

1.

**New floral, sedimentological and isotopic investigation of the Triassic–
Jurassic boundary strata in Jameson Land, East Greenland**

**Stephen P. Hesselbo¹, Jennifer C. McElwain², Mihai Popa³, Finn Surlyk⁴, Matthew
Haworth¹**

¹Department of Earth Sciences, University of Oxford, Parks Road, Oxford OX1 3PR, U.K.

stephen.hesselbo@earth.ox.ac.uk

³Department of Geology, The Field Museum, 1400 S Lake Shore Drive, Chicago, Illinois, 60606, USA.

³Laboratory of Palaeontology, Faculty of Geology and Geophysics, University of Bucharest, 1 N. Balcescu Ave., 70111, Bucharest, Romania.

⁴Geological Institute, University of Copenhagen, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark.

Key words: Triassic/Jurassic strata, sedimentology, terrestrial plants, C isotopes, E Greenland

The Kap Stewart Formation, Jameson Land, East Greenland, is of Rhaetian–Hettangian age and, through the work of Harris in the mid-20th century, is well known for its diverse and extensive macroflora of cycadophytes, ginkgophytes, conifers, pteridosperms and ferns that spans the Triassic–Jurassic boundary. The flora has been divided into two well differentiated biozones, a lower *Lepidopteris* Zone and an upper *Thaumatopteris* Zone separated by a narrow ‘transition’ zone. The two zones are highly distinctive at species level, but less well discriminated at higher taxonomic levels. Recent work on leaf morphology, stomatal densities and carbon-isotope composition of fossil wood has highlighted the importance of this succession for understanding changes in terrestrial environments across the Triassic–Jurassic boundary interval. Changes in anatomy and morphology of fossil leaves from both East Greenland and Sweden show that major climatic warming occurred at the Triassic–Jurassic boundary and a fourfold increase in atmospheric CO₂ concentration and an associated 3–4°C “greenhouse” warming has been suggested. The warming has been proposed as the cause of high-temperature injury to many of the large-leaved plants, which were replaced by related taxa with smaller, narrower or more dissected leaves, especially in

the transition zone. Carbon-isotope records and palynology have additionally been used to suggest a link to initiation of flood basalt volcanism in the Central Atlantic region.

As a result of these earlier studies, we have initiated a multidisciplinary study focussed on: refined correlation to from East Greenland to other successions; an understanding of the sedimentological context of the plant fossils; reconstruction of the plant communities and their evolution, and; quantitative assessments of important palaeoclimatological variables such as atmospheric pCO₂ and palaeotemperature. In summer 2002, two sections were investigated in detail: Ranunkeldal, in the east of the Jameson Land basin, provides an expanded record of the *Thaumatopteris* Zone and comprises an upward transition from fluvial to lacustrine sedimentation; Astartekløft, in the east of the basin, provides a record from the *Lepidopteris* Zone to the *Thaumatopteris* Zone and comprises principally fluvial deposits. Bulk sediment samples have been collected at a high resolution for both sections and have been processed to separate microscopic plant debris, including leaf cuticles and fossil wood debris. These materials are being used for comprehensive appraisal of the stomatal responses of a variety of taxa to the major environmental changes that occurred at the Tr-J boundary and analysis of carbon-isotope ratios of microscopic and molecular components.

The sedimentary succession of the Kap Stewart comprises fluvial and lacustrine facies. Fluvial facies comprise approximately 50% channel sandstones, commonly Fe-rich calcite- and chamosite-cemented, and 50% overbank siltstones and mudstones. These facies dominate the lower part of the succession, including the florally defined Tr-J boundary. Sideritic laminated shales and calcite-cemented shoreface sandstones make up most of the lacustrine facies at the top of the succession.

A further field season will be carried out in July 2004 aimed at bulk rock and plant fossil collections across the Tr-J boundary from previously poorly investigated sections along the Hurry Inlet, closely adjacent to the key Astartekløft section.

2.

Triassic-Jurassic stages of the Carpathian basins development

Jan Golonka¹, Michał Krobicki², Nestor Oszczytko¹, Tadeusz Słomka²

¹Jagiellonian University, Oleandry Str. 2a, 30-063 Kraków, Poland,

gonlonka@geos.ing.uj.edu.pl; ²University of Mining and Metallurgy, Mickiewicza 30, PL-30-059 Kraków, krobicki@geol.agh.edu.pl

Key words: plate tectonics, Tethys, Triassic, Jurassic, basins.

After the Late Paleozoic tectonic events the Paleotethys Ocean was formed, which was located between northern, Laurussian (North America, Baltica and Siberia) and southern, Gondwanian branch (Africa, Arabia and Iranian terranes) of Pangea (Golonka, 2002). North-dipping subduction developed along the Paleotethys margin. This subduction was a major force driving the Early Mesozoic movement of plates in this area. It caused Triassic back-arc rifting in the proto-Black Sea area forming the Tauric basin between the Pontides and the Dobrogea-Crimea. This trough was perhaps connected with the rift situated in Poland. The Polish rift, also known as the Polish-Danish Aulacogen has SE-NW direction parallel to the Transeuropean Suture Zone. The oceanic system was established in Southern and Central Europe during the Permian-Triassic time. The Vardar-Transilvanian Ocean separated the Tisa (Bihor-Apuseni) block from the Moesian-Eastern European Platform (Săndulescu, 1988). There is a possibility of existence of the embayment of Vardar-Transilvanian oceanic zone between Inner Carpathian and European Platform (Golonka et al., 2000). The pelagic Triassic limestones in the exotic pebbles in the Pieniny Klippen Belt (Birkenmajer *et al.*, 1990) and Magura Unit (Soták, 1986) could have originated in this embayment. The embayment position and its relation to the other parts of Tethys, Vardar Ocean, Meliata-Halstatt Ocean,

Dobrogea rift and Polish-Danish Aulacogen remain quite speculative. According to Rakús *et al.* (1998) two oceanic units were located south of the Inner Carpathian plate. One was open during the Triassic time, closed during the Late Triassic as a result of the Early Cimmerian collision. Another, represented by sequences at the classic profile of Meliata in Southern Slovakia, opened during Early-Middle Jurassic as a back-arc basin and closed during Late Jurassic time. The position of the Meliata Ocean, time of closing and a role of the Tisza unit in the Mesozoic collisional events is still the subject of lively discussion. The Ligurian Ocean, as well as the central Atlantic and Penninic Ocean were opening during Early – Middle Jurassic. Pieniny data fit with the supposed opening of the Ligurian and Penninic Ocean basins (Golonka *et al.*, 2000). The orientation of Pieniny ocean was SW-NE (Golonka & Krobicki, 2001). The Pieniny Ocean was divided into the northwestern and southeastern basins by the Czorsztyn Ridge. The deepest parts of both basins are documented by deep water, extremely condensed, Jurassic-Early Cretaceous pelagic limestones and radiolarites. The shallowest ridge sequences are known as the Czorsztyn Succession. In this succession the Early Jurassic *Bositra* ("*Posidonia*") marls are followed by Middle Jurassic-earliest Cretaceous crinoidal and nodular limestones and the Late Cretaceous pelagic marl facies. The transitional slope sequences between deepest basinal units and ridge units consist of mixed cherty, limestone and marly facies. This Jurassic ocean was connected with older, Triassic embayment of Vardar-Transylvanian Ocean.

During the Late Jurassic time, the Meliata-Halstatt was closed and subduction jumped to the northern margin of the Inner Carpathian terranes and began to consume the Pieniny Klippen Belt Ocean. The Outer Carpathian rift had developed with the beginning of calcareous flysch sedimentation. The Silesian Ridge separated the Silesian and Magura basins. The Jurassic separation of Bucovino-Getic microplate from European plate is perhaps

related to the origin of the Silesian Ridge. The Silesian – Sinaia basin developed as a back-arc basin.

This research has been partially supported financially by the Polish Committee for Scientific Research (KBN) - grant 6 P04D 040 19 and 6 P04D 032 21. It is also a contribution to the IGCP 455.

*3rd Workshop od the IGCP Project 458 :
„Triassic/Jurassic Boundary Changes”
Stará Lesná, Slovakia 2003*

3.

Rhaetian facies sequences in a storm-dominated intrashelf setting of the Veľká Fatra Mts (Fatric Superunit, West Carpathians)

Adam Tomašových

Würzburg University, Paleontological Institute, Pleicherwall 1, 97070, Würzburg, Germany,

adam.tomasovych@mail.uni-wuerzburg.de

Key words: Rhaetian, West Carpathians, carbonate sedimentology, sequence stratigraphy

The depositional environment of the Rhaetian Fatra Formation was characterized as a storm-dominated, carbonate intra-shelf depression, with high spatio-temporal facies variations (Michalík 1977). In order to understand the development of depositional environments at the end of the Triassic and appreciate range and nature of environmental changes leading to the Triassic-Jurassic boundary mass extinction event, 13 sections of the Fatra Formation were investigated lithologically in the Veľká Fatra Mountains (central Slovakia, Tomašových & Michalík 2000, Tomašových 2000).

At some intervals of the Fatra Formation, small-scale shallowing-upward parasequences bounded by flooding surfaces are preserved. Three types of parasequences were distinguished,

including a) lagoonal-peritidal, b) lagoonal-skeletal bank and c) lagoonal-skeletal bank-peritidal type. They can be interpreted as units of autocyclic aggradation/progradation of tidal flats/islands and carbonate sand banks. In lower and upper part of the Fatra Formation, they form parasequence sets with a typical stacking pattern consisting of lagoonal-peritidal parasequences in lower parts and lagoonal-skeletal bank parasequences in upper parts.

Four widespread correlative boundaries were distinguished in the Fatra Formation (Figs. 3-5):

1. The first one is defined by the abrupt change from grainstones and packstones to marly wackestones and floatstones in the lower part of the Fatra Formation. It corresponds probably to the transgressive peak interval.

2. The second boundary is situated in the uppermost part of peritidal stromatolitic bindstones and mudstones which are capped by an erosional unconformity in the lower part of the Fatra Formation, indicating extensive shallowing. Above this unconformity, the 90-300 cm thick limestone beds are preserved.

3. The third boundary is formed by an erosional unconformity and is preserved at the top of well-bedded laminated stromatolitic dolomitized limestones and dolomites in the middle part of the Fatra Formation. It is overlain by very well sorted biointra-grainstones/packstones.

4. The fourth boundary, forming an erosional unconformity, is lying at the upper boundary of the dolomudstone beds with stromatolitic laminations in the upper part of the Fatra Formation. Based on the occurrence of the last three extensive correlation boundaries that represent erosional unconformities, four 6-15 m thick, large-scale sequences with transgressive-regressive trend were recognized.

Based on these unconformities and relatively regular facies distribution patterns in vertical direction within large-scale sequences, the reconstruction of depositional history is interpreted in terms of relative sea level change. Water depths remained very shallow throughout the whole Fatra Formation. The architecture of these large-scale sequences can be interpreted as the superposition of aggradational/progradational sets of small-scale parasequences of autocyclic origin separated by drowning or back-stepping events characterized by deeper water facies. The development of large-

scale sequences was most probably controlled by the interplay between eustatic/tectonic sea level change and rate of accumulation related to biogenic carbonate production.

Facies types and macrobenthic associations are comparable in some aspects to those known from the uppermost Triassic of the Eastern and Southern Alps (Hochalm Member of the Kössen Formation or Calcare di Zu Formation), pointing to similar intra-shelf depositional conditions. The absence of large-scale patch-reefs and poor diversity of level-bottom and patch-reef associations reflect the fact that the Fatric intra-shelf lagoonal setting was more restricted from the open ocean than the intra-shelf habitats in the Eastern or Southern Alps at the end of the Triassic. In spite of the probable high-stress ecologic conditions and abundance of eurytopic taxa in poorly diverse benthic assemblages in uppermost Triassic deposits, bivalves, brachiopods and corals of the Fatra Formation did not survive terminal extinction event at the end of the Triassic.

*3rd Workshop od the IGCP Project 458 :
„Triassic/Jurassic Boundary Changes”
Stará Lesná, Slovakia 2003*

4.

Onset of the Pangea breakup marked by the migration of the Early Jurassic bivalves

¹Michał Krobicki & ²Jan Golonka

¹University of Mining and Metallurgy, Mickiewicza 30, PL-30-059 Kraków; krobicki@geol.agh.edu.pl;

²Jagiellonian University, Oleandry Str. 2a, 30-063 Kraków, Poland, gonlonka@geos.ing.uj.edu.pl;

Key-words: mollusks, paleobiogeography, Pangea, Triassic, Jurassic, Atlantic, Tethys.

The supercontinent Pangea was formed during the Carboniferous time as the result of the Hercynian orogeny (Golonka 2000, 2002). Its onset began with the Early Triassic rifting. This rifting was magnified at the Triassic/Jurassic boundary. The Atlantic Ocean originated as a consequence of this breakup (Withjack et al. 1996). The connection of the Panthalassa Ocean (Proto-Pacific) and western Tethys gradually started with the origin of the narrow sea strait (so

called „Hesperian Strait”), which allowed the migration of the Early Jurassic (Sinemurian) bivalves of *Weyla* genus from the Chile and Argentina basins to western Tethys (Damborenea & Manceñido 1979).

Previously – in Triassic – the migration of sea fauna (late Triassic crinoids, mollusks, crustaceans and so on) was going through the vast eastern Tethys branch of the Panthalassa Ocean which is perfectly visible in the distribution of the typical „Alpine” fauna of the western Tethys found in the numerous terranes along the western coasts of South and North America. The fauna did not have a possibility to migrate westward, but it could use the numerous terranes within Panthalassa as „stepping-stones” allowing relatively free migration eastward from the Alpine Tethys. This migration direction was preserved later as demonstrated by the presence of the Early Jurassic (Pliensbachian-Toarcian) reefal buildups made by oyster-like bivalves from *Lithiotis* and *Cochlearites* genera.

On this background the paleobiogeographical distribution of the cosmopolitan bivalves from the *Cardinia* genus could serve as a tool of reconstruction of their migration ways from the area of their first appearance. The oldest findings are known from the Late Triassic Sub-Arctic regions and the rapid worldwide spreading of species from this genus during the Early Jurassic (Hettangian) indicates the possible ways of their migration. Because of the strong paleoenvironment opportunism (their settle in practically all clastic/carbonate Hettangian facies as well in Europe as outside this area, even in the poorly oxygenated and brackish, almost fresh water environments) they migrated fast. They are known from the lower part of European Hettangian including Polish platform (Holy Cross Mts Margin) and Carpathians (Tatra- and Pieniny Mts). They are numerous indication that the Sub-Arctic *Cardinia* genus initiated the early Hettangian presence of these bivalves in Central Europe by utilization of the primarily ephemerical sea and continental basins at the Triassic/Jurassic boundary, which existed in this

part of Pangea between present-day Greenland and Scandinavia. These basins marked the early stages of the supercontinental breakup.

This work was supported by AGH grant 11.11.140.888 (MK). It is also a contribution to the IGCP project 485.

*3rd Workshop of the IGCP Project 458 :
„Triassic/Jurassic Boundary Changes”*

Stará Lesná, Slovakia 2003

5.

Bivalvia from the T/J boundary beds in the central Western Carpathians

Marián Golej

Comenius University, Faculty of Science, Mlynská dolina, 842 15, Bratislava, Slovakia, neritic@pobox.sk

Key words: mollusc assemblages, Bivalvia, T/J boundary, central Western Carpathians

Rhaetian and Hettangian sequences in the most important central West Carpathian tectonic units (Tatric, Fatric, Hronic and Silicic domains) consist of shallow marine fossiliferous deposits. These strata are rich in benthic macrofaunal remnants, dominated by molluscan shells. Fossil bivalves of that age were frequently reported and described by geoscientists working in Carpathian territory in XIX-th century, namely by Zejszner (1858), Štúr (1860, 1868), Hauer (1865), Foetterle (1865), Stache (1867), or Paul (1870). The outstanding geologist of the early XXth century, Victor Uhlig (1897) and his successors (Schréter 1915; Vigh 1915; Goetel 1916; Ferenczy 1917, 1918; Kulcsár 1917, 1918; Matějka & Andrusov 1931; Rösing 1949; or Biely 1960) called the Rhaetian strata as the „leading star“ of Carpathian mapping geologists due to abundance of easily determinable fossil bivalves.

Detailed studies of Triassic / Jurassic bivalve molluscs were summarized by

Kochanová in 1967. Gaździcki published short paper on Rhaetian megalodonts (1971), Michalík & Jendrejáková (1978) gave paleoecological interpretation of Rhaetian / Hettangian benthic communities from the T/J boundary formations (Fig.10). The marginal development of Rhaetic sea was typical by molluscan assemblages (bivalves and gastropods) traditionally known as the „Swabian beds“. This development represent also the lowermost member of the Fatra Formation (Michalík 1975, 1976, 1977) – a cyclic sequence of dark coloured organogene to organodetrital and oolitic limestones, dolomite and marl containing several diversified molluscan assemblages. The Fatra Formation basin was rimmed from the south by the Hronic carbonate platform with a Dachstein- type sedimentation (the Norovica Fm). It was dissected by channels with sedimentation of shally Hybe Formation (Michalík 1973). Black shales contain rich benthic association of brachiopods and bivalves (Michalík 1976).

Hettangian Kapienec Formation was deposited in the Fatric and adjacent areas as the product of rised terrigenous clastic influx at the beginning of the Jurassic. Bivalve fauna of this shally complex was known to Goetel (1917) and Kochanová (1965, 1967). Diversity of bivalve assemblages is shown in the table.

Unit / Superunit	No of the Rhaetian bivalve assemblages	No of the Hettangian bivalve assemblages
Fatric Superunit	42	38
Hronic Superunit	17	4
Manín Unit	2	1
Tatric Superunit	1	10
Silicic Superunit	1	-

In sixties (1967), 98 bivalve and 3 gastropod species have been recognized by Kochanová.

Although Hettangian associations were not studied as intensively, it seems that their abundance is lower if compared with the Rhaetian ones.

6.

**Mineralogical changes in the shell of epifaunal bivalves
at the Triassic/Jurassic boundary**

Michael Hautmann

University of Würzburg, Germany, hautmann@mail.uni-wuerzburg.de

Key words: Bivalve molluscs, epifauna, shell mineralogy, Triassic/Jurassic boundary

During the Phanerozoic, the prevailing mineralogy of non-skeletal marine carbonates (ooides and cements) changed several times (Sandberg 1983). The Triassic/Jurassic boundary was assumed to coincide with a reversal from aragonite-facilitating to calcite-facilitating conditions, but neither the physico-chemical causes of this change nor their consequences for carbonate-secreting animals are clear. The present contribution focuses on the latter point by comparing the shell mineralogy of Triassic and Jurassic epifaunal bivalves.

Epifaunal bivalves are probably the most suitable group of organisms to test a possible influence of changing physico-chemical conditions on marine biocalcifiers, because their shell is in direct contact with the surrounding seawater and may consist of either aragonite, calcite or both aragonite and calcite. However, the shell mineralogy of most bivalve families is only known from few stratigraphic levels and specimens, and consequently, interpretation of the available data has not been unambiguous (e.g., Harper et al. 1997 vs. Carter et al. 1998). In order to improve the deficient data base for Triassic epifaunal bivalves, new shell mineralogical examinations were carried out, chiefly based on well preserved specimens from a recently discovered bivalve fauna of the Norian-Rhaetian Nayband-Formation of east-central Iran (Hautmann 2001a, b). The new data revealed hitherto unknown shell mineralogical differences between Triassic and Jurassic taxa of the families Ostreidae,

Pectinidae and Plicatulidae, which correspond to the trend seen in inorganic carbonates: Aragonite formed the thick inner shell layer of the Late Triassic ostreid genus *Umbrostrea*, while calcite was restricted to a very thin prismatic and foliated outer shell layer. By contrast, the shell of all known post-Triassic oysters has been completely calcitic except for myostracal deposits (Carter 1990). Similarly, calcite was restricted to a very thin prismatic and foliated outer shell layer in Late Triassic plicatulids such as *Eoplicatula parvadehensis* (Hautmann 2001a, b), but it expanded into the middle and parts of the inner shell layer of Lower Jurassic *Harpax spinosus* (Carter 1998). The Late Triassic pectinid *Indopecten* differs from its post-Triassic relatives by having even a completely aragonitic shell.

Ostreidae, Plicatulidae and Pectinidae arose in the Triassic, and the chiefly aragonitic shell mineralogy of their examined Triassic representatives corresponds to the aragonite-facilitating conditions in the oceans of that time. This concurrence supports the view that marine biocalcifiers predominately developed skeletons that were in equilibrium with the sea-water chemistry of the time when the particular group came into existence, as previously proposed by Wilkinson (1979), Constanz (1986) and Railsback & Anderson (1987). However, these authors also assumed that clades would usually maintain their once adopted shell mineralogy even if physico-chemical conditions reversed. The proof of an increasing portion of calcite in the shell of several bivalve families in accordance with the onset of calcite-facilitating conditions contradicts this claim. Ostreidae and Pectinidae were the most diverse epifaunal bivalve families of the Middle and Late Mesozoic, and the question arises whether the adaptation of their shell mineralogy to the prevailing physico-chemical conditions might have contributed to their great success during that “calcite sea” time. Future analyses of extinction and diversification patterns during the Triassic/Jurassic transition will therefore have to take shell mineralogical aspects into consideration, as well as to clarify whether there was a link between the physicochemical changes (as reflected by carbonate mineralogy) and the end-Triassic mass extinction.

7.

**Triassic/Jurassic Boundary of the Tatra Mountains in light of
micropaleontological data**

Andrzej Gaździcki

Institute of Paleobiology, Polish Academy of Sciences, Twarda 51/55, 00-818 Warszawa,
Poland, e-mail: gazdzick@twarda.pan.pl

Key words: Triassic/Jurassic, Tatra Mts, foraminifera, conodonts, biostratigraphy

The carbonate shallow-marine Late Triassic strata exposed in the Tatra Mts contain biostratigraphically important microfossils, mostly foraminifera and conodonts, as well as palynomorphs and coprolites (Gaździcki 1974, 1978, 1983; Salaj et al. 1983, Fijałkowska & Uchman 1993, Gaździcki et al. 2000). They have been used to erect local zonations and they may also be of prime importance for regional biostratigraphic correlations and paleogeographic reconstruction. The representative sections of the Late Triassic and Early Jurassic of the Tatra Mts in the *Fatricum* and *Hronicum* have been measured and sampled in order to establish a vertical distribution of the microfossils and associated biotas (Gaździcki 1974, 1983; Gaździcki & Michalík 1980, Gaździcki et al. 1979, Michalík & Gaździcki 1983).

A marked acceleration in evolution and radiation of the calcareous benthonic foraminifera of the family Involutinidae in the Late Triassic (Norian-Rhaetian). This is reflected by the appearance of numerous species of the genus *Aulotortus*. The species are characterized by planispiral pattern of test structure but they differ markedly from one another in test shape and number and arrangement of whorls (Fig. 11). The Late Norian marks the appearance of the genus *Triasina*, which is represented by *T. oberhauseri* → *T. hantkeni*, lineages characterized by very short evolutionary durations. The appearance of segmentation of deuterolocus represents a new feature in the evolutionary lineage of involutinids. The

presence of pillars in the tests of *Involutina liassica*, *I. turgida*, *I. farinacciae* and *Trocholina umbo*, which did not appear before the Late Rhaetian, most probably represent another new morphological feature in the involutinids. Many involutinids became extinct at the Rhaetian / Hettangian boundary and only few survived into the Liassic and younger strata (Fig. 11).

The record of the youngest conodont assemblage, *Misikella posthernsteini* and *Misikella* sp. *A*, from the Rhaetian of the Tatra Mts makes it possible to draw several general conclusions. The lack of any elements of conodont apparatus other than the spathognathoid one, suggests that this element was the last element remaining in the apparatus of the conodontophorid animal. *Misikella posthernsteini* is likely to have evolved from *Misikella hernsteini*. This may have involved the reduction in the number of denticles and the infolding of the posterior margin. It is highly probable that *Misikella* sp. *A* represents a member of the evolutionary lineage *M. hernsteini* → *M. sp. A* → *M. posthernsteini*. The scarcity and marked monotypicity conodonts in the Rhaetian may also represent evolutionary changes in this group just before its extinction at the end of the Triassic.

The presence of several evolutionary lineages and the rapid rates of evolutionary changes of representatives of the foraminifer families Involutinidae and Ammodiscidae and the subfamily Ophthalmitidae permit an establishment of relatively high resolution zonation. A sequence of two foraminifer zones – *Glomospirella friedli* and *Triasina hantkeni* (Assemblage Zone, Rhaetian) and *Ophthalmitium leischneri* and *Ophthalmitium walfordi* (Assemblage Zone, Hettangian-?Sinemurian) is recognized.

The *Glomospirella friedli* and *Triasina hantkeni* Zone may be correlated with ammonoid *Choristoceras haueri* and *Ch. marshi* Zones (Rhaetian) and its extent corresponds to that of the conodont *Misikella posthernsteini* Zone. The extent of Early Liassic *Ophthalmitium leischneri* and *Ophthalmitium walfordi* Zone may correspond to that of the ammonoid *Psiloceras planorbis*, *Schlotheimia angulata* and presumably *Arietites bucklandi* Zones (Hettangian-?Sinemurian) – defining the basal part of the Jurassic system in the Tatra Mts.

The biostratigraphic zonation of the Late Triassic/Early Jurassic in the Tatra Mts shows that the boundaries of the lithostratigraphic units i.e. Carpathian Keuper, Fatra- and Kopieniec Formations in *Fatricum*, are diachronous (Fig. 12).

8.

Triassic/Jurassic Boundary and foraminifers of the West Caucasus

Vuks Valery Ja.

All Russia Geological Research Institute (VSEGEI), Sredny pr. 74, 199106 St. Petersburg, Russia;
vsegei@vsegei.sp.ru

Key-words: Triassic/Jurassic boundary, biostratigraphy, foraminifers, West Caucasus

The uppermost Triassic deposits of the West Caucasus are presented by the Khodz Group, which overlies with an erosional contact on the Ladinian – Lower Carnian deposits (Sakhray Group) and is represented by diverse limestones. These deposits correspond to the Upper Norian - Lower Rhaetian and contain diverse fauna assemblages (foraminifers and others). The Khodz Group contains two foraminifera associations - *Aulotortus friedli*- and *Involutina liassica* assemblages. The second foraminifera assemblage was found in the red and brown massive reef limestones (the upper part of the Upper Norian and the lower part of the Rhaetian, *Sagenites reticulatus*- and *Vandaites sturzenbaumi* zones). This foraminifera association predominant consists of involutinids, miliolids and nodosariids. Besides foraminifers, there are algae, ammonoids, brachiopods (Shevyrev 1995). *Involutina liassica* assemblage of the West Caucasus is very similar to the Norian-Rhaetian assemblages (*Miliolipora cuvillieri*-*Semiinvoluta clari* assemblages) of the Crimea and Pamirs, and there are a lot of common species with the coeval associations of the Carpathians, Balkan, the Hellenic Realm, Turkey, and Indonesia (Vuks 1996, 2000).

The Lowest Jurassic deposits (Bugunzha Formation = Upper Sinemurian - lower part of the Pliensbachian) overlie with an erosional contact on the Upper Triassic and are represented

by sandy clay and argillites with calcareous concretions and lenses of bioclastic limestones. The foraminiferal *Cornuloculina clausa* assemblage occupies the lowest part of the Bugunzha Formation (Upper Sinemurian). This association predominantly consists of miliolids and nodosariids accompanied by a number of nodosariid species. In the assemblage with *Cornuloculina clausa* there is a lot of typical the Triassic species. Besides foraminifers, there are rare ammonoids and brachiopods (Shevyrev 1995). The *Cornuloculina clausa* assemblage is similar or has a lot of common species with the coeval associations from Bulgaria, Poland, northern Germany and northern France.

The assemblages considered from the uppermost Triassic and lowest Jurassic are rich and very diverse, but their generic composition is very variegated and there are only few species common. The uppermost Triassic assemblage with *Involutina liassica* is typical of the reefal facies, but the Lowest Jurassic assemblage with *Cornuloculina clausa* typically occurs in the terrigenous facies along the marginal continental basins. The analysis of taxonomic composition of foraminiferal assemblages from the the uppermost Triassic and lowest Jurassic of Caucasus allows to state that the first assemblage is similar to the simultaneous associations from Tethyan regions and the second one resembles the coeval Peri-Tethyan assemblages. The foraminifers indicate the essential rebuilding of the environment in this basin and mark the important changes of the fauna migration ways. The analysis of the generic and specific composition of foraminiferal assemblages in time and space allows to define two different stages of their evolutionary development during Late Triassic (Late Norian - Early Rhaetian) and Early Jurassic (Late Sinemurian-Pliensbachian) stages.

This research was supported by the Peri-Tethys Programme, the Cariplo Foundation for Scientific Research and Landau Network-Centro Volta, which presented the grant for the work in Milan University. Author warmly thanks to Prof. M. Gaetani and the above mentioned organizations for a kind support.

**9. High-nutrient conditions at the end of the Triassic Period:
The evidence of the last complex foraminifers and dasycladaceans
from the Western Carpathians**

Ján Soták

Geological Institute, Slovak Academy of Sciences, Severná 5, SK 974 01 Banská Bystrica,
Slovakia, e-mail: sotak@savbb.sk

Key words: Foraminifera, Dasycladacea, ecology, Triassic / Jurassic boundary, Western Carpathians

The Triassic-Jurassic boundary is marked by pronounced changes in productivity and nutrient resources as well (Ward et al. 2001., etc.). In the Carpathian sections, the productivity changes are inferred in the boundary clays, which reveal highly reducing conditions of carbonate precipitation. Non-calcareous clays at the T/J boundary seem to be deposited in high-nutrient environment, which did not favoured oligotrophic biostrome communities of the Fatra Formation.

Paleoproductivity changes were recorded mostly by distribution of complex foraminifers and dasycladaceans, which are regarded oligotrophic in nature. Foraminifers like *Triasina hantkeni* Majzon exhibit complex internal morphostructure and large test size typical of symbiotic life mode (see Brasier 1995). These foraminifers fade out a few meters below the expected T/J boundary, e.g. their last occurrences in the Furkaska section are known in the bed n₀ 393. At the same time, *Triasina hantkeni* tests increase both in size and in frequency of

microsphaeric forms, which indicate their opportunistic reproductive strategy due to eutrophication. Distribution of dasycladacean algae towards the T/J boundary shows a similar decline. The last dasycladacean remains, belonging to *Placklesia multipora* Bilgutay, occur in the bed n_o 376 of the Furkaska section. This species is an infrequent Rhaetian alga, which preceded dasycladacean biotic crisis across the TJ boundary. Nutrient-limited habitants like corals disappeared in top of the Fatra Formation as well; in the Furkaska section they form the last biostromatic overgrowth in the bed n_o 400. Increased nutrient level can be also evidenced by high juvenile brachiopod mortality in *Rhaetina* coquinal layers, or by abundant microborings in skeletal grains, when the endolithic microbes benefited from nitrate-rich nutrients. Cyanobacterial nodules like *Girvanella* (e.g. in the bed n_o 404 of the Furkaska section) are also very frequent. Furthermore, both high nutrient supply and productivity rate are evidenced by biogenic barium, concentrating in the boundary beds of the Kardolina section (the bed n_o 73).

Transitional beds on the T / J boundary are marked by a steep decrease in the carbonate content in the Furkaska section (from 10.5 % TIC in the bed n_o 408 to 0.26 % TIC in the boundary clay in direct overlie). Carbonate depletion on the T / J boundary might reflect an excess of nitrogenous and phosphate nutrients, which lowered the rate of carbonate production (Hallock 1988). Biogenic content of the boundary clays is drastically impoverished, being represented by rare ostracods and microgastropods only. Ostracods (pioneer forms e.g. *Ogmoconcha*) display an opportunistic eutrophic or everyoxibiont faunal character. Anoxic conditions of boundary clays are also indicated by rare pyritized gastropods shells and by the abundance of sulphide frambooids.

3rd Workshop od the IGCP Project 458 :
„Triassic/Jurassic Boundary Changes”

10.

Quantitative analysis of biofacies in the Rhaetian Fatra Formation of the central Western Carpathians)

Jozef Michalík

Geological Institute, Slovak Academy of Science, Dúbravská 9, PO Box 106, 84005 Bratislava, Slovakia,

geolmich@savba.sk

Key words: Carbonate biofacies, cyclostratigraphy, sequence stratigraphy, Rhaetian, Fatra Formation

During last decades, the sequential stratigraphy attained important position in geological interpretative methods. The sequential analysis is based on both macroscopic and microscopic study of complete rock sequences. The first group is represented by geometric study of lithosomes (correlative unconformities, cycles, thickness change), facies correlation (clastic interbeds, sedimentary textures) and content of fossils (reefs, biostromes, shell accumulations). The second circle comprises the mineralogical, chemical composition of correlative beds, composition of isotopes (δC^{14} , δO^{18}), and the composition of microfacies studied in thin sections sets.

In pelagic carbonate basins (Reháková & Michalík 1994), the microfacies elements can be divided into evolutionary group (test of plankton and authochthonous benthic microorganisms plus unidentifiable micrite, accumulated during late transgressive and highstand stage of the sea level), and the revolutionary group (clasts of neritic benthic organisms plus terrigenous lithoclasts, transported during falling stage and lowstand sea level stage basinwards. The percentual share of these categories can be estimated by Schäfer's (1969) and Soudant's (1972) optical method and evaluated in two dimensional graphs. Finally, the results from individual sections are compared by

plotting into palinspastic scheme of the basin (see Michalík 1997b, or Michalík & Reháková 1997 for the Zliechov basin during Early Cretaceous).

Sequential analysis of Triassic deposits is always complicated task, as the geometry of lithosomes is highly variable and eustatic signal was rather weak in comparison with autocyclic mechanisms in the carbonate ramps and platforms. Nevertheless, the concept of quantitative microfacies analysis is effective and helpful, too. The principal antagonism between micrite and sparite content can be interpreted in terms of either increase of environmental energy (turbulence) during sea level fall, causing out-washing of fine fraction, of decreasing of sedimentary rate, or of decreasing of clay input resulting in increase of carbonate content and in more rapid lithification.

Although the highstand portion of the cycles can be characterized by increase of micrite and by decrease of other components only, the sequence of the Fatra Formation could be divided into fourteen eustatic cycles, well correlable in distant section (Fig. 13). Moreover, paleogeographic division of the Fatra Fm basin into structural highs and flat, less elevated areas (cf. Michalík 1977a, Tomašových 2000, Tomašových & Michalík 2000) could be confirmed on a palinspastic plan.

*3rd Workshop of the IGCP Project 458 :
„Triassic/Jurassic Boundary Changes”
Stará Lesná, Slovakia 2003*

11. Hettangian ammonites in the Western Carpathians

Miloš Rakús

Geological Survey of the Slovak Republic, Mlynská dolina 1, Bratislava, Slovakia, rakus@gssr.sk

It is notoriously known that the Rhaetian strata are very poor in ammonites in the Western Carpathians. Up to now only one arcestid ammonite (*Arcestes* (*Arcestes*) cf.

rhaeticus Clark, 1887; Andrusov, 1934) was collected from the locality of Hybe. Moreover, this taxon has larger stratigraphic range and is not very useful for the detailed biostratigraphy. On the other hand, the same locality yielded a nautiloid fauna – *Cenoceras hybense* Rakús (1992). It is notable by its particular shape, especially by its trapezoidal whorl section with flat to depressed venter as well as by its septal line. All these characters linked it with group of *Cenoceras schlumbergeri* (Terquem), which is Hettangian in age.

Some other ammonites were described from the Hybe Formation, as well. One of them is a pleuroacanthitid ammonite, which seems to be close to *Pleuroacanthites biformis* (Sowerby). This genus appears in the Lower Hettangian only (Fig. 14). Unfortunately, the specimen was found by an amateur collector and therefore, its precise stratigraphical position in the Hybe section is unknown. However its co-occurrence together with Rhaetian type fauna, comprising brachiopods and bivalves (Rakús, 1992, p. 40) indicates that at least the upper part of the Hybe beds could be ranked to Lower Hettangian.

The Hettangian stage is better documented by ammonites, we distinguish all of three principal ammonite zones like in the Eastern Alps. The best localities are situated in the Krížna Nappe, mainly in the Kopianec Fm. Interesting Hettangian fauna comes from another two localities, the first one from the Nový Svet Fm near Banská Bystrica (Tomašových & Michalík, 2000) and the second from the brecciated and phosphatised limestone from the Sokol Valley in the Malá Fatra Mts (Rakús, 1993).

The Planorbis Zone was documented in the Rakytov locality in the Veľká Fatra Mts (annotated by D. Štúr, 1860) and Babky Hill in the West Tatra Mts (Rakús, 1993). Both sections yielded *Psiloceras psilonotum* (Quenstedt). The Planorbis Zone was proved also in the mouth of the Sokol Valley, a tributary to the Valley, where a specimen of *Caloceras cf. torus* (d'Orbigny) has been found.

The Liasicus Zone: It is qualitatively the richest in ammonites (Fig. 15). The following taxa are ranged in this zone: *Gonioptychoceras viskupi* (Rakús), *Kammerkarites* cf. *curviornatus* (Wähner) [locality Kozinec in the Strážovská hornatina Mts.]; *Alsatites liasicus* (d'Orbigny) sensu Wähner, *Alsatites sublaqueus* (Wähner), *Kammerkarites extracostatum* (Wähner), *K. sokolensis* Rakús, *K. megastoma* (Wähner), *K. frigga* (Wähner), *Saxoceras langei* Rakús, *Schlotheimia taurina* (Wähner), *Sch. aff. taurina* (Wähner) [the Sokol Valley].

Moreover, the *Kammerkarites haploptychum* (Wähner) occurs in the deposits of the Nový Svet Fm (Tomašových & Michalík, 2000). The fauna permit to correlate it with the Liasicus Zone. It is interesting that in the Sokol Valley this fauna is associated with schlotheimiid species from the *extranodosa/taurina* group. A similar situation was already noted by Wähner (1886) and recently by Guex (1987).

The Angulata Zone: The presence of this zone in the Western Carpathian Hettangian is poorly documented. Till now, only a poor fauna with *Schlotheimia* sp. from the Borišov locality (the Veľká Fatra Mts) and *Schlotheimia* cf. *oxygonia* Lange from Mt Osobitá (Andrusovová & Andrusov, 1968) was described.

A particular fauna comes from brecciated and phosphatised limestones from the vicinity of the Čierna Lehota village (the Strážovská hornatina Mts; Fig. 16). The list of fauna includes: ?*Gyrophioceras* aff. *praespiratissimum* (Wähner), *Sulciferites martinischmidtii* (Lange), *S. charmassei* (d'Orbigny) and *Tayloricites waehneri* (Rakús). The precise stratigraphical position of the fauna is not clear, as some of the mentioned taxa can go through up to the Lowermost Sinemurian (a condensed assemblage).

From the paleobiogeographical point of view, the Western Carpathian Hettangian assemblage displays a high generic and specific affinity with the Alpine assemblages, but some independence and „distance“ from the Alpine radiation center is suggested by existence

of endemic taxa, such as *Kammarkarites sokolensis*, *Gonioptychoceras viskupi* and *Tayloricites langei*. It is also worth to note surprising total absence of Phyloceratina in this stratigraphical interval, probably due to local paleogeographical and paleoenvironmental conditions.

*3rd Workshop of the IGCP Project 458 :
„Triassic/Jurassic Boundary Changes”
Stará Lesná, Slovakia 2003*

12.

The terebratulid brachiopod *Lobothyris ? subgregaria* as an Early Jurassic Elvis species from Hungary

Alfréd Dulai¹ & József Pálffy²

¹Hungarian Natural History Museum, Department of Geology and Paleontology; H-1431 Budapest, P. O. Box 137, Hungary; dulai@paleo.nhmus.hu

²Hungarian Academy of Sciences - Hungarian Natural History Museum, Research Group for Paleontology, H-1431 Budapest, P. O. Box 137, Hungary, palfy@paleo.nhmus.hu

Key words: brachiopods, extinction, ecomorphism, T/J boundary

The end-Triassic mass extinction ranks among the „Big Five” extinction events of the Phanerozoic. The victims included numerous brachiopod taxa but *Rhaetina gregaria*, one of the most common Late Triassic species, has been regarded as a survivor that ranges across the Triassic-Jurassic boundary into the Early Jurassic (e.g. Geyer 1889; Pearson 1977; Michalík et al. 1991). This claim was founded on external morphology as similar, characteristically biplicate forms occur frequently in both uppermost Triassic and lowermost Jurassic

sediments. However, the study of the internal morphology of Early Jurassic specimens from Hungary revealed important differences. Serial sections of specimens from the Kardosrét Limestone, from localities near Sümeg and in the Gerecse Mts. display internal features of the genus *Lobothyris* (Dulai 1993). Thus, despite the external similarity, the Early Jurassic form represent a separate taxon, identified as *Lobothyris ? subgregaria*. In the Transdanubian Range, *Rhaetina gregaria* is confined to the Upper Triassic. A survey of other reported occurrences of allegedly Liassic *Rhaetina gregaria* also reveals that their true age is most likely Late Triassic, suggesting that this species did not survive the end-Triassic extinction.

Complementing the better established Lazarus taxa (Jablonski 1986), Ervin & Droser (1993) introduced the concept of Elvis taxa for those forms that appear shortly after an extinction event and bear close resemblance to an extinct victim species, albeit their distinctness can be proved by detailed taxonomic studies. (The term refers to the imitators of Elvis Presley after his death.) We suggest that *Lobothyris ? subgregaria* can be regarded as an Elvis taxon. As a first example from the Mesozoic of the western Tethys, it strengthens the case that Elvis taxa represent a real phenomenon in the biotic patterns of extinction and recovery.

Further studies of biplicate terebratulids around the Triassic-Jurassic boundary (*Rhaetina gregaria*, *Triadithyris gregariaeformis*, *Pseudorhaetina antimoniensis*, and *Lobothyris subgregaria*) will be needed to decipher the phylogenetic relationship and paleobiogeographic affinities of these taxa.

*3rd Workshop od the IGCP Project 458 :
„Triassic/Jurassic Boundary Changes”
Stará Lesná, Slovakia 2003*

13. Micro- and clay mineralogy of carbonates in the Tr/J boundary section at Csóvár, Hungary

Norbert Zajzon

Department of Mineralogy Eötvös Lóránd University, Pázmány Péter sétány 1/c, H-1117 Budapest, HUNGARY, nzajzon@hotmail.com

Key words: clay mineralogy, carbonate petrology, Triassic / Jurassic boundary, Hungary

Introduction: The Csóvár section is located in N-Hungary, about 40 km to north-eastward from Budapest. This outcrop is a good opportunity to study the Tr/J boundary, with its continuous late Triassic – early Jurassic marine carbonates. We studied the micro- and clay mineralogy of the section to supply data for a more detailed picture of the Tr/J boundary event.

Clay mineralogy: Throughout the section 12 samples were analyzed for clay minerals, including a clay-rich layer in the uppermost Triassic part, called as "tuff-layer" in the preliminary geological characterization of the section. The presence of a tuff layer close to the boundary would be significant for the reconstruction of the event.

Beside that clayey layer limestone and marl layers were studied.

After milling the samples, the carbonate content was dissolved by 5% acetic acid. X-ray powder diffraction (XPD) was carried out on all of the insoluble residues. The diffractograms of the clayey layer and that of the residual insoluble clay fractions of the other layers (limestones, marls) were similar: beside the dominant quartz kaolinite group mineral ($d_{001}=7.1\text{Å}$), an illite-muscovite phase ($d_{001}=10\text{ Å}$) and an illite-smectite interstratified phase ($d_{001}=11.7\text{Å}$) were identified. No montmorillonite reflections were detected. The smectite content in the illite-smectite mixed and interlayered phase was determined by using a modified version of the method of Reynolds and Hower (1970). The determined smectite/illite content is 25/75%.

The data show no volcanic component in any of the samples and no change throughout the section. The only variable is the carbonate content which acts as a diluting factor against a relatively constant clay sedimentation, thus causing a layered structure with different amounts of clay content. Therefore the alleged mentioned "tuff bed" is shown to be only a condensed layer.

Micromineralogy: After dissolving 39 samples collected from the section, heavy liquid separation was applied (by using bromoform). From the heavy mineral fraction, all the allotigenous grains were handpicked under a stereomicroscope. The grains were observed by stereo- and petrographic-microscope, and analyzed with microprobe (equipped with WDS). The identified minerals: two types of almandine, grossular, andradite, tourmaline, staurolite, magneziohornblende, rutile, ilmenite, titanomagnetite, magnetite and gold.

Despite the large sample size (1 kg/sample), there were only few allotigenous grains, and some samples were completely devoid of them. Because of the small number of grains the regular statistical methods cannot be used to infer the parent rock and the provenance area, the mineral association still allows a reliable qualitative assessment. This association is thought to have derived from an eroding metamorphic area, with meso-metamorphic rocks of sedimentary origin, contact metamorphic rocks and magmatic rocks.

The Triassic and the Jurassic parts of the section show similar composition, but in the Jurassic part, a few meters above the boundary, a significant increase of the allotigenous material is demonstrated. This correlates well with a change in the average sea level and the palaeogeographical position of the area.

A hydrothermal overprint with an association of quartz, calcite, fluorite and barite was also detected in the section, in agreement with the previous observations. The earlier studies (Jugovits 1912) connected these minerals to veins, but we found quartz, fluorite and barite also in limestone beds, which otherwise seemed unaltered.

Pyrite, marcasite and most of magnetite in the section is altered, maybe also in connection with the hydrothermal fluids.

This fluid flow could also influence the $\delta^{18}\text{O}$ data in the section. According to A. Demény, who performed stable isotope measurements from the section (Pálfy et al. 2001), outliers in the $\delta^{18}\text{O}$ data were observed that reach -8‰ (relative to VSMOW) instead of the typical values of -1‰ to -4‰. These data were rejected, because they were thought to be affected by carbonate transport from the adjacent platform or diagenesis. We note that these data were obtained from layers, which suggest hydrothermal alteration. A hydrothermal overprint can explain the anomalously low -8‰ values in the $\delta^{18}\text{O}$ data, thus we propose that a hydrothermal origin is more likely. However hydrothermal alteration was not indicated in

the samples where the prominent negative $\delta^{13}\text{C}$ peak occurs near the boundary, thus it is likely to represent a primary signal.

This contribution was sponsored by the Hungarian Scientific Research Fund (OTKA) Project No. T042802.

14. Sequence stratigraphy vs C and O isotopes across the T/J boundary beds in the Fatric, Tatra Mts (central Western Carpathians)

Otília Lintnerová¹ & Jozef Michalík²

¹Comenius University, Faculty of Science, Mlynská dolina, 842 15, Bratislava, Slovakia,

lintnerova@fns.uniba.sk

²Geological Institute, Slovak Academy of Science, Dúbravská 9, PO Box 106, 84005 Bratislava, Slovakia,

geolmich@savba.sk

Key words: sequence stratigraphy, carbonate sedimentology, C and O isotope excursions, Fatric Basin, Western Carpathians

The Triassic / Jurassic boundary in the Fatra Formation / Kopieniec Formation sections in the Western Carpathians is generally poorly recorded due to incomplete exposures, or erosion prior to start of the Hettangian sedimentation. Three best sections have been selected in the Tatra Mts area, namely the Furkaska, Kardolina and Široký žľab sections. The boundary beds are well exposed here. The transition from limestone to more clastic type of sedimentation is well visible. However, the lack of index fossils prevent any exact estimation of biostratigraphic Rhaetian / Hettangian boundary.

Detailed microfacies analysis revealed presence of fourteen cycles in the Fatra Formation sequence (Fig. 17). At the beginning of every cycle, content of sparite and clasts prevails over another components. Higher up, bioclasts and micrite content increases. The uppermost part of cycles consists of micrite. This trend indicate gradual decrease of environment energy (shallowing upwards-type). Four uppermost cycles, belonging to the „transitional member” to the overlying Hettangian Kopieniec Formation comprise lithologically different rock types including dark limestones with nodular surfaces, ferroan oolitic limestones and beds with possible spherulites. The contact with the Kopieniec Fm claystones is sharp.

Results of C and O isotope analysis show much greater variability of values in the transitional member if compared with the underlying biostromatic member of the Fatra Formation. The values of the $\delta^{13}\text{C}$ are comparable with the lithology of limestone beds, especially with their micrite, or bioclasts content. The increase in the fluctuations range upwards in the section is remarkable. On the other hand, the fluctuations of the $\delta^{18}\text{O}$ curve are much broader in all the section, reflecting dynamic character of the sedimentation. Slight positive correlation between high $\delta^{18}\text{O}$ values and high micrite content could be stated. The trend of $\delta^{18}\text{O}$ decrease towards T/J boundary should be proved by new sample sets from another sections.

15.

Organic carbon and nitrogen isotope disturbances in the Upper Triassic

Ken Amor¹, M. Sephton², I. A. Franchi³, P.B. Wignall⁴, R. Newton⁵ & J. P. Zonneveld⁶

¹Dept. of Earth Sciences, University of Oxford, Parks Road, Oxford, OX1 3PR, UK

²Planetary and Space Sciences Research Institute, Open University, Milton Keynes, MK7 6AA, UK

³Planetary and Space Sciences Research Institute, Open University, Milton Keynes, MK7 6AA, UK

⁴School of Earth Sciences, University of Leeds, Leeds LS2 9JT, UK

⁵School of Earth Sciences, University of Leeds, Leeds LS2 9JT, UK

⁶Geological Survey of Canada, 3303-33rd Street Northwest, Calgary, Alberta T21 2A7, Canada

A coincidental disturbance in the organic carbon and nitrogen isotope profile of a Late Triassic sedimentary succession from Western Canada, suggest a change in nutrient dynamics of the oceans at this time. Organic carbon and nitrogen isotope compositions measured in bulk samples from Black Bear Ridge, British Columbia, provide data from the Late Norian to Lower Jurassic. A positive 2‰ excursion in $\delta^{13}\text{C}$ occurs between the disappearance of Monotid bivalves and the appearance of Lower Jurassic fauna. This carbon isotope excursion is interpreted as an increased propensity towards storage of organic carbon in marine sediments and is thought to indicate widespread oceanic anoxia. A complex organic nitrogen isotopic event coincides with the carbon isotope excursion. Here a positive 2‰ shift in $\delta^{15}\text{N}$ is followed by a dramatic negative excursion to 0‰, a value similar to that for atmospheric nitrogen. The positive excursion is thought to confirm ocean stratification and stagnation and nitrate limited productivity. The negative shift is interpreted as a switch in the dominant phytoplanktonic community to atmospheric nitrogen fixing microbes such as cyanobacteria. A recent re-evaluation of the stratigraphy at Black Bear Ridge suggests a hiatus of unknown duration occurred during this time interval. However this only affects our understanding of the rapidity with which these events transpired.