took place in the progressive lineage Owenites – Parapopanoceras – Ptychites. In this lineage, septal necks change abruptly from retrochoanitic to modified retrochoanitic over the course of the second whorl, except Owenites, the initial member of the lineage, characterized by having of retrochoanitic septal necks throughout ontogeny, like in primitive representatives of the family Melagathiceratidae. One of the characteristic features in the ammonoid shells of the progressive lineage is a near-ventral or near-central position of the siphuncle (at least in the 1st whorl of the phragmocone). There is trend toward a larger ammonitellas and most elongated living chambers in the progressive lineage (Owenites – Parapopanoceras – Ptychites). Furthermore, ammonoids of the first conservative lineage Prejuvenites (Ptychitoidea fam. nov.) - Melagathiceratidae gen. nov. - Melagathiceras (Melagathiceratidae) had simple (goniatitic) to moderately complex (primitive ceratitic) sutures, whereas ammonoids of the progressive lineage possess advanced ceratitic and ammonitic ones. We suggest a monophyletic origin of the suborder Ptychitina in the Ceratitida. Very similar shell form, ornamentation and suture of the new genus (Melagathiceratidae gen. nov.) and some latest Permian liuchengoceratid ammonoids from Primorye and South China clarify the systematic position of the Melagathiceratidae. In view of new facts, it seems likely that the Prejuvenites (Ptychitoidea fam. nov.) - Melagathiceratidae gen. nov. - Melagathiceras (Melagathiceratidae) evolutionary branch is derived from the Changhsingian Liuchengoceratidae (Paraceltitina). The central position of the siphuncle in ammonoids of the suborder Anarcestina was inherited apparently from Owenites (Owenitidae) - Parapopanoceras (Parapopanoceratidae) – Ptychites (Ptychitidae) evolutionary branch.

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Stratigraphic architecture of the Ladinian-Carnian boundary interval in the Peace River foothills and front ranges, northeastern British Columbia

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The Middle -Upper Triassic (=Ladinian-Carnian) boundary in the Peace River Foothills occurs within the upper Toad, Liard, Ludington, and Charlie Lake formations. In westernmost outcrop sections, such as Ursula Creek, this boundary approximates the Toad-Ludington lithostratigraphic contact. Despite sedimentological evidence that both formations were deposited in offshore settings well below storm wave base, this contact exhibits evidence of a depositional disconformity (i.e., an intraclastic lag and missing biostratigraphic zones).

To the east (i.e., Brown Hill, West Glacier Spur, and Folded Hill), it is herein proposed that the Ladinian-Carnian boundary occurs within an overall transgressive succession in the Toad and Liard formations, overlying a thin tongue of the Charlie Lake Formation. Trough cross-stratified bioclast-rich, quartz-dominated sandstone beds are conformably overlain by a series of brachiopod-dominated limestone beds with subordinate, thin siltstone beds. The brachiopod beds have produced both ammonoids (Nathorstites mcconneli, Lobites ellipticus, and Muensterites glaciensis) and conodonts (Budurovignathus mungoensis and Paragondolella inclinata) suggestive of uppermost Ladinian deposition. These beds are sharply overlain by a thick, planar-laminated to ripple-laminated siltstone succession that has produced poorly preserved ammonoids tentatively referred to Daxatina canadensis as well as conodont faunas that include Paragondolella? sulcata, P. willistonensis, and Neogondolella liardensis indicating earliest Carnian deposition.

Our work indicates that the Ladinian-Carnian boundary in the Peace River Foothills and Front Ranges outcrop belt occurs within an overall transgressive succession rather than at a major marine lowstand as has been previously postulated. Furthermore, correlation of the outcrop succession with equivalent strata in the subsurface to the east supports preliminary biostratigraphic data that indicate that the regional, mid-Charlie Lake Coplin unconformity occurs later in the Carnian and not at the Ladinian-Carnian boundary as proposed elsewhere.

Triassic field studies on the upper Peace river / Williston lake, northeastern British Columbia: 1875-2011

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Triassic strata in the Canadian Rocky Mountains have been the focus of numerous paleontologists and stratigraphers since their discovery on the upper Peace River in 1875 by a Geological Survey of Canada field crew led by A.R.C. Selwyn. Although Triassic rocks crop out extensively in the Rocky Mountain Front Ranges and Foothills of western Alberta and northeastern British Columbia, access has always been problematic due to the remote, mountainous nature of this area. The few areas where access is not a major problem include sites where major rivers or roads bisect the Rocky Mountain Foothills and Front Ranges. Of these, the Peace River outcrop belt is characterized both by numerous exceptionable outcrop exposures as well as comparative ease of access.

Triassic outcrop along the Peace River first became the focus of detailed paleontological analyses in 1917. Field reconnaissance by Frank H. McLearn (1885-1964) in 1917, 1920, and 1922 resulted in the first ammonoid and bivalve collections from the Peace River, allowing lithostratigraphic and biostratigraphic delineation of the late Middle to Upper Triassic Schooler Creek Formation. Further fieldwork was delayed until 1937 and 1938 when McLearn returned to the Peace. This fieldwork heralded the initial development of detailed, integrated bivalve and ammonoid zonations.

The biostratigraphic zonation initiated by McLearn was continued by the work of E.T. Tozer (1928-2010). Tozer's interest in Triassic ammonoids was sparked by discussions with McLearn prior to the beginning of several field seasons in Canada's far north. Tozer was able to identify equivalencies between ammonoid and bivalve successions in Canada's Arctic with those in western Canada. More recent work has added conodonts to the mix, providing a detailed, truly integrated, multi-taxonomic biostratigraphic framework and has established these successions as a template to which other global successions must be compared.

New Triassic Literature

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Forthcoming Meetings

IGCP 572 Closing conference
May 30 – June 7, 2012, Eger, Hungary

First circular

Invitation

The Hungarian Geological Society and the Triassic Subcommission of the Hungarian Stratigraphic Commission invite you to the IGCP 572 Closing meeting in Eger, Hungary, a beautiful baroque town in northern Hungary. The meeting will consist of a two-day symposium and will be complemented by three field trips to excellent Permian-Triassic sections.

The symposium will consist of presentations and posters that focus on the causes and consequences of Permian–Triassic events and ecosystem recovery patterns, as well as discussions of the main results and contributions of the IGCP 572 project. Trips include: a three-day trip before the symposium to the classic Triassic exposures in the picturesque Balaton Highland; a one-day trip after the symposium to the P/T boundary and Lower Triassic sections in the Bükk Mountains; and a three-day excursion to the Triassic ramp and Middle Triassic reef facies of the Aggtelek Karst.

Local Organising Committee

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József Pálfy, Eötvös University, Budapest
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Field Trip Coordinators:
Tamás Budai, Hungarian Geological Institute, Budapest
Felicitász Velledits, Limestone Bt.

International Advisory Committee

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Thomas J. Algeo, University of Cincinnati
Kliti Grice, Curtin University
David Bottjer, University of South California
Aymon Baud, Université de Lausanne
Charles Henderson, University of Calgary
George Stanley, University of Montana

Scientific program

Two days symposium will be organised at the Eszterházy Károly College, Eger. Keynote speakers will be invited to summarize the main results of the ongoing project and outline the perspectives. The talks will be followed by open discussion. Oral and poster presentations on the topic of the project are welcome!

Field excursions

1. Pre-conference field trip (3 days; May 30 – June 1): Sedimentary succession from Permian/Triassic boundary up to Ladinian, in Balaton Highland.

2. Post-conference field trip: Permian/Triassic boundary and Lower Triassic sections in Bükk Mts. (one day; June 4)

3. Post-conference field trip: Lower to Middle Triassic succession in Aggtelek Karst (3 days; June 5–7.

Social programme

An icebreaker party will take place on the evening of the 1th of June 2012, in Eger. A conference dinner will be offered. The city of Eger and the surrounding areas have numerous interesting places to visit, including hot springs, mountains, and vineyards.

Abstracts

Authors are invited to submit abstracts of one printed page by e-mail attachment (preferred), fax, or post. The deadline for abstract submission is

March 31, 2012.

The official language of the meeting is English. A detailed guide for submission of abstracts will be available on the website of the meeting.

Registration

before March 31, 2012: on the website
http://www.geology.hu

Registration fees

An approximate estimate of the registration fees is:
Full participant: 180/220 euro before/after March 31, 2012.
Student: 130/160 euro before/after March 31, 2012.
Accompanying member: 80 euro

1. Pre-conference field trip: 200/230 euro (student: 120/150 euro) before/after March 31, 2012.
2. Post-conference field trip: 60/80 (student: 30/40 euro) before/after march 31, 2012.
3. Post-conference field trip: 200/230 euro (student: 120/150 euro) before/after March 31, 2012.

Funding

Studenst will be able to apply to the IGCP 572 project for travel funds.

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Key dates

Reply to the First Circular: December 15, 2011.
Distribution of Second Circular: January 31, 2012.
Registration/Abstract deadline: March 31, 2012.

RESPONSE TO THE FIRST CIRCULAR
The Second Circular will be mailed to responders to the First Circular.
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