Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Berichte des Institutes für Erdwissenschaften, Karl-Franzens-Universität Graz, Band 16

IGCP 596
Opening Meeting

Graz, 19-24th September 2011

ABSTRACT VOLUME

Editorial: SUTTNER, T.J., KIDO, E., PILLER, W.E. & KÖNIGSHOF, P.

Impressum:

Medieninhaber, Herausgeber und Verleger: Institut für Erdwissenschaften,
Karl-Franzens-Universität Graz, homepage: www.uni-graz.at
Druck: Medienfabrik Graz GmbH, Dreihackengasse 20, 8020 Graz

Organization

Organizing Committee

Thomas J. Suttner (Graz, Austria)
Erika Kido (Graz, Austria)
Werner E. Piller (Graz, Austria)
Peter Königshof (Frankfurt, Germany)

Technical Staff

Gertraud Bauer (Graz, Austria)
Elisabeth Gülli (Graz, Austria)
Erwin Kober (Graz, Austria)
Georg Stegmüller (Graz, Austria)

Scientific Committee

Iliana A. Boncheva (Sofia, Bulgaria)
Leona Koptiková (Prague, Czech Republic)
Toshiyuki Kurihara (Niigata, Japan)
Carine Randon (Paris, France)
Johnny A. Waters (Boone, USA)

Geological Survey of Austria: *Books & Maps Desk*

Thomas Hofmann (Wien, Austria)

Sponsors & Cooperation Partners

Preface

The recently started project IGCP 596 focuses on Mid-Paleozoic climate and biodiversity. As one of the most intensely studied periods the Mid-Paleozoic conforms to an interval of dynamic long-term climate change which was accompanied by substantial variations in biodiversity. Within the frame of the Opening Meeting, we intend to discuss the “state-of-the-art” of biodiversity during the Devonian and Carboniferous. Such a summary of the presently known record of all kinds of different fossil groups will serve as basis for revision or further identification of terrestrial and marine taxa, and shall help to clarify links between specific biodiversity patterns and climate change in subsequent project years. Groups distinctive for different ecosystems, especially indicating terrestrial, neritic and pelagic marine environments, are land plants, phytoplankton, foraminifers, sponges, corals, arthropods, cephalopods, echinoderms, brachiopods, bryozoans, conodonts, fishes and others. In addition we also invite participants to enhance the discussion with contributions regarding Mid-Paleozoic climate change, paleoclimate models and related topics.

The Organizing Committee

IGCP 596 Leaders

senckenberg
forschungsinstitut und naturmuseum

Peter Königshof
Germany
email: Peter.Koenigshof@senckenberg.de

Research microfacies; stratigraphy; low grade meatmorphism; focus on Devonian sediments

ĐẠI HỌC QUỐC GIA HÀ NỘI
Tin tức & Sự kiện

Phuong Ta Hoa
Vietnam
email: tahoaphuong@gmail.com

Research micropaleontology (conodonts, tentaculites); tabulate corals; events

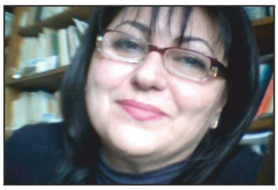
UNI GRAZ
ÖAW Austrian Academy of Sciences

Thomas J. Suttner
Austria
email: thomas.suttner@uni-graz.at

Research paleoecosystem research; Devonian reefs and related facies; conodont stratigraphy

Thasinee Charoentitirat
Thailand
email: thaicat@hotmail.com

Research paleogeography; fusulinid stratigraphy; Carboniferous & Permian carbonates and related facies



Geological Institute BAS

Iliana A. Boncheva
Bulgaria
email: boncheva2005@yahoo.com

Research Paleozoic paleontology, stratigraphy & taxonomy of conodonts; paleoecology; paleoenvironm. reconstr.

Appalachian
STATE UNIVERSITY

Johnny A. Waters
USA
email: watersja@appstate.edu

Research Paleozoic echinoderms ecosystems; particularly Blastozoa, rebound from Paleozoic mass extinctions

SB RAS
Siberian Branch of the Russian Academy Of Sciences

Nadezhda G. Izokh
Russia
email: IzokhNG@ipgg.nsc.ru

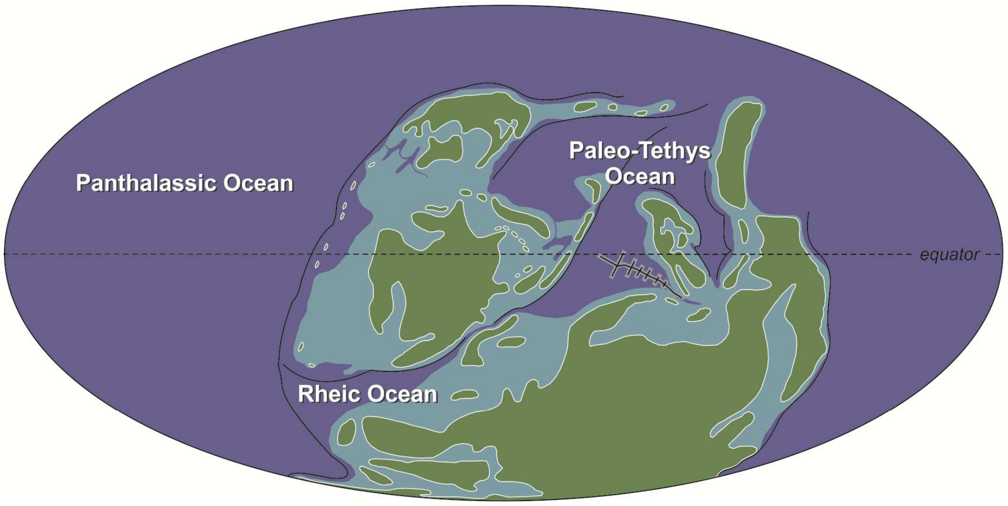
Research paleontology and biostratigraphy; Devonian facies (reefs, etc.); conodont stratigraphy

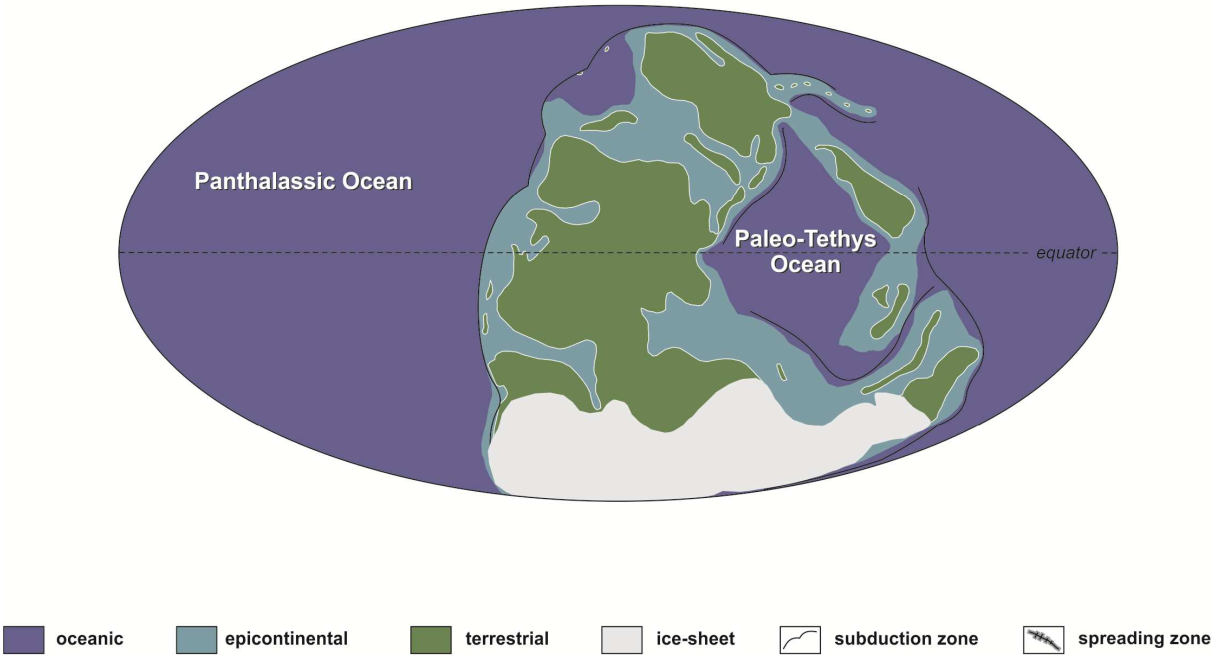
museum für naturkunde
Leibniz-Institut für Evolutions- und Biodiversitätsforschung
an der Humboldt-Universität zu Berlin

Wolfgang Kiessling
Germany
email: Wolfgang.Kiessling@mfn-berlin.de

Research biodiversity dynamics of marine organsims; mass extinction; Phanerozoic reef evolution

IGCP 596 Mid-Paleozoic climate and biodiversity


Early Devonian (390 Ma)


Late Carboniferous (306 Ma)

Distribution of land & sea during the Devonian and Carboniferous (simplified after SCOTESE, 2000).

Contents

- In Memorial -

- Abstracts -

- Field-Workshop -

In Memorial

Otto H. WALLISER (03.03.1928 – 30.12.2010)

Otto Heinrich Walliser was born in Krettenbach near Crailsheim in Southern Germany. He studied Geology and Paleontology at Tuebingen University under the head of Prof. Otto H. Schindewolf. The main interest at this time was the stratigraphy and paleontology of Jurassic ammonoids in Southern Germany.

In 1954 he graduated from Tuebingen University and came to the University of Marburg as assistant of Prof. Carl Walter Kockel. Besides research on Devonian goniatites he began the study of Silurian and Devonian conodonts of Germany and adjacent areas, especially of the Carnical Alps and Bohemia. His famous publication ‘Conodonten des Silurs’ did not only focus on their systematics, correlation purpose and detailed biostratigraphy. For the first time he reconstructed the conodont apparatuses theoretically by means of statistical methods.

In 1965 he became Professor of Historical Geology and Paleontology of Goettingen University and up to his retirement in 1993 he stimulated many theses, mostly on biostratigraphy, facies and fauna of the Silurian to Lower Carboniferous of Europe and Morocco.

Otto was very interested in biostratigraphy and bio-events and therefore he initiated and coordinated the ICGP 216 ‚Global Biological Events in Earth History’, which was a very successful international program. The results were published in two voumes (edited by KAUFFMANN & WALLISER, 1990 and WALLISER, 1996).

For many years he stimulated the discussions on stratigraphic boundaries and international correlations of Silurian and Devonian sequences. His heart problems and the unexpected death abruptly finished the detailed studies on conodonts at the Eifelian/Givetian boundary, which hopefully will be published by P. Bultynck.

Helga Groos-Uffenorde (Göttingen University)

IGCP 216 “Global Biological Events in Earth History” (1st Meeting in Göttingen, 1986):
Tatyana Koren, Otto Walliser and Art Boucot. (Photo H. Groos-Uffenorde)

Abstracts

Carbon isotope geochemistry and clay mineralogy of lower Famennian deposits in the Timan-northern Ural Region – implications for paleoclimatic changes

ANTOSHKINA, A.I.[1], KANEVA, N.A.[1] & KÖNIGSHOF, P.[2]

(1) Institute of Geology, Komi Science Centre, Ural Branch, RAS, 54 Pervomayskaya St., 167982 Syktyvkar, Russian Federation; *Antoshkina@geo.komisc.ru*; *nakaneva@geo.komisc.ru*
(2) Senckenberg Forschungsinstitut und Naturmuseum Frankfurt, Senckenberganlage 25, 60325 Frankfurt am Main, Germany; *peter.koenigshof@senckenberg.de*

Upper Devonian strata record global events, sea-level fluctuations, and perturbations to the global isotopic record of seawater. There is increasing evidence that climate change and biotic crises in the Late Devonian may also be driven by terrestrial plant radiation. The record of these crises coincides with lithological changes and/or carbon isotope excursions (e.g., BUGGISCH & JOACHIMSKI 2006).

Lower Famennian deposits from different facies settings were investigated in the Timan-northern Ural region in different facies settings: coastal lagoons (sections at the Izhma River, Southern Timan), shallow-water lagoons of carbonate banks (the Pechora Syncline, the East-Kolva square), and microbial mounds of carbonate bank slopes (sections of the Chernyshev Ridge, along the Shar'yu River). Paleogeographic reconstructions place the Timan-northern Ural Region in the northeastern part of the European continent during the Famennian time at an approximate paleolatitude of 30°N (ZONENSHAIN *et al*. 1990). Thicknesses of the lower Famennian deposits varies from 30 m in the South Timan (Izhma River) to 100 m thick sediments preserved in the well 50 East-Kolva. The lower Famennian deposits of the Izhma River sections are represented by an alternation of marly limestones, clays, and massive limestones and dolostones (MAJDL' & BEZNOSOV 2011). In the well 50 East-Kolva marls and fenestral limestone-dominated successions are the characteristic sediments (ANTOSHKINA 2009). In sections along the Shar'yu River microbial mounds of the lower Famennian interval exhibit alternations of massive microbial and mat-like stromatolite boundstones, massively bedded fenestral limestones, microbial and skeletal packstones and grainstones (ANTOSHKINA 2006). The $\delta^{13}C_{carb}$ and $\delta^{18}O$ data of the sections mentioned above have been used in this study. Compared with coeval sections in the other regions (e.g., JOACHIMSKI *et al*. 2002), the Izhma and Shar'yu rivers sections are characterized by lower $\delta^{13}C_{carb}$ values (from -3.3 to 2.0‰) and the well 50 East-Kolva section by raised $\delta^{13}C_{carb}$ values (from 2.6 to 3.5‰), whereas the maximum value in subequatorial sections is 4‰. The carbon isotope shift amplitude of the South Timan section reaches 5‰, which is 1.5-2 times higher than those in other sites of the region. Absolute $\delta^{18}O$ values in the studied sections are on the average 1-1.5‰ lower than in lower latitudes. The minimum $\delta^{13}C_{carb}$ values in clayish carbonates of the South Timan section (Izhma River) may be a result of fresh water input from the continent with lighter isotopes of soil bicarbonates. The minimum values may also be a result of the lower temperatures of seawater as compared with the subequatorial areas (JOACHIMSKI *et al*. 2004). As shown in the diagram of the carbon and oxygen isotopes locating, the highest $\delta^{13}C_{carb}$ values (2.0-3.5‰) are revealed in the Shar'yu River and the well 50 East-Kolva microbial limestones (Fig. 1). It reflects the increase of organic matter and bioproductivity in sediments during the early Famennian. Anomalous $\delta^{18}O$ low values (21.8-26.1‰) in all sections of the given region may indicate a strong influence of sulphate reduction and formation of bicarbonate-ions in interstitial waters.

Additionally, we have analysed the clay minerals of the Izhma River and well 50 East-Kolva sections. Mineral association the Izhma River sediments is poor – only illite and a hydrated chlorite occur. Some difference is observed in the association of the clay minerals from the well 50 East-Kolva. Here illite is the most common clay mineral whereas sericite and chlorite occur in a subordinate number. In comparison to modern environments in high-altitudes a clay mineral association dominated by chlorite and illite is a common feature. Chlorite acts as the stablest product of severe climatic conditions and processes of a physical weathering. The data indicate that the lower Famennian deposits were most probably formed in cooler climate conditions. On the other hand also warmer periods occurred during the Famennian in the Timan-northern Ural Region. We will describe different facies settings of early Famennian age in the Timan-northern Ural Region, and to determine their relationship to secular changes in the carbon isotope composition of seawater.

References

Antoshkina, A.I. (2006): Palaeoenvironmental implications of *Palaeomicrocodium* in Upper Devonian microbial mounds of the Chernyshev Swell, Timan-northern Ural Region. - Facies, 52: 611-625.

Antoshkina, A.I. (2009): Sedimentologicheskaya model' phamenskikh karbonatnykh otlozhenij v tsentral'noj chasti Khorejverskoj vpadiny. - Materialy XV geologicheskogo s''ezda Respubliki Komi. Syktyvkar: Geoprint. T. II: 211-214. [in Russian]

Buggisch, W. & Joachimski, M. (2006): Carbon isotope stratigraphy of the Devonian of Central and Southern Europe. – Palaeogeography, Palaeoclimatology, Palaeoecology, 240: 68-88.

Joachimski, M., Pancost, R., Freeman, K., Ostertag-Henning, C. & Buggisch, W. (2002): Carbon isotope geochemistry of the Frasnian-Famennian transition. - Palaeogeography, Palaeoclimatology, Palaeoecology, 181: 91-109.

Joachimski, M., van Geldern, R., Breisig, S., Buggisch, W. & Day, J. (2004): Oxygen isotope evolution of biogenic calcite and apatite during the Middle and Late Devonian. – Int. J. Earth Sci. (Geol Rundsch), 93: 542-553.

Kuleshov, V.N. (2001): Evolutsiya izotopnykh uglekislotno-vodnykh sistem v litogeneze. Soobshshenie 1 Sedimentogenez I diagenez. - Litologiya I poleznye iskopaemye, 5: 491-508. [in Russian]

Majdl', T.V. & Beznosov, P.A. (2011): Carbon and oxygen isotope composition and the distribution of strontium in the lower Famennian section of Izhma River (South Timan). - Vestnik of Institute of Geology, Komi Sc. Centre, Ural Branch, RAS, 4: 4-8. [in Russian]

Zonenshain, L.P., Kuzmin, M.I. & Natapov, L.M. (1990): Geology of the USSR: A plate-tectonic synthesis. - AGU Geodinamic Series, 21, 242 pp.

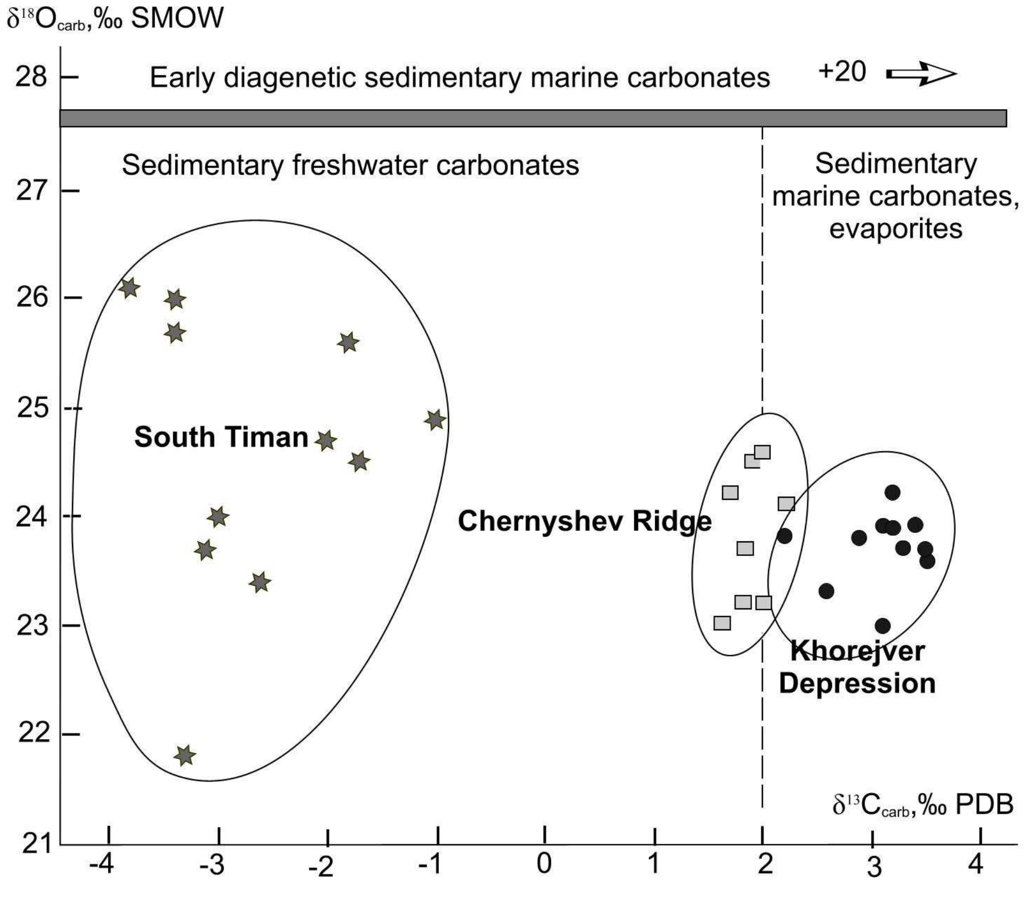


Fig. 1: Distribution of carbon and oxygen isotopes of the lower Famennian deposits in the Timan-northern Ural Region (a diagram modified from Kuleshov 2001).

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Carboniferous fossils of Mongolia

ARIUNCHIMEG, Ya.

Paleontological Center, Mongolian Academy of Sciences, Enkhtaivan evenue 63, Ulaanbaatar, Mongolia;
ariuna_ya@magicnet.mn

The lower Carboniferous of Mongolia is characterized by marine sedimentation, and the upper Carboniferous by a dominance of terrestrial volcanic and clastic deposits. Only in the south-eastern part Carboniferous reef deposits are developed. The Carboniferous deposits of Mongolia can be divided into main four provinces. Continuous stratigraphic sections with fossils are absent there so the sporadic biostratigraphic studies have to be limited to some isolated outcrops (DURANTE *et al*. 1980, Fig.1).

Brachiopods, bryozoa and crinoids as well as conodont, fusulinaceans and corals in some provinces are of primary importance in the lower Carboniferous, while goniatite, bivalves and macroflora play a supporting role. Phytostratigraphic work for the upper Carboniferous have been well done.

In the northern part of Mongolia biostratigraphic studies on main fossil groups such as brachiopods, bryozoans are systematically undertaken in Mongol-Ochotsk province and related Orchon, Bayanchongor and Bayantsagaan basins. The fauna of Early Carboniferous of northern Mongolia include some characteristic taxa of the Siberian provinces. Terrestrial sediments contain abundant representatives of the Angaran floras (DURANTE *et al*. 1996).

Coal-bearing lower and upper Carboniferous sequences containing floras of Angarian affinities are developed along the Tsagaanshuvuut fault in Western Mongolia.

In the southern part of Mongolia the upper Carboniferous is rather well developed while the lower Carboniferous is absent in some regions. The brachiopods, bryozoans and crinoids recovered from the Lower Carboniferous and megaplants from the Upper Carboniferous. Very rare finds of ammonoids are reported from the Baruunhurai region (KUZINA *et al*.1994).

The Carboniferous of south-eastern Mongolia is dominated by a stable shallow shelf facies with Tethyan affinity. Three fusulinid zones (Serpuchovian-Bashkirian *Archaediscus-Eostaffella*, Moskovian *Profusulinella* and Kassimovian-Gjelian *Triticites*) and one coral zone (Visean-Serpuchovian *Diphyphullum-Dibuphullyum*) can be recognized in this region (SUETENKO 1968). This zone marks the boundary between South Asian domain and the Gondwana domain.

On a basis of a study of Carboniferous fossils five associations with flora (Lepidophitian-1, Lepidophitian-2, Lepidophitian-3, Pteridospermian or Angaropteridiumian and Pteridospermian-Cordaites), six with brachiopods (*Ovania*, *Scissicosta*, *Parallelova*; *Absenticosta*, *Impiacus*, *Lanipustula*, *Eolissochonetes-Sajakella-Ectochoristites* and *Jakutoproductus*) (AFANASJEVA *et al*. 2003) and eight bryozoans (*Nematopora afgana*, *Pseudobatostomella minima*, *Rhombopora simplex*, *Sulcoretepora minor*, *Paranicklesopora vera*, *Lanopora eximia*, *Mongolodictya insperata* and *Shulgapora aguiulensis*) are established (ARIUNCHIMEG 2008).

The conodonts along the Devonian-Carboniferous boundary have been reported from two localities in Southern Mongolia and following conodon zones were recognized: *sulcata-duplicata-crenulata-isostica-typicus* (NYAMSUREN 1998).

Based on reliable fossil data the biostratigraphic framework provided is a foundation for chronostratigraphic correlation of the Mongolian Carboniferous with the standart schenes for the Carboniferous system accepted in Europe and other parts of the world.

References

ARIUNCHIMEG, Ya. (2008): Compleksy paleozoiskich mshanok Mongolii I ich characteristika. - Tr. Ins-ta Geologii i min. resursov, vyp., 18: 66-93. [in Russian]

AFANASJEVA, G.A., ALEKSEEVA, R.E., GRUNT, T.A. *et al*. (2003): Paleontologiya Mongolii. Tom Brachiopody. - M., Nauka: 254. [in Russian]

DURANTE, M.V., GOLIDENBERG, V.I., DERGUNOV, A.B., LUVSANDANZAN, B. *et al*. (1980): Stratigrafiya camennougolinych otlojenii Mongolii. V kn.: Biostratigrafiya nijnego kembriya I carbona Mongolii. - M. Nauka, Trudy SSMNIGE, vyp., 26: 192. [in Russian]

DURANTE, M.V., LAZAREV, S.S. & PAVLOVA, E.E. (1996): The Carboniferous of the world, vol. III. The former USSR, Mongolia, Middle Eastern platform, Afghanistan, and Iran: 409-441.

KUZINA, L.F. & LAZAREV, C.C. (1994): New early Carboniferous ammonoids from Mongolia. - Paleontological Journal, 28 (1A): 157-171.

NYAMSUREN, G. (1998): Biopstratigraphiya I conodonty devona-nijnego Carbona yujnoi Mongolii. - Moskva, PIN. Avtoreferat dis. Kand. geol-min.nauk: 22. [in Russian]

SUETENKO, O.D. (1968): Pervye nachodki foraminifer v yugo-vostochnoi Mongolii. - Dokl. AN SSSR,T., 180 (3): 691-695. [in Russian]

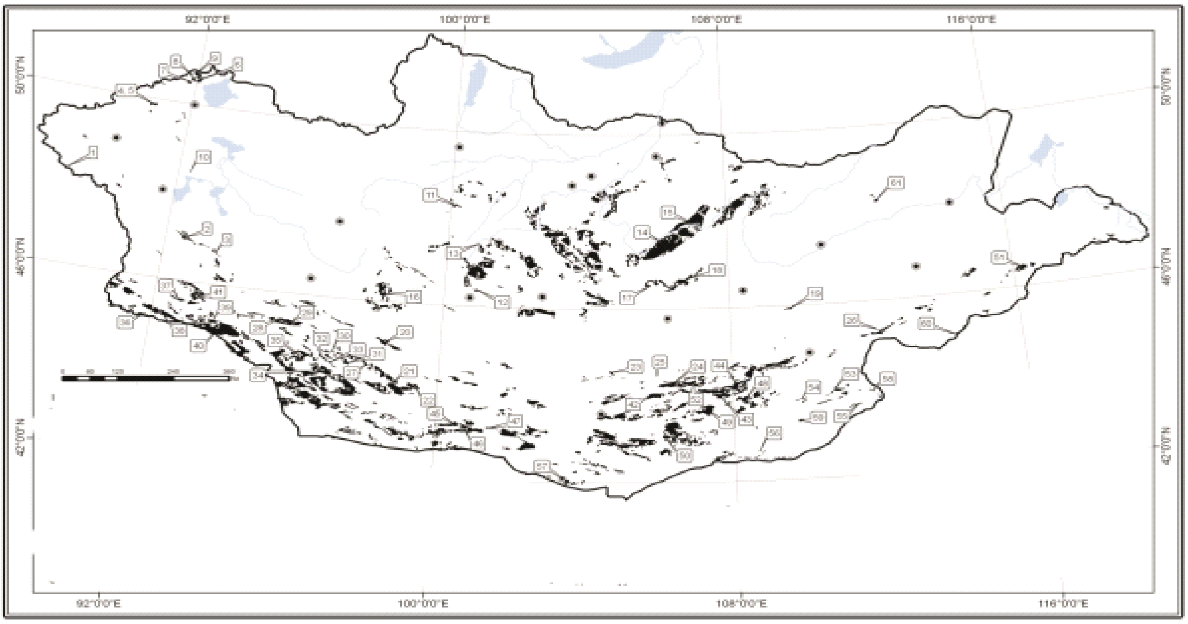


Fig.1: Map showing the distribution of Carboniferous outcrops and studied sections.

Devonian Volcanism and Conodont Biodiversity in the South Urals

ARTYUSHKOVA, O.V.[1] & MASLOV, V.A.[1]

(1) Institute of Geology, Ufa Scientific Centre, Russian Academy of Sciences, 16/2 Karl Marx street, Ufa, the Republic of Bashkortostan, 450077 Russian Federation; *stpal@anrb.ru*

In the Devonian history of the South Urals volcanic activity was the strongest factor that determined the basinal sedimentation and biodiversity of the inhabiting faunas. In general, volcanism was of unstable character with both explosive eruptions of the island-arc type and fissure ones peculiar to rift systems. There were also geodynamically quiet periods of different duration, when volcanic eruptions if any were episodic, momentary and had very insignificant environmental impacts. The main feature of volcanic activity in the South Urals was its submarine occurrence at great depths (below Calcium-carbonate-compensation depth – CCD).

At present there exists a well-developed Devonian stratigraphy for the eastern slope of the South Urals, whose section is represented mainly by volcanogenic or volcano-sedimentary units. It is totally built upon conodonts (more exactly on their imprints). It is precisely these fossils distributed in different types of rocks (sometimes in limestones, but mostly in cherts and others) that made possible subdivision and correlation of volcanites. We succeeded to establish practically complete continuous sequence of the Devonian section (ARTYUSHKOVA 2009, MASLOV & ARTYUSHKOVA 2010) and recognize faunistically rich, poor and utterly barren intervals.

In the Early Devonian (pre-Emsian time) conodonts are extremely rare in spite of the fact that the section consists exclusively of sedimentary siliceous and carbonate rocks. Nevertheless, the Upper Lochkovian interval is noted for taxonomically and quantitatively rich assemblages of conodonts typical for the *delta-pesavis* Zones. Radiolarians are always found in siliceous rocks together with conodonts. In the Sakmara Zone conodont faunal assemblages are accompanied by graptolites. Carbonate deposits of the western slope also show a distinct presence of diversified nektonic and benthic faunas.

The very first short-duration and local occurrences of the Devonian fissure-type volcanic activity (Mostostroevsky volcanic complex) are known in the Early Emsian (*kitabicus-excavatus-nothoperbonus* Zones). Probably, the transgression onset on the western slope is associated with this phenomenon. As a consequence, these processes caused essential biotic changes in all paleo-basinal areas. Conodont assemblages with zonal species are found in heterogeneous facies sections, primarily within deep-water bathyal deposits.

The Late Emsian is characterized by intense prolonged island-arc volcanism (Baimak-Buribai volcanism) occurring at great depths. There is no evidence to support the existence of long hiatuses in volcanic activity marked in the section by sedimentary rock members with faunal remains. As volcanism terminates at the end of the Emsian, there occurs accumulation of cherry-red jaspers of the Sagitovo Formation containing a great deal of radiolarian and conodont materials. The cosmopolitan species *Polygnathus serotinus* TELF. is dominant in the conodont assemblages and usually represented by a large number of specimens. The species *Pol. linguiformis bultyncki* WEDD. is found in the same amount while *Pol. costatus patulus* KLAPP. is less frequent.

The beginning of the Eifelian age (*partitus-costatus* Zones) marks the new onset of volcanism (Irendyk volcanism). Its intense explosive character with very short inactive periods was not conducive to preserving conodonts in the sediments. Only after volcanism termination bioherms and shoals built up by brachiopods, corals and crinoids begin to evolve on elevated parts of submarine ridges. Conodonts are rare in them.

At the boundary between the *costatus* and *australis* Zones and also in the *kockelianus* Zone volcanism (Karamalytash volcanism) takes on another character. Fissure effusions that resulted from spreading and changed hydrochemical and temperature regimes were responsible for basin deepening over the vast territory of the South Urals. Accordingly, these factors provided conditions favourable for the development of benthic and nektonic faunas in all basinal areas. Karamalytash volcanism was discontinuous as demonstrated by frequent interbeds of cherry-red jaspers between basalt layers. The jaspers are rich in conodonts and radiolarians. The species composition of conodont assemblages is diverse with quantitatively prevailing *Pol. linguiformis linguiformis* HINDE. Deposits of the distance-related facies coeval with volcanites are represented by sedimentary rocks. These are black cherts and cherry-red jaspers containing many conodonts as well.

During the Givetian age active explosive volcanism (Ulutau volcanism) took place over a prolonged length of time (conodont *hemiansatus-varcus* Zones) within the East Magnitogorsk Zone. It served as a supplier of huge masses of volcanic clastics carried by turbidity flows at avalanche speed (FAZLIAKHMETOV 2011). That is the probable reason why we have no conodont findings in the accumulated thick layers of the Ulutau Formation. The time interval corresponding to the ?*hermanni-cristatus – disparilis* Zones is characterized by decreased depths in the basin. The maximum Pashiya regression clearly marked in the shelf sections by a deep washout manifested itself in the paleo-oceanic zone by widespread occurrence of large biohermic structures with benthic stromatoporates, corals, brachiopods and ostracods. Conodonts are extremely rare and can be found only as solitary specimens.

The volcanism finally stops acting in the *falsiovalis* Zone, and in the *transitans* Zone there occurs an acute change in the sedimentation scenario associated with increased depths. High organic content plays a noticeable role in the sediments. Rocks are dark-grey and black in colour. In the *punctata* Zone depths reach their maximum all over the South Ural region. The time interval corresponding to the *punctata – hassi-jamieae* – Late *rhenana* Zones is the period of prolonged geodynamically quiet conditions on the eastern slope without volcanic effusions. At that time thin-layered siliceous and siliceous-clayey deposits (Mukasovo Formation) are accumulated for the most part all over the territory of the South Urals (with bituminous limestones on the western slope in addition). Benthic faunas are rarely found. Nektonic faunas, i.e., tentaculites, ammonoids and conodonts, have a dominant role. Radiolarians are also widespread. Conodont assemblages from these deposits are diversified both with regard to species content and quantity. If conodont assemblages of the *punctata* Zone that occur in cherts involve 8-10 species belonging to the genera *Ancyrodella, Mesotaxis* and *Palmatolepis*, those of the Late *rhenana* Subzone contain 17 species of the genus *Palmatolepis*. The number of specimens in each species varies from 15-20 to 50-70 respectively.

Last explosion-type volcanic eruptions take place in the *linguiformis* – Early-Middle *triangularis* Zones. The area of volcanic activity reduces. Eruptions supply enormous masses of volcano-sedimentary material, including mixtites. Conodonts preserve higher diversity in the *linguiformis* Zone. Representative of the genus *Palmatolepis* are also dominant. Some species of the genus *Ancyrodella* are practically always present in the assemblages whereas the *Ancyrognathus* species are sporadic. The assemblages of the Early-Middle *triangularis* Subzones are characterized by an extremely poor species composition that involves only four species.

Beginning with the Late *triangularis* Subzone up to the end of the Famennian time volcanic activity in the South Urals covers a limited area within the East Magnitogorsk Zone. Thick flysch units (Zilair Formation) evolve within the West Magnitogorsk Zone. At that time interval an increase in conodont species diversity and number is noted in the Late *triangularis* and *crepida* Zones. In the *marginifera* Zone the conodont association is distinguished for a considerable species diversity with more than 20 taxa. In the *expansa* Zone there occur pronounced taxonomic changes at the genus level. The genera *Bispathodus, Neopolygnathus* and *Pseudopolygnathus* make their first appearance alongside the genus *Palmatolepis*.

Thus, the conodont distribution analysis for the Devonian section of the eastern slope of the South Urals shows a certain dependence on the type and duration of volcanic processes. Fissure volcanism accompanied by gas emanations definitely had a strong influence on chemical composition and temperature of seawater. It is evident that during hiatuses planktonic growth tended to increase nektonic faunas first of all. Explosion-type volcanism contributed to accumulation and transport of great masses of sedimentary material formed quickly in the hydrodynamically active setting. Water body was probably saturated with suspended small particles responsible for turbidity. These factors could adversely affect the composition and biotic diversity. In contrast, very long non-volcanic phases of stable and quiet sediment genesis under deepwater conditions in the absence of flows were accompanied by gradual equivalent accumulation of biomass (both nutritional components and consumers).

References

ARTYUSHKOVA, O.V. (2009): Biostrarigrafiya po konodontam vulkanogenno-osadochnykh otlozhenyi devona Magnitogorskoi megazony Yuzhnogo Urala. - Avtoref. doctor. diss. – Novosibirsk, 40 pp. [in Russian]

FAZLIAKHMETOV, A.M. (2011): About reasons of avalanche sedimentation of the ulutau formation in the West-Magnitogorsk zone of the South Urals. - Vestnik of IG Komi SC UB RAS, 1: 19-21. [in Russian]

MASLOV, V.A. & ARTYUSHKOVA, O.V. (2010): Strarigraphiya I korrelyatsiya devonskikh otlozhenyi Magnitogorskoi megazony Yuzhnogo Urala. - Ufa, DizainPoligrafServis, 288 pp. [in Russian]

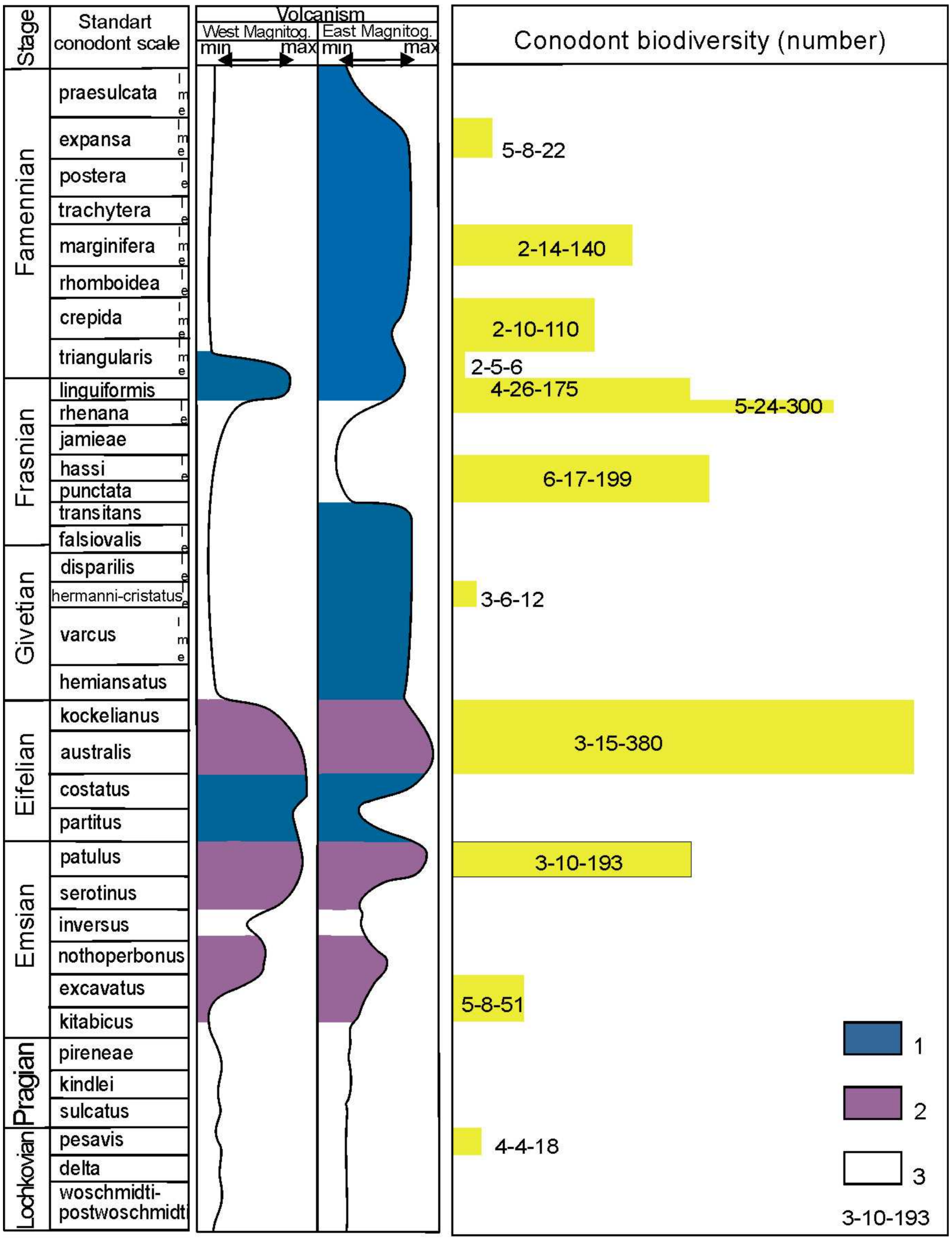


Fig. 1: Volcanism intensity curve in the Devonian of the Eastern South Urals (Magnitogorsk megazone) and Conodont Biodiversity. 1 – rift basalts, 2 – volcano-ark deposits, 3 – deposits without volcanites. The numerals designate content of conodonts: the first is the number of genera, the second is the number of species and the third is the number of specimens.

Sedimentary and faunal evidence for the Late Devonian Kellwasser and *Annulata* events in the Balkan Terrane (Bulgaria)

BONCHEVA, I.[1], SACHANSKI, V.[1] & BECKER, R.T.[2]

(1) Geological Institute, Bulgarian Academy of Sciences, Acad. G. Bonchev St., Bl. 24, 1113 Sofia, Bulgaria; *boncheva2005@yahoo.com*; *v_sachanski@geology.bas.bg*
(2)Westphälische Wilhelms-Universität, Institut für Geologie und Paläontologie, Correnstr. 24, D-48149 Münster, Germany; *rbecker@uni-muenster.de*

Late Devonian global events include a sequence of sudden biotic changes and various kinds of drastic environmental perturbations. There were fast transgressions and regressions (eustatic sea-level pulses) as well as catastrophic sedimentary events, well documented by intervals of anoxic marine sediments with elevated organic content, and changes in the geological record of stabile isotopes and rare elements. The recognition of some of the well-known specific events in the Balkan region adds to the knowledge of their spatial distribution and, possibly, of their nature and origin.

Devonian marine sedimentary rocks of Bulgaria are related to three tectonic units – the Lyubash-Golo Bardo Unit, Morava Unit, and the Svoge Unit. The most complete Upper Devonian sections of the Lyubash-Golo Bardo and Svoge units were studied in detail, which enabled the recognition of the Kellwasser and *Annulata* events.

The Lyubasha-Golo Bardo Unit is a fault-bounded structure belonging to the Srednogorie Zone. The Devonian consists regionally of black graptolitic shales, a lydite series, and a rhythmic succession of shales, siltstones and sandstones. The upper Emsian – lower Visean flysch sedimentation in western Bulgaria documents the final stage of the Paleozoic marine basin, which development is related to compression and the Variscan orogeny. Upper Devonian turbiditic sediments are unconformably overlain by Permian continental clastic rocks.

The 1400 m thick Upper Devonian flysch sediments are subdivided into three formations: Parchar, Tumba, and Propalnitsa (YANEV & SPASSOV 1985). The Parchar Formation is up to 770 m thick and consists of a rhythmic alternation of sandstones, siltstones, and shales. At the base, there are packages of lydites and silicified shales. Carbonate rocks are characteristic only of the Parchar Formation and are represented by rare, dark, micritic limestone interbeds, which yielded Emsian to lower Famennian conodonts. Established Middle Givetian to lower Famennian conodont zones of the Parchar Formation are the *varcus, hassi, rhenana* and *triangularis* (SACHANSKI & BONCHEVA 2002) zones. Recent studies (BONCHEVA *et al*. 2010) based on conodonts from two new localities documented the following zones and/or stages: upper Emsian – lower Eifelian (*serotinus* to *partitus* Zones), top Eifelian/Givetian (*ensensis* and *varcus* Zones), Frasnian (*hassi* ? and *rhenana* Zones), Famennian (*triangularis* Zone). A miospore association from the terrigenous matrix at the base of the rhythmic alternation suggests an upper Emsian - lower Eifelian age for the onset of turbiditic deposition. In the upper part of the Parchar Formation, ca. 615 m above the base, there is a distinctive black shale, which yielded frequent bivalves (*Guerichia venusta*) in association with clymeniids (involute and evolute morphotypes of *Platyclymenia subnautilina,* ?*Pl. annulata*, and *Protactoclymenia* sp.). It clearly represents the *Annulata* Black Shales, first recognized in the Rhenish Massif of Germany, and indicates sudden eutrophication of the basin, with increased organic productivity and oxygen deficiency in the lower part of Famennian IV. The *Annulata* Event falls in the top part of the Upper *trachytera* Zone low in the upper Famennian in all regions with conodonts (HARTENFELS & BECKER 2010).

The Tumba Formation is 130 m thick. It is characterised by alternating lydites and shales, with minor sandstones and siltstones. It contains fragments of undeterminable radiolarians and land plant fragments. An upper Famennian age is tentatively assumed based on its position between the Parchar and Propalnitsa Formations.

The Propalnitsa Formation, over 540 m thick, consists of sandstones with intercalations of thin siltstones and shales. It is assigned to the upper Famennian – Lower Carboniferous mainly based on land plants, such as *Cyclostigma hercynium, C. ursinum, C. kiltorkense, Sphenophyllum subtenerrimum, S. kiltorkense, Bowmanites tumbana, Archeopteris cf. halliana* (REMY & SPASSOV 1959, YANEV & SPASSOV 1985), and *Sphenophyllostachys tumbana* (TENCHOV & YANEV 1987).

The lithologic studies in the Svoge Unit allow to distinguish three formations in the Devonian (TENCHOV 1965): the Ogradishte Formation, Romcha Formation and Katina Formation.

The Ogradishte Formation consists of predominant black, thick-bedded (15-30 cm) silty argillites and subordinate grey to dark grey, laminated argillites and silty argillites. The total thickness of the formation is about 300 m. The rocks contain only sporadic fossil remains. Rare graptolites have been found in the lowermost part of the section. They indicate an interval from the Upper Silurian (Pridoli) to the Lower Devonian (Pragian). The boundary between the Silurian and Devonian systems is set at about 20 m above the contact with the underlying Yabukovdol Formation.

The lower boundary of the Romcha Formation is gradational from the Ogradishte Formation. The upper boundary shows a short transition to the Katina Formation. The Romcha Formation consists of predominant greenish and grey-greenish, crudely bedded argillites plus subordinate silty argillites in the lower part of the section. A characteristic lithologic feature is the presence of lenticular nodules and dark spots. Its thickness is 300-350 m. On the basis of chitinozoa and the stratigraphic position below the biostratigraphically dated Katina Formation, it has been assumed that the Romcha Formation covers parts of the Emsian (Lower Devonian) and parts of the Middle Devonian.

The Katina Formation starts with a pre-flysch series of lydites, shales and siliceous shales, 380 m thick. This succession does not contain fossils and is tentatively assigned to the Middle (?) Devonian. Conformably, a flysch succession follows, up to1000 m thick, consisting of sandstones and shales. It belongs to the Upper Devonian – Visean (?) based on macroflora and on conodonts in single carbonate layers. The continental cover consists of Upper Carboniferous and Permian sediments and pyroclastics. The conodont zones established (BONCHEVA & YANEV 1993) in the Katina Formation include the topmost Frasnian *linguiformis* Zone and the Lower Famennian *triangularis* Zone. Both carbonate layers are separated by black shales. These organic-rich sediments indicate anoxic (oxygen-deprived) bottom waters and are thought to correlate with the Upper Kellwasser level right below the stage boundary.

References

BONCHEVA, I., LAKOVA, I., SACHANSKI, V. & KOENIGSHOF, P. (2010): Devonian stratigraphy, correlations and basin development in the Balkan Terrane, western Bulgaria. - Gondwana Research, v. 17: 573-583.

BONCHEVA, I. & YANEV, S. (1993): New data on the Paleozoic flysch of the Sofiyska Stara Planina Mountain. - Geologica Balcanica, 23 (5): 15-22.

HARTENFELS, S., BECKER, R.T. & TRAGELEHN, H. (2009): Marker conodonts around the global *Annulata* Events and the definition of an Upper Famennian substage. - SDS Newsletter, 24: 40-48.

REMY, W. & SPASSOV, Ch. (1959): Der paläontologische Nachweis von Oberdevon in Bulgarien. - Monatsbucher Deutsche Akademie der Wissenschaften zu Berlin, 1 (6): 380-387.

SACHANSKI, V. & BONCHEVA, I. (2002): Geological events and process dating by the rate of sedimentation in the area of Cherna Gora Height. - Geologica Balcanica 32, (2-4): 127-129.

TENCHOV, Y. (1965): Upper Devonian in the core of the Svoge anticline. - Review of the Bulgarian Geological Society, 26 (1): 109-112.

TENCHOV, Y. & YANEV, S. (1987): The Paleozoic sediments in Bulgaria. Guide Book, Problem Commission IX, Project 5.1 (Sofia, October 1987). - Bulgarian Academy of Sciences: 1-86.

YANEV, S. & SPASSOV, Ch. (1985): Lithostratigraphy of the Devonian flysh between Tran and Temelkovo. - Paleontology, Stratigraphy, Lithology, 21: 82-86.

Extinctions, survival and innovations of conodont species during the Kačák Episode (Eifelian-Givetian) in south-eastern Morocco

BULTYNCK, P.[1] & WALLISER, O.H.[+]

(1) Department of Palaeontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; *pierre.bultynck@naturalsciences.be*
(+) O.H. WALLISER passed away late December 2010. He was Prof. Emeritus at the Institute und Museum für Geologie und Paläontologie of the University of Göttingen, Germany.
The last two years we studied together the conodont faunas discussed herein.

The Global Stratotype Section and Point (GSSP) for the base of the Givetian is located in the Jebel Mech Irdane in the Tafilalt of SE Morocco (WALLISER 2000). The position of the boundary is based on the first occurrence of the conodont species *Polygnathus hemiansatus* and is within the Kačák Episode (WALLISER *et al*. 1995). However at the time of the discussion of the GSSP for the base of the Givetian the study of the conodont faunas was limited to the group of species that were important for the boundary definition. They belong to the evolutionary lineage *P. pseudofoliatus – P. hemiansatus.* For the present contribution the complete conodont faunas have been studied.The conodont faunas are not only rich by the number of specimens but most species also demonstrate a large variability. This allows to recognize different morphotypes in species and new species that are useful for establishing lineages and for biostratigraphy. The study of the Mech Irdane conodonts is combined with the updating of earlier described conodonts from the same time interval in the Bou Tchrafine section in the Tafilalt (BULTYNCK 1987) and in the Ou Driss section in the Mader (BULTYNCK 1989). HOUSE (1985) introduced the name Kačák Event, after the Kačák Member, a black and calcareous shale in the Bohemian in which the tentaculite *Nowakia otomari* occurs. At the same time WALLISER (1985) proposed the *otomari* Event based on the onset of the dacryoconarid lineage of the species *Nowakia otomari*. Later it was demonstrated that the Kačák Event was not instantaneous but represents a polyphased biotic crisis (GARCÍA-ALCALDE *et al.* 1990). In order to solve this confusing situation WALLISER (2000) proposed an hypoxic Kačák Episode with a Late Eifelian 1 Event and the Late Eifelian 2 Event.

So the Kačák cannot strictly be considered as an event. It is best qualified as an hypoxic episode. Extinctions are limited to five species of the *Polygnathus angusticostatus* group. More important are the innovations in the *Polygnathus pseudofoliatus* group, with several new species. Also the typical Eifelian *Icriodus corniger- struvei* group disappears and is succeeded by the *Icriodus obliquimarginatus* group (Fig. 1).

References

BULTYNCK, P. (1987): Pelagic and neritic conodont successions from the Givetian of pre-Sahara Morocco and the Ardennes. - Bulletin van het Koninklijk Belgisch Instituut voor Natuurwetenschappen, Aardwetenschappen, 57: 149-181.

BULTYNCK, P. (1989): Conodonts from a potential Eifelian/Givetian global boundary stratotype at Jbel Ou Driss, southern Ma'der, Morocco. - Bulletin van het Koninklijk Belgisch Instituut voor Natuurwetenschappen, Aardwetenschappen, 59: 95-103.

GARCÍA-ALCALDE, J.L., MONTESINOS, J.R., TRUYOLS-MASSONI, M., GARCÍA-LÓPEZ, S., ARBIZU, M. & SOTO, F. (1988): El Silúrico y el Devónico del Dominio Palentino (No de España). - Revista de la Sociedad Geológica de España, 1: 7-13.

HOUSE, M.R. (1985): Correlation of Mid-Palaeozoic ammonoid evolutionary with globaly sedimentary perturbations. - Nature, 313: 17-22.

WALLISER, O.H. (1985): Natural boundaries and commission boundaries in the Devonian. - Courier Forschungs-Institut Senckenberg, 75: 401-408.

WALLISER, O.H. (2000): The Eifelian-Givetian Stage Boundary. - Courier Forschungs-Institut Senckenberg, 225: 37-47.

WALLISER, O.H., BULTYNCK, P., WEDDIGE, K., BECKER, R.T. & HOUSE, M. (1995): Definition of the Eifelian-Givetian Stage Boundary. - Episodes, 18 (3), 107-115.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

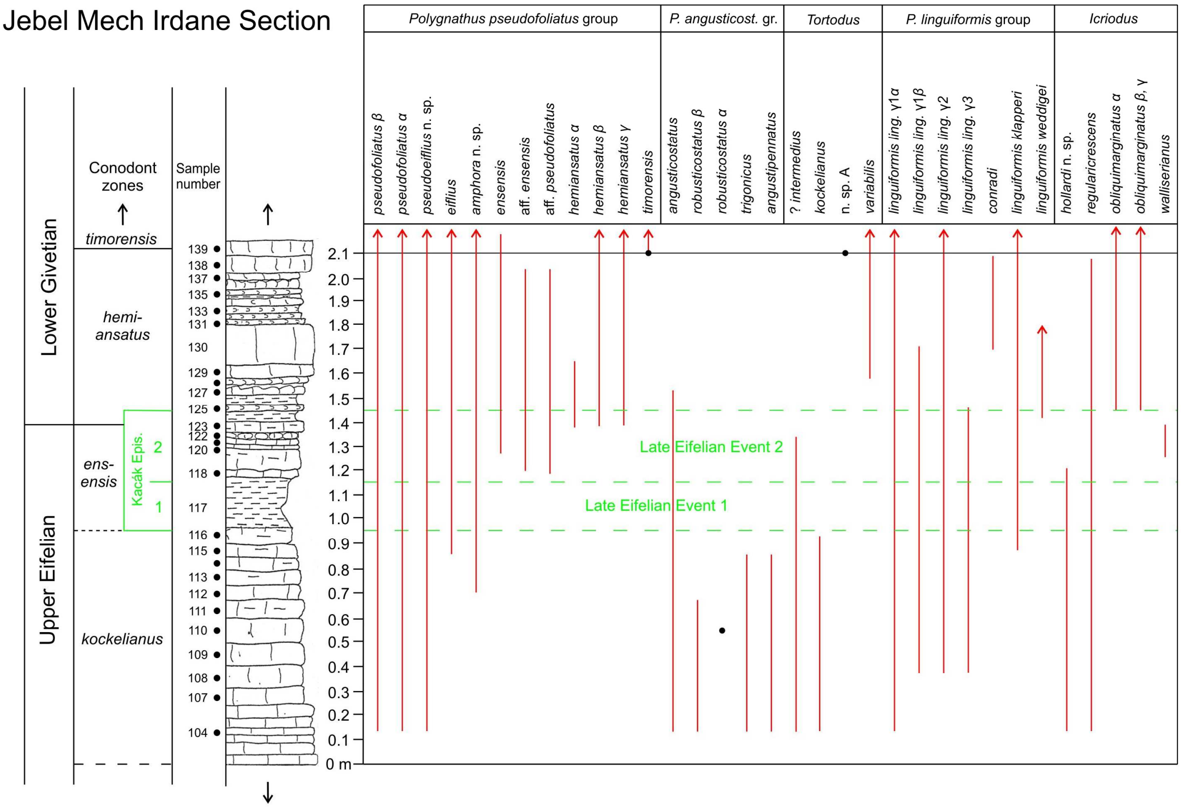


Fig. 1: Conodont distribution in the Mech Irdane Section (Tafilalt, south-eastern Morocco).

Ostracods, rock facies and magnetic susceptibility of the Givetian / Frasnian transition at Ave-et-Auffe (Dinant Synclinorium, Belgium)

CASIER, J-G.[1,2], DEVLEESCHOUWER, X.[1,2], MAILLET, S.[3], PETITCLERC, E.[1] & PRÉAT, A.[2]

(1) Institut royal des Sciences naturelles de Belgique, rue Vautier, 29, B-1000 Bruxelles, Belgique;
casier@naturalsciences.be; *Xavier.Devleeschouwer@naturalsciences.be*; *estelle.petitclerc@naturalsciences.be*
(2) Département des Sciences de la Terre et de l'Environnement, Université libre de Bruxelles, av. F. Roosevelt, 50, B-1000 Bruxelles, Belgique; *apreat@ulb.ac.be*
(3) Laboratoire de Paléontologie Stratigraphique, Université de Lille 1, 41 rue du Port, F-59046 Lille Cedex, France; *sebastien.maillet@icl-lille.fr*

The Sourd d'Ave section at Ave-et-Auffe exposes the upper part of the Moulin Boreux Mbr (8 m of built-up limestones with massive and branched stromatoporoids) and the Fort Hulobiet Mbr (28 m of calcareous shales and argillaceous limestones) belonging to the Fromelennes Fm (Givet Group). The section exposes also the Pont d'Avignon Mbr (45 cm-thick nodular argillaceous limestone), the Sourd d'Ave Mbr (9.3 m-thick and made up of calcaro-argilaceous nodular shales with rare small argillaceous limestone beds) and the base of the La Prée Mbr (shales with rare calcaro-argillaceous nodules) belonging to the Nismes Fm (Frasnes Group). The position of the G/F boundary in the Dinant Synclinorium is still in debate, and is fixed arbitrary in the Sourd d'Ave section at the Givet Group / Frasnes Group boundary where the first *Ancyrodella* have been identified by BULTYNCK (1974), after a 15 m-thick episode without any conodonts.

Systematic sampling has been carried out in order to establish the evolution of the environments and to detail the G/F transition. This lead to the examination of 254 thin sections which allowed recognition of 13 microfacies types paralleling the standard sequence of MAMET & PRÉAT (1989) from open marine shallow subtidal to restricted supratidal near emersion. The Boreux Mbr and the Fort Hulobiet Mbr display restricted facies (*Amphipora,* spongiostromid and algal bafflestones and bindstones, loferites with desiccation lumps) with poorly fossiliferous beds interbedded with higher energy peloidal and sometimes oolitic grainstone facies. Laminite horizons, sometimes with small-sized LLH-stromatolites are uncommon, and they are associated with dolomicrites showing pseudomorphs of evaporite minerals. These evaporitic facies become common in the upper part of the Hulobiet Mbr suggesting the paleoclimate may be becoming more arid at the G/F transition. The boundary between the Givet Group and the Frasnes Group which is very distinctive on the field, is therefore characterized by a transition from restricted evaporative lagoonal facies to open marine interbedded marly shales and nodular limestones. A meter-scale cyclicity is very pervasive throughout the Givetian part of the section. Cyclicity was determined by assessing the vertical stacking of facies, the base of a cycle being identified by the initial backstepping of less restricted facies-type over a restricted facies-type. Cycles have open or semi-restricted subtidal bases with stromatopores, crinoids, corals and restricted supratidal tops with common "algal chips". They record a decrease in circulation, a decrease in diversity of organisms, which are endemic (cynaobacteria, stromatolites, ostracods, gastropods, umbellids), and increase in salinity upwards through the cycles. Horizons rich in ostracods are commonly seen representing the impingement of storms in the low energy restricted lagoons. Oncoids are locally abundant in specific horizons. The upper part of the Fort Hulobiet Mbr consists of interbedded biostromes (semi-restricted stromatoporoid boundstones) followed by *Amphipora* floatstones, then of fossil-poor units and restricted supratidal laminites with well-developed fenestral fabrics. The Frasnian Pont d'Avignon Mbr shows a rich faunal assemblage (bryozoans brachiopods, molluscs, nautiloids, tentaculitids) suggesting an abrupt deepening of the Frasnian from the marginal Givetian carbonate platform to a deep basinal environment below or near the storm wave base.

For the study of ostracods, 47 new samples were collected in the Sourd d'Ave section, and approximately 1,130 carapaces, valves and fragments have been extracted. More than 500 ostracods collected by CASIER (1977, 1987) and MILHAU (1983) in the Sourd d'Ave section were also reviewed. Approximately 45 ostracod species are recognized in the Fromelennes Fm and 27 in the Nismes Fm, and they belong exclusively to the Eifelian Mega-Assemblage.

In the Moulin-Boreux Mbr, ostracods are generally poorly preserved, and frequently coated. In two samples, the monospecificity occurs with the genus *Cryptophyllus,* indicative of semi-restricted environments. These environmental conditions occurred also in the Fort Hulobiet Mbr except during a short interval during which ostracods are indicative of an open-marine environment. In this interval the fauna is more diversified and *Bairdia paffrathensis* and *Polyzygia neodevonica* are present. The transition Givet Group / Frasnes Group is abrupt in the Sourd d'Ave section, and the environment becomes exclusively and durably marine. In the Pont d'Avignon Mbr, the relative proportion of podocopids and metacopids indicates a well oxygenated marine environment a little below fair-weather wave-base level. In the Sourd d'Ave Mbr, the depth increases as showed by the ascendance of metacopids comparatively to podocopids, and in the base of the La Prée Mbr, with the deepening, ostracods became more rare. Finally in an other section located in the prolongation of the Sourd d'Ave section, CASIER (1987) recorded the presence of entomozoid ostracods (*Franklinella*) proxy for hypoxic water conditions (CASIER 2004). However the exact dating of this last section is controversial.

The Frasnes Group / Givet Group transition has been recently studied at Nismes by CASIER & PRÉAT (2009), and at Flohimont close to Givet by MAILLET (2010). The only significant change as deduced from the ostracod fauna and the sedimentology in the three sections is the transition from lagoonal and semi-restricted environments to open-marine environments close to the Givet Group / Frasnes Group boundary. But at Sourd d'Ave, this change is abrupt and takes place exactly at this boundary. On the contrary, in the Nismes and Flohimont sections, this change corresponding to the entry of *Polyzygia beckmanni beckmanni*, occurred in the upper part of the Fromelennes Fm. In fact, the Sourd d'Ave section is condensed by comparison with the Nismes and Flohimont sections and their is a hiatus at the contact Givet Group / Frasnes Group boundary emphasized by an irregular contact (BULTYNCK & COEN *in* BOULVAIN *et al.* 1999).

339 samples were collected for low-field magnetic susceptibility (X_{LF}) analyses in the Sourd d'Ave section. The X_{LF} values were measured with a Kappabridge MFK1-A with a CS-3 furnace. The MS values range between 6.0 x 10^{-10} m^3/kg and 4.52 x 10^{-7} m^3/kg. The highest X_{LF} values are present in the Fort Hulobiet Mbr and are observed at the top of each magnetic susceptibility evolutions. A clear decreasing trend of the X_{LF} is discernible at the end of the Fort Hulobiet Mbr and the X_{LF} values remain weaker in the sediments at the base of the Frasnian.

References

BOULVAIN, F., BULTYNCK, P., COEN, M., COEN-AUBERT, M., LACROIX, D., LALOUX, M., CASIER, J-G., DEJONGHE, L., DUMOULIN, V., GHYSEL, P., GODEFROID, J., HELSEN, S., MOURAVIEFF, N., SARTENAER, P., TOURNEUR, F. & VANGUESTAINE, M. (1999): Les Formations du Frasnien de la Belgique. - Memoirs of the Geological Survey of Belgium, 44, 126 pp.

BULTYNCK, P. (1974): Conodontes de la Formation de Fromelennes du Givétien de l'Ardenne franco-belge. - Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre, 50 (10), 30 pp.

CASIER, J-G. (1977): Contribution à la connaissance des ostracodes du Frasnien de la Belgique. - Professional Paper Administration des Mines - Service Géologique de Belgique, 147, 22 pp.

CASIER, J-G. (1987): Etude biostratigraphique et paléoécologique des ostracodes du sommet du Givétien et de la base du Frasnien à Ave-et-Auffe (Bord sud du Bassin de Dinant, Belgique). - Bulletin de la Société belge de Géologie, 96 (1): 23-34.

CASIER, J-G. (2004): The mode of life of Devonian entomozoacean ostracods and the Myodocopid Mega-Assemblage proxy for hypoxic events. - Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre, 74-suppl.: 73-80.

CASIER, J-G. & PRÉAT, A. (2009): Late Givetian to Middle Frasnian ostracods from Nismes (Dinant Synclinorium, Belgium) and their lithological context. - Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre, 79: 87-115.

MAILLET, S. (2010): Les ostracodes du Givétien supérieur au bord sud du Synclinorium de Dinant (Formation de Fromelennes, région de Givet, Ardennes): biostratigraphie, paléoécologie, recherche de bioévénements. - Unpublished Master Environment, Université Lille 1, 39 pp.

MAMET, B. & PREAT, A. (1989): Sédimentation de la plate-forme givétienne franco-belge. - Bulletin des Centres de Recherche Exploration-Production Elf-Aquitaine, 13: 47-86.

MILHAU, B. (1983): Valeur biostratigraphique et paléoécologique des ostracodes du Givétien Supérieur de la région-type. - Geobios, 16 (3): 347-359.

The distribution of *Zdimir* fauna and age in South China

CHEN, X.-Q.[1] & SUTTNER, T.J.[2]

(1) Chinese Academy of Sciences, Nanjing Institute of Geology and Palaeontology, Department of Invertebrate Palaeontology, 39 East Beijing Road, Nanjing 210008, China; *xqchen@nigpas.ac.cn*
(2) Austrian Academy of Sciences (CPSA) c/o University of Graz, Institute for Earth Sciences (Geology & Paleontology), Heinrichstrasse 26, A-8010 Graz, Austria; *thomas.suttner@uni-graz.at*

The genus *Zdimir* is a special group of large, thick-shelled, strong costate brachiopods which are preserved in dark, rather pure micritic limestones. This brachiopod group and its related fauna is very important for palaeoecological studies, as especially this assemblage could be used as paleoenvironmental marker. It has been reported from South China (Beiliu of Guangxi, Guizhou, Yunnan, Longmenshan of Sichuan), South Tianshan, Japan (Kitakami Mountains), eastern Australia, Belgium and Austria (e.g. BOUCOT & SIEHL 1962, CHEN & LIAO 2006, TAZAWA 1988, WANG & ZHU 1979, BAI & BAI 1988 and BAI *et al*. 1998). Taxa grouped within this genus are restricted in their range from the Late Emsian (*Polygnathus serotinus* Zone) to the Early Eifelian (*Polygnathus c. partitus* Zone) in South China. If this range can be applied for the occurrence of this genus globally, then this taxon would be a good indicator for the Basal Choteč Event (Early Eifelian; *Polygnathus c. costatus* Zone), one of the global big five extinction events. With this knowledge it might become easy to trace the stratigraphic position of shallow marine sequences, when no relevant microfauna can be obtained. Specimens of *Zdimir*, stored in Nanjing Institute are: *Zdimir beiliuensis* (WANG & ZHU), *Z. contractus* (ANDRONOV), *Z. baschkiricus* (VERNEULI), *Z. gorezkii* (ANDRONOV), *Z. guitangensis* (WANG & ZHU), *Z. pseudobaschkiricus* (TSCHERNYSCHEW), *Z. strachovi* (ANDRONOV) and *Z. triangulicostatus* (ANDRONOV).

References

BAI, Z.Q. & BAI, S.L. (1988): Conodont biostratigraphy of the Devonian *Zdimir* from Bahe, Guangxi, China. - *In*: MCMILLAN, N.J., EMBRY, A.F. & GLASS, D.J. (eds.): Devonian of the World, Calgary, 3: 529-534.

BAI, Z.Q., BAI, S.L. & WANG, P. (1998): Paleoenvironment and Correlation of Devonian Transitional Facies Beds (*Zdimir* Beds) South China. - *In*: Department of Geology, Peking University, ed. collected works of International Symposium on Geological Science held at Peking University, Beijing, China: 373-378 [*in Chinese with English abstract*].

BOUCOT, A.J. & SIEHL, A. (1962): *Zdimir* Barrande (Brachiopoda) redefined. - Notizblatt des Hessischen Landesamtes für Bodenforschung zu Wiesbaden, 90: 117-131.

CHEN, X.-Q. & LIAO, Z. (2006): Discovery of the brachiopod *Zdimir* in the West of South Tianshan and its biostratigraphic significance. - Acta Paleontologica Sinica, 45 (3): 351-358.

TAZAWA, J. (1988): *Zdimir* (Devonian Brachiopoda) from the Kitakami Mountains, northeast Japan and its paleobiogeographical significance. - Journal of the Geological Society of Japan, 94(12): 1013-1016 [*in Japanese*].

WANG, Y. & ZHU, R.F. (1979): Beiliu (Middle Middle Devonian) brachiopods from South Guizhou and central Guangxi. - Palaeontologia Sinica, New Series B, 158 (15): 1-95 [*in Chinese with English abstract*].

Magnetic susceptibility evolution on Paleozoic sedimentary settings, a clue for past paleoenvironments

DA SILVA, A.C.[1], PAS, D.[1], MABILLE, C.[1] & BOULVAIN, F.[1]

(1) Petrologie sedimentaire, B20, Boulevard du Rectorat, Université de Liège, Sart Tilman, 4000 Liège, Belgium; *ac.dasilva@ulg.ac.be*; *dpas@ulg.ac.be; cmabille@ulg.ac.be*; *fboulvain@ulg.ac.be*

Since the fifties, magnetic susceptibility (MS) technique is frequently used in order to correlate sediments or rocks and as a proxy for paleoclimatic changes in Recent sedimentary rocks. Since the nineteen's, magnetic susceptibility was also applied to Paleozoic rocks for correlations (CRICK *et al*. 1997). Magnetic susceptibility signal is interpreted as mainly related to lithogenic inputs (magnetic minerals like magnetite and clay in opposition with non magnetic minerals like carbonates) and lithogenic inputs are mainly related to sea level variations and climate. So a transgression will be associated with decreasing magnetic susceptibility and a regression will produce a MS peak. Increasing rainfalls as well as glaciations will also increase lithogenic inputs and so magnetic susceptibility. This relationship between MS and sea level and/or climate led to use the MS technique for high-resolution, global correlations of marine sedimentary rocks (CRICK *et al*. 1997).

In order to get a better understanding of the factor influencing the final magnetic susceptibility signal, we compare the record of magnetic susceptibility signal in different sedimentary settings, across different paleolocations and during different time interval (Devonian to Carboniferous and cycles of a few thousand years to million years).

Magnetic susceptibility measurements were performed on different carbonate systems:

(1) shallow-water carbonate shelf (Eifelian-Givetian and Frasnian)
(2) mixed siliciclastic-carbonate ramp (Eifelian and Carboniferous)
(3) carbonate isolated mud mounds and atolls (Frasnian)

(1) In the shallow water carbonate shelf of Belgium, magnetic susceptibility allows to perform precise correlations between the sections (fourth-order correlations). A strong relationship between MS and facies (increasing MS with more proximal facies, Fig. 1-1a-b) and MS and fourth order sequences (increasing MS at the top of a regressive sequence) is observed (DA SILVA *et al*. 2009). This relationship confirms the strong link between magnetic susceptibility and sea level variations.

(2) In the eifelian mixed siliciclastic-carbonate ramp, magnetic susceptibility provides also good correlations. It seems that magnetic susceptibility values are also linked to facies but in an opposite way. Actually the higher MS values are corresponding to the deepest facies (Fig. 1-2) and MS increases during transgressive phase. The higher agitation during deposition of shallow water facies (shoals, grainstones) probably prevented deposition of fine detrital magnetic particles.

(3) In the Frasnian carbonate mounds and atolls, magnetic susceptibility brings also good correlations between the mounds. As for carbonate ramp, magnetic susceptibility increases slightly during transgressive phases and towards deeper facies (Fig. 1-3). The sedimentation rates of the carbonate mounds and the surrounding deposit are very different and probably strongly influenced MS signal, as well as the fact that the mound was isolated and protected from the rest of the platform.

In synthesis, in the three cases, it appears that magnetic susceptibility is related to main sea level changes but in an opposite direction. For the carbonate attached platform, a transgression will decrease magnetic susceptibility but for the atolls and the ramp, a transgression will increase magnetic susceptibility. In these two cases, the lithogenic inputs will not be the main parameter but sedimentation rate and wave strength will also influence the amount of magnetic susceptibility (a strong carbonate production will dilute the magnetic minerals and an important agitation will probably scatter the minerals). It highlight also that correlations between different carbonate systems are highly speculative because of the different origin of magnetic peaks.

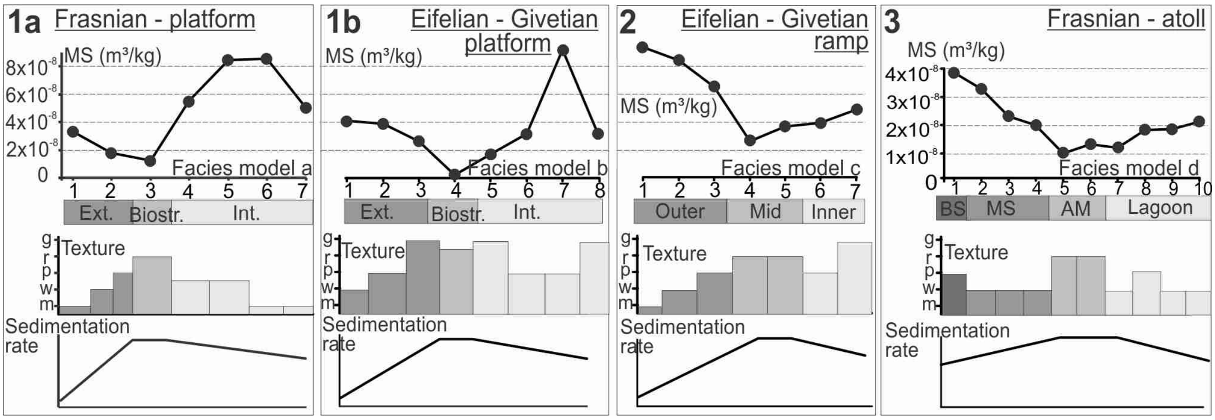


Fig. 1: Mean magnetic susceptibility values on relative proximality transects with corresponding textures and sedimentation rates. (1a) Frasnian carbonate platform. (1b) Eifelian and Givetian mixed platform. (2) Eifelian – Givetian mixed ramp. (3) Frasnian carbonate mound and atoll. Textures are ordered from the lower to the higher water energy during deposition: m = mudstone, w = wackestone – floatstone, p = packstone, r = rudstone and g = grainstone and boundstone. Abbreviations are: Ext. = External Distal facies; Biostr. = Biostromal facies; Int.= Internal facies; Outer = outer ramp; Mid = Mid ramp; Inner = Inner ramp; BS = Basinal and flank facies, MS = Mud or skeletal mound facies; AM = Algal and microbial mound facies; lagoon = lagoonal facies inside the crown. For complete explanation see Da Silva *et al*. (2009).

References

Crick, R.E., Ellwood, B.B., El Hassani, A., Feist, R. & Hladil, J. (1997): Magnetosusceptibility event and cyclostratigraphy (MSEC) of the Eifelian - Givetian GSSP and associated boudary sequences in north Africa and Europe. - Episodes, 20 (3): 167-175.

Da Silva, A.C., Mabille, C. & Boulvain, F. (2009): Influence of sedimentary setting on the use of magnetic susceptibility: examples from the Devonian of Belgium. - Sedimentology, 56: 1292-1306.

Precessional and half-precessional climate forcing of Mid-Devonian monsoon-like dynamics

DE VLEESCHOUWER, D.[1], DA SILVA, A.C.[2], BOULVAIN F.[2], CRUCIFIX, M.[3] & CLAEYS, Ph.[1]

(1) Earth System Sciences, Vrije Universiteit Brussel, B-1050 Brussels, Belgium; *dadevlee@vub.ac.be*; *phclaeys@vub.ac.be*
(2) Pétrologie sédimentaire, B20, Université de Liège, Sart Tilman, B-4000 Liège, Belgium; *ac.dasilva@ulg.ac.be*; *fboulvain@ulg.ac.be*
(3) Centre de recherche sur la Terre et le climat Georges Lemaître, Earth and Life Institute, Université catholique de Louvain, B-1348 Louvain-la-Neuve, Belgium; *michel.crucifix@uclouvain.be*

A Devonian magnetic susceptibility (MS) record obtained on limestones ranging from the Uppermost-Eifelian to the Lower-Givetian and located on the southern border of the Dinant Synclinorium in Belgium, was selected for time-series analysis. In these carbonate ramp and platform deposits, spectral analyses highlight persistent high-frequency cycles in both, the MS-signal and the microfacies curve, reflecting environmental and climate changes. These meter-scale variations in the MS-signal are interpreted as changes in the flux of magnetic minerals towards the marine system, most likely controlled by monsoon rainfall-intensity. By combining chrono- and biostratigraphic information with theoretical knowledge of sedimentation rates in different depositional environments, these cycles are interpreted as astronomically driven (precession-dominated). It is hypothesized that during precession maxima the trans-equatorial pressure gradient reaches a maximum and intensifies monsoonal circulation. The consequent increased moisture transport towards the continent leads to enhanced precipitation and runoff, which in turn leads to an increased flux of detrital material (including magnetic minerals responsible for the MS-signal) towards the marine system. Moreover, this unique high-resolution climate signal reveals half-precessional cycles. These cycles suggest the important response of intense monsoonal systems to periodic changes in the strength of low-latitude (equatorial) insolation.

Drowning of a carbonate platform at the Givetian/Frasnian boundary (Sourd d'Ave section, Belgium): a comparison of different proxies (magnetic susceptibility, microfacies and gamma-ray spectrometry)

DEVLEESCHOUWER, X.[1,2], CASIER, J-G.[1,2], PETITCLERC, E.[1] & PRÉAT, A.[2]

(1) Institut royal des Sciences naturelles de Belgique, rue Vautier, 29, B-1000 Bruxelles, Belgique; *Xavier.Devleeschouwer@naturalsciences.be*; *casier@naturalsciences.be*; *estelle.petitclerc@naturalsciences.be*
(2) Département des Sciences de la Terre et de l'Environnement, Université libre de Bruxelles, av. F. Roosevelt, 50, B-1000 Bruxelles, Belgique; *apreat@ulb.ac.be*

The Sourd d'Ave section at Ave-et-Auffe exposes the upper part of the Moulin Boreux Mbr (8 m of built-up limestones with massive and branched stromatoporoids) and the Fort Hulobiet Mbr (28 m of calcareous shales and argillaceous limestones), both belonging to the Fromelennes Fm (Givet Group). The section exposes also the Pont d'Avignon Mbr (45 cm-thick nodular argillaceous limestone), the Sourd d'Ave Mbr (9.3 m-thick of carbonate nodules and shales with rare thin argillaceous limestone beds). The position of the Givetian / Frasnian boundary in shallow environments is still in debate, and is fixed arbitrary at the Givet Group / Frasnes Group boundary where the first *Ancyrodella rotundiloba* have been identified by BULTYNCK (1974), after a 15 m-thick episode without any conodonts.

Systematic sampling has been carried out in order to establish the evolution of the environments and to detail the Givetian/Frasnian transition. This led to the fabrication of 219 thin sections which alllowed recognition of 13 microfacies types paralleling the standard sequence of MAMET & PRÉAT (1989) from open marine shallow subtidal to restricted supratidal near emersion. The Boreux and Fort Hulobiet members display restricted facies (*Amphipora,* spongiostromid and algal bafflestones and bindstones, loferites with desiccation lumps) with poorly fossiliferous beds interbedded with higher energy peloidal and sometimes oolitic grainstone facies. Laminite horizons, sometimes with small-sized LLH-stromatolites are uncommon; they are associated with dolomicrites showing pseudomorphs of evaporite minerals. These evaporitic facies become common in the upper part of the Hulobiet Mbr. suggesting the paleoclimate may be becoming more arid at the Givetian/Fransian transition. The boundary between the Givetian and the Frasnian which is very distinctive on the field, is therefore characterized by a transition from restricted evaporative lagoonal facies to open marine interbedded marly shales and nodular limestones. Meter-scale cyclicity is very pervasive throughout the Givetian part of the section. Cyclicity was determined by assessing the vertical stacking of facies, the base of a cycle being identified by the initial backpstepping of less restricted facies-type over a restricted facies-type. Cycles have open or semi-restricted subtidal bases with stromatopores, crinoids, corals and restricted supratidal tops with common 'algal chips'. They record a decrease in circulation, a decrease in diversity of organisms, which are endemic (cyanobacteria, stromatolites, ostracods, gastropods, umbellids), and increase in salinity upwards through the cycles. Horizons rich in ostracod are commonly seen representing the impingement of storms in the low energy restricted lagoons. Oncoids are locally abundant in specific horizons. The upper part of the Fort Hulobiet Mbr. consists of interbedded biostromes (semi-restricted stromatoporoid boundstones) followed by *Amphipora* floatstones, then fossil-poor units and restricted supratidal laminites with well-developed fenestral fabrics. The Frasnian Pont d'Avignon Fm. shows a rich faunal assemblage (bryozoans brachiopods, molluscs, nautiloids, tentaculitids) suggesting an abrupt deepening of the Frasnian from the marginal Givetian carbonate platform to a deep basinal environment below or near the storm wave base.

A total of 339 samples were collected for the study of low-field magnetic susceptibility (X_{LF}) in the Sourd d'Ave section. The MS values were measured with a Kappabridge MFK1-A with a CS-3 furnace and CS-L cryogenic apparatus. The MS values range between 6.0×10^{-10} m^3/kg and 4.52×10^{-7} m^3/kg. The highest X_{LF} values are present in the Fort Hulobiet Mbr and observed at the top of magnetic susceptibility evolutions. A clear decreasing trend of the X_{LF} is discernable at the end of the Fort Hulobiet Mbr and the X_{LF} values remain weaker in the sediments at the base of the Frasnian. Nevertheless, the X_{LF} are quite high and remain around 1×10^{-7} m^3/kg throughout the Frasnian. To better constrain and understand the origin of the signal, magnetic mineralogical analyses have been launched through hysteresis measurements and thermomagnetic curves revealing the presence of ferromagnetic *s.l.* and paramagnetic minerals controlling the X_{LF} signal.

Gamma-ray spectrometry (GRS) measurements (n =188) were measured on the field with a Gamma Surveyor handheld spectrometric probe with a 6.3 in^3 BGO detector. Counts per seconds in selected energy windows were directly converted to concentrations of K (%), U (ppm) and Th (ppm). One measurement with a 120-s count time was performed at each logging point, placed on the outcropping rock section and at full contact with the rock. The section was logged at a 0.25-m interval both in the Fromelennes and Nismes formations. K and Th concentrations fluctuate cyclically during the Givetian but remain generally below 1% and 5 ppm respectively. The concentrations start to increase for both elements before the Givetian-Frasnian boundary and continue into the Nismes Fm at the base of the Frasnian. The K values increase up to 5-6% at the top of the section. The Th concentrations follow a similar trend revealing an increase up to 18.6 ppm. GRS data show a strong correlation between K and Th values (R^2=0.97) which indicate a strong positive correlation between these elements. Th and K concentrations usually relate to the presence of aluminosilicates (illite and other clay minerals, potassium feldspars, micas) in carbonates while a good correlation between K and Th is considered to reflect a fine-grained siliciclastic admixture in carbonate rocks (KOPTIKOVÁ *et al*. 2010). U/Th ratios remain generally below 0.8 with few peaks up to 1.0 during the Givetian. The U/Th ratios decrease at the base of the Frasnian in the Nismes Fm. down to an average value around 0.25. The U/Th ratio is generally interpreted as an index to derive information on the paleo-oxygen level of the depositional environments. This ratio is considered as an indicator of the terrigenous-to-marine influence due to the terrigenous affinity of Th and the affinity of U, mostly in the form of soluble U6+, to adsorb to organic matter and/or co-precipitate in calcium phosphates in marine anoxic/dysoxic environments (LÜNING *et al*. 2004). The U/Th ratios indicate relatively well-oxygenated paleo-conditions in the marine waters throughout the section and even more in the Nismes Fm.

A detailed comparison of microfacies and magnetic susceptibility around the Givetian/Frasnian boundary allows the recognition of 14 sedimentary cycles, the first twelve are regressive at the 5th order and characterise the classical carbonate Givetian platform (Fromelennes Fm). The two last cycles are transgressive and related to the development of a siliciclastic ramp setting at the base of the Frasnian. Cycle thickness range from 0.5 to over 3 m, with an average thickness of 1.6 m in the Upper Givetian and is plurimetric (between 5 and 7 m) in the base of the Frasnian. Confrontation of microfacies and magnetic susceptibilty values leads to these three main conlusions:

(i) the semi-restricted subtidal bases of the Givetian cycles consist of high energy peri-reefal floatstones-rudstones (stromatoporoids and corals). They systematically display low X_{LF} values,

(ii) the restricted inter-supratidal tops of the Givetian cycles record very quiet lagoonal environments with cyanobacterial and algal peloidal wackestones. They display high X_{LF} values,

(iii) the ‘deeper’ open marine facies of the Frasnian consist of bioclastic packstones with common tempestites. The X_{LF} values are in the same range as (i).

We may conclude that the key parameters to interpret the X_{LF} values are the energy index and the water circulation. The lagoonal environments trapped the minerals carrying the magnetic signal and coming from the proximal emerged areas, while these minerals were dispersed in the higher energy environments (peri-reefal) or in the ‘deeper’ open marine settings where water circulation was efficient and storms common. These latter facies being partly argillaceous and silty, this mineralogical paramagnetic fraction contribute to the magnetic signal observed in the Nismes Fm as also revealed by increasing K and Th concentrations.

The Givetian/Frasnian boundary is thus characterised by a major transgression recording the drowning of the Givetian carbonate platform and the establishment of a siliciclastic ramp morphology during the Frasnian.

References

BULTYNCK, P. (1974): Conodontes de la Formation de Fromelennes du Givétien de l'Ardenne franco-belge. - Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre, 50 (10), 30 pp.

KOPTIKOVÁ, L., BABEK, O., HLADIL, J., KALVODA, J. & SLAVIK, L. (2010): Stratigraphic significance and resolution of spectral reflectance logs in Lower Devonian carbonates of the Barrandian area, Czech Republic; a correlation with magnetic susceptibility and gamma-ray logs. - Sedimentary Geology, 225: 83-98.

LÜNING, S., WENDT, J., BELKA, Z. & KAUFMANN, B. (2004). Temporal-spatial reconstruction of the early Frasnian (Late Devonian) anoxia in NW Africa; new field data from the Ahnet basin (Algeria). - Sedimentary Geology, 163: 237-264.

MAMET, B. & PRÉAT, A. (1989): Sédimentation de la plate-forme givétienne franco-belge. - Bulletin des Centres de Recherche Exploraiton-Production Elf-Aquitaine, 13: 47-86.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Early Devonian Biostratigraphy with ostracodes: Problems, Progress und Possibilities

DOJEN, C.

Landesmuseum Kärnten, Museumsgasse 2, A-9021 Klagenfurt, Austria; *claudia.dojen@landesmuseum.ktn.gv.at*

More than 10 years ago, GROOS-UFFENORDE, LETHIERS & BLUMENSTENGEL (2000) presented a state of the art on Devonian ostracodes and stratigraphy for the Subcommission on Devonian Stratigraphy. Since then, several more sections, areas and faunas have been studied. In this talk, a summary of data on Early Devonian ostracodes published in the last decade will be given, and the problems, progress and possibilities concerning their use in biostratigraphy will be commented.

Up to now, no international standard ostracode zonation for the Devonian exists, although interbasinal correlations are possible with Late Devonian pelagic entomozoids or assumed nectobenthic spinose ostracodes of the so-called Thuringian Mega-assemblage. However, so far Early Devonian ostracodes are used for regional correlations only, and are therefore considered of little biostratigraphical significance. But why should the Early Devonian ostracodes be useless for this purpose, whereas the Late Devonian ones provide partly excellent data for detailed biostratigraphical subdivisions?

A general problem in using ostracodes for correlations is their strong facies dependence, which affects their stratigraphical and correlative value. But besides the facies dependence three main problems are hindering the biostratigraphical use of Early Devonian ostracodes: (1) the absence of suitable sections without facies change, but rich in conodonts and ostracodes (2) high variability, and (3) an inadequate knowledge as regards geographical and stratigraphical distribution and precise age of many localities.
In order to meet these problems future work has to consider: (1) sections which may not be without facies change, but where the disruption of biostratigraphical interpretation is minimal and sampling of these sections with new methods to get calcareous ostracodes from the limestones; (2) Morphometric analysis to inquire variation and unravel morphotype distribution and evolutionary patterns; (3) improvement of information to fill up our knowledge at the at present scattered stratigraphical and geographical data. And as many beds without conodonts are rich in ostracodes, the ostracodes can become a vital source of auxiliary information for biostratigraphical correlation once a conodont-dated baseline with ostracodes is erected.

A good improvement is already noticeable regarding the available information. Since GROOS-UFFENORDE *et al.* (2000) several additional ostracode faunas have been studied. Outstanding is the work from Bakharev describing large faunas e.g. from the Emsian of the Salair and the Kuznik basin in Russia (BAKHAREV 1998, BAKHAREV & BAZAROVA 2000). Large faunas are also published from the Spanish Peninsula, such as from the Pyrenees, the Guadarrama, Aragón (e.g., DOJEN 2005, DOJEN *et al.* 2009) and the Cantabrian Mountains (e.g., BECKER 2000, 2001). Further new data are available for example from Morocco (e.g., BECKER *et al*. 2004; DOJEN *et al*. 2010), from Nevada (DOJEN *et al*. 2009) and from Turkey (DOJEN *et al*. 2004). However, the taxonomical, geographically and stratigraphically crossovers are still small, but some taxa are already regarded as possible supraregional biostratigraphical markers such as various species of *Miraculum* POLENOVA, *Polyzygia* GÜRICH, and the species *Placentella heraultiana* GROOS-UFFENORDE.

Future studies on calcareous ostracodes e.g. from the Carnic Alps and analysis with morphometric methods should provide us with conodont-correlated ostracode zonation with interbasinal application potential, which will greatly strengthen our ability to correlate early Devonian strata.

References

BAKHAREV, N.K. (1998): Noviye rody i vidy paleokopidnykh ostracod telengitskogo nadgorizonta (devon, Salair). - *In*: Fauna I stratigrafiya paleozoya Srednei Sibiri I Urala. – Novosibirsk, Nauka: 36-44.

BAKHAREV, N.K. & BAZAROVA, L.S. (2004): Silurian and Devonian ostracodes of the genus Miraculum: new species and phylozones. - News of Paleontology and Stratigraphy. Supplement to Journal Geologiya i Geofizika. Iss. 6-7: 75-89.

BECKER, G. (2000): Eine offen-marine Ostracoden-Fauna aus der Aguión-Formation (Unter-Devon, Ober-Emsium) von Asturien (N-Spanien). - Palaeontographica, Abt. A., 256: 77-158.

BECKER, G. (2001): Fazies-anzeigende Ostracoden-Faunen aus der Santa Lucía Formation (Unterdevon, Ober-Emsium) von Asturien und N León (N-Spanien). - Palaeontographica, Abt. A, 263: 1-136.

BECKER, G., LAZREQ, N. & WEDDIGE, K. (2004): Ostracods of Thuringian provenance from the Devonian of Morocco. – Paleontographica, Abt. A, 271: 1-109.

DOJEN, C. (2005): Early Devonian ostracods of Celtiberia (NE Spain) – taxonomy, palaeoecology, biostratigraphy, and biogeography. - Electronic ed.,Braunschweig, Techn. Univ, Diss, 2005: XIX, 256, [liii] p.; Braunschweig.

DOJEN, C., ABOUSSALAM, S.Z. & BECKER, R.T. (2010): Palaeoecological and biogeographical interpretation of Devonian ostracodes (Emsian to basal Givetian) of the Western Dra Valley, Morocco (sections Bou Tserfine, Rich Tamelougou and Hassi Mouf). - SDS Newsletter, No. 25: 37-40.

DOJEN, C., EVOLA, G.M. & MURPHY, M.A. (2009): Early Devonian Ostracodes from the Coal Canyon Sections (Northern Simpson Park Range, central Nevada). - SDS Newsletter, No. 24: 36-39.

DOJEN, C., ÖZGÜL, N., GÖNCÜOGLU, Y. & GÖNCÜOGLU, M.C. (2004): Early Devonian Ostracodes of Thuringian Ecotype from NW Anatolia (Turkey). - Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 12: 733-748.

DOJEN, C., VALENZUELA-RÍOS, J.I. & CARLS, P. (2009): Biostratigraphy of Early Devonian ostracodes from Celtiberia and Pyrenees (Spain). - Palaeontographica Americana 2009 (63): 143-153.

GROOS-UFFENORDE, H., LETHIERS, F. & BLUMENSTENGEL, H. (2000): Ostracodes and Devonian Stratigraphy. - Courier Forschunginstitut Senckenberg, 220: 99-111.

Early to Middle Devonian ostracodes from the Western Dra Valley (Morocco): first eventstratigraphical implication

DOJEN, C.[1], ABOUSSALAM, S.[2] & BECKER, R.T.[2]

(1) Landesmuseum Kärnten, Museumsgasse 2, A-9021 Klagenfurt, Austria;
claudia.dojen@landesmuseum.ktn.gv.at
(2) Westfälische Wilhelms-University, Institute for Geology and Palaeontology, Corrensstr. 24, D-48149 Muenster, Germany; *taghanic@uni-muenster.de*; *rbecker@uni-muenster.de*

The Devonian of the Anti-Atlas in southwest Morocco is world-famous for its extensive outcrops that are rich in well-preserved faunas, but those of the Western Dra Valley are still under study and especially the lower Devonian ostracodes are poorly known. We propose first eventstratigraphical results on ostracodes of earliest Emsian to basal Givetian age from the sections Bou Tserfine, Rich Tamelougou and Hassi Mouf near Assa, which are well dated by conodonts. All ostracode associations indicate an offshore position below wave base. Paleobiogeographically, most taxa belong to the Paleotethysian Province, but few North-American taxa are also present and corroborate migration paths between both areas via North Africa.

At present, some hundred ostracode individuals belonging to about 45 benthic taxa have been tentatively identified. Lower Emsian samples with ostracodes are from sections Rich Tamelougou and Bou Tserfine. They yielded taxa such as *Polyzygia kroemmelbeini* and *Bollia azagora*, which are in these sections restricted to the Early Emsian although their global range is longer. But most of the ostracodes are from the lower Upper Emsian *Hollardops* Limestone (basal Khebchia Fm) and the Eifelian *Pinacites* Limestone (lower Yeraifa Fm).

The *Hollardops*-Limestone is a regionally distinctive limestone that has furnished frequently *Caudicriodus culicellus - Icriodus corniger ancestralis* conodont assemblages, which indicate early Late Emsian age. Only its basal bed is latest early Emsian as indicated by monospecific occurrences of the *bilatericrescens* conodont assemblage. The ostracode assemblages belong to the so-called “mixed faunas” with only few palaeocopes but rich in metacopes (some of them with small spines), indicating an offshore position probably in deeper and less agitated water below wave base. The *Pinacites* Limestone contains goniatites (e.g., *Pinacites*, *Fidelites*), and conodonts of the *costatus* Zone (Eifelian). The ostracode fauna is partly similar to those of the *Hollardops*-Limestone and long ranging taxa such as *Ulrichia* ex gr. *acricula* and *Jenningsina planocostata* occur throughout the sections. But several taxa as e.g. *Bufina* aff. *bicornuta, Bufanchiste bufinoides, Polyzygia symmetrica* or *Favulella frankenfeldi* are despite their global ranges restricted here to the Eifelian. Besides these, several spiny taxa such as *Semibolbina, Loquitzella*, *Berounella* or *Tricornina* occur, thus, reflecting slightly deeper and calmer water conditions than during the sedimentation of the *Hollardops*-Limestone. So far, Givetian strata with ostracodes have been found in the studied sections only at Hassi Mouf. The occurring taxa are long-ranging and globally widely distributed such as *Jenningsina planocostata* or *Praepilatina*, and the assemblages present low diversities.

As regards Devonian events and their effect on ostracodes both the Kellwasser-Event and the Hangenberg-Event are studied thoroughly. However, the smaller-scale events such as the Daleje, Choteč or Kačák Event have not been studied in detail so far. Without covering the eventhorizons in detail, our study gives nonetheless preliminary information on the possible influence of these events on benthic ostracodes faunas in the W Dra Valley:

- After the Daleje-Event horizon (approx. Early/Late Emsian boundary), eight of thirteen taxa still occur; *Polyzygia vinea* disappears worldwide, whereas *P. kroemmelbeini* disappears locally.

- After the Choteč-Event horizon (approx. Emsian/Eifelian boundary), thirteen of twenty-four taxa still occur; *Jenningsina thuringica* disappears worldwide; *Bufina sotoi* and *Tricornina* ex gr. sp. A survive only in Morocco.

- After the Kačák-Event horizon (approx. Eifelian/Givetian) only five from twenty-seven taxa still occur; the five survivors are ubiquitous taxa, such as the long-ranging and globally widely distributed *Jenningsina planocostata;* even some long ranging taxa such as *Ulrichia* ex gr. *fragilis*, *U.* ex, gr. *spinifera* and "*Cyterellina" inconstans* disappear locally.

Thus, the Kačák-Event seems to be the most effective one of the minor events as regards the ostracodes of the Western Dra Valley. However, further studies have to include more material covering the event horizons in detail. In addition, the results have to be compared with the studies on Devonian ostracodes from other Moroccan and North African areas as described e.g. by CASIER or by BECKER.

Late Devonian climatic deterioration on the East European Platform and marine biota reaction on it

GATOVSKY, Yu.A.

Department of Paleontology, Geological Faculty, Moscow State University, Vorob'evy Gory, 1, Moscow, 119991, Russian Federation; *gatovsky@geol.msu.ru*

Remarkable changes are apparent in climate during Late Devonian-Carboniferous times. Mostly the climate was rather different from the present. The faunas offer much evidence for understanding the climate but, in turn, understanding the paleogeography of the faunas is dependent on understanding the climate and the changes in climate. The Devonian period as a whole was a time of very warm climate on the Earth (SIMON *et al*. 2007). The Late Devonian at first had a warm climate (Frasnian), and in Famennian time there was a gradual decrease in temperature, with the development of the first glaciation in the end-Famennian (Hangenberg event) (JOACHIMSKI *et al*. 2009). Late Devonian glaciation is well-documented in three Brazilian basins, and the glaciation has shown a wider extent for this event, reaching Bolivia, Peru, Central African Republic, Niger, and the USA (ISAACSON *et al*. 2008). Physical evidence for this event includes glacial pavements and polymict striated, and faceted clasts as dropstones and within marine resedimented deposits. These climatic changes have been accompanied by the sharp glacioeustatical fluctuations in sea level that led to the cyclic structure of the deposits of this age on a global scale (KAISER 2005, KAISER *et al.* 2008, SANDBERG *et al*. 2002, PERRI & SPALLETTA 2000, ALEKSEEV *et al*. 1996, JOHNSON *et al*. 1985). Late Devonian climatic deterioration is clearly recorded in the sections of the East European platform. At present, very little is known about the beginning of the first Late Devonian glaciation, as well as a reaction to it of the marine biota. Paleoclimatic models on the basis of actual contemporary have never been implemented. It is very important to specify the start time of glaciation and to identify the sequence of biotic and abiotic events that took place during the transition from "warm" to "cold" the biosphere at the end of the Devonian. The research aims to address the fundamental problems in Earth sciences related to identification of the nature of the relationship of climate change and major events in the development of marine biota, such as mass extinctions, changes in the diversity of individual groups, the change of major evolutionary trends.

So far in the world the epicontinental basins have attracted attention in terms of their comprehensive detailed analysis. Publications available on the sedimentary basins of the North American platform, especially the Appalachian, devoted only to individual sections and individual groups, they do not give a general idea. The basins of folded regions (Kuzbass, Western Australia, Cordillera, etc.) are known better, where there were significant reef building and the gradient of depth. The combination of detailed biostratigraphic, sedimentological, paleontological and paleoclimatic studies, of course, will reflect the most current trends in the geosciences. Comparative analysis of sequences of shallow-water carbonate sedimentation basins, formed in different states of the biosphere by anyone is not satisfied. So far, the Late Devonian climate deterioration and the marine biota reaction on it have not been studied in the shallow-water epicontinental basins.

The problem of the relationship of climate deterioration and major events in the development of marine biota, such as mass extinctions, changes in the diversity of individual groups, the change of major evolutionary trends in response to transgressions and regressions, the mass migration of fauna, etc. debated for a long time. The global Devonian eustatic curve proposed by D. Johnson and others (JOHNSON *et al*. 1985), does not rely on the synthesis of regional curves of relative sea-level fluctuations, which until now existed only as separate not linked to each other pieces of the low temporal resolution. None analysis of sea level fluctuations and changes in the structure and composition of marine biota, especially benthic communities, for large regions with a relatively quiet tectonic setting, which is the East European Platform. Relationships in the development of half-closed marine basins in response to climate deterioration, as well as to fluctuations in their messages to the open ocean and changes in local levels of the seas remain undetected. Shallow-water basin that existed in the central part of the East European Platform during the Late Devonian is a good model to identify the main patterns of development of large epicontinental basins paleoequatorial area during the period of "warm" the biosphere. In this area, starting from the Lower Carboniferous to Late

Carboniferous, there was generally similar basin, but during the "cold" of the biosphere. The nature of the "cold" Carboniferous basin and its biota inhabiting is known (MAKHLINA *et al*. 1993). At the same time the Late Devonian deposits of the East European Platform analyzed only in terms of stratigraphy and cyclicity (RODIONOVA *et al*. 1995, TIKHOMIROV 1967).

Concerning the conditions of sedimentation and, especially, on the biota of the epicontinental basin, we know very little. Therefore, synthesis of existing data and new studies using the most modern techniques are essential. Paleoclimatic reconstruction on the basis of the actual current is never executed. Meanwhile, of course, that the deposits of "warm" Late Devonian and "cold" Carboniferous basins have different character and different sets of cyclic lithofacies under identical environments of sedimentation, although both were very shallow and located in the equatorial region. Identifying these differences is extremely important for understanding the basic laws of development of the biosphere in the broadest sense of the word. This study provides for special researches to analyze the Late Devonian basin of the East European Platform, which will identify specific characteristics of this basin at various state of the global biosphere. The solution of the problem stated above base on the most advanced methods and approaches that exist in this area.

A comprehensive analysis of the section of the Late Devonian of East European Platform on the basis of stratigraphic, sedimentological, paleoecological and paleoclimatic studies have performed. Only the combination of such studies can to give the main features of the Late Devonian basin and the organic world and can to reveal its evolutionary patterns. The territory which covered by research, include the Moscow syneclise, Voronezh anteclise and Timan, i.e. the main part of the basin at which we can follow the main facies transitions, and to restore the community of benthic organisms. For this kind of research is extremely important to have detailed and reliable tools near and distant stratigraphic correlation of shallow-water strata of the Late Devonian of East European Platform. Such tools have appeared only in recent years. It is above all detailed scale of the Late Devonian of East European Platform on conodonts. It is currently linked to reliably polygnatid conodonts with standard scale (ARISTOV, 1988). Application of zonal scale in the aggregate allow a reliable correlation between a different part of the basin and correlate a regional scale to the standard scale of the Late Devonian. According to the results of the study, this detailed zonal sequence supplemented by event-frame. Sedimentological studies are central to the establishment of environments of sedimentation, paleodepths, salinity and other characteristics of the ocean basins also implemented. The section covering each area paleobasin a significant part of the sedimentary sequence studied on sedimentological data. Particular attention was paid to surf and shoaling of sharp breaks and marking them paleosols (in the Famennian). Recent widespread in the Middle and Upper Carboniferous of Central Russia, but has not yet been identified in the Late Devonian (Famennian). The combined analysis paleotectonic, sedimentological, paleoecological and paleoclimatic data on the basis of detailed stratigraphic allowed the construction of curves of relative sea-level fluctuations for different parts of the basins. Dating of events calculated on a scale DCP-2003 (MENINNG *et al*. 2006). In the comprehensive study of the biota of the Late Devonian focus on groups such as the benthic brachiopods and corals. The nekton is studied in detail by conodonts. The fish is subjected to special study.

Our studies are concentrated on the identification of the reaction of the marine biota on climate deterioration and on the eustatic sea level fluctuations which occurred on the East European Platform in the Late Devonian. The investigations are based on biostratigraphic on eight Devonian/Carboniferous sections and boreholes.

References

ALEKSEEV, A.S., KONONOVA, L.I. & NIKISHIN, A.M. (1996): The Devonian and Carboniferous of the Moscow Syneclise (Russian Platform): stratigraphy and sea-level changes. - Tectonophysics 268: 149-168.

ARISTOV, V.A. (1988): Devonian Conodonts of Central Devonian Field (Russian Platform). - Geol. Inst. Acad. Sci. USSR, Trans., 432, 120 pp. [in Russian]

ISAACSON, P.E., DIAZ-MARTINEZ, Z., GRADER, G.W. *et al*. (2008): Late Devonian-earliest Mississippian glaciation in Gondwanaland and its biogeographic consequences. - Palaeogeography, Palaeoclimatology, Palaeoecology, 268: 126-142.

JOACHIMSKI, M.M., BREISIG, S., BUGGISCH, W., TALENT, J.A., MAWSON, R., GEREKE, M., MORROW, J.R., DAY, J. & WEDDIGE, K. (2009): Devonian climate and reef evolution: Insights from oxygen isotopes in apatite. Earth and Planetary Science Letters, 284: 599-609.

JOHNSON , J.G., KLAPPER, G. & SANDBERG, C.A. (1985): Devonian eustatic fluctuations in Euramerica. - Geological Society American Bulletin, 96: 567-587.

KAISER, S.I. (2005): Mass extinctions, climatic and oceanographic changes at the Devonian-Carboniferous boundary. - Doktorarbeit, Fakultät für Geowissenschaften, Ruhr-Universität Bochum, 156 pp.

KAISER, S.I., STEUBER, T. & BECKER, R.T. (2008): Environmental change during the Late Famennian and Early Tournaisian (Late Devonian -Early Carboniferous): implications from stable isotopes and conodont biofacies in southern Europe. - Geological Journal, 43: 241-260.

MAKHLINA, M.KH., VDOVENKO, M.V., ALEKSEEV, A.S. *et al*. (1993): Lower Carboniferous of the Moscow Syneclise and Voronezh Anteclise. - Nauka, Moscow, 221 pp. [in Russian]

MENINNG, M., ALEKSEEV, A.S., CHUVASHOV, B.I. *et al*. (2006): Global time scale and regional stratigraphic reference scales of Central and West Europe, East Europe, Tethys, South China, and North America as used in the Devonian-Carboniferous-Permian Correlation Chart 2003 (DCP 2003). - Palaeogeography, Palaeoclimatology, Palaeoecology, 240, 1-2: 318-372.

PERRI, M.C. & SPALLETTA, C. (2000): Late Devonian-Early Carboniferous transgressions in the Carnic Alps (Italy). - Records of the Western Australian Museum Supplement 58: 305-319.

RODIONOVA, G.D., UMNOVA, V.T., KONONOVA, L.I. *et al*. (1995): Devonian of Voronezh Anteclise and Moscow Syneclise. - Centrgeologia, Moscow, 265 pp. [in Russian]

SANDBERG, C.A., MORROW, J.R. & ZIEGLER, W. (2002): Late Devonian sea-level changes, catastrophic events, mass extinctions. - Geological Society of America, Special Paper, 356: 473-487.

SIMON, L., GODDERIS, Y., BUGGISCH, W. *et al*. (2007): Modeling the carbon and sulfur isotope compositions of marine sediments: Climate evolution during the Devonian. - Chemical Geology, 246: 19-38.

TIKHOMIROV, S.V. (1967): Stages of sedimentation of the Russian Platform Devonian. - Nedra, Moscow, 268 pp. [in Russian]

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

How much do we already know about biodiversity of the Austrian Paleozoic?

HUBMANN, B.

Karl-Franzens-Universität Graz, Institute for Earth Sciences, Heinrichstraße 26, A-8010 Graz;
bernhard.hubmann@uni-graz.at

The research history of the alpine Paleozoic looks back on an amazingly long period of more than 150 years. Although all systems of the Paleozoic erathem had been defined and established to end of the first half of the 19th century, it might be considered as a special „stratigraphical highlight“ that FRANZ UNGER, a paleobotanist at the Joanneum in Graz, recognized in the year 1843 strata in the vicinity of Graz containing characteristic petrified organisms which he considered to be Devonian (- only four years after establishment of the system!) in age! A few years later, particularly during comprehensive geological mapping of the Alpine region by the Austrian Geological Survey Silurian successions were recognized by FRANZ HAUER in 1847, Permian rocks containing fusulinids by GUIDO STACHE in 1872 and Ordovician strata - likewise by STACHE – in 1884. The Carboniferous (“age of carbonaceous limestone”) was for a long time well-known in alpine geology, however for several decades this system remained a vast bin for unidentified Paleozoic rocks.

The completion of the first geological land survey and the first establishment of a (bio)stratigraphical frame for Austria’s geological units gave birth to the wish to a more finely subdivision. Evaluating the literature reporting on some of the results obtained up to the beginning of World War II, one cannot avoid the impression that ”the wish was father to the thought”: even from geological units which suffered from high metamorphosis remains of graptolites and trilobites were described and a Cambrian age of the strata postulated! Furthermore, reference specimens are frequently missing although their names are cited in the geologic literature.

To illustrate the variety of genera and/or species of the Paleozoic of Austria trustworthily would mean to subject nearly all groups of organisms to a revision. The attempt to display the biodiversity deduced from evaluated literature data results in the following compilation:

	Algae	Foraminifers	Sponges	Corals	Gastropods	Bivalves	Cephalopods
Permian	73	324	2	58	184	294	66
Carboniferous	34	322	18	122	100	129	43
Devonian	11	71	138	411	331	82	22
Silurian	-	27	4	23	107	245	227
Ordovician	-	-	2	1	5	-	-

	Trilobites	Bryozoans	Brachiopods	Echinoderms	Conodonts	Land plants	others
Permian	10	-	631	11	-	131	104
Carboniferous	56	83	450	5	748	410	429
Devonian	168	7	675	17	2305	-	217
Silurian	142	-	178	2	655	-	594
Ordovician	17	69	161	-	232	-	94

A more detailed analysis of these “raw data“ reveal interesting trends. For instance, rugose as well as tabulate corals show steeply rising diversity gradients up to the middle Devonian, followed by a rapid decline during the Mississippian and an anew rise in the Pennsylvanian and a minor drop in the lower Permian. This pattern is correlated with the global diversity trend but also reflects the general changes of the depositional environment in the alpine realm: increasing diversity from the Silurian to middle Devonian corresponds with the establishment of wide-ranging carbonate platforms during that time. Drowning of shallow marine areas during the upper Devonian and the beginning of the Variscan flysch sedimentation during lower Carboniferous strongly affected the corals. Post-Variscan shallow marine habitats of the Carnic Alps (Auernig) and Eastern Greywackezone were re-colonized by a diverse rugose fauna (Fig. 1).

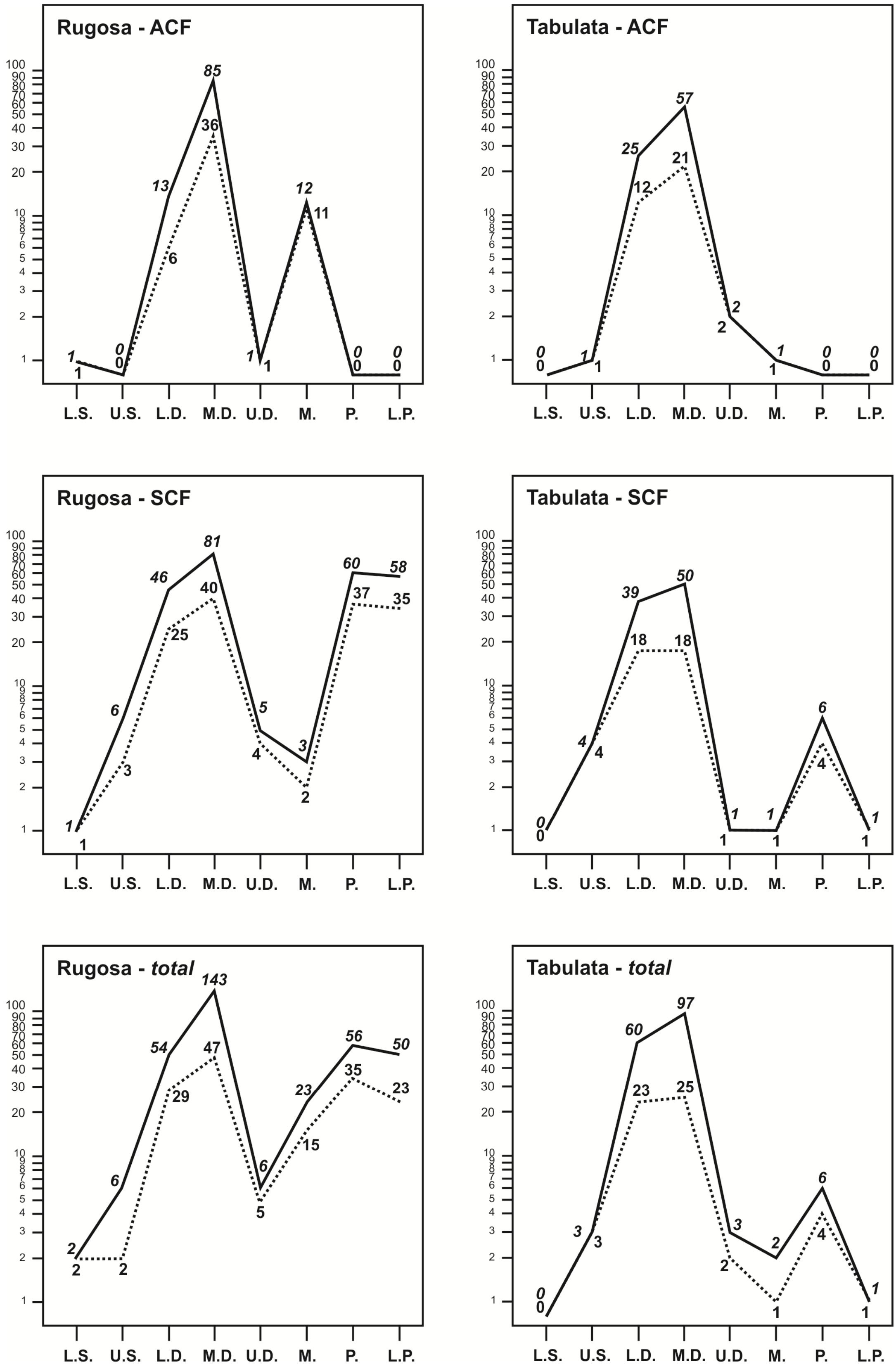


Fig. 1: "Diversity-curve" of Alpine Paleozoic corals. ACF: Austroalpine Coral Fauna; SCF: Southalpine Coral Fauna; Ordinate: number of entities; Abscissa: period/epoch (L.S. = Lower Silurian, U.S. = Upper Silurian, L.D. = Lower Devonian, M.D. = Middle Devonian, U.D. = Upper Devonian, M. = Mississippian, P. = Pennsylvanian, L.P. = Lower Permian); numbers indicate genera (normal type) and species (italic type); continuous line: diversity on species level; dotted line: diversity on genus level.

Generaly two major regions of Paleozoic developments may be distinguished, that are separated by the Periadriatic Line, the most prominent alpine fault system: the Upper Austroalpine Variscan sequences (i.e. the Greywacke Zone of Tyrol, Salzburg, Styria and Lower Austria, the Nötsch Carboniferous, the Gurktal Nappe, the Graz Paleozoic and some isolated outcrops in South Styria and Burgenland) and the Southern Alpine sequences (i.e. the Carnic Alps and the Karawanken Alps).
Corresponding with this subdivision of Paleozoic remnants in Austria differing corals faunas are distinguishable: the „Austroalpine Coral Fauna" (ACF) and the „Southalpine Coral Fauna" (SCF).

A review of more than 200 articles, that taxonomically deal with or cite Paleozoic corals in Austria (including coral sites near the border in Italy and Slovenia), lists 220 rugose and 113 tabulate taxa known (or even cited in the literature) from this region (see HUBMANN 2002).
A data base of Paleozoic corals from Austria (FLÜGEL & HUBMANN 1994, HUBMANN 1995, HUBMANN *et al*. 2003) registers 125 taxa (81 Rugosa, 33 Tabulates and 11 Heliolitids) on species level and 16 taxa on subspecies level (12 Rugosa, 4 Tabulates) which were described for the first time.

References

FLÜGEL, H.W. & HUBMANN, B. (1994): Catalogus Fossilium Austriae, Anthozoa palaeozoica: Rugosa. - Österreichische Akademie der Wissenschaften, IVc/1a, 141 pp.

HAUER, F. (1847): Versteinerungen von Dienten. - Mitteilungen der Freunde der Naturwissenschaften 1: 187-189.

HUBMANN, B. (1995): Catalogus Fossilium Austriae, Anthozoa palaeozoica: Tabulata (inklusive Chaetetida und Heliolitida). - Österreichische Akademie der Wissenschaften, IVc/1b, 111 pp.

HUBMANN, B. (2002): Palaeozoic corals in Austria: state of knowledge after 150 years of research. - Coral Research Bulletin, 7: 73-86.

HUBMANN, B., POHLER, S., SCHÖNLAUB, H.P. & MESSNER, F. (2003): Paleozoic Coral-Sponge Bearing Successions in Austria. - Berichte der Geologischen Bundesanstalt, 61, 91 pp.

STACHE, G. (1872): Entdeckung von Graptoliten-Schiefern in den Südalpen. - Verhandlungen der kaiserlich-königlichen Geologischen Reichsanstalt, 1872: 234-235.

STACHE, G. (1884): Ueber die Silurbildungen der Ostalpen mit Bemerkungen über die Devon-, Carbon- und Perm-Schichten dieses Gebietes. - Zeitschrift der Deutschen Geologischen Gesellschaft, 36: 277-378.

UNGER, F. (1843): Geognostische Skizze der Umgebung von Grätz. - *In*: SCHREINER, G. (ed.): Grätz, ein naturhistorisch-statistisch-topographisches Gemälde dieser Stadt und ihrer Umgebungen: 69-82.

Biodiversity of Devonian conodonts from the West Siberia

IZOKH, N.G.

Trofimuk Institute of Petroleum Geology and Geophysics SB RAS, Acad. Koptyug Av., 3, Novosibirsk, 630090, Russia; *IzokhNG@ipgg.nsc.ru*

In West Siberia the Devonian deposits compose a part of the shelf belt along the western margin of the Siberian continent and extend from W to NE: from Altai to Salair and Kuznetsk Basin deepening farther north beneath the Mesozoic-Cenozoic cover of the West Siberian Lowland. Devonian marine sediments contain abundant benthic and pelagic fauna. Conodont associations were recovered from the NW and central parts of the West-Siberia Geo syncline (WSG), Rudny and Gorny Altai, Kuznetsk Basin.

Many conodont index-species of two (deep- and shallow-water) parallel zonal scales were recovered from the several Devonian sections.

The north-west of the West-Siberia Geosyncline. The Upper Emsian – middle Famennian conodont association from the Shchuchiy Ledge (IZOKH 2011). The Emsian association includes: *Polygnathus serotinus* TELFORD, *P. bultyncki* WEDDIGE, *Neopanderodus perliniatus* ZIEGLER & LINDSTROM, *N.* cf. *transitans* ZIEGLER & LINDSTROM, *Belodella devonica* (STAUFFER), *B. triangularis* (STAUFFER), *B. resima* (PHILIP), *Panderodus* sp. and *Pseudooneotodus* sp.

The Eifelian association is characterized by species derived from Emsian and entering Givetian. It includes: *Polygnathus serotinus* TELFORD, *P. costatus patulus* KLAPPER, *P. costatus partitus* KLAPPER *et al*., *P.* cf. *linguiformis* HINDE, *P. costatus costatus* KLAPPER, *P.* aff. *P. trigonicus* BISCHOFF & ZIEGLER, *P. pseudofoliatus* WITTEKINDT, *P. eiflius* BISCHOFF & ZIEGLER, *Icriodus* cf. *regularicrescens* BULTYNCK, *Belodella devonica* (STAUFFER).

The Upper Frasnian association is represented by *Polygnathus decorosus* STAUFFER, *P.* cf. *P. aequalis* KLAPPER & LANE, *P.* cf. *P. samueli* KLAPPER & LANE, *P.* cf. *P. politus* OVNATANOVA, *Palmatolepis* cf. *Pa. rhenana* BISCHOFF, *Pa.* cf. *Pa. subrecta* MILLER & YOUNGQUIST, *Nothognatella* sp., *Belodella devonica* (STAUFFER).

Upper Famennian olistostrome-turbidite complex is composed of large limestone blocks characterized by three different in age conodont associations. The first is early Emsian which includes *Pedavis* aff. *sherryae* LANE & ORMISTON, *Pandorinellina* cf. *exigua philipi* (KLAPPER) and *Pseudooneotodus beckmanni* (BISCHOFF & SANNEMANN). The other two are Famennian: Second association characterizes triangularis Zone (*Palmatolepis praetriangularis* ZIEGLER & SANDBERG, *Pa. triangularis* Sannemann, *Icriodus alternatus* BRANSON & MEHL), third – belong to *marginifera*—Early *trachitera* zones (*Palmatolepis marginifera marginifera* HELMS, *Polygnathus* sp. A).

In the central part of WSG. *Ozarkodina remscheidensis remscheidensis* (WALLISER), *Oz. r. repetitor* (CARLS & GANDL), *Pandorinellina exigua philipi* (KLAPPER), and *Pand. steinhornensis miae* (BULTYNCK) were defined from the Lower Devonian deposits. The Emsian sequences yielded *Polygnathus kitabicus* YOLKIN *et al*., *P. excavatus* CARLS & GANDL, *Pandorinellina e. exigua* (PHILIP), *Polygnathus nothoperbonus* MAWSON, *P. inversus* KLAPPER & JOHNSON, *P. serotinus* TELFORD and *P. foliformis* SNIGIREVA. The Eifelian association being very poor, only Upper Eifelian species were identified: *Tortodus kockelianus australis* and *P. x. ensensis*. *Icriodus obliquimarginatus* BISCHOFF & ZIEGLER, *Polygnathus x. xylus* STAUFFER, *P. varcus* STAUFFER, *Ozarkodina brevis* BISCHOFF & ZIEGLER, *Klapperina disparilis* ZIEGLER & KLAPPER were found in the Givetian. The Frasnian associations include *Palmatolepis hassi* MÜLLER & MÜLLER, *Ancyrognathus triangularis* KLAPPER, *Pa. gigas* MILLER & YOUNGQUIST, *Pa. subrecta* MÜLLER & YOUNGQUIST. The Famennian associations are dominated by *Palmatolepis* (*Pa. triangularis* SANNEMANN, *Pa. rhomboidea* SANNEMANN, *Pa. quadrantinodosa inflexoidea* ZIEGLER, *Pa. postera* ZIEGLER), with rare *Polygnathus* (*Polygnathus znepolensis* Spasov) (DUBATOLOV *et al*. 1990).

Salair, Rudny and Gorny Altai. The Lochkovian conodont association was found in Salair. It includes the following taxa: *Caudicriodus woschmidti transiens* CARLS & GANDL, *Pedavis* cf. *Ped. breviramus* MURPHY & MATTI, *Pandorinellina exigua philipi* (KLAPPER), *Pand. optima* (MOSKALENKO), *Pelekysgnathus serratus* JENTZSCH, *Ozarkodina e. excavata* BRANSON & MEHL, *Panderodus* sp. and

Belodella sp. Predominant are the *Panderodus* elements (up to 75%) in the conodont collection. Most diverse conodont associations were established in the Emsian of Rudny Altai, Gorny Altai, Salair and Tuva Depression. They include species belonging to *Pandorinellina*, *Caudicriodus*, *Latericriodus*, *Ozarkodina*, *Polygnathus*, *Panderodus*, *Pelekysgnathus*, *Vjaloviodus* and *Belodella*. Almost all Emsian zonal index-species have been identified. Among them are *Polygnathus kitabicus* YOLKIN *et al*., *P. excavatus* CARLS & GANDL, *P. nothoperbonus* MAWSON, *P. inversus* KLAPPER & JOHNSON, *P. serotinus* TELFORD. The Emsian-Eifelian boundary interval is expressed by non-marine deposits with flora remains.

The Eifelian sequences of Rudny Altai, Gorny Altai and Salair are characterized by *Polygnathus*, *Icriodus* and *Tortodus*, including *Polygnathus costatus partitus* KLAPPER *et al*., *Po. costatus costatus* KLAPPER, *Po. linguiformis klapperi* CLAUSEN *et al., Icriodus regularicrescens* BULTYNCK (BAKNAREV *et al*. 2004). The Givetian interval is represented by shallow-water associations of *Icriodus* with rare *Polygnathus* in Rudny Altai, NW Kuznetsk Basin and Minusa Depression (AKSENOVA *et al*. 1994, BAKNAREV *et al*. 2004). The *Icriodus obliquimarginatus* BISCHOFF & ZIEGLER species was identified in Rudny Altai and NW Kuznetsk basin.

Most diverse Frasnian associations which typify complete zonal succession (*falsiovalis* - *linguiformis* zones) were found in Rudny Altai. The Lower and Middle Frasnian carbonates contain abundant *Polygnathus*, *Ancyrodella*, *Mesotaxis*, and rarely, Icriodus and *Palmatolepis*. The Late Frasnian siliceous-terrigenous sequences contain rare *Palmatolepis* and *Polygnathus* (BAKNAREV *et al*. 2004, IZOKH *et al*. 2004, OBUT *et al*. 2007).

The Frasnian conodonts, comprising common *Polygnathus*, *Ancyrognathus*, *Icriodus*, few *Pelekysgnathus* and *Ancyrodella* from SE Altai differ from the above associations.

NW Kuznetsk Basin. The Frasnian sequences contain shallow-water biofacies association, mainly *Polygnathus* and *Icriodus*, single *Palmatolepis*, *Ancyrodella*, *Ancyrognathus*, *Polylophodonta*. Among them: *Polygnathus dengleri* BISCHOFF & ZIEGLER*, P. angustidiscus* YOUNGQUIST*, Po. brevilamiformis* OVNATANOVA, *P. webbi* STAUFFER, *P. aequalis* KLAPPER & LANE, *P. robustus* KLAPPER & LANE, *P. costulatus* ARISTOV, *P. samueli* KLAPPER & LANE, *Palmatolepis hassi* MÜLLER & MÜLLER, *Ancyrodella gigas* YOUNGQUIS, *An. nodosa* ULRICH & BASSLER). F/F interval is characterized by: *Polygnathus brevilaminus* Branson & Mehl, *Icriodus praealternatus* Sandberg, Ziegler & Dreesen, *I. alternatus alternatus* BRANSON & MEHL*, I. alternatus helmsi* SANDBERG & DREESEN.

Polygnathus izhmensis KUZMIN, *P.* gr. *P. semicostatus* BRANSON & MEHL and *I. iowaensis* YOUNGQUIST & PETERSON are found beginning from the base of the Famennian. Conodonts diversity sharply increased at the base of the Lower Famennian crepida Zone: abundant *Polygnathus* and *Palmatolepis*, rare *Icriodus* and single *Ancyrolepis* (*Palmatolepis triangularis* SANNEMANN, *Pa. quadrantinodosalobata* SANNEMANN, *Pa. crepida* SANNEMANN, *Ancyrolepis cruciformis* ZIEGLER and others).

The Uppermost Famennian complex of conodonts from the NW Kuznetsk Basin contain *Polygnathus*, *Pelekysgnathus*, *Neopolygnathus*, *Bispathodus*, *Icriodus*, and *Siphonodella*.

This study has been supported by RFBR grants № 11-05-00737, 11-05-01105, RAS Projects 21, 25. Contribution to IGCP 596 Project.

References

AKSENOVA, L.M., RODYGIN, S.A. & KHALYMBADZHA, B.G. (1994): Konodontovaya kharakteristika pogranichnykh otlozhenii severnoi okrainy Kuzbassa. - *In*: PODOBINA, B.M. & RODYGIN, S.A. (eds.): Voprosy geologii Sibiri. 2. - Izd-vo Tomskogo un-ta, Tomsk: 320-336. [in Russian]

BAKNAREV, N.K, SENNIKOV, N.V, YOLKIN, E.A, IZOKH, N.G. *et al*. (2004): Key Devonian sections from Rudny Altai, Salair and Kuznetsk Basin regions. - Publishing House of SB RAS, Novosibirsk, 104 pp. [in Russian]

DUBATOLOV, V.N., KRASNOV, V.I., BOGUSH, O.I., AKSENOVA, L.M. *et al.* (1990): Stratigrafiya paleozoiskikh otlozhenii yugo-vostoka Zapadno-Sibirskoi plity. - Nauka, Novosibirsk, 181 pp. [in Russian]

IZOKH, N.G., YOLKIN, E.A., BAKHAREV, N.K. (2004): Early Frasnian conodonts from the Rudniy Altai (West Siberia) // News of Paleontology and Stratigraphy, 6-7. - Novosibirsk: Publishing House of SB RAS: 89-101. Suppl. to J. Geologiya i Geofizika, 45. [in Russian]

IZOKH, N.G. (2011): Devonian conodont association of the Shchuchiy Ledge (NW of the West Siberian Geosyncline). - GEO-Sibir-2011. Nedropol’zovanie. Gornoe delo. Novye napravleniya i tekhnologiya poiska, razvedki i razrabotki mestorozhdenii poleznykh iskopaemykh. Sbornik Materialov VII mezhdunar. Nauchnogo Kongressa “GEO-Sibir-2011”, 19-29 aprelya 2011, Novosibirsk. - SGGA, Novosibirsk, 2 (1): 96-99. [in Russian]

OBUT, O.T., IZOKH, N.G. & YOLKIN, E.A. (2007): First occurrences of radiolarians and conodonts in Frasnian siliciclastic sequences of the Rudny Altai (south of West Siberia, Russia). Subcommission on Devonian Stratigraphy and IGCP 499 Devonian Land Sea Interaction, Eureka, Nevada, 9-17 September 2007. - Minuteman Press, Rochester, NY.: 69-70.

Climate and Ice Volume History of the Mid-Paleozoic: Insights from oxygen isotope proxies

JOACHIMSKI, M.M.[1] & BUGGISCH, W.[1]

(1) GeoZentrum Nordbayern, University of Erlangen-Nuremberg, Schlossgarten 5, 91054 Erlangen, Germany; *michael.joachimski@gzn.uni-erlangen.de*; *buggisch@geol.uni-erlangen.de*

Oxygen isotopes have been successfully applied to studies on Cenozoic climate and ice volume history (ZACHOS *et al*. 2001). The use of oxygen isotopes in older time periods is hampered by potential diagenetic resetting of the oxygen isotope signals. Brachiopod shells have been preferentially used to reconstruct Paleozoic paleotemperatures due to their low-magnesium calcitic shell mineralogy that is assumed to be relatively resistant to diagenetic recrystallisation. In comparison to biogenic calcite, biogenic apatite represents an alternative mineralogical phase for oxygen isotope analysis since apatite is very resistant to diagenetic exchange of phosphate-bound oxygen. Devonian and Carboniferous conodonts, microfossils composed of carbonate–fluor apatite were studied for oxygen isotopes in order to reconstruct climatic changes and the onset of the Late Paleozoic Glaciation (LPG).

Devonian conodonts were studied from several sections in Germany, the Czech Republic, France, the USA and Australia spanning the time interval of latest Silurian (Pridoli) to Late Devonian (Famennian). Late Silurian to Lochkovian sea surface temperatures (SST) are relatively high. Average SSTs start to decrease in the early Pragian and show minimum and about 8℃ cooler SSTs in the late Emsian to Givetian. Temperatures reconstructed for the middle to late Frasnian and early Famennian were again significantly warmer indicating considerable warming of low latitudes during the Frasnian. During the middle to late Famennian a moderate cooling trend is apparent culminating in the short-term glaciation at the Devonian–Carboniferous boundary, documented by a positive $\delta^{18}O$ excursion in conodont apatite (KAISER *et al*. 2006, BUGGISCH *et al*. 2008). The reconstructed Devonian paleotemperature record contradicts earlier views that the Middle Devonian represented a supergreenhouse.

The climax of coral–stromatoporoid reef development was during the Middle Devonian, an interval characterized by cool to intermediate tropical SSTs. Coral–stromatoporoid reefs were rare in the Early Devonian, finally becoming extinct in the latest Frasnian. Microbial reefs were abundant in the Early and Late Devonian suggesting that warm to very warm SSTs in the Early and Late Devonian were unfavourable for the development of coral–stromatoporoid reefs, but promoted growth of autotrophic reefs. Our data suggest that SST exerted a control on Devonian reef development and that climatic warming in the Late Frasnian in conjunction with short-term cooling pulses may have contributed to the extinction of coral–stromatoporoid reef ecosystems during the Frasnian–Famennian life crisis (JOACHIMSKI *et al*. 2009).

Carbon isotopes of whole rock carbonates and oxygen isotopes of conodont apatite from Late Devonian to Early Pennsylvanian sections in Europe, Russia and Laurentia were measured in order to reconstruct variations in the carbon cycle, marine paleotemperature, and ice volume during the Mississippian (BUGGISCH *et al*. 2008) and Pennsylvanian Conodont apatite oxygen isotope values show two major positive shifts of +2‰ and +1.5‰ V-SMOW in the late Tournaisian and Serpukhovian, respectively, that are interpreted to reflect climatic cooling and changes in ice volume. Carbon isotope ratios of inorganic and organic carbon show a major positive excursion with an amplitude of +6.5‰ V-PDB in the Tournaisian and a positive shift of up to +5‰ V-PDB in the Serpukhovian. The positive carbon isotope excursions coincide with the deposition of organic carbon-rich black shales which indicate that organic carbon burial, lowering of atmospheric $p\mathrm{CO}_2$, and climatic cooling may have occurred during these time intervals. However, while in the Tournaisian the positive shifts in apatite $\delta^{18}O$ and $\delta^{13}C$ coincide, the Serpukhovian positive shift in $\delta^{18}O$ precedes the positive shift in $\delta^{13}C$ and raises the question as to whether changes in the global carbon cycle were the ultimate cause of the inferred climatic changes. The conodont apatite oxygen isotope values suggest that a first major cooling and potential glaciation event occurred in the Tournaisian with ice masses persisting into the Visean. The second glaciation event occurred in the Serpukhovian and culminated in the first glacial maximum of the LPG.

References

BUGGISCH, W., JOACHIMSKI, M.M., SEVASTOPULO, G. & MORROW, J. (2008): Mississippian $\delta^{13}C_{carb}$ and conodont apatite $\delta^{18}O$ records: Their relation to the Late Palaeozoic glaciation. - Palaeogeography, Palaeoclimatology, Palaeoecology, 268: 273-292.

JOACHIMSKI, M.M., BREISIG, S., BUGGISCH, W., TALENT, J.A., MAWSON, R., GEREKE, M., MORROW, J.M., DAY, J. & WEDDIGE, K. (2009): Devonian climate and reef evolution: insights from oxygen isotopes in apatite. - Earth and Planetary Science Letters, 284: 599-609.

KAISER, S.I., STEUBER, T., BECKER, R.T. & JOACHIMSKI, M.M. (2006): Geochemical evidence for major environmental change at the Devonian-Carboniferous boundary mass-extinction. - Palaeogeography, Palaeoclimatology, Palaeoecology, 240: 146-160.

ZACHOS, J., PAGANI, M., SLOAN, L. & THOMAS, E.K. (2001): Trends, rhythms, and aberrations in global climate. - Science, 292: 686-693.

Middle Devonian rugose corals of the Carnic Alps and their relation to the Late Eifelian Kačák Event

Kido, E.[1], Suttner, T.J.[1], Pondrelli, M.[2], Corradini, C.[3], Corriga, M.G.[3], Simonetto, L.[4] & Berkyová, S.[5]

(1) Austrian Academy of Sciences (CPSA) c/o University of Graz, Institute for Earth Sciences (Geology & Paleontology), Heinrichstrasse 26, A-8010 Graz, Austria; *erika.kido@uni-graz.at*; *thomas.suttner@uni-graz.at*
(2) Università D'Annunzio, International Research School of Planetary Sciences, viale Pindaro 42, I-65127 Pescara, Italy; *monica@irsps.unich.it*
(3) Università di Cagliari, Dipartimento di Scienze della Terra, via Trentino 51, I-09127 Cagliari, Italy; *corradin@unica.it*; *maria.corriga@unica.it*
(4) Museo Friulano di Storia Naturale, via Marangoni 39-41, I-33100 Udine, Italy; *luca.simonetto@comune.udine.it*
(5) Czech Geological Survey, P.O.B. 85, 118 21 Praha 1, Czech Republic; *berkyova.s@seznam.cz*

The Early to Middle Devonian is known as an interval dominated by global greenhouse conditions with an acme in diversity, size and latitudinal distribution of reefs during the Eifelian to Givetian. Nonetheless, also the Middle Devonian climax witnessed several climate perturbations that resulted in more or less severe biotic events. One of these events is the Late Eifelian Kačák Event (House 1985), which is represented by a black shale and chert interval documented in sedimentary sequences globally. The polyphase dysoxic/anoxic event-interval is constrained to the *kockelianus*-*ensensis* conodont biozones (House 1985). The event is characterized by significant extinctions among benthic invertebrate groups such as trilobites (e.g., Chlupáč 1994) and distinctive faunal changes as observed in planktonic dacryoconarid tentaculites (e.g., an appearance of index species *Nowakia* (*Nowakia*) ex. gr. *otomari* Bouček & Prantl (e.g., Walliser 1985 and 1996). In addition, effects on other marine organisms such as algae, ammonoids, brachiopods, corals and conodonts were reported in the Barrandian of Czech Republic, the type area of the Kačák Event (Budil 1995, Walliser *et al*. 1995).

Since its recognition, the Kačák Event is known from one lacustrine and at least ten marine areas within the Panthalassic, Rheic and Paleotethys oceans (e.g., Marshall *et al*. 2007, Ellwood *et al*. 2010). As far as documented, biotic response related to the event has been observed mainly from benthic organisms of pelagic deposits. However, the coral community, which is observed in neritic deposits of the Barrandian also shows a faunal change after the Kačák Event (Galle & Hladil 1991). For a better understanding of the processes behind the event we realized that it is necessary to focus especially on changes in neritic tropical coral-communities which are observed before and after the event as these are regarded as the first ones that suffer changing environmental conditions.

Middle Devonian strata of the Carnic Alps are distinguished into ten different units representing a neritic to pelagic succession within an area of approx. 240 km^2 across Austrian-Italian border. According to Schönlaub *et al*. (2004), a horizon with dark-stained (phosphoritic?) lithoclasts of an interval known as “unit 3” within the pelagic succession at Mt. Freikofel (= Mt. Cuelat) could be related to the Kačák Event or the Eifelian/Givetian boundary. A more distally deposited lateral unit of this succession is the Hoher Trieb Formation (Eifelian to Frasnian). In general it is assigned to the distal slope facies and characterized by flaser and platy limestone with clay and chert layers (Kreutzer 1992). Either of above mentioned unit yield corals in breccia-levels. From the breccia level of the Hoher Trieb Fm. exposed at Mt. Findenig (= Mt. Lodin) silicified corals composed of eight species in seven genera have been reported (see Fig. 1). According to the Flügel & Hubmann (1994), the age of these silicified corals is not clear. Latter author referred to “?Givetian” age. Our preliminary study revealed that the conodonts collected from the breccia levels bearing the silicified corals within the Hoher Trieb Fm. cropping out at Lanza area (Italy) indicate not exclusively Givetian but also Eifelian age (*kockelianus* to Lower *varcus* conodont zones). This indicates that the silicified corals were accumulated as redeposited material derived from either Eifelian or Givetian reefal limestone of the neritic carbonate platform. Eifelian to Givetian neritic deposits are observed in the Spinotti Limestone and the overlying Kellergrat Reef Limestone. Although abundant and well preserved corals are known from “unit A” at the base of the Spinotti Lst. (Eifelian; Schönlaub *et al*. 2004), exposed at the Sentiero Spinotti (Italy), they have not been studied in detail yet. From Givetian to Frasnian deposits of the Kellergrat Reef Lst. at Hohe Warte, Kellerwände and Kollinkofel (Austrian-Italian border) ten rugosan species belonging to nine genera are reported (Fig. 1; Oekentorp-Künster & Oekentorp 1992). Of them, one species, *Dendrostella trigemme*, also occurred in the massive reefal limestone unit at Mt. Zermula (Italy). Following Flügel & Hubmann (1994) the massive limestones at Mt. Zermula possibly represent equivalent strata to the Kellergrat Reef Lst. Totally 12 rugosan species in 9 genera have been described from this unit (Ferrari 1968). They are considered to be ?Givetian in age, except for *Tabulophyllum delicatum* which ranges from ?Givetian to Frasnian age (Flügel & Hubmann 1994). Apart from the rugose corals that occur in the Hoher Trieb Fm. at Mt. Findenig, as well as in the Kellergrat Reef Lst. and in the reefal limestone at Mt. Zermula, 29 rugosan species belonging to 18 genera have been found in the Givetian or ?Givetian deposits of the Carnic Alps (e.g., Frech 1887 and Vinassa de Regny 1918).

Kellergrat Reef Limestone	**Massive reefal limestone in Mt. Zermula**	**Hoher Trieb Formation**
Dendrostella trigemme	*Dendrostella trigemme*	*Cystiphyllum*? *geyeri*
Battersbyia sp.	*Palaeophyllum vurgaris*	*Grewingkia*? *carnica*
Acanthophyllum concavum	*Pseudamplexus* sp. aff. *P. frechi*	*Barrandeophyllum carnicum*
Acanthophyllum sp.	*Tabulophyllum delicatum*	*Entelophyllum articulatum*
Grypophyllum sp.	*Tabulophyllum heckeri giveticum*	*Entelophyllum*? *alpinum*
Stringophyllum sp.	*Battersbyia devonica*	*Pycnactis mitratum*
Cyathophyllum? *bathycalyx*	*Stringophyllum schwelmense*	*Sociophyllum torosum*
Columnaria sp.	*Neospongophyllum primordiale*	*Cyathophyllum*? *taramelli*
Alaiophyllum jarushevskyi	*Cyathophyllum dianthus*	
Temnophyllum sp. cf. *T. latum*	*Cyathophyllum coespitosum*	
	Cyathophyllum sp. cf. *C. volaicum*	
	Disphyllum? *recressum*	

Fig. 1: List of the corals from the Kellergrat Reef Limestone (central Carnic Alps), massive reefal limestone at Mt. Zermula and the Hoher Trieb Formation at Mt. Findenig, based on Vinassa de Regny (1918), Ferrari (1968) and Flügel & Hubmann (1994).

An important step was achieved just recently during field work in Lanza area where we found out that in deeper marine deposits the coral bearing breccia-levels commonly are succeeding an interval of black shale with chert nodules. This black shale interval, dated by conodonts in the Oberbuchach II section (Schönlaub *et al*. 2004), represents the Kačák Event and is traceable throughout the entire deeper marine sequence of the Carnic Alps, whereas no black shale was found on the platform where the corals derived from. In order to identify this event also within the shallow marine sequence, we aim to reveal an overview of middle Devonian rugose coral assemblages of the proto-alpine realm, to see if there were any distinctive changes at species-level, which are linked with the Kačák Event.

Research is funded by FWF P23775-B17 and project 334000 of the Czech Geological Survey. This is a contribution to IGCP 596.

References

Budil, P. (1995): The Middle Devonian Kačák Event in the Barrandian area. - Geolines, 3: 7-8.

Chlupáč, I. (1994): Devonian trilobites-evolution and events. - Geobios, 27: 487-505.

Ellwood, B.B., Algeo, T.J., El Hassani, A., Tomkin, J.H. & Rowe, H.D. (2010): Defining the timing and duration of the Kačák Interval within the Eifelian/Givetian boundary GSSP, Mech Irdane, Morocco, using geochemical and magnetic susceptibility patterns. - Palaeogeography, Palaeoclimatology, Palaeoecology doi: 10.1016/j.palaeo.2010.10.012

Flügel, H.W. & Hubmann, B. (1994): Catalogus Fossilium Austriae, Anthozoa palaeozoica: Rugosa. - Österreichische Akademie der Wissenschaften, IVc/1a: 1-141.

Ferrari, A. (1968): Tetracoralli delle Alpi Carniche. - La. Fauna die Monte Zermula. - *Annali* del *Museo* Geologico di *Bologna,* (2a), 36: 531-594.

Frech, F. (1887): Über das Devon der Ostalpen, nebst Bemerkungen über das Silur und einen palaeontologischen Anhang. - Zeitschrift der deutschen Geologischen Gesellschaft, 39: 659-738.

Galle, A. & Hladil, I. (eds.): (1991): Lower Paleozoic Corals of Bohemia and Moravia. - Excursion-Guidebook B3. VI. International Symposium on Fossil Cnidaria: 1-83.

HOUSE, M.R. (1985): Correlation of mid-Palaeozoic ammonoid evolutionary events with global sedimentary perturbations. - Nature, 313: 17-22.

KREUTZER, L.H. (1992): Photoatlas zu den variszischen Karbonat-Gesteinen der Karnischen Alpen (Österreich/Italien). - Abhandlungen der Geologischen Bundesanstalt, 47: 1-46.

MARSHALL, J.E.A., ASTIN, T.R, BROWN, J.F., MARK-KURIK, E. & LAZAUSKIENE, J. (2007): Recognizing the Kačák Event in the Devonian terrestrial environment and its implications for understanding landsea interactions. - Geological Society, London, Special Publications, 278: 133-155.

OEKENTORP-KÜSTER, P. & OEKENTORP, K. (1992): Rugose Korallenfaunen des Mittel- und Ober-Devons der zentralen Karnischen Alpen. - Jahrbuch der Geologischen Bundesanstalt, 135: 233-260.

SCHÖNLAUB, H.P., HISTON, K. & POHLER, S. (2004): The Palaeozoic of the Carnic Alps. - *In*: SCHÖNLAUB, H.P. (ed.): Field Trip Carnic Alps Guidebook. June 23-24, 2004, Carinthia Austria. - Geologische Bundesanstalt, 40: 2-32, Wien.

VINASSA DE REGNY, P. (1918): Coralli mesodevonici della Carnia. - Palaeontographia Italica, 24: 59-121.

WALLISER, O.H. (1985): Natural boundaries and Commission boundaries in the Devonian. - Courier Forschunginstitut Senckenberg, 75: 401-408.

WALLISER, O.H. (1996): Global events in the Devonian and Carboniferous. - *In*: WALLISER, O.H. (ed.): Global events and event stratigraphy in the Phanerozoic. 313 pp. Springer.

WALLISER, O.H., BULTYNCK, P., WEDDIGE, K., BECKER, R.T. & HOUSE, M.R. (1995): Definition of the Eifelian-Givetian Stage boundary. - Episodes, 18: 107-115.

Marine biodiversity dynamics in the mid-Paleozoic oceans and their potential controls

KIESSLING, W.[1], SUTTNER, T.J.[2] & KÖNIGSHOF, P.[3]

(1) Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin; Invalidenstraße 43, 10115 Berlin, Germany; *wolfgang.kiessling@mfn-berlin.de*
(2) Austrian Academy of Sciences (CPSA) c/o University of Graz, Institute for Earth Sciences (Geology & Paleontology), Heinrichstrasse 26, A-8010 Graz, Austria*; thomas.suttner@uni-graz.at*
(3) Senckenberg - Forschungsinstitut und Naturmuseum, Senckenberganlage 15, 60325 Frankfurt, Germany; *peter.koenigshof@senckenberg.de*

Marine biodiversity dynamics during Devonian-Carboniferous times are broadly characterized by two modes: one of high turnover in the Devonian-Mississippian and one of low turnover in the Pennsylvanian. Previous work has attributed this dichotomy to long-term climate change, the change from a (super) greenhouse world to the late Paleozoic Ice Age (STANLEY & POWELL 2003). New oxygen isotopic data (JOACHIMSKI *et al*. 2009) and new analyses of global diversity based on the Paleobiology Database suggest that the relationship between climate change and diversity dynamics was much more complex. For example, global marine diversity declined sharply from an Emsian peak up to the Famennian although climate cooled towards the Middle Devonian but then warmed markedly during the Frasnian. Extinction rates were on average greater in the Devonian than in the Carboniferous but the position of extinction peaks varies substantially between raw data and analyses taking sampling incompleteness into account. Only the latter confirm a major extinction spike at the Frasnian-Famennian boundary. Extinctions were highly selective with respect to physiological buffering capacity (KNOLL *et al*. 2007) in three consecutive stages from the Givetian to the Famennian. The preferential extinction of unbuffered organisms such as corals, sponges and brachiopods might indicate chemical insult as a major trigger of Devonian extinctions (KIESSLING & SIMPSON 2011).

Although comprehensive data on marine organisms are already available in the Paleobiology Database for Devonian-Carboniferous times (91200 occurrences), there are still issues with taxonomic and geographic coverage, as well as stratigraphic resolution. Moreover, analysis of terrestrial changes is currently prevented by a lack of data. These issues need to be solved in IGCP 596 if we are to better biodiversity dynamics in this critical interval of time.

References

JOACHIMSKI, M.M., BREISIG, S., BUGGISCH, W., TALENT, J.A., MAWSON, R., GEREKE, M., MORROW, J.R., DAY, J. & WEDDIGE, K. (2009): Devonian climate and reef evolution: Insights from oxygen isotopes in apatite. - Earth and Planetary Science Letters, 284: 599-609.

KIESSLING, W. & SIMPSON, C. (2011): On the potential for ocean acidification to be a general cause of ancient reef crises. - Global Change Biology, 17: 56-67.

KNOLL, A.H., BAMBACH, R.K., PAYNE, J.L., PRUSS, S. & FISCHER, W.W. (2007): Paleophysiology and end-Permian mass extinction. - Earth and Planetary Science Letters, 256: 295-313.

STANLEY, S.M. & POWELL, M.G. (2003): Depressed rates of origination and extinction during the late Paleozoic ice age: A new state for the global marine ecosystem. - Geology, 31: 877-880.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz | ISSN 1608-8166 | Band 16 | Graz 2011
IGCP 596 Opening Meeting | Graz, 19-24th September 2011

The influence of different acid dissolution methods on insoluble residues of limestones and their magnetic properties and mineralogical composition

Koptiková, L.[1,2], Hladil, J.[1], Schnabl, P.[1,2], Skála, R.[1], Slavík, L.[1], Šlechta, S.[1,2], Böhmová, V.[1] & Šťastný, M.[1]

(1) Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic; *koptikova@gli.cas.cz*; *hladil@gli.cas.cz*; *schnabl@gli.cas.cz*; *skala@gli.cas.cz*; *slavik@gli.cas.cz*; *slechta@gli.cas.cz*; *bohmova@gli.cas.cz*
(2) Charles University in Prague, Faculty of Science, Albertov 6, Prague 2, 12843, Czech Republic

Three different acids and dissolution methods were applied to obtaining of acid-insoluble residues of limestones in the Prague Synform, central Bohemia (Lochkov Formation, Lochkovian, Pozar 3 section near Praha-Reporyje). We have studied mineralogical compositions, structures and physical characteristics of these residues, with particular emphasis on the relationships between compositions and applied methods. The techniques of limestone dissolution are routinely used to extract conodont elements, heavy minerals or any non-noncarbonate impurities in limestone at all. The material obtained is then often used for instrumental analyses, e.g. X-ray, mass spectrometric or image analysis methods, and the results might be considerably affected by different techniques of extraction.
This study is based on three sets of dissolution experiments using the acetic, formic and hydrochloric acid. Mineralogical and magneto-mineralogical properties of these insoluble residues are related to the whole-rock magnetism and identification of carriers of magnetic susceptibility (MS) can help and better understand the complexity of rock magnetism but also the specific effects of each kind of acid on the residual mineral structures. Also the solution regimes have to be considered.

Light and heavy fractions were studied separately using measurements of magnetic susceptibility (MS), temperature, field and frequency dependence of MS, isothermal remanent magnetization (IRM), saturated isothermal remanent magnetization (SIRM), anhysteretic remanent magnetization (ARM), together with X-ray diffraction (XRD) identification of clay minerals and scanning electron microprobe (SEM) and energy dispersive spectroscopic (EDX) analyses. Moreover the results acquired were compared with whole-rock samples and their parameters to find out the role of dissolution of some important magnetic phases and carriers (e.g. iron oxides and oxyhydroxides) in the acids.

This experimental study extends the results of the previous work on residues from the Lochkovian up to Emsian strata from the same section (Koptíková *et al*. 2010) and also the results on the two sets of residues after dissolution in acetic and hydrochloric acids, which were obtained from the S-D boundary beds in the Prague Synform by Vacek *et al*. (2010).

Hydrochloric acid solution method causes almost complete dissolution of iron oxides (magnetite, hematite grains) but SIRM curve reveals the possibility of their later neoformation. XRD analyses revealed very similar diffractograms but slight differences have been identified, despite the fact that the measured amounts of mineral phases are also influenced by detection limits of these methods (1 to 5%), influences of coexisting phases, degree of crystallinity or preferential arrangement. This was eliminated using SEM-EDX analyses of polished samples of aggregated residues and individual mineral grains. Quartz, clay minerals (illite, kaolinite), feldspars (microcline), micas (muscovite, biotite), pyrite and gypsum were identified as the prevailed phases. Marcasite, pyroxene/amphibole grains or rutile grains occur more scarcely, but still in amounts which must be considered for the rock characteristics. The residues obtained using acetic acid have higher variability in mineral assemblages (clay minerals, micas) if compared to those dissolved in formic or hydrochloric acid. All of the studied samples show an evident dominance of mineral phases with paramagnetic behaviour, and iron-bearing minerals of paramagnetic behaviour control the MS signal rather than those having ferromagnetic characteristics (the latter have surprisingly slight contribution to MS, being detected only e.g. by means of IRM).

This study contributes to IGCP 596, IGCP 580, and projects P210/10/2351 and IAAX00130702.

References

KOPTIKOVÁ, L., HLADIL, J., SLAVIK, L., CEJCHAN, P. & BABEK, O. (2010): Fine-grained non-carbonate particulates embedded in neritic to pelagic limestones (Lochkovian to Emsian, Prague Synform, Czech Republic): composition, provenance and links to magnetic susceptibility and gamma-ray logs. - Geologica Belgica, 13 (4): 407-430.

VACEK, F., HLADIL, J. & SCHNABL, P. (2010): Testing the stratigraphic correlation potential of magnetic susceptibility and gamma-ray spectrometric variations in calciturbiditic facies (Silurian-Devonian boundary, Prague Synclinorium, Czech Republic). - Geologica Carpathica, 61 (4): 257-272.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Microhabitat complexity – an example from Middle Devonian Bryozoan-rich sediments

KÖNIGSHOF, P.[1], ERNST, A.[2] & TAYLOR, P.[3]

(1) Senckenberg – Forschungsinstitut und Naturmuseum Frankfurt, Senckenberganlage 25, 60325 Frankfurt am Main, Germany; *peter.koenigshof@senckenberg.de*
(2) Institut für Geowissenschaften der Christian-Albrechts-Universität zu Kiel, Ludewig-Meyn-Str. 10, 24118 Kiel, Germany; *ae@gpi.uni-kiel.de*
(3) Department of Palaeontology, Natural History Museum, Cromwell Road, London SW7 5BD, United Kingdom; *p.taylor@nhm.ac.uk*

West of the river Rhine, the Eifel area (Eifel synclines) is the dominating structural unit interpreted as a N-S trending axial depression of the Rheinisches Schiefergebirge. Siliciclastic sediments were delivered from the north during the Early Devonian and early Middle Devonian (Eifelian) but diminished during Givetian times when shallow subtropical carbonates were established over much of the region.

The study area lies within the Blankenheim syncline, between the villages of Blankenheim and Blankenheimersdorf and comprises shallow shelf mixed carbonate and siliciclastic facies of Middle Devonian age (Eifelian) accumulated on the southern margin of the former Avalonia microcontinent. The outcrop exposes deposits from the top of the Junkerberg Formation (Grauberg sub-formation, Nims, *Latistriatus* and Eisen members) and the transition to the Freilingen Formation (Giesdorf Member) which can be assigned to the *Polygnathus kockelianus/ensensis* conodont biozone. This section exhibits a rather diverse fauna, dominated by bryozoans, brachiopods, corals and other calcifying taxa such as calcimicrobes. Sedimentation rates were quite low as indicated by the abundant occurrence of suspension-feeding organisms and microfacies analysis. According to Standard Microfacies Types (SMF) the carbonates represent wackestones and floatstones and can be assigned to SMF 8 (Facies Zone 7).

A huge number of calcifying taxa such as *Girvanella* occur in some layers, particularly at the transition between the Freilingen Formation and the Junkerberg Formation. Other encrusting/calcifying organisms are present in various layers suggesting deposition during supersaturation of $CaCo_3$ minerals in a calcite sea in a low energy, subtidal environment. The studied bryozoan fauna is very diverse throughout the entire section, erect branched colonies are dominating. Five new taxa were described.

The interesting section attributed to the base of the *otomari* event interval displays an overall transgressive trend in a shallow water environment. One level – the transition between the Freilingen and Junkerberg Formations – coincides with the so-called *ostiolatus* event. Complex fossil communities in some horizons suggest excellent living conditions during deposition correlating with the global rise in sea-level at this time.

Late Devonian pelagic carbonates in northwestern Thailand: constraints and plate tectonic implications based on a multidisciplinary approach

KÖNIGSHOF, P.[1], SAVAGE, N.M.[2], LUTAT, P.[3], DOPIERALSKA, J.[4], BELKA, Z.[4], RACKI, G.[5] & SARDSUD, A.[6]

(1) Senckenberg - Forschungsinstitut und Naturmuseum, Senckenberganlage 15, 60325 Frankfurt, Germany; *peter.koenigshof@senckenberg.de*
(2) Department of Geological Sciences, University of Oregon, Eugene Oregon 97405, USA; *nmsavage@uoregon.edu*
(3) Palaeontological Research and Education Centre, Mahasarakham University, Mahasarakham 44150, Thailand; *petra.l@msu.ac.th*
(4) Isotope Laboratory, Adam Mickiewicz University, 61606 Poznan, Poland; *dopieralska@amu.edu.pl*; *zbelka@amu.edu.pl*
(5) Department of Earth Sciences, Silesian University, 41-200 Sosnowiec, Poland; *racki@twarda.pan.pl*
(6) Sardsud, Apsorn, Department of Mineral Resources, Geological Survey Division, Bangkok 10400, Thailand; *apsornsa@yahoo.com*

Southeast Asia comprises a complex assembly of continental blocks, volcanic arcs, accreted continental crust, and suture zones which constitute remnants of the closed oceanic basins and it is widely accepted that the two principal microcontinents, Sibumasu in the west and Indochina in the east, had formerly been a part of Gondwana. The tectonic framework of Thailand is formed of four units; these are from west to east, the Sibumasu block, the Inthanon zone, the Sukhothai zone, and the Indochina block (e.g., METCALFE 2006, 2009, 2011, UENO 1999).

Detailed conodont stratigraphy, microfacies, isotop geochemistry (see contribution by SAVAGE *et al*., this meeting) as well as Nd isotop studies have been undertaken in two Late Devonian sections in the northwestern part of Thailand. The Mae Sariang section is characterized by very homogenous light- to dark-grey well-bedded limestones. This 11 m thick sequence of Late Devonian very condensed limestones in northwestern Thailand exhibits faunal associations and sedimentological / microfacies criteria which are indicative for an isolated pelagic facies setting, most probably on a seamount. Similar sequences are known worldwide in a few sections only. The unique Mae Sariang section is characterised by low sedimentation rates as recognised by a number of hardgrounds, Fe/Mn crusts, and occuring phosphates. The sequence comprises a number of pelagic faunal elements e.g., conodonts, cephalopods and pelagic ostracodes. The fauna is composed of rare megafossils and the faunal diversity is low (KÖNIGSHOF *et al*. in press). The sequence also contains some Late Devonian events as shown by stratigraphical and geochemical results.

The Thong Pha Phum section which is located about 350km farher south is characterized by a different facies setting, suggesting a proximal position of the section on the shelf. Furthermore, we present Nd isotopic data measured from conodonts of the two sections. These data constitute the first Devonian seawater signatures recognized within the Australian shelf of northeastern Gondwana and in the adjacent Paleotethys Ocean. Although the conodont samples in the investigated sections were not exactly of the same age (in terms of the conodont zonation), they clearly reveal a fundamentally different Nd seawater composition at both sites. Based on a multidisciplinary approach the position of the two Late Devonian sections are dicussed in the framework of existing plate tectonic models.

References

KÖNIGSHOF, P., SAVAGE, N., LUTAT, P., SARDSUD, A., DOPIERALSKA, J., BELKA, Z. & RACKI, G. (in press): Late Devonian sedimentary record of the Palaeotethys Ocean – the Mae Sariang succession, northwestern Thailand. - Journal of Asian Earth Sciences.

METCALFE, I. (2006): Paleozoic and Mesozoic tectonic evolution and palaeogeography of East Asian crustal fragments: The Korean Peninsula in context. - Gondwana Research, 9: 24-46.

METCALFE, I. (2009): An alternative plate tectonic model for the Palaeozoic-early Mesozoic Palaeotethyan evolution of Southeast Asia (northern Thailand-Burma); discussion. - Tectonophysics, 471: 329-332.

METCALFE, I. (2011): Tectonic framework and Phanerozoic evolution of Sundaland. - Gondwana Research, 19: 3-21.

UENO, K. (1999): Gondwana/Tethys divide in East Asia; solution from Late Paleozoic foraminiferal paleobiogeography. - *In*: RATANASTHIEN, B. & RIEB, S.L. (eds.): Proceedings of the International Symposium on Shallow Tethys (ST). - Chiang Mai University, Chiang Mai: 45-54.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Taxonomic diversity of the late Famennian - early Carboniferous foraminifers of the South Urals

KULAGINA, E.I.

Institute of Geology, Ufa Scientific Centre, Russian Academy of Sciences, Ufa, 450077, K. Marx St. 16/2,
Russian Federation; *kulagina@anrb.ru*

The taxonomic diversity of foraminifers from the Devonian-Carboniferous boundary beds was studied based on material from the key sections of the western slope of the South Urals in Russia (Zigan, Sikaza, Ryauzyak, Usuili) and the Berchogur sections of Kazakhstan. These sections are mainly composed of marine carbonates, apparently formed in a shallow-water environment.

This boundary interval includes the *Quasiendothyra communis*, *Q. kobeitusana, Tournayellina pseudobeata, Earlandia minima,* and *Chenyshinella disputabilis* foraminiferal zones of the Russian Scale. The *T. pseudobeata* Zone in the South Urals corresponds to the beds with remnant *Quasiendothyra*. The first appearance of the conodont *Siphonodella sulcata* is fixed within these beds. More than 110 species of 26 genera are identified in the Devonian-Carboniferous boundary interval (KOCHETKOVA *et al*. 1985, 1987). Ten genera are represented by unilocular and bilocular foraminifers (orders Parathuramminida, Earlandiida and Incertae sedis). The others are endothyrids and tournayellids. 41 species are determined in the *Q. communis* Zone. The number of foraminiferal species reaches 90 in the overlying zone, where the maximum diversification of the subfamily Quasiendothyrinae is recorded (in the taxonomy of RAUSER-CHERNOUSOVA *et al*. 1996). About 30 *Quasiendothyra* species and subspecies are recorded in this zone. The assemblage also includes species of *Septatournayella, Septaglomospiranella, Septabrunsiina, Tournayellina* (order Tournayellida).

The minimum species diversity is observed in the *Earlandia minima* Zone, where only 26 species are determined (Fig.1). Most of them unilocular taxa (*Archaesphaera* – 3 species, *Vicinesphaera* - 3, *Parathurammina* – 5, *Parathuramminites* – 3, *Bisphaera* – 5, *Eotuberitina* - 2). Bilocular forms are represented by *Rauserina notata, Earlandia minima* and *Caligella antropovi*. Of multi-locular foraminifers, only *Glomospiranella rara* and *Tournayellina* cf. *pseudobeata* are found in the *E. minima* Zone.

Species diversity begins to increase in the *Ch. disputabilis* Zone and reaches 60 in the overlying *P. tchernyshinensis* Zone due to radiation of the family Chernyshinellidae (Order Tournayellida). The total number of genera reaches 30. At the end of the Tournaisian, due to the extinction of tournayellids and the decreasing diversity of Tournaisian endothyrids, the species diversity drops to 50, in spite of the appearance of numerous short lived taxa.

Viséan and Serpukhovian deposits are widespread in the South Urals. The taxonomic diversity is studied in the sections of the west and east subregions of the Urals. In the early Viséan the species diversity increased from 80 in the *E. simplex* Zone to 100 in the *U. rotundus* Zone due to the rapid evolution of Archaediscida, Endothyrida and Staffellida. The number of genera increased to 50.

In the Late Viséan, species diversity reached its maximum for the Early Carboniferous. This time is characterized by maximum diversification of Endothyrida, Archaediscida, Palaeotextulariida, Ozawainellida (family Eostaffellidae).

At the Viséan-Serpukhovian boundary, species diversity almost halved compared to the underlying beds. More than 60 species known from the Upper Viséan did not continue into the Serpukhovian. At the same time the number of species of encrusting foraminifers increased, and several new eostaffellid and archaediscid (family Howchiniidae) species appeared. In total 45 new taxa appeared in the Serpukhovian, and after reaching maximum diversity in the *E. paraprotvae* Zone, species diversity again decreased.

The study was supported by the Russian Foundation for Basic Research, grant no. 10-05-01076.

References

KOCHETKOVA, N.M., ALEKSEEV, A.S., BARSKOV, I.S., BOGOSLOVSKYI, B.I., GAGIEV, M.KH., KONONOVA, L.I., KULAGINA, E.I., PAZUKHIN, V.N., REITLINGER, E.A., ROMANOV, V.A. & JANBULATOVA, M.G. (1987): Fauna i biostratigrafiya pogranichnykh otlozhenij devona i karbona Berchogura (Mugodzhary). - Moscow, Nauka, 121 pp. [in Russian]

KOCHETKOVA, N.M., PAZUKHIN, V.N., REITLINGER, E.A. & SINITSINA, Z.A. (1985): Opornyje razrezy pogranichnykh otlozhenij devona i carbona zapadnogo sklona Yuzhnogo Urala. Issue 6. Preprint. - Magadan, North-East Research Institute, FESC USSR Academy of Sciences, 66 pp. [in Russian]

MENNING, M., ALEKSEEV, A.S., CHUVASHOV, B.I. *et al*. (2006): Global time scale and regional stratigraphic reference scales of Central and West Europe, East Europe, Tethys, South China, and North America as used in the Devonian – Carboniferous – Permian Correlation Chart 2003 (DCP 2003). - Palaeogeography, Palaeoclimatology, Palaeoecology, 240: 318–372.

RAUSER-CHERNOUSOVA, D.M., BENSH, F.R., VDOVENKO, M.V., GIBSHMAN, N.B., LEVEN, E.YA., LIPINA, O.A., REITLINGER, E.A., SOLOVIEVA, M.N. & CHEDIYA, I.O. (1996): Reference-book on the systematic of the Paleozoic foraminifera (Endothyroida, Fusulinoida) - Moscow, Nauka, 204 pp. [in Russian]

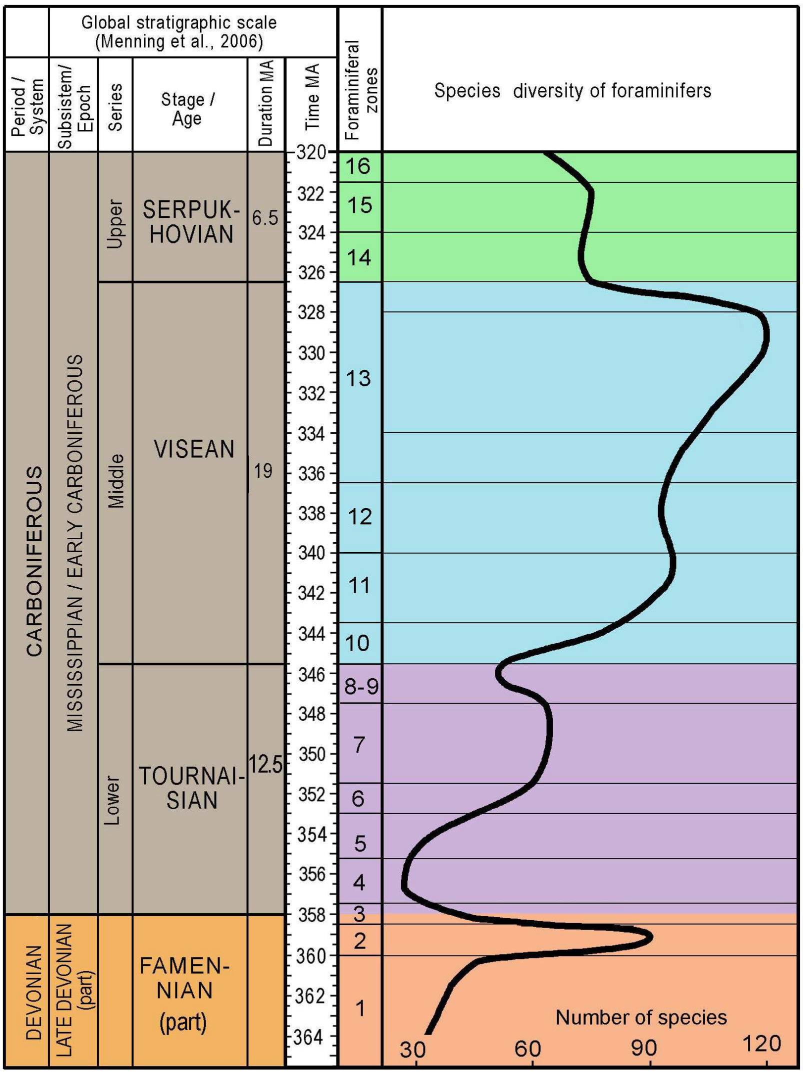


Fig. 1: The species diversity of the late Famennian - early Carboniferous foraminifers of the South Urals. 1-16 – the foraminiferal zones: 1 – *Quasiendothyra communis*, 2 – *Q. kobeitusana*, 3 – *Tournayellina pseudobeata*; 4 – *Earlandia minima*; 5 – *Chernyshinella disputabilis*; 6 – *Palaeospiroplectammina tchernyshinensis*; 7 – *Spinoendothyra costifera*; 8 – *Eotextularia diversa*; 9 – *Eoparastaffella rotunda*; 10 – *E. simplex*; 11 – *Uralodiscus rotundus*; 12 – *Paraarchaediscus koktjubensis*; 13 – *Endothyranopsis crassa – Archaediscus gigas* (3 subzones); 14 – *Neoarchaediscus postrugosus*; 15 – *Eostaffellina paraprotvae*; 16 – *Monotaxinoides transitorius.*

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Latest Silurian and Early Devonian radiolarian assemblages from tuffaceous rocks in the Tomochi area of the Kurosegawa Terrane, central Kyushu, Southwest Japan

KURIHARA, T.

Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan;
tosiyuki@rj8.so-net.ne.jp

Moderately well-preserved radiolarian assemblages of latest Silurian and Early Devonian age were recovered from the Tomochi area in the Kurosegawa Terrane, central Kyushu, Southwest Japan. These radiolarian assemblages provide information in developing the Silurian and Devonian radiolarian biostratigraphy and taxonomy. Silurian and Devonian strata in this area consist of lower felsic tuffaceous rocks (Horagatake Formation) and overlying clastic rocks (Yamaide Formation) (SAITO *et al*. 2005). The former unit is composed of felsic tuff, tuffaceous sandstone, and tuffaceous mudstone and yields abundant radiolarians. From the latter unit, a Late Devonian plant *Leptophloeum* has been reported by SAITO *et al*. (2003).

Three distinctive radiolarian assemblages have been identified in felsic tuff and tuffaceous mudstone. The oldest assemblage recovered from the northeastern flank of Mt. Horagatake contains *Pseudospongoprunum sagittatum* WAKAMATSU, SUGIYAMA & FURUTANI, *Oriundogutta* (?) *kingi* NOBLE, *Ceratoikiscum armiger* FURUTANI, and large inaniguttid species such as *Zadrappolus yoshikiensis* FURUTANI (KURIHARA 2009). This assemblage correlates with the zonal fauna of the Upper Silurian (possible Pridolian) *Devoniglansus unicus – Pseudospongoprunum* (?) *tauversi* Interval Zone of NOBLE (1994). Thin felsic tuff interbedded with tuffaceous sandstone in the northern flank of Mt. Horagatake contains abundant *Pactarentinia holdsworthi* FURUTANI along with *Tlecerina exilis* FURUTANI and *Glanta yokokurayamaensis* UMEDA. It can be correlated with the Emsian *Glanta fragilis* Zone of UMEDA (1998). The youngest assemblage occurs above strata containing *P. sagittatum* and contains *Palaeoscenidium ishigai* WAKAMATSU, SUGIYAMA & FURUTANI, *Deflantrica solidum* WAKAMATSU, SUGIYAMA & FURUTANI, *P. holdsworthi*, *Tlecerina horrida* FURUTANI, and *Protoholoeciscus hindea* AITCHISON. This assemblage is Emsian in age, based on the correlation with the *Protoholoeciscus hindea* Zone of UMEDA (1998).

From this preliminary examination, it is clear that radiolarian assemblages in the Tomochi area have high biostratigraphic potential, and further biostratigraphic work is needed to refine the age calibration and to recognize distinctive biohorizons.

References

KURIHARA, T. (2009): Late Silurian radiolarians from the Horagatake Formation of the Kurosegawa terrane in the Tomochi area, central Kyushu, Southwest Japan. - News of Osaka Micropaleontologists (NOM), Special Volume, no. 14: 571-576. [in Japanese with English abstract]

NOBLE, P.J. (1994): Silurian radiolarian zonation for the Caballos Novaculite, Marathon Uplift, West Texas. - Bulletin of American Paleontology, 106: 1-55.

SAITO, M., MIYAZAKI, K., TOSHIMITSU, S. & HOSHIZUMI, H. (2005): Geology of the Tomochi district. - Quadrangle Series, 1:50,000, Geological Survey of Japan, AIST, 218 p. [in Japanese with English abstract]

SAITO, M., SAIKI, K. & TOSHIMITSU, S. (2003): Late Devonian *Leptophloeum* from the coherent strata in the Kurosegawa Belt, Tomochi district, central Kyushu. - Journal of the Geological Society of Japan, 190: 293-298.

UMEDA, M. (1998): Upper Silurian - Middle Devonian radiolarian zones of the Yokokurayama and Konomori areas in the Kurosegawa Belt, southwest Japan. - The Island Arc, 7: 637-646.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Late Silurian to Devonian pelagic facies in the Khangai–Khentei belt, Central Mongolia (Central Asian Orogenic Belt) and its radiolarian age

KURIHARA, T.[1], TSUKADA, K.[2], OTOH, S.[3], MANCHUK, N.[2,4], MATSUMOTO, A.[1], SERSMAA, G.[4] & MINJIN, CH.[4]

(1) Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan; *tosiyuki@rj8.so-net.ne.jp*
(2) The Nagoya University Museum, Nagoya 464-8601, Japan; *tsukada@num.nagoya-u.ac.jp*
(3) Department of Earth Sciences, Faculty of Science, University of Toyama, Toyama 930-8555, Japan; *shige@sci.toyama-u.ac.jp*
(4) School of Geology and Petroleum Engineering, Mongolian University of Science and Technology, Ulaanbaatar, Mongolia; *manchukn@gmail.com*; *sers_gon@yahoo.com*; *c_minjin@yahoo.com*

In the past 15 years, radiolarian researches for pelagic chert facies within Middle Paleozoic accretionary complexes or upon ophiolites have been increasing steadily worldwide and contributed to the understanding of their evolutionary histories. Recent studies undertaken in the Khangai–Khentei belt of the Central Asian Orogenic Belt, Central Mongolia have revealed the widespread occurrences of radiolarian chert and related oceanic and terrigenous rocks within Paleozoic accretionary complexes. Here we present the results of the detailed lithostratigraphic and radiolarian biostratigraphic investigations of the Gorkhi and Erdenetsogt formations in the Khangai–Khentei belt.
The Gorkhi and Erdenetsogt formations consist of sandstone, shale, alternating sandstone and shale of turbidite affinity and chert with small amounts of siliceous shale, basalt, limestone, and clast-bearing mudstone. Radiolarian chert that is completely devoid of terrigenous clastic material is commonly associated with underlying basalt (sedimentary contact) and conformably overlying siliceous shale and turbidite deposits. The tectonic stacking of basalt–chert and chert–turbidite successions is the most remarkable structural feature of the formations.

A standard hydrofluoric acid etching technique was used to recover moderately well-preserved radiolarians and conodonts from red chert, leading to the recognition of four radiolarian assemblages (Assemblages 1 to 4) that have a combined age range from the latest Silurian (Pridolian) to the Late Devonian (Frasnian) (KURIHARA *et al*. 2009). Assemblage 1, constrained to the latest Silurian on the basis of conodonts (e.g., *Ozarkodina remscheidensis eosteinhornensis*), is characterized by the occurrence of spumellarians (ca. 120-140 μm in shell diameter), but preservation is very poor. Several specimens have a moderately large cortical shell with a short external spine grooved at the base. These characteristics support the assignment of these specimens to the family Inaniguttidae, which ranges from Middle Ordovician to Lower Devonian and is most common in the Upper Silurian. Assemblage 2 includes diversified palaeoscenidiids (*Deflantrica solidum*, *Pactarentinia holdsworthi*, *Tlecerina horrida*) which have previously been reported from only a handful of Lower Devonian localities in Japan. Assemblage 3 is characterized by diverse Middle Devonian entactiniid species, such as *Trilonche parapalimbola*, *T. elegans*, and *T. davidi*. Assemblage 4 is composed of poorly preserved but robust taxon *T. minax*, ranging from late Givetian to Frasnian. It also contains poorly preserved conodont elements of *Palmatolepis* sp. Assemblages 1, 2, and 4 were recovered from red chert of the Gorkhi Formation around Ulaanbaatar. Radiolarians of Assemblage 3 were recognized in several chert localities in the Gorkhi Formation and a small chert block of the Erdenetsogt Formation in the Harhorin area. Although no biostratigraphic control exists for the siliceous shale, shale, and sandstone, they are considered to be latest Devonian or slightly younger on the basis of the stratigraphic relationships with underlying chert. According to KELTY *et al*. (2008), the peak U–Pb age of zircon grains collected from sandstone of the Gorkhi Formation outcropping near our radiolarian localities is earliest Carboniferous, indicating that felsic volcanism along the subduction zone above which the Gorkhi Formation formed.

The Gorkhi and Erdenetsogt formations have previously been interpreted as a thick sedimentary basin deposit overlying a hidden Archean–Neoproterozoic basement (BADARCH *et al*. 2002); however, the stratigraphy within individual tectonic slices clearly corresponds to that of an ocean plate stratigraphy generated by the trenchward movement of an oceanic plate. From the lowermost to uppermost units, the stratigraphy comprises ocean floor basalt, pelagic deep-water radiolarian chert, hemipelagic siliceous shale, and terrigenous turbidite deposits. The biostratigraphic data obtained in the present study provide corroborating evidence for the existence of a (probably gigantic) deep-water ocean that enabled the continuous sedimentation of pelagic chert over a period of nearly 50 million years. These data, together with structural data that are characterized by tectonic repetition of the stratigraphy, indicate that these rocks formed as an accretionary wedge along an active continental margin, possibly that of the Angara Craton. The ocean chert deposited probably corresponds to the northern hemisphere portion of the Paleo-Pacific Ocean that faced the Angara Craton and the North China–Tarim blocks. Thus, we propose that pelagic facies within the accretionary complex of Mongolia will play important roles in understanding detailed tectonic history of the Central Asian Orogenic Belt and biodiversity of pelagic realm in Middle Paleozoic time.

References

BADARCH, G., CUNNINGHAM, W.D. & WINDLEY, B.F. (2002): A new terrane subdivision for Mongolia: implications for the Phanerozoic crustal growth of Central Asia. - Journal of Asian Earth Sciences, 21: 87-110.

KELTY, T.K., YIN, A., DASH, B., GEHRELS, G.E. & RIBEIRO, A.E. (2008): Detrital zircon geochronology of Paleozoic sedimentary rocks of the Hangay-Hentey basin, north-central Mongolia: Implications for the tectonic evolution of the Mongol-Okhtsk Ocean in central Asia. - Tectonophysics, 451: 290-311.

KURIHARA, T., TSUKADA, K., OTOH, S., KASHIWAGI, K., MINJIN, CH., DORJSUREN, B., BUJINLKHAM, B., SERSMAA, G., MANCHUK, N., NIWA, M., TOKIWA, T., HIKICHI, G. & KOZUKA, T. (2009): Upper Silurian and Devonian pelagic deep-water radiolarian chert from the Khangai–Khentei belt of Central Mongolia: Evidence for Middle Paleozoic subduction–accretion activity in the Central Asian Orogenic Belt. - Journal of Asian Earth Sciences, 34: 209-225.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Evaluation of the intended Givetian (Middle Devonian) Substages subdivision in the Spanish Central Pyrenees

LIAO, J.-C.[1,2], VALENZUELA-RÍOS, J.I.[2] & GOUWY, S.[3]

(1) Department of Paleontology, University Complutense, C/. Antonio Novais 2, E-28040 Madrid, Spain;
jau.liao@uv.es
(2) Department of Geology, University of Valencia, c/Dr. Moliner 50, E-46100 Burjasot, Spain;
jose.i.valenzuela@uv.es
(3) University of Missouri, 101 Geological Sciences Building, 65211 Columbia (MO), USA;
sofiegouwy@yahoo.com

After a successful investigation in many regions globally distributed, the International Subcommission on Devonian Stratigraphy (SDS) formally voted the definition of Givetian substages in 2007. This subdivision is based in the conodont zonal scheme that has been achieved after more than 30 years of intense research in many areas worldwide. However, data from Spain were not considered (as they were not available in enough detail at that time) in this decision. Therefore, a detailed study of key Spanish sections for testing the applicability of the intended subdivision in Spain was undertaken. The purpose of this report is, thus, to present the state-of-the-art regarding the Givetian conodont sequence from one Spanish key region (the Central Pyrenees) and to correlate this sequence with the globally established as standard.

After the SDS formal Givetian sub-stage ballot, this stage is subdivided into three sub-stages, Lower, Middle and Upper Givetian respectively. The base of the Lower Givetian coincides with the base of the Givetian, which is defined by the entry of the conodont *Polygnathus hemiansatus*. The Middle Givetian starts at the base of the *rhenanus*/*varcus* Zone. The base of the Upper Givetian coincides with the beginning of the *hermanni* Zone.

The Spanish sequence studied herein is compiled from five relevant sections that stretch between the Esera and Segre rivers (about 100 km along W-E strike) and comprises two of the main sub-facies areas of the Pyrenean southern facies.

The entry of *P. hemiansatus* in section Renanué (LIAO *et al*. 2008) permits precise location of the Eifelian/Givetian boundary and, consequently, of the Lower Givetian base. The second Givetian zone, the *timorensis* zone, is identified in several Pyrenean sections.

The entry of *P. rhenanus* allows identification of the Middle Givetian base. The taxon is recorded in the Renanué, Compte, La Guardia d'Ares and Villech sections (LIAO *et al*. 2008, LIAO & VALENZUELA-RÍOS 2008, GOUWY 2010), although the record in the latter section is delayed as its first occurrence is within the overlying *ansatus* Zone. The *ansatus* Zone is recorded in all sections. In the upper half of this zone a radiation of *Tortodus* is documented. The upper zone of the Middle Givetian, the *semialternans/latifossatus* zone is identified by the entry of the nominal taxa in Villech and Compte sections; in the other sections the conodont association and its stratigraphical position permits its recognition.

The appearance of *Schmidtognathus hermanni* defines the Upper Givetian; the record of *P. cristatus ectypus* permits recognition of its two-fold subdivision (LIAO & VALENZUELA-RÍOS 2008). The sequential entries of *Klapperina disparilis* and *P. dengleri* warrants identification of the *disparilis* zone and of its further subdivision into two parts in most of the Pyrenean sections. The entry of *Skelethognathus norrisi* in all sections identifies the latest Givetian LIAO *et al*. 2008, LIAO & VALENZUELA-RÍOS 2008, GOUWY 2010).

The compiled Pyrenean conodont sequence is comparable with the standard succession document in other parts of the world. The successive entry of key index taxa permits identification of the intended three-fold subdivision of the Givetian Stage and supports this proposal.

Acknowledgements

This work is a contribution to the IGCP-596 Climatic change and biodiversity patterns in the Mid-Paleozoic (Early Devonian to Late Carboniferous). It has been partially supported by the DAAD (J-C. L), the AvH-Stiftung (J.I. V-R), ACI2009-1037 of the MICINN (Spain) and by the CGL2011-24775.

References

GOUWY, S. (2010): Middle Devonian conodonts from the northwestern margin of Gondwana. - Unpublished Ph. D. Thesis, Univerità di Modena e Reggio Emilia and Universitat de València, 199 pp.

LIAO, J.-C., KÖNIGSHOF, P., VALENZUELA-RÍOS, J.I. & SCHINDLER, E. (2008): Depositional environment interpretation and development of the Renanué section (Upper Eifelian- Lower Frasnian; Aragonian Pyrenees, N. Spain). - Bulletin of Geosciences, 83 (4): 481-490.

LIAO, J.-C. & VALENZUELA-RÍOS, J.I. (2008): Givetian and early Frasnian conodonts from the Compte Section (Middle-Upper Devonian, Spanish Central Pyrenees). - Geological Quaterly, 52 (1): 37-54.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

U-Pb isotopic dating of Devonian radiolarian-bearing Yoshiki Formation in Japan

MANCHUK, N.[1], TSUKADA, K.[2], HIDAKA, H.[3], HORIE, K.[4] & SUZUKI, K.[5]

(1) School of Geology and Petroleum Engineering, Mongolian University of Science and Technology. P.O.Box 46/654, Ulaanbaatar 46, Mongolia 210646; *manchukn@gmail.com*
(2) Nagoya University Museum. Chikusa, Nagoya 464-8601, Japan; *tsukada@num.nagoya-u.ac.jp*
(3) Department of Earth and Planetary Systems Science, Hiroshima University. Higashi-Hiroshima 739-8526, Japan; *hidaka@hiroshima-u.ac.jp*
(4) National Institute of Polar Research, 10-3, Midoricho, Tachikawa, Tokyo 190-8518, Japan; *horie.kenji@nipr.ac.jp*
(5) Center for Choronological Research, Nagoya University. Chikusa, Nagoya 464-8601, Japan; *suzuki@nendai.nagoya-u.ac.jp*

Post-Carboniferous, global, radiolarian biostratigraphy is based on numerous studies, and radiolaria is currently recognized as an important tool for revealing Earth's history. That said, much work remains to be done on the biostratigraphy of pre-Devonian radiolarians.

In order to test the ages of Devonian radiolarian biostratigraphic zones, we did radiometric dating of magmatic zircons within the Devonian radiolarian-bearing Yoshiki Formation, Takayama city, Japan. The Yoshiki Formation is mainly composed of alternating beds of tuffaceous sandstone, tuffaceous mudstone, and felsic tuff. The tuffaceous mudstone and tuff yield very well-preserved radiolarian fossils.

We collected well-preserved radiolarians and zircon grains from 21 tuffaceous mudstones and 30 tuff horizons of the Yoshiki Formation. The following species were identified: *Zadrappolus* (?) *nudus, Zadrappolus lunaris, Oriundogutta* (?) *varisoina, Futobari solidus, Oriundogutta* (?) *kingi, Futobari morishitai, Zadrappolus tenuis and Zadrappolus yoshikiens.* These radiolarians assigned to the *Zadrappolus tenuis-Futobari solidus* Assemblage (KURIHARA 2007) are considered to be Late Silurian to Early Devonian in age. The 11 zircon and 2 monazite grains obtained from the same stratigraphic levels with the radiolarians yielded U-Pb SHRIMP and CHIME ages ranging from Paleozoic to Mesozoic up to 180 Ma. We will discuss the exact age of the *Zadrappolus tenuis-Futobari solidus* Assemblage from the Yoshiki Formation in Japan using U-Pb isotopic dating in the presentation.

References

KURIHARA, T. (2007): Uppermost Silurian to Lower Devonian radiolarians from the Hitoegane area of the Hida-gaien terrane, central Japan. - Micropaleontolgy, 53: 221-237.

Diversity of conodonts in the Lochkovian and Early Pragian (Early Devonian) of the western slope of the Southern Ural

MAVRINSKAYA, T.M.

Institute of Geology, Ufimian Scientific Centre, RAS K. Marx Str., 16/2, Ufa 450077, Russia; *stpal@anrb.ru*

The representative and complete Lower Devonian sections of Lochkovian and Pragian deposits are located in the southern part of the West Zilairian structural-facial zone and correspond to the shelf facies of the Southern Ural paleobasin (Fig. 1).

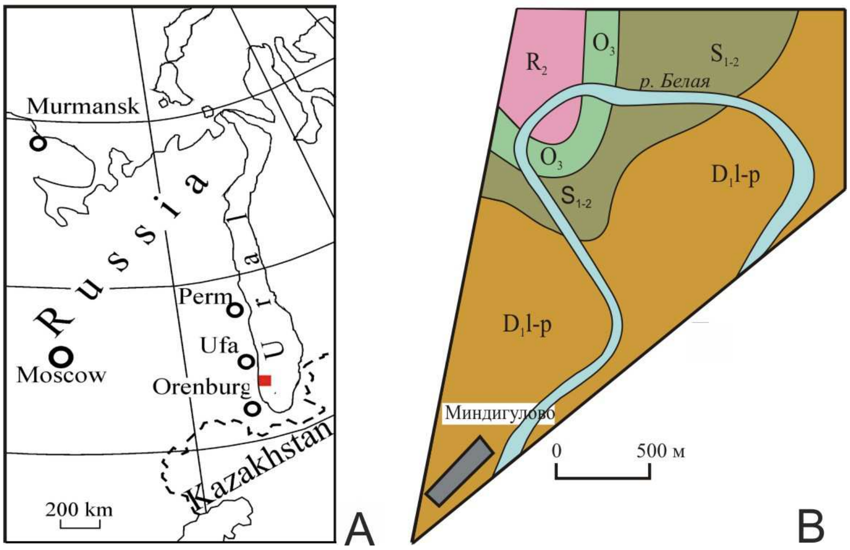


Fig. 1: A – The location of the area under study in Russia, B – Geological map of the area under study (according to SHEFER *et al*. 2001).

Detailed stratigraphic and biostratigraphic studies the Lower Devonian formations in the area were carried out in 1960 - 70 years (KRAUSE & MASLOV, 1961, TYAZHEVA *et al*. 1976).

In recent years several sections were studied for the purpose of investigation of conodont fauna. The most informative data were obtained from a section on the right bank of Belaya river at the village Mindigulovo. For the first time in the Lochkovian and the lower part of the Pragian of the Southern Ural a sequence of conodont associations was established, which can be correlated with the standard conodont zones (bottom-up):

1) The lowest part: the *postwoschmidti – woschmidti* Zone – *Ozarkodina remscheidensis remscheidensis* ZIEGL., *Caudicriodus woschmidti* (ZIEGL.) complex;
2) The next complex is characteristic one of the *delta* Zone, is represented by species *Ancyrodelloides* cf. *asymmetricus* (BISCH. & SANN.), *A.* aff. *delta* (KLAPP. & MUR.), *Ozarkodina remscheidensis repetitor* (CARLS & GANDL), *O. stygia* FLAJS, *Ozarkodina remscheidensis* ZIEGL. → *Ozarkodina pandora* MUR., MATTI & WALL., *Pandorinellina optima optima* (MOSK.);
3) The complex typical for the *pesavis* Zone, presented by *Ancyrodelloides trigonicus* (BISCH. & SANN.), *A. eleanorae* (LANE & ORM.), *A. transitans* (BISCH. & SANN.), *A. orcula* WILSON, *Ozarkodina pandora* MUR., MATTI & WALL., *O. stygia* FLAJS, *Pandorinellina exigua philipi* (KLAPP.), *Pandorinellina optima optima* (MOSK.);
4) The complex with *Caudicriodus angustoides alcoleae* (CARLS), *Pandorinellina exigua philipi* (KLAPP.) (with a predominance of *C. a. alcoleae),* common in *pesavis* Zone;

5) The complex typical for *sulcatus* Zone, contains: *Ozarkodina pandora* MUR., MATTI & WALL., *Ozarkodina pandora* MUR., MATTI & WALL. → *Eognatodus sulcatus eosulcatus* MUR., *Eognatodus sulcatus eosulcatus* MUR., *Pandorinellina miae* BULT.

The abundance and diversity of taxa in selected conodont associations are not equal (Fig. 2). The complex 4 (*pesavis* Zone) is the richest in species diversity and abundance of conodonts. 16 species and subspecies of 6 genera were identified in this complex. The number of specimens in it is up to 150 sp. per 1 kg of rock. 10 species and subspecies of 5 genera are found in the complex 3 (*delta* Zone). Number of conodonts in it is 90-100 sp. / 1 kg of rock. The remaining complexes are few in number and poor in species composition.

There is a facies dependence of conodont fauna in this section. Clay and lump limestone, apparently formed in calm, relatively deep-water conditions, is characterized by presence of a greatest number of diverse conodont fauna. Conodont complexes are represented mostly by genera *Pandorinellina, Ozarkodina, u Ancyrodelloides.* The organogenic, organogenic-detrital limestone, formed in well-aerated shallow-water shelf, contain fauna poor in taxonomy and abundance. They are dominated by Icriodontidae family. Fig. 2 shows that the levels where conodont complexes change are close to the levels of facial changes.

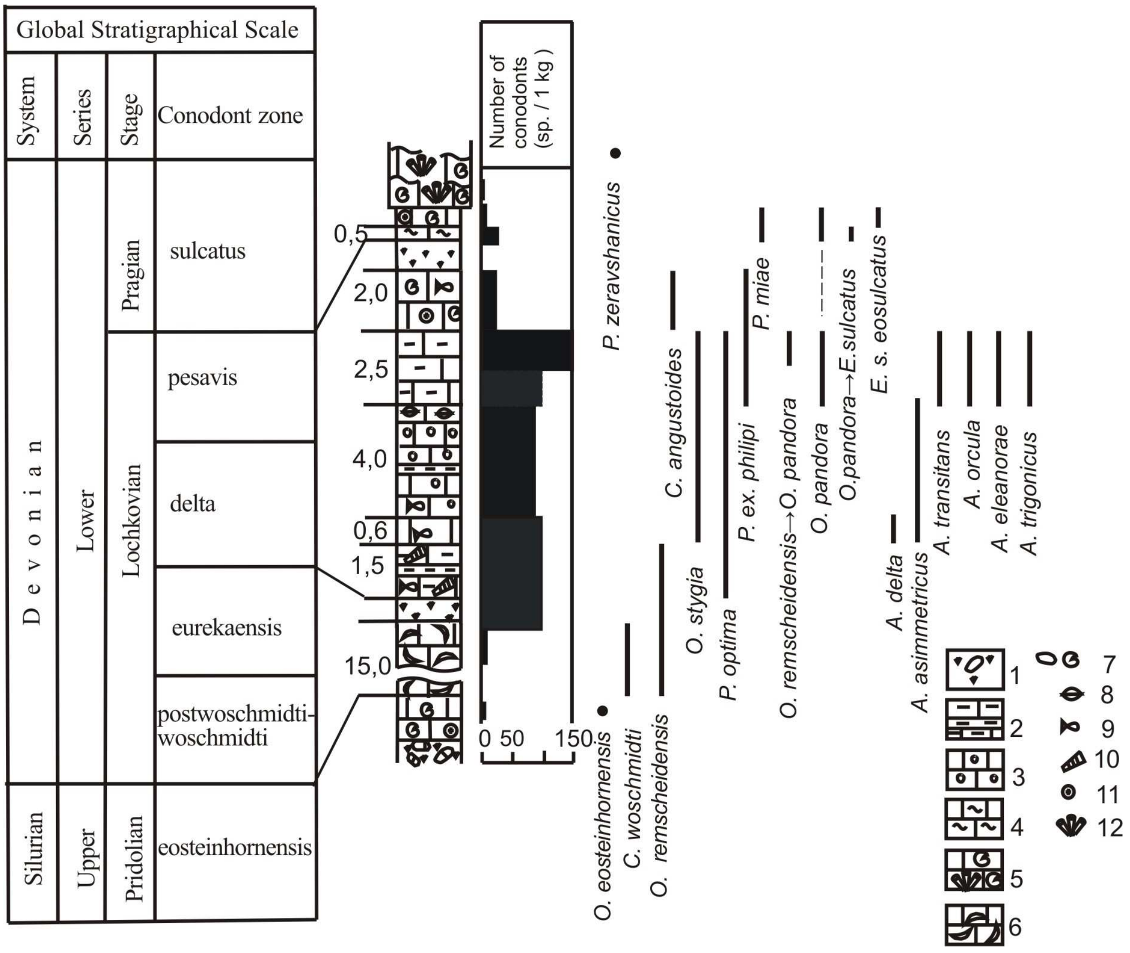


Fig. 2: Distribution of typical conodonts in the Lochkovian and Lochkovian/Pragian boundary beds of the Mindigulovo section. 1 – grass-covered interval with limestone boulders; 2 – clay limestone with interbeds of clay shale; 3 – lump limestone; 4 – bituminous limestones; 5 – organogenic limestones; 6 – organogenic-detrital limestones; 7 – shell fauna; 8 – ostracods; 9 – fish remains; 10 – tentaculites; 11– crinoids;12 – corals.

A preliminary analysis of selected conodont fauna allowed to outline two phylogenetic lines: *Ozarkodina remscheidensis – Ozarkodina pandora – Eognatodus sulcatus u Ozarkodina remscheidensis – Pandorinellina optima – Pandorinellina exigua philipi – Pandorinellina miae.*

It is supposed that the evolutionary line *Ozarkodina remscheidensis - O. pandora - Eognatodus sulcatus* marked the start of a new genus *Polygnathus*, on the phylogeny of which, next conodont zonal scales from the top of Prague until the end of the Middle Devonian are based (MAWSON, 1998). Thus, the development of Lochkovian and Pragian conodont fauna in the Southern Urals paleobasin is a continuous series of phylogenetic and biofacies change.

This work supported by RFBR, RAS, project 11-05000737-a.

References

KRAUZE S.N. & MASLOV V.A. (1961): Ordovik, silur i nizhnii devon Zapadnogo sklona Bashkirskogo Urala - Ufa: BFAN SSSR, 94 pp.

MAWSON, R. (1998): Thoughts on Late Pragian- Emsian polygnathid evolution: documentation and discussion. - *In*: SZANIAWSKI, H. (ed.): Proceedings of the Sixth European Conodont Symposium (ECOS VI). - Palaeontologia Polonica 58: 201-211.

SHEFER, V.A., KOCHERGIN, A.V. & KOCHERGINA, I.A. (2001): Geological study of the scale 1:50000 with general search Kana area within the sheet N-40-103-A, a, b, d; N-40-103-B; N-40-103-B-b, d; N -40-103-T. - Ufa, Bashgeolfond, 2001. 298 pp.

TYAZHEVA, A.P. ZHAVORONKOVA, R.A. & GARIFULLINA A.A. (1976): Korally i brachiopodi nizhnego devona Yuzhnogo Urala. - Nauka, Moscow, 184 pp. [in Russian]

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Conodont biofacies record of the Givetian transgressive levels in the Lublin and Łysogóry-Radom basins (SE Poland)

NARKIEWICZ, K.[1] & NARKIEWICZ, M.[1]

(1) Polish Geological Institute-National Research Institute, Rakowiecka 4, 00-975 Warszawa, Poland; *katarzyna.narkiewicz@pgi.gov.pl*; *marek.narkiewicz@pgi.gov.pl*

The paleoecological studies of the Devonian conodonts have been continuing for the last half a century. Only recently, however, they tend to compare strictly contemporaneous assemblages (to exclude an effect of evolution), and are increasingly conducted not only on a generic but also on a species level. We applied such an analytical approach in a case of the Middle and Upper Givetian conodonts from the Mid-Devonian epicontinental basins in SE Poland. The Lublin Basin is characterized by a prevalence of nearshore marine facies with a considerable proportion of terrigeneous and evaporitic sediments, whereas in the adjoining Łysogóry-Radom Basin open-shelf carbonate-shaly facies dominate. We analysed material from a basal part of the regional transgressive-regressive cycles T-4 and T-5 and their equivalents. These strata were dated as the *ansatus* and *norrisi* zones, respectively (NARKIEWICZ & NARKIEWICZ 1998, NARKIEWICZ & BULTYNCK 2007), and were referred to the eustatic transgressive events of the global T-R cycles IIa (Taghanic Event) and IIb.

The biofacies study comprised 23 samples from 7 boreholes, with no less than 20 specimens per sample, 730 platform (P_1) elements in total. The studied assemblages were dominated by genera *Polygnathus* and *Icriodus*. Their distribution in the host sediments generally confirms previous paleoecological models for the Mid-Devonian which interpret *Polygnathus* as a more open/deeper shelf form, and *Icriodus* as a more proximal and shallow-water.

The T-4 cycle in the Lublin Basin displays a characteristic vertical pattern of biofacies. It starts with the early transgressive phase typified by a polygnathid-icriodid (P-I) biofacies with a considerable proportion of icriodids and a maximum percentage of *P. ansatus*. Peak flooding is recorded as a transition to polygnathid biofacies with a significant drop in icriodids and a maximum abundance of *P. linguiformis*. The succeeding stage is associated with a return of P-I biofacies under conditions of incipient regression. The regressive trend led to an overall conodont retreat followed by a subordinate transgressive pulse associated with the icriodid biofacies.

The lateral variation in conodont biofacies of the initial IIa and IIb transgressions is compared to depositional patterns in both basins (Fig. 1). In the early stage of the Taghanic transgression the basins are characterized by a development of the P-I biofacies which suggests generally uniform conditions for conodont faunas. *Belodella* seems to have preferred most shallow-water and/or nearshore conditions as it is associated with flanks of a carbonate shoal (Fig. 1A). Proportion of polygnathids to icriodids is comparable, nevertheless the former attain a maximum abundance in the open-shelf environment (Korczmin IG 1) while their minimum corresponds to a brackish lagoon or estuary with intermittent open-marine conditions (Terebiń IG 5). Among the polygnathids the most distal form is *P. linguiformis* which thus represents an opposite extreme of ecological requirements relative to the proximal *Belodella*.

The depositional environments of the *norrisi* Zone (transgression IIb) are comparable to the earlier ones but the associated conodont assemblages are different. To a large degree this is due to an evolutionary factor, including disappearance of some forms and introduction of other, mainly in the *hermanni* Zone. The transition from a shallow-water carbonate platform to an open shelf (Fig. 1) is paralleled by a change from the icriodid to P-I biofacies. The shallowest environments were inhabited by *Pandorinellina insita* (appearing in the *norrisi* Zone) and *I. subterminus*. Among the icriodids the species diversity is comparable to that in the *ansatus* Zone. Nevertheless, among the forms typical for deeper-water facies the extinct *I. arkonensis* and *I. platyobliquimarginatus* were replaced by *I. expansus* and *I. cedarensis*. Similarly, the most abundant polygnathid species in the *ansatus* Zone, *P. linguiformis* and *P. ansatus* were replaced by narrow-platform species like *P. webbi* and *P. dubius*.

References

Narkiewicz, K. & Bultynck, P. (2007): Conodont biostratigraphy of shallow marine Givetian deposits from the Radom-Lublin area, SE Poland. - Geological Quarterly, 51: 419-442.

Narkiewicz, K. & Narkiewicz, M. (1998): Conodont evidence for the Mid-Givetian Taghanic Event in south-eastern Poland. - Palaeontologia Polonica, 58: 213-223.

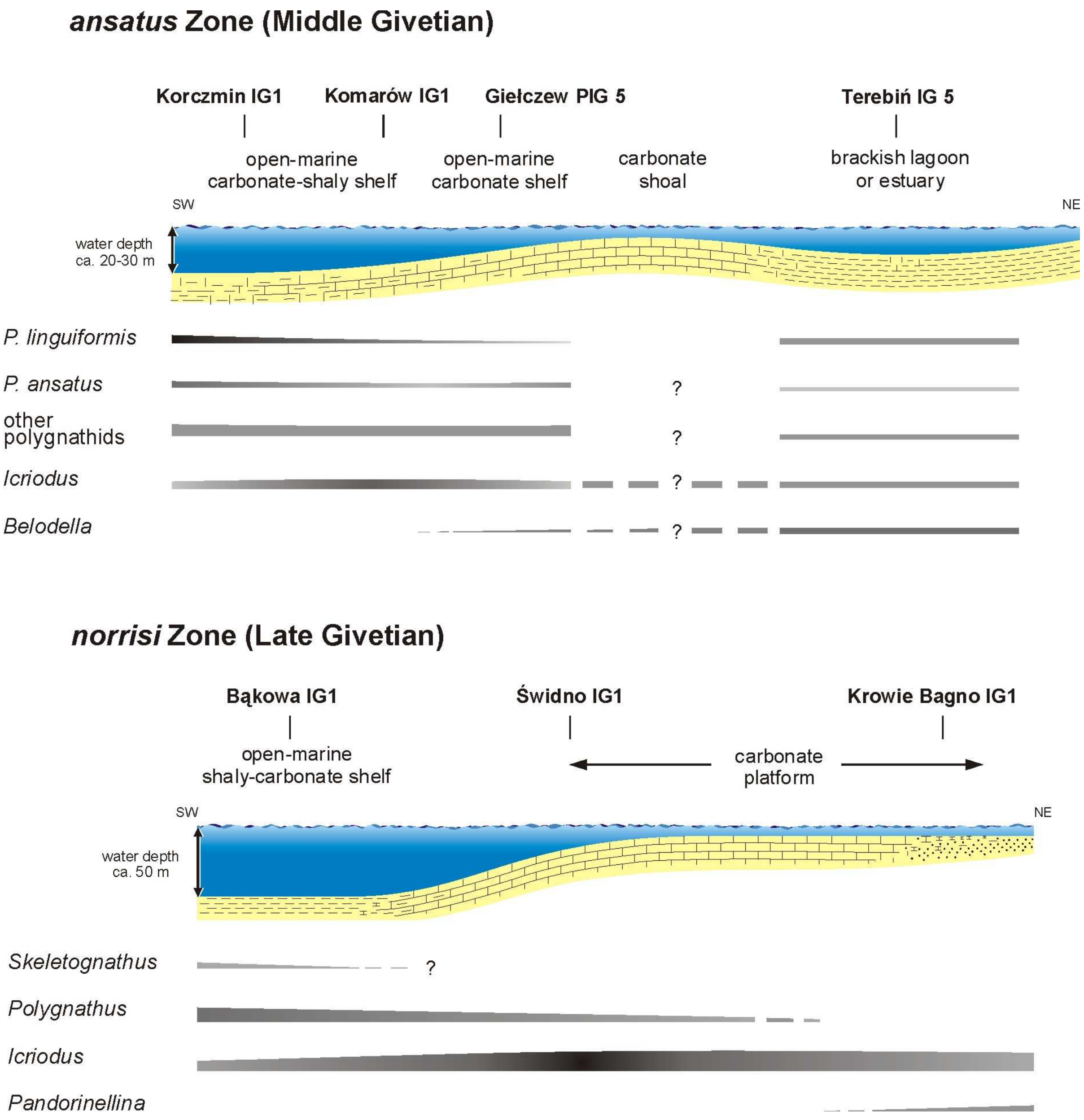


Fig. 1: Patterns of conodont taxa distribution in depositional environments of the Givetian Lublin and Łysogóry-Radom basins of the *ansatus* Zone (IIa transgression) and *norrisi* Zone (IIb transgression).

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Sedimentology of a continuous Givetian-Frasnian carbonate succession in Sauerland (Germany) and MS comparison with the time-equivalent ones of Ardennes (Belgium) and Moravia (Czech Republic)

PAS, D.[1], DA SILVA, A.C.[1], BOULVAIN, F.[1], CORNET, P.[1] & KÖNIGSHOF, P.[2]

(1) Sedimentary Petrology, B20, Université de Liège, Sart-Tilman 4000, Liège, Belgium; *dpas@ulg.ac.be*; *ac.dasilva@ulg.ac.be*; *fboulvain@ulg.ac.be*; *pierrejcornet@gmail.com*
(2) Senkenberg, Forschunginstitut und Naturmuseum Frankfurt, Senkenbergganlage 25, 60325 Frankfurt, Germany; *peter.koenigshof@senckenberg.de*

This study focuses on the continuous Givetian-Frasnian section of the abandoned Burgberg quarry (Messinghausen Anticline, northern margin of the Rhenish Mountains). The exposed section (102 m thick) covers a well constraint stratigraphic interval starting at the base of the Givetian (STRITZKE 1991, ABOUSSALAM *et al*. 2003) and according to STRITZKE (1991) and our new datations ending within the Lower Famennian.

The Middle-Upper Devonian shelf-edge within the Rheinisches Schiefergebirge can be traced from the supposed position along the southern rim of the Dinant Syncline and the Eifel Synclines, northwards along a line connecting the southern margin of the Devonian reefal outcrops of Attendorn and Brilon (KREBS 1967, 1974). The depositional setting of the investigated section corresponds to complex slope and basinal environments where reworked material from the proximal Brilon platform (located to the north) and basin deposits coexist. Thus, this section allows to follow the evolution of the Givetian-Frasnian Brilon platform (e.g., MACHEL 1990, STRITZE 1990, 1991) in a deeper setting. Petrographic analysis of more than 300 thin-sections leads to the identification of 10 microfacies which are integrated into a paleoenvironmental model. Microfacies curve evolution shows two main trends. A shallowing upward trend ending within a typical proximal slope setting (dismantling of the platform) followed by a deepening upward trend which is characterized by several meter of pelagic mudstone within the upper part of the studied section.

Magnetic susceptibility variations in sedimentary rocks, have commonly been interpreted as related to variations of detritic inputs through climatic or sea level changes (CRICK *et al*. 1994). The magnetic susceptibility (MS) study of more than 330 samples from this long-time fore-reef carbonated succession is an opportunity to better constraint our sedimentological interpretations. To do so, we propose a comparison between general MS trends and some parameters such as microfacies and relative sea level fluctuations interpreted on the basis of the sedimentological study. The relatively long stratigraphic interval covered by the Burgberg section offers a good opportunity to compare our data with the time equivalent Devonian sections of the Ardennes (Belgium) and Moravian karst area (Czech Republic) (BOULVAIN *et al*. 2010). And thus to test the magnetic susceptibility tool for long distance correlation between stratigraphically well constraint sections. The comparison of the MS trends from the Givetian-Frasnian Burgberg section (Sauerland) and the time-equivalent ones from Czech Republic (Moravia) and Belgium (Ardennes), despite a different background shows a surprising similarity.

References

ABOUSSALAM, Z.S. (2003): The “Taghanic Event” in the late Middle Devonian of Western Europa and Morocco. - Münstersche Forschungen zur Geologie und Paläontologie, 97: 330 pp.

BOULVAIN, F., DA SILVA, A-C., MABILLE, C., HLADIL, J., GERSL, M., KOPTIKOVÁ, L. & SCHNABL P. (2010): Magnetic susceptibility correlation of km-thick Eifelian-Frasnian sections (Ardennes and Moravia). - Geologica Belgica, 13/4: 309-318.

CRICK, R.E., ELLWOOD, B.B. & EL HASSANI, A. (1994): Integration of biostratigraphy, magnetic susceptibility and relative sea-level change: A new look at high resolution correlation. - Subcommission on Devonian Stratigraphy, newsletter, 11: 59-66.

KREBS, W. (1967): Reef development in the Devonian of the eastern Rhenish Slate Mountains, Germany. - *In*: OSWALD, D.H. (ed.): Alberta Society Petroleum Geologists. International Symposium Devonian System, Calgary, vol. 2: 295-306.

KREBS, W. (1974): Devonian carbonate complexes of central Europe. - *In*: LAPORTE, L.F. (ed.): Reefs in time and space. Society Economic Palaeontologists Mineralogists Special Publication, 18: 155-208.

MACHEL, H.-G. (1990): Fazies interpretation des Briloner Riffs mit Hilfe eines Fazies modells für devonische Riffkarbonate. - Geologisches Jahrbuch, Reihe D, Heft 95: 43-83.

STRITZKE, R. (1990): Die Karbonat sedimentation im Briloner Vorriffbereich. - Geologisches Jahrbuch, Reihe D, Heft 95: 253-315.

STRITZKE, R. (1991): Zur Geologie am Südrand des Briloner Riffs. - Geologie und Paläontologie in Westfalen, Heft 18: 85-91.

Pragian to Famennian depositional evolution of the M. Pizzul area (Carnic Alps, Italy): preliminary results

PONDRELLI, M.[1], CORRADINI, C.[2], CORRIGA, M.[2], KIDO, E.[3], SIMONETTO, L.[4], SPALLETTA, C.[5], SUTTNER, T.J.[3] & CARTA, N.[6]

(1) International Research School of Planetary Sciences, Università d'Annunzio, viale Pindaro 42, I-65127, Pescara, Italy; *monica@irsps.unich.it*
(2) Dipartimento di Scienze della Terra, Università di Cagliari, via Trentino 51, I-09127 Cagliari, Italy; *corradin@unica.it*, *maria.corriga@unica.it*
(3) Austrian Academy of Sciences (CPSA) c/o University of Graz, Institute for Earth Sciences (Geology & Paleontology), Heinrichstrasse 26, A-8010 Graz, Austria; *erika.kido@uni-graz.at*; *thomas.suttner@uni-graz.at*
(4) Museo Friulano di Storia Naturale, via Marangoni 39-41, I-33100 Udine, Italy; *luca.simonetto@comune.udine.it*
(5) Dipartimento di Scienze della Terra e Geologico Ambientali, Alma Mater Studiorum Università di Bologna, via Zamboni 67, I-40126 Bologna, Italy; *claudia.spalletta@unibo.it*
(6) via Emilio Lussu 21, I-09040 Settimo S. Pietro (CA); *nicola.carta1@virgilio.it*

The Carnic Alps represents the non- to low-grade metamorphic portion of the Variscan substratum of the Alps (VAI 1976, SCHÖNLAUB 1979). The whole "pre-flysch" Variscan succession of the Carnic Alps is thought to have developed in correspondence of a mainly carbonate platform not deeper than few hundred meters. Up to the Pragian, the basin physiography can be roughly schematized as a ramp-type, while from the Pragian to Famennian differential carbonate growth controlled by tectonics led to a differentiation between shallow water facies, high-density and low density resedimented gravitative driven deposits and deeper water facies.

The study area of the M. Pizzul is located in the central part of the Carnic Alps, south of Cason di Lanza Pass and east of Mt. Zermula (Fig. 1). The transition between resedimented gravitative deposits and deeper water facies is here exposed. The entire succession is overturned and disrupted by Variscan as well Alpine faults and thrusts, but the stratigraphic succession is nevertheless well preserved (Fig. 1). The shallow water body that fed the gravitative deposits is now thrusted on top of the deeper-water facies though a roughly E-W trending top to the south thrust of Alpine age (VENTURINI 1990), while the most proximal part of the resedimented facies was subjected to tectonic elision, with the exception of a single outcrop at the Forca di Lanza (Fig. 1).

The transition between distal resedimented facies and deeper water facies – which corresponds here to the Findenig, Hoher Trieb and Pal Grande Formations – represents the most obvious place to observe the response of the depositional systems to the fluctuations of the allogenic controls.

The Findenig Formation (Pragian/Emsian) consists mainly of purple red centimetric thick layers, interpreted as pelagic deposits. Hoher Trieb Formation (Eifelian/Frasnian) consists of intercalations between light gray metric thick silicified corals bearing breccia levels and centimetric to decimetric normally graded thick levels of medium gray grainstone and packstone (and locally sandstone), purple red to gray mudstone to wackestone and black radiolarites to pelites. We interpret the silicified corals bearing breccia levels as high-density gravity driven flows, the grainstone to packstone (and sandstone) as turbiditc and/or storm layers and the mudstone-packstone and radiolarite-pelite layers as pelagic deposits. The Pal Grande Formation consists of light gray to purple red centimetric thick mudstone to wackestone layers interpreted as pelagic deposits.

The overall succession appears to show different hierarchy of cyclic controls, which suggest a possible climatic control on at least part of the depositional framework.

References

SCHÖNLAUB, H.P. (1979): Das Paläozoikum in Österreich. Verbreitung, Stratigraphie, Korrelation, Entwicklung und Paläogeographie nicht-metamorpher und metamorpher Abfolgen. - Abhandlungen der Geologische Bundesanstalt, 33: 1-109.

VAI, G.B. (1976): Stratigrafia e paleogeografia ercinica delle Alpi. - Memorie Società Geologica Italiana, 13: 7-37.

VENTURINI, C. (1990): Geologia delle Alpi Carniche centro orientali. - Pubbl./Ed. del Museo friulano di storia naturale.

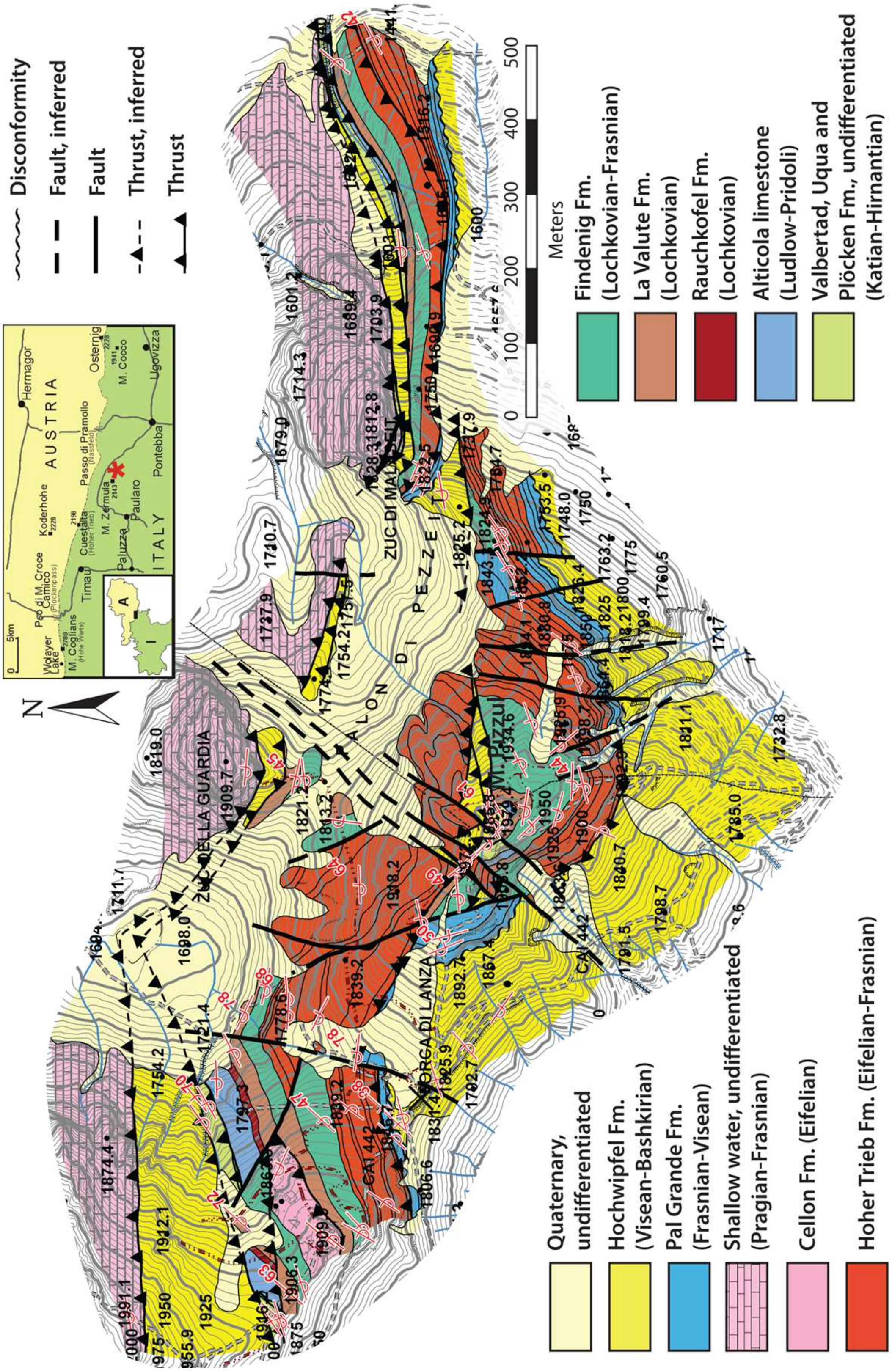


Fig. 1: Geological map of the M. Pizzul area

Mississippian siliceous deposits: origin and importance for the estimation of biodiversity

RANDON, C.[1] & CARIDROIT, M.[2]

(1) UPMC Univ Paris 06, UMR 7207-CNRS, Centre de Recherche sur la Paléobiodiversité et les Paléoenvironnements, 4, Place Jussieu, Tour 56, 5e étage, case 104, 75252 Paris cedex, France; *carine.randon@upmc.fr*
(2) Université de Lille-1, Sciences de la Terre, FRE 3298- CNRS, 'Géosystèmes', F-59655 Villeneuve-d'Ascq cedex, France; *martial.caridroit@univ-lille1.fr*

During Phanerozoic times, there are several hypersiliceous periods, sometimes associated with icehouse conditions. These biogenic siliceous deposits are particularly widespread in the Mississippian of Central Europe. They consist of regularly-bedded deposits within limestone successions and are mostly composed of radiolarian tests. These radiolarian cherts are variously coloured red, green or black, but the black varieties have the more specific name of 'lydites'. Despite being easily identified and ubiquitous in nature, there are few studies addressing their age and origin. These Mississippian radiolarites have often been interpreted as evidence for deepening and/or upwelling conditions and therefore classed as basinal deposits due to the presence of abundant radiolarians. Nevertheless, the presence or even abundance of radiolarian remains in sediment is not necessarily bathymetry-related. In fact, the relative abundance of radiolarian skeletons can be affected by their high preservation rate relative to other allochems.

These radiolarites are studied to characterize the signature of this 'siliceous period' and its significance, particularly in the Hercynian history of Europe and its relation with D/C climate change. Therefore, a multidisciplinary approach was conducted, using analysis of conodont faunas, lithologic and microfacies analyses, and the study of inorganic geochemistry, from outcrops in the French Pyrénées and Spanish Cantabric Chain.

The Mississippian siliceous deposits in the studied sections are of two types: (1) black radiolarites (called 'lydites') deposited during the lower *crenulata* to the *anchoralis-latus* zones interval; and (2) green or red jaspers poor in radiolarians and deposited during the end of the *anchoralis-latus* Zone to the beginning of the *bilineatus* Zone interval.

The sedimentological study shows that the sediments were deposited on an external continental shelf, at a depth of less than 300 m. The change from a carbonate to a siliceous sedimentation corresponds to a relative and progressive deepening.

Analysis of major and trace elements does not show particular trends, and there is no discernible change in the ocean water chemistry (detrital input, redox conditions or paleoproductivity) to explain the change of sediment type.

The disappearance of limestone deposits and the formation of radiolarites are interpreted as a combination of several factors including a transgression that changes the oceanic circulation, and eutrophication linked to the circulation of nutrient-rich cold currents. These factors have allowed the development of a planktonic fauna and the preservation of silica in the sediment and, above all, were unfavourable to the carbonate deposits (an essential condition so that biogenic silica is not diluted).

This study also permits to discuss about the biodiversity variations through times and point out the importance of the understanding of the taphonomy before discussing the biodiversity increase or mass extinction.

Late Devonian conodonts and isotope geochemistry, northwestern Thailand

SAVAGE, N.M.[1], LUTAT, P.[2], SARDSUD, A.[3], KÖNIGSHOF, P.[4], RACKI, G.[5], DOPIERALSKA, J.[6] & BELKA, Z.[6]

(1) Department of Geological Sciences, University of Oregon, Eugene Oregon 97405, USA; *nmsavage@uoregon.edu*
(2) Palaeontological Research Centre, Mahasarakham University, Mahasarakham 44150, Thailand; *Petra.l@msu.ac.th*
(3) Department of Mineral Resources, Geological Survey Division, Bangkok 10400, Thailand; *apsornsa@yahoo.com*
(4) Senckenberg Naturmuseum, 60325 Frankfurt am Main, Germany; *Peter.Koenigshof@senckenberg.de*
(5) Department of Earth Sciences, Silesian University, 41-200 Sosnowiec, Poland; *racki@us.edu.pl*
(6) Isotope Laboratory, Adam Mickiewicz University, PL61606, Poznam, Poland; *dopieralska@amu.edu.pl*; *zbelka@amu.edu.pl*

A roadside section near Thong Pha Phum, northwestern Thailand, includes the Upper Kellwasser event and probably also includes the upper part of the Lower Kellwasser event. Stable isotope geochemistry for this interval shows a positive $\delta^{13}C$ excursion in the Late *rhenana* conodont Zone followed by a gradual return to normal, followed by a sudden positive excursion near the conodont extinction event.

About 350 km farther north, a near-vertical section almost eleven metres thick near the town of Mae Sariang, northwestern Thailand, has yielded conodont faunas of late Frasnian to late Famennian age. The section appears to include the Lower and Upper Kellwasser, Enkeberg, and the lower part of the Hangenberg events, as indicated by the conodonts and $\delta^{13}C$ isotope excursions. The faunas are mostly cosmopolitan but include several new species. The $\delta^{18}O$ isotope data are unreliable because of diagenetic overprint.

The 80 conodont faunas from Mae Sariang suggest the presence of the Late *rhenana*, *linguiformis*, *triangularis*, *crepida*, *rhomboidea*, *marginifera*, *trachytera*, *postera*, *expansa*, and *praesulcata* zones. The $\delta^{13}C$ pattern closely resembles the global carbon isotope pattern of BUGGISCH & JOACHIMSKI (2006). In the *linguiformis* Zone the $\delta^{13}C$ isotope data have values less than 0.9 but there are major positive spikes to between 3.0 and 4.0 during the Late *rhenana* and Early *triangularis* zones. In the succeeding samples the ^{13}C values fluctuate with a general trend down to about 2.1 but with a positive spike to 3.1 in the Middle *marginifera* Zone and an increase to approximately 2.8 during what is thought to be the lower and middle *praesulcata* zones near the top of the section.

An outer shelf, starved basin setting is probable. A microfacies study of the section (see contribution by KÖNIGSHOF *et al*., this meeting) indicates the well-bedded limestones are condensed with some sedimentary interruptions and hardgrounds.

An examination of the geochemistry of the Mae Sariang marine late Frasnian to latest Famennian site should take account of the increasing terrestrial vegetation during the Devonian. The input of fresh water from the continents had occurred for billions of years prior to the Devonian but the water had flowed mostly from bare soil. Some spore-bearing vegetation was present in moist and mostly low-lying areas in Late Ordovician, Silurian, and Early Devonian times but it was the advent of pollen-bearing conifers that lead to the greening on the continents during the Late Devonian. These coniferous plants made decomposing organic material in the soil a factor in the geochemical content of water flowing into the oceans.

Some paleontologists have invoked ocean-floor volcanic hydrothermal release of iron, phosphorus, sulfur, nitrogen, and trace elements as sources of eutrophic nutrients. They note the abundance of silica-rich radiolarian cherts in the dark anoxic shales that characterize Late Devonian and other extinctions. Anoxic shales are not present in the Mae Sariang section, nor are they present in the Late Frasnian to early Famennian section 350 km south at Thong Pha Phum (SAVAGE *et al*. 2006).

There is some evidence of volcanic input at Mae Sariang but mostly during Upper Kellwasser time. There is also evidence of some hydrothermal activity in the sediments during most of the Famennian, and especially towards the latest Famennian. In the Mae Sariang sedimentation the near-bottom seawater was mostly oxic, with anoxia only notable during the Upper Kellwasser and Enkeberg intervals. Cool water contains far more oxygen than warm water, being twice as great at 10℃ as at 20℃. Rising cool water and conditions of high phosphorus, barium, vanadium and molybdenum input could have caused high algal blooms leading to excessive bacteria, radiolarians, and multiplication up the animal food-chain. These organisms could ultimately deplete the algae and use much of the available oxygen causing "dead zone" conditions, well-known at today's ocean margins. This eutrophication cycle may have resulted in anoxia during Upper Kellwasser and Enkeberg times.

References

BUGGISCH, W. & JOACHIMSKI, M.M. (2006): Carbon isotope stratigraphy of the Devonian of Central and Southern Europe. - Palaeogeography, Palaeoclimatology, Palaeoecology, 240: 68-88.

SAVAGE, N.M., SARDSUD, A. & BUGGISCH, W. (2006): Late Devonian conodonts and the global Frasnian-Famennian extinction event. - Palaeoworld 15: 171-184.

What do latest Famennian and Viséan diamictites from Western Gondwana tell us?

STREEL, M.[1], CAPUTO, M.V.[2] & MELO, J.H.G.[3]

(1) Department of Geology, University of Liege, Sart-Tilman B18, BE 4000 Liège 1, Belgium;
Maurice.Streel@ulg.ac.be
(2) Universidade Federal do Pará, Geologia, Av. Perimetral s/n, 66075-110 Belém-PA, Brazil;
caputo@interconect.com.br
(3) Petrobras/Cenpes/Pdgeo/Bpa, Av. Horácio Macedo 950, I. Fundão, 21941-915 Rio de Janeiro, Brazil;
jhmelo@petrobras.com.br

Late Devonian and Mississippian diamictites have been described from several regions of South America, their palynomorph content being partly studied in some detail. Lately, considerable controversy has arisen regarding their actual age and climatic versus sedimentary interpretations. We present here two miospore-based case studies focusing respectively on latest Famennian and on Late Viséan diamictites of the Parnaíba Basin (northern Brazil).

Varve-like rhythmites, usually very finely laminated sandstones, siltstones and shales with scattered clasts and tillites are known from outcrops and well cores of the latest Famennian upper Cabeças Formation, with sediments deposited under glacial and periglacial conditions (CAROZZI *et al*. 1975, CAROZZI 1980, LOBOZIAK *et al*. 1993, STREEL *et al*. 2001, CAPUTO *et al*. 2008*)*. The investigated material comes from four samples of well 1-TM-1-MA, core 16. One of these (CAPUTO 1985, CAPUTO & CROWELL 1985, fig. 11E) is a laminite (varve-like rhythmite) composed of white very fine sandy and dark silty layers, each being approximately half a millimetre thick; eight layers have been macerated separately. The quantitative palynological analysis shows a miospore / miospore + acritarch ratio ranging from 40 to 70%. The palynomorph concentrations (number of specimens per gram of rock) suggest also some rhythmicity. Miospores progressively decrease from 4k to 2.5k in the silty layers (from 2.5k to 1k in the very fine sandy layers) before another rhythm starts. This could result from the changing intensity of water currents over basinal glacio-marine sediments deposited from subaqueous fans and related turbidity currents as well as from the calving of icebergs (CAROZZI 1980). Glacio-marine rhythmites have been described in the Carboniferous of Argentina (MILANA & LOPEZ 1998 and DEL PAPA & DI PASQUO 2007), but no analysis of the palynomorphs from the different rhythmites was provided. Tillites and associated silts allowed to identify 41 miospore taxa, most of which (29 i.e.70%) reworked from Middle and Late Devonian sediments. Among the other 12 taxa, *Vallatisporites vallatus* has the youngest first occurrence, at the base of the latest Famennian LVa (*lepidophyta-vallatus*) Zone, equivalent of the upper part or the entire LN (*lepidophyta-nitidus*) Zone according to MELO & LOBOZIAK (2001, 2003). The other 11 taxa could be also latest Famennian, but elsewhere they are known to range down into older parts of the Famennian. Curiously enough, the Middle Devonian miospores were found only in the tillite samples, whereas the Late Devonian miospores occur both in the tillites and laminites. It is suggested here that the LVa miospores represent the local vegetation of a deltaic and coastal environment, locally disrupted by some lobes of the contemporaneous ice cap (CAROZZI 1980). LVa miospores were distributed on the subaqueous fans and mixed with miospores reworked from underlying Frasnian strata of the upper Pimenteira Formation. Reworked Middle Devonian miospores might have originated from erosion and glacial carving of lower parts of the Pimenteira Formation (LOBOZIAK *et al*. 2000a). In the Parnaíba Basin, the LVa Zone characterizes latest Famennian sections of the Cabeças Formation in several wells (LOBOZIAK *et al.* 1992) and outcrops along the Tocantins River valley (LOBOZIAK *et al*. 2000b).

Cores from shallow boreholes penetrating the Mississippian Poti Formation, drilled for the construction of a dam on the Tocantins River (western margin of Parnaíba Basin, about 200 km west of well 1-TM-1-MA), include sandstones, siltstones and dark gray diamictites, very similar to the Late Devonian tillites that occur in the same well near the top of the Cabeças Formation. Palynomorphs have been extracted from 30 samples taken from 7 shallow wells drilled through diamictite sections ca. 26 m thick. All samples are extremely rich in well preserved palynomorphs, so that each slide prepared contains several thousands of miospores. Both Devonian and Mississippian miospores are present not only in the diamictites but also in some samples collected from silty strata on top of the diamictites, no difference being noticed along the cores. Tillites and associated silts allowed identifying 88 miospore taxa. Of these, 15 taxa (17%) are Late Viséan markers like *Schulzospora* sp. or *Raistrickia nigra.*

Other 37 taxa (42%) could be Late Viséan but are also known earlier in the Mississippian or even in the latest Famennian. Besides, 36 taxa (41%) are obviously reworked: 19 (22%) from the Tournaisian or the Upper Devonian and 17 taxa (19%) from the Upper or Middle Devonian. Acritarchs, where present, are presumably all reworked from the Devonian. MELO & LOBOZIAK (2000) assigned a Late Viséan age (coeval with the Holkerian and Asbian stages of the British Isles) to the Poti Formation, and correlated it with two Western European palynozones, *viz.*, TC (*tessellatus- campyloptera*) and NM (*nigra-marginatus*). MELO & LOBOZIAK (2003) related this formation to the Late Viséan Mag (*C. magnidictyus*) palynozone. In the Cortaderas Formation of Rio Blanco Basin (Argentina), which likewise contains glacial deposits, PEREZ LOINAZE (2007) defined the late Viséan MQ (*magnidictyus-quasigobbettii*) palynozone, which is correlative of the Mag palynozone of Brazil. The age of the MQ Zone is now constrained by recent (CÉSARI *et al.* 2011) radiometric data (335.99 +/- 0.06 Ma). This fits an earliest Asbian or latest Holkerian age determination, according to the Carboniferous time scales of MENNING *et al.* (2006) and OGG *et al.* (2008), respectively.

Reworked palynomorphs are well known to help finding the source area of sediments (STREEL & BLESS 1980). Their occurrence in diamictites has been emphasized since many years in Argentina (DI PASQUO & AZCUY 1997 and DI PASQUO 2007). As discussed above, diamictite datings should rely only on those species having the youngest first occurrences. However, WICANDER *et al.* (2011), working on an 18 m-thick diamictite in the lower portion of the Itacua Formation, in southeast Bolivia, recognized three successive miospore Devonian zones established in western Europe: LL (*lepidophyta-literatus)*, LE (*lepidophyta-explanatus*), and LN (*lepidophyta-nitidus*). They concluded that the diamictite sequence is to be envisaged as a composite that represents several deglaciation events. But, as mentioned by the authors themselves, the recognition of the LL Zone in that sequence was only tentative (it might be LE as well). On the other hand, in Brazil at least, the succession LE-LN is not easily distinguished and has been replaced by MELO & LOBOZIAK (2001, 2003) with the successive Rle (*R.lepidophyta*, with *i.a. Indotriradites explanatus* and *Vallatisporites verrucosus*) and LVa (*lepidophyta-vallatus*) zones, the former possibly representing an impoverished variant (ecofacies?) of the latter in places where *V. nitidus* is absent. It is true, however, that in western Germany, the bathymetry and palynofacies of the Stockum section (STREEL 1999 and STREEL *et al.* 2000) suggest that, during the LE-LN time (about 100 ky), the climatic system became more unstable, oscillating back and forth between regression (glacial) and transgression (interglacial) phases (BUGGISCH & JOACHIMSKY 2006). Detailed Mississippian biostratigraphic zonations comparable to the Western European palynozones are still in revision for South America (CAPUTO *et al.* 2008). However, alternating climates during 4 Ma certainly induced glacial and warm climates in close succession (BRUCKSCHEN & VEIZER 1997), allowing the warm-climate Paraca Flora (IANNUZZI & PFEFFERKORN 2002) to intervene between the Late Viséan and Serpukhovian ice ages (CÉSARI *et al*. 2011).

References

BRUCKSCHEN, P. & VEIZER, J. (1997): Oxygen and carbon isotopic composition of Dinantian brachiopods: Paleoenvironmental implications for the Lower Carboniferous of western Europe. - Palaeogeography, Palaeoclimatology, Palaeoecology, 132: 243-264.

BUGGISCH, W. & JOACHIMSKY, M.M. (2006): Carbon isotope stratigraphy of the Devonian of Central and Southern Europe. - Palaeogeography, Palaeoclimatology, Palaeoecology, 240: 66-88.

CAPUTO, M.V. (1985): Late Devonian glaciation in South America. - Palaeogeography, Palaeoclimatology, Palaeoecology, 51: 291-317.

CAPUTO, M.V. & CROWELL, J.C. (1985): Migration of glacial centers across Gondwana during Paleozoic Era. - Geological Society of America Bulletin, 96: 1020-1036.

CAPUTO, M.V., MELO, J.H.G., STREEL, M. & ISBELL, J.L. (2008): Late Devonian and Early Carboniferous glacial records of South America. - Geological Society of America Special Papers, 441: 161-173.

CAROZZI, A.V., FALKENHEIN, F.U.H., CARNEIRO, R.G., ESTEVES, F.R. & CONTREIRAS, C.J.A. (1975): Análise ambiental e evolução tectônica sinsedimentar da seção siluro-eocarbonífera da Bacia do Maranhão. - Ciência Técnica do Petróleo. Seção: Exploração do Petróleo, Rio de Janeiro 7: 1-48.

CAROZZI, A.V. (1980): Tectonic control and petroleum geology of the Paleozoic clastics of the Maranhao Basin, Brazil. - Journal of Petroleum Geology, 2 (4): 389-410.

CÉSARI, S.N., LIMARINO, C.O. & GULBRANSON, E.L. (2011): An Upper Paleozoic bio-chronostratigraphic scheme for the western margin of Gondwana. - Earth-Science Reviews, 106 (1-2): 149-160.

DEL PAPA, C. & DI PASQUO, M.M. (*2007*): Palaeoenvironmental interpretation and palynology of outcrop and subsurface sections of the Tarija Formation (Upper Carboniferous), Northwestern Argentina. - Journal of South American Earth Sciences, 23: 99-119.

Di Pasquo, M.M. (2007): Asociaciones palinológicas en las formaciones Los Monos (Devónico) e Itacua (Carbonífero Inferior) en Balapuca (Cuenca Tarija), sur de Bolivia. Parte 1. Geología, estratigrafía y asociaciones de la Formación Los Monos. - Revista Geológica de Chile, 34 (1): 97-137 and 34 (2): 163-198.

Di Pasquo, M.M. & Azcuy, C.L. (1997). Palinomorfos retrabajados en el Carbonífero Tardío de la Cuenca Tarija (Argentina): su aplicación a la datación de eventos diastróficos. - Revista Universidade Guarulhos, Série Geociências, Número Especial, 2: 28-42.

Iannuzzi, R. & Pfefferkorn, H.W. (2002): A pre-glacial, warm-temperate floral belt in Gondwana (Late Visean, Early Carboniferous). - Palaios*,* 17*:* 571-590.

Loboziak, S., Melo, J.H.G. & Streel, M. (2000a): Latest devonian and early carboniferous palynostratigraphy of northern Brazil and north Africa - A proposed integration of western european and gondwanan miospore biozonations. - Bulletin des Centres de Recherches ExplorationProduction ElfAquitaine, 22 (2): 241-259.

Loboziak, S., Caputo, M.V. & Melo, J.H. (2000b): Middle Devonian-Tournaisian miospore biostratigraphy in the southwestern outcrop belt of the Parnaíba Basin, North-Central Brazil. - Revue de Micropaléontologie, 43/4: 301-318.

Loboziak, S., Streel*,* M., Caputo, M.V. & Melo, J.H.G. (1992): Middle Devonian to Lower Carboniferous miospore stratigraphy in the Central Parnaíba Basin (Brazil), Annales de la Société Géologique de Belgique, 115: 215-226.

Loboziak. S., Streel, M., Caputo, M.V. & Melo, J.H.G. (1993): Middle Devonian to Lower Carboniferous miospores from selected boreholes in Amazonas and Parnaíba Basins (Brazil): additional data, synthesis, and correlation. - Documents des Laboratories de Geologie de la Faculte des Sciences de Lyon, 125: 277-289.

Melo, J.H.G. & Loboziak, S. (2000): Viséan miospore biostratigraphy and correlation of the Poti Formation (Parnaíba Basin, northern Brazil). - Review of Palaeobotany and Palynology, 112: 147-165.

Melo*,* J.H.G. & Loboziak*,* S. (2001): New miospore zonation of Devonian- Early Carboniferous strata in the Amazon Basin: a preliminary account. - *In*: Melo, J.H.G. & Terra, G.J.S. (eds.): Cienc-Tecnic-Petrol, Exploraçao de Petroleo, 20: 99-107.

Melo, J.H.G. & Loboziak, S. (2003): Devonian–Early Carboniferous miospore biostratigraphy of the Amazon Basin, northern Brazil. - Review of Palaeobotany and Palynology, 124: 131-202.

Menning, M. *et al*. (2006): Global time scale and regional stratigraphic reference scales of Central and West Europe, East Europe, Tethys, South China, and North America as used in the Devonian–Carboniferous–Permian Correlation Chart 2003 (DCP 2003) - Palaeogeography, Palaeoclimatology, Palaeoecology, 240: 318-372.

Milana, J.P. & Lopez, S. (1998): Solar cycles recorded in Carboniferous glacimarine rhythmites (Western Argentina): relationships between climate and sedimentary environment. - Palaeogeography, Palaeoclimatology, Palaeoecology, 144: 37-63.

Ogg, J.G., Ogg, G. & Gradstein, F.M. (2008): The concise geologic time scale. - Cambridge University Press, 177 pp.

Perez Loinaze, V.S. (2007): A Mississippian palynological bio-zone for Southern Gondwana. - Palynology, 31: 101-118.

Streel, M. (1999): Quantitative palynology of Famennian events in the Ardenne-Rhine Regions. - Abhandlungen der Geologischen Bundesanstalt, Wien, 54: 201-212.

Streel, M. & Bless, M. (1980): Occurrence and significance of reworked palynomorphs. - Mededelingen Rijks Geologische Dienst*,* 32 (10): 69-80.

Streel*,* M.*,* Caputo, M.V., Loboziak, S. & Melo, J.H.G. (2000): Late Frasnian-Famennian climates based on palynomorph analyses and the question of the Late Devonian glaciations. - Earth-Science Reviews, 52: 121-173.

Streel, M., Caputo, M.V., Loboziak, S., Melo, J.H.G. & Thorez, J. (2001): Palynology and sedimentology of laminites and tillites from the latest Famennian of the Parnaíba Basin, Brazil. - Geologica Belgica, 3: 87-96.

Wicander, R., Clayton, G., Marshall, J.E.A., Troth, I. & Racey, A. (2011): Was the latest Devonian glaciation a multiple event? New palynological evidence from Bolivia. - Palaeogeography, Palaeoclimatology, Palaeoecology, 305: 75-83.

Conodont Biodiversity at the F/F boundary interval in carbonate sections of western slope of the South Urals

TAGARIEVA, R.Ch.

Institute of Geology, Ufa Scientific Centre, Russian Academy of Sciences, 16/2 Karl Marx street, Ufa, the Republic of Bashkortostan, 450077 Russian Federation; *stpal@anrb.ru*

F/F boundary interval in many carbonate sections of western slope of the South Urals is represented by brachiopods shell unit, the thickness of which doesn't exceed 2.1 m. The interstage boundary is located at the bottom of the Barma Horizon and is determined by simultaneous appearance of conodonts *Palmatolepis triangularis* SANN. and brachiopods *Parapugnax markovskii* (YUD.) (ABRAMOVA 1999, ABRAMOVA & ARTYUSHKOVA 2004, TAGARIEVA 2010). The lower part of the shell deposits corresponds to the Askyn horizon of Frasnian stage – conodont subzone Late *rhenana* and *linguiformis* zone (ABRAMOVA 1999).

The biodiversity analysis of conodonts of F/F boundary interval was performed on 4 characteristic sections – Bol'shaya Barma (stratotype of the Barma horizon), Akkyr, Ryauzyak and Kuk-Karauk. The Askyn Horizon conodonts complex is characterized by a rich species and quantitative diversity (Fig. 1). From the base of linguiformis zone in addition to zonal species *Palmatolepis linguiformis* MÜLL., the appearance of *Polygnathus brevilaminus* BR. & M. and *Pol. macilentus* OVN. & KUZ. was noted in all sections. *Icriodus* taxa start to play significant role in conodont complexes (see Fig. 1). All Frasnian *Palmatolepis, Polygnathus*, *Ancyrognathus* disappear on the F/F boundary. *Ancyrodella* and *Belodella* genera are totally extinct (see Fig. 1).

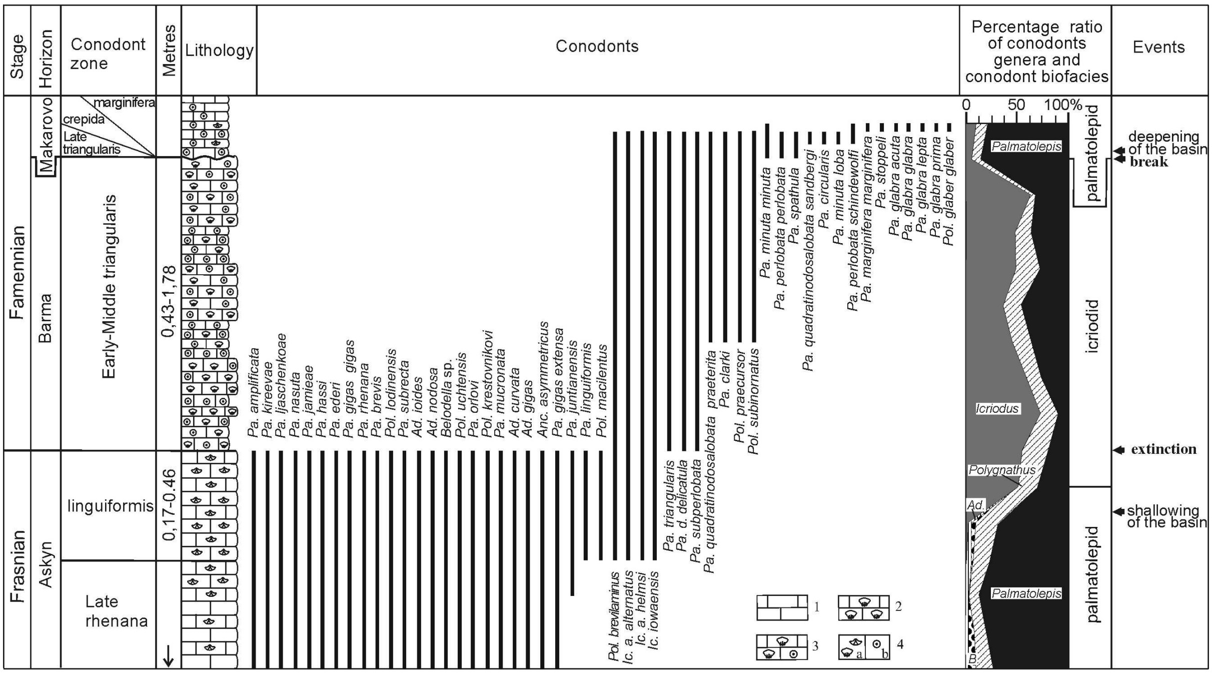


Fig. 1: Distribution of conodonts in F/F boundary interval of Bol'shaya Barma, Akkyr, Ryauzyak and Kuk-Karauk sections and conodont biofacies. Legend: 1 – limestone; 2 – brachiopod shell; 3 – brachiopod-crinoid limestone; 4 – a – brachiopods, b – crinoids. Abbreviations: *Ad. – Ancyrodella, Anc. – Ancyrognathus*; *B. – Belodella*; *Ic. – Icriodus*; *Pa. – Palmatolepis; Pol. – Polygnathus*.

The Barma Horizon in the sections under review corresponds to undivided Early and Middle *triangularis* subzones*.* The conodont biodiversity is extremely poor. Apart from single specimens of zonal species *Palmatolepis triangularis* SANN., the complex is characterized by presence of rare

Palmatolepis delicatula delicatula BR. & M., *Pa. clarki* ZIEG., *Pa. quadratinodosalobata praeterita* SCHÜL., *Pa. subperlobata* BR. & M., *Pol. praecursor* MAT., *Pol. subinornatus* STREL. Abundant *Icriodus alternatus alternatus* BR. & M., *Ic. alternatus helmsi* SAND., *Ic. iowaensis iowaensis* YOUNG. & PET. and rare *Polygnathus brevilaminus* BR. & M. go from the Frasnian deposits situated below (see Fig. 1).

Barma shell deposits are overlain by crinoidal-brachiopod limestones of the Makarovo Horizon with stratigraphic break (the exception is Bol'shaya Barma section). The duration of the break in Akkyr and Ryauzyak sections corresponds to the interval of the Late *triangularis* subzone. In Kuk-Karauk section the break is more prolonged and Barma Horizon is overlain by the marginifera zone (see Fig. 1).

Biofacial analysis shows that the taxa of *Palmatolepis* genus prevail in conodont complexes of Askyn Horizon in all sections (ca. 77%). Almost in every sample the domination of *Pa. nasuta* MÜLL. species was noted. It makes up to 37-50% from all taxa discovered. According to (SEDDON & SWEET 1971, BARSKOV 1985, ZIEGLER & SANDBERG 1990) the specified complexes can be compared with palmatolepid biofacies indicating relatively deep-water environments (see Fig. 1). F/F boundary interval is characterized by prevailing of *Icriodus* (55% species) in conodonts complexes, which corresponds to icriodid biofacies (see Fig. 1). Perhaps it is connected with establishment of extremely shallow-water conditions at the end of Askyn time. This phenomenon became the reason of extinction of main Frasnian conodonts taxa (see Fig. 1). From the base of the Makarovo Horizon the diversity *Palmatolepis* species in conodont complexes increases again (ca. 85%). The change of icriodid biofacies to palmatolepid one can be indicative of deepening of the basin (see Fig. 1).

The work was supported by RFBR (Russian Foundation for Basic Research) grants № 08-05-00575-a and № 11-05-01105-a.

References

ABRAMOVA, A.N. (1999): Franskyi yarus zapadnogo sklona Yuzhnogo Urala. - IGG Ufimsky Nauchny Tcentr Ros. Acad. Nauk. Ufa, 55 pp. [in Russian]

ABRAMOVA, A.N. & ARTYUSHKOVA, O.V. (2004): The Frasnian-Famennian boundary in the Southern Urals. - Geol. Quart., 48 (3), Warszawa: 137-154.

BARSKOV, I.S. (1985): Konodonty v sovremennoy geologii / «Obshchaya geologiya» (Itogi nauki i tekhniki).T. 19. - M.: VINITI: 93-221. [in Russian]

SEDDON, G. & SWEET, W.C. (1971): An ecological model for conodonts.Journal of Paleontology 45: 896-880.

TAGARIEVA, R. Ch. (2010): Novye dannye o granitse frana i famena v parastratotipe barminskikh sloyev (zapadnyi sklon Yuzhnogo Urala). - Sovremennaya paleontologiya: klassicheskiye i noveyshiye metody. Tezisy dokladov sed'moy vserossiyskoy nauchnoy shkoly molodykh uchenykh-paleontologov 4-6 oktyabrya 2010 g. - Paleontologicheskiy institut im. A.A. Borisyaka RAN. Moskva: 36-37. [in Russian]

ZIEGLER, W. & SANDBERG, C.F. (1990): The Late Devonian Standart Conodont Zonation - Cour. Forschungsinst. Senckenberg, 121:1-115.

Preliminary study of Late Middle Devonian Bentonites in Western Black Sea (Zonguldak-Bartin) Region, NW Turkey: a possible link with climate change

TÜRKMENOGLU, A.G.[1], GÖNCÜOGLU, M.C.[1], YILMAZ, I.O.[1] & ÜNLÜCE, O.[1]

(1) Middle East Technical Univerity, Department of Geological Engineering, Ankara, Turkey,
asumant@metu.edu.tr; mcgoncu@metu.edu.tr; ioyilmaz@metu.edu.tr

In addition to climatic biological changes, extensive volcanic activity associated with the closure of the Rheic Ocean took place during Late Devonian. The products of explosive eruptions in the form of volcanic ash, after long distance transportation, were settled down and the diagenetic processes converted the ashes into pottasium rich claystones called as K-bentonites or metabontonites. They are originally silisic volcanic ashes which are altered to claystones rich in smectite.

In the western Black Sea region, near Bartin and Zonguldak cities, yellowish brown and gray-green colored claystones having maximum thicknesses of 50-60 cm are exposed along with thick sequences of limestones-dolomitic limestones (Middle Devonian to Early Carboniferous in age, The Yılanlı formation). These carbonates were deposited on a shallow marine carbonate platform. Microfacies analysis of limestones indicate the cyclic nature of alternation charophyta and ostracoda rich wackestones, pellodial intraclastic packstones/wackestones and breccia along the section. Claystones are alternating with these microfacies without transition or gradual passage. Cyclic alternation of very shallow marine facies are interrupted by volcanic occurences. Our preliminary investigations indicate that these claystone horizons are K-bentonites of volcanic origin (TÜRKMENOGLU 2001, TÜRKMENOGLU *et al*. 2009). Thus, they indicate successive Devonian explosive volcanic eruptions, with yet unknown source and distances.

In this research, two sections across bentonite-bearing successions in the Yılanlı Formation were measured and sampled both for clay mineralogical and paleontological purposes. The preliminary XRD data indicate that these K-bentonites are mainly consisting of illite, trace amounts of kaolinite, some quartz, feldspar, biotite, zircon, pyrite, calcite and gypsum. Chemical analyses demonstrate the volcanic origin of these K-bentonites. The foraminiferal content of the studied sections assign the Late Middle Devonian age (TÜRKMENOGLU *et al*. 2009). Results of this investigation have implications on tephra diagenesis and event-stratigraphic applications of the Bartin K-bentonites.

References

TÜRKMENOGLU, A.G. (2001): A Paleozoic K-bentonite occurrence in Turkey. - Mid-European Clay Conference'01, MECC201, September 9-14, 2001, Stara Lesna, Slovakia.

TÜRKMENOGLU, A.G., GÖNCÜOGLU, M.C. & BAYRAKTAROGLU, Ş. (2009): Early Carboniferous K-bentonite formation around Bartin: Geological implications. - 2nd Int. Symposium on the Geology of the Black Sea Region ISGB-2, Ankara-Turkey. Abstract Book, 209.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Lochkovian conodonts (Lower Devonian) from the Spanish Central Pyrenees and its potential for a standard subdivision

VALENZUELA-RÍOS, J.I.

Department of Geology, University of Valencia, c/Dr. Moliner 50, E-46100 Burjasot, Spain;
jose.i.valenzuela@uv.es

After a successful definition and redefinition of Devonian Stages, including revision of GSSPs, the International Subcommission on Devonian Stratigraphy has started to formally define substages. Advances have mostly been produced on the upper part of the System (Givetian, Frasnian and Famennian) and, to some extend, on the Pragian. The subdivision of the Emsian is linked to its redefinition and only the intention to formally subdivide this Stage into two substages has been decided. Lochkovian and Eifelian have received less attention, although an informal three fold Lochkovian subdivision was already proposed by VALENZUELA-RÍOS & MURPHY (1997). The purpose of this report is to analyze the potential of this conodont-based subdivision from one of the key areas (the Pyrenees) and evaluate its correlation potential.

The initial subdivision of VALENZUELA-RÍOS & MURPHY (1997) subsequently improved in MURPHY & VALENZUELA-RÍOS (1999) was based on the consistent conodont sequences registered in Central Nevada and the Pyrenees that permitted an accurate correlation of the main boundaries. The selected taxa to define the boundaries of the middle part (and consequently the lower/middle and middle/upper boundaries) were *Lanea omoalpha* and *Masaraella pandora* beta respectively. Both are well characterized and globally distributed taxa that allow worldwide correlations. Inner subdivisions of these parts were also provided in several papers and summarized below in the context of the Pyrenean up-dated sequence.

The lower Lochkovian was initially subdivided into two zones, *hesperius* and *eurekaensis*, in the Cordillera area (KLAPPER 1977). Subsequently, it was demonstrated that the range of these two taxa largely overlap, and therefore, the interval was left open for global correlation on a zonal scale until new studies can provide tide worldwide correlatable markers. In the Pyrenees this interval is represented in three sections (Gerri 1.1, Compte-I and Baen). The conodont sequence prompted VALENZUELA-RÍOS (1990, 1994a) to establish a local subdivision of, at least, regional value. Afterwards, studies in the Pyrenees confirm the following conodont sequence: a lower part comprised between first appearances of *Icriodus woschmidti* and *I. transiens* (*woschmidti-transiens* Zone) that is followed by an interval between the lower entries of *I. transiens* and *I. angustoides bidentatus* (*transiens-bidentatus* Zone). In the upper part (*bidentatus-omoalpha* Zone) is remarkable the entry of *Ancyrodelloides carlsi* in all sections, and the *I. ang. angustoides* in the Compte-I section. This three-fold zonation for the lower Lochkovian is only of local value and any correlation with other areas is still precipitate. A remarkable datum is, however, the entry of *A. carlsi* in the lower part of the *bidentatus-omoalpha* Zone, certifying its entry below the beginning of the *Lanea* stock.

Contrasting with the lower Lochkovian, the middle Lochkovian seems to be a time of cosmopolitan conodonts, and their taxa are widespread allowing accurate global correlations for the interval. The interval was initially subdivided into five parts in the Pyrenees (VALENZUELA-RÍOS 1994a) which were largely based on the sequential occurrences of the genus *Ancyrodelloides*. Combining this subdivision with the globally presented in MURPHY & VALENZUELA-RÍOS (1999) and with new records from the Pyrenees a local subdivision into five zones can be presented. In ascending chronological order these zones are: *omoalpha-transitan*s, *transitans-trigonicus*, *trigonicus-kutscheri*, *kutscheri-sequeirosi* and *sequeirosi-pandora* beta. The number of zones can be increased when the ranges of *L. eoeleanorae* and *L. eleanorae* can precisely be established in the Pyrenean sections. Besides, the entries of some of the worldwide distributed species of the genus *Flajsella* permits accurate correlation within the zones. In brief, the net of worldwide distributed taxa recorded in the Pyrenees permits one of the finest subdivision and global correlation of the whole Devonian; some of these intervals having an estimated duration under 500 ky.

Based on sequences from Spain and Nevada, VALENZUELA-RÍOS (1994b) subdivided the upper Lochkovian into two zones, *pandora* beta-*gilbeti* and *gilberti-irregularis*. Due to relative scarce records in the upper Lochkovian, these two zones are not well characterized globally, but their indexes seem to have consistent stratigraphical worldwide distribution and, thus, can be used in a global scheme.

Acknowledgements

This work is a contribution to the IGCP-596 Climatic change and biodiversity patterns in the Mid-Paleozoic (Early Devonian to Late Carboniferous). It has been partially supported by the AvH-Stiftung, ACI2009-1037 of the MICINN and by the CGL2011-24775.

References

KLAPPER, G. (1977): Lower and Middle Devonian conodont sequence in central Nevada, with contributions by D.B. Johnson. - *In*: MURPJY, M.A., BERRY, W.B.N. & SANDBERG, C.A. (eds.): Western North America: Devonian. - University of California, Riverside Campus Museum Contribution, 4: 33-54.

MURPHY, M.A. & VALENZUELA-RÍOS, J.I. (1999): *Lanea* new genus, lineage of Early Devonian conodonts. - Bolletino della Società Paleontologica Italiana, 37 (2/3): 321-334.

VALENZUELA-RÍOS, J.I. (1990): Lochkovian Conodonts and Stratigraphy at Gerri de la Sal (Pyrenees). - Courier Forschungsinstitut Senckenberg, 118: 53-63.

VALENZUELA-RÍOS, J.I. (1994a): Conodontos del Lochkoviense y Praguiense (Devónico Inferior) del Pirineo Central español. - Memorias del Museo Paleontológico de la Universidad de Zaragoza 5, 178 pp.

VALENZUELA-RÍOS, J.I. (1994b): The Lower Devonian conodont *Pedavis pesavis* and the *pesavis* Zone. - Lethaia, 27 (3): 199- 207.

VALENZUELA-RÍOS, J.I. & MURPHY, M.A. (1997): A new zonation of middle Lochkovian (Lower Devonian) conodonts and evolution of Flajsella n. gen (Conodonta). - *In*: KLAPPER, G., MURPHY, M.A. & TALENT, J.A. (eds.): "Paleozoic Sequence Stratigraphy and Biogeography: Studies in Honor of J. Granville ("Jess") Johnson" - Memoir of the Geological Society of America Special Paper, 321: 131-144.

Devonian to Carboniferous microconchid tubeworms: invasion of fresh-water habitats

VINN, O.[1], ZATOŃ, M.[2] & SUTTNER, T.[3]

(1) Department of Geology, University of Tartu, Ravila 14A, 50411 Tartu, Estonia, *olev.vinn@ut.ee*
(2) Department of Palaeontology and Stratigraphy, Faculty of Earth Sciences, University of Silesia, Będzińska str., 60, 41-200 Sosnowiec, Poland; *mzaton@wnoz.us.edu.pl*
(3) CPSA, Austrian Academy of Sciences c/o University of Graz, Heinrichstrasse 26, 8010 Graz, Austria; *thomas.suttner@uni-graz.at*

Small, spirally-coiled calcareous worm tubes are common in the Paleozoic and Triassic (WEEDON 1990, TAYLOR & VINN 2006, ZATOŃ & VINN 2011), but rare in the Jurassic (VINN & TAYLOR 2007, ZATOŃ & TAYLOR 2009). Such tubeworms are traditionally assigned to the polychaete genus *Spirorbis*. However, the pre-Cretaceous examples have been reinterpreted as microconchids (Class Tentaculita BOUČEK 1964) on the basis of the early ontogeny and microstructure of their tubes. Within the substrate-cemented tentaculitoids, it is possible that spirorbiform microconchids (Katian) have been derived from the geologically older, non-spiral cornulitids (first known from the Darriwilian) (VINN & MUTVEI 2009, VINN 2010).

Microconchid tube worms originated in normal marine environment during the Late Ordovician and not before the Early Devonian they spread to marginal marine brackish and fresh-water habitats. The fresh-water colonization by microconchids presumably took place via the brackish water habitats, similarly to several other groups of marine invertebrates. It seems that the occupation of the brackish and fresh water environments proceeded nearly in the same time in different regions of the Earth. Most probably, early fresh-water microconchids gained a vast food resources in the form of suspended organic matter that could be delivered from the land by rivers and streams, and originated straight in the place of microconchid living. The unlimited food resources connected with microconchid biology enabled them to reproduce fast and in large numbers. In addition, opportunistic microconchids benefited from the weaker competition by the other suspension feeding encrusters in the Devonian to Carboniferous fresh water habitats. Microconchids occupied brackish and fresh water environments especially often during the Carboniferous. During the expansion of land-masses with prolific flora and terrestrial aquatic basins in the Carboniferous, microconchids also commonly used terrestrial plants and bivalves as a hard substrate in fresh- and brackish-water environments. In Carboniferous brackish water environments, microconchids usually lived in great densities and formed buildups such as patch-reefs, bioherms or biostromes. In contrast, fresh water microconchids have never seen to form similar organic buildups.

References

BOUČEK, B. (1964): The Tentaculites of Bohemia. - Publication of the Czechoslovakian Academy of Sciences, Prague, 125 pp.

TAYLOR, P.D. & VINN, O. (2006): Convergent morphology in small spiral worm tubes ('Spirorbis') and its palaeoenvironmental implications. - Journal of the Geological Society, London 163: 225-228.

VINN, O. (2010): Adaptive strategies in the evolution of encrusting tentaculitoid tubeworms. - Palaeogeography, Palaeoclimatology, Palaeoecology, 292: 211-221.

VINN, O. & MUTVEI, H. (2009): Calcareous tubeworms of the Phanerozoic. - Estonian Journal of Earth Sciences, 58: 286-296.

VINN, O. & TAYLOR, P.D. (2007): Microconchid tubeworms from the Jurassic of England and France. Acta Palaeontologica Polonica, 52: 391-399.

WEEDON, M. J. (1990): Shell structure and affinity of vermiform 'gastropods'. - Lethaia, 23: 297-309.

ZATOŃ, M. & TAYLOR, P.D. (2009): Microconchids (Tentaculita) from the Middle Jurassic of Poland. - Bulletin of Geosciences, 84: 653-660.

ZATOŃ, M. & VINN, O. (2011): Microconchids and the rise of modern encrusting communities. - Lethaia, 44: 5-7.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Echinoderm Community Evolution in the Devonian and Mississippian

WATERS, J.A.[1] & DEREUIL, A.A.[1]

(1) Department of Geology, Appalachian State University, Boone, NC 28608, USA; *watersja@appstate.edu*

Crinoids and blastoids reached their zenith in generic richness and abundance during the Mississippian, leading many paleontologists to refer to the interval as the "Age of Crinoids" (KAMMER & AUSICH 2006). Crinoids and blastoids were so abundant that encrinites, grainstones and packstones with >50% echinodermal debris, contributed 1000s of km^3 of carbonate deposition globally.

Explanations for the increased diversity and superabundance of crinoids and blastoids in the Mississippian include the following: 1. Rising biodiversity of advanced cladids during the transition from the Middle Paleozoic to the Late Paleozoic Crinoid Macroevolutionary Fauna (KAMMER & AUSICH 2006), 2. The establishment of widespread carbonate ramps after the demise of Late Devonian reef communities (KAMMER & AUSICH 2006), and 3. Response to declining predation pressure caused by extinctions of major groups preying on crinoids at the Hangenberg extinction event (SALLAN *et al.* 2011).

Although the causes of the Mississippian crinoid explosion are probably multifaceted, climatic events in the Devonian likely played a major role. KAMMER & AUSICH (2006) recognized a peak in crinoid generic richness in the Early Devonian. The Emsian peak reflects the success of the camerate-dominated Middle Paleozoic Crinoid Macroevolutionary Fauna (MPCMF) during an interval of widespread reefal facies. Emsian blastoids also are diverse and locally abundant for the first time in the history of the clade, although the most abundant faunas were associated with deeper water microbial mud mounds not shallow water reefal facies. Throughout most of the Devonian, crinoid diversity paralleled the diversity found in reefal ecosystems, which paralleled patterns of low latitude sea surface temperature (JOACHIMSKI *et al.* 2009). This pattern changed after the Givetian / Frasnian and Frasnian / Famennian extinction events, which significantly reduced crinoid diversity and decimated reefal faunas respectively.

Historically Famennian crinoid and blastoid diversity was thought to be quite low suggesting that these faunas did not recover from the G/F and F/F extinctions until well into the Mississippian. Over the past decade, however, discovery of new Famennian echinoderm faunas and re-evaluation of existing faunas have resulted in a 500% increase in generic diversity from that reported in SEPKOSKI (2002). In terms of crinoid generic diversity, global Famennian echinoderm communities are dominated by cladid crinoids (WATERS & WEBSTER 2009) and more closely resemble Late Paleozoic rather than Middle Paleozoic Crinoid Macroevolutionary Faunas. The demise of reef communities in the Late Devonian led to the development of widespread carbonate ramps in the Mississippian and for a time the resurgence of the camerate-dominated MPCMF. The ultimate success of the Late Paleozoic Crinoid Macroevolutionary Fauna reflects the climate-controlled transition from carbonate-dominated sedimentation in the Lower and Middle Mississippian to clastic-dominated sedimentation in the Late Mississippian and Pennsylvanian. The long-term iterative nature of the transition between the two crinoid faunas suggests that the driving force was climatic and not changes in predation pressure.

In a novel paper, RIDING (2009) suggested that significant changes in Devonian atmospheric chemistry in the Devonian led to changes in phytoplankton communities which led to significant increases in abundance of suspension-feeding echinoderms beginning in the Late Devonian and accelerating into the Mississippian. Riding's analysis provides an explanation for the "phytoplankton blackout" in the Late Devonian as a taphonomic artefact reflecting the shift from acritarch-sized plankton to smaller picophytoplankton.

Testing Riding's hypothesis on the relationship between changes in phytoplankton composition and crinoid and blastoid abundance involves a more detailed understanding of feeding preferences of different clades of Paleozoic crinoids and blastoids than is currently available. However, it does present an intriguing possible explanation for the occurrences of abundant blastoids in deep-water environments in the Lower Devonian of Spain. It also provides support for the apparent divergence of patterns of diversity reefal ecosystems and crinoid diversity in the Famennian, and the halos of crinoids and blastoids that occur around deep water Waulsortian mud mounds that are common in the Early Mississippian.

Although much work remains to understand the dynamics of echinoderm community evolution in the Devonian and Mississippian, climate mediation rather than changing predation pressures seems a more plausible process. The relationship between the Middle and Late Paleozoic Cirnoid Macroevolutionary Faunas and large-scale sedimentological regime has been understood for many years. That the patterns in sedimentation are more climatically controlled rather than tectonically controlled now seems clear. Crinoid communities were able to be successful both in the Lower Devonian greenhouse world and in the Mississippian icehouse world because different clades were able to adapt to changing climates and the demise of reef ecosystems and flourish. Whether this success was the result of adaptation to changing sedimentological regime or changing patterns of plankton diversity is unclear at the present time.

References

JOACHIMSKI, M.M., BREISIG, S., BUGGISCH W., TALENT, J.A., MAWSON, R., GEREKE, M., MORROW, J.R., DAY, J. & WEDDIGE, K. (2009): Devonian climate and reef evolution: insights from oxygen isotopes in apatite. - Earth and Planetary Science Letters, 284: 599-609.

KAMMER, T.W. & AUSICH, W.I. (2006): The “Age of Crinoids”: A Mississippian biodiversity spike coincident with widespread carbonate ramps. - Palaios, 21: 238-248.

RIDING, R. (2009): An atmospheric stimulus for cyanobacterial-bioinduced calcification ca.350 million years ago? - Palaios, 24: 685-696.

SALLAN, L.C., KAMMER, T.W., AUSICH, W.I. & COOK, L.A. (2011): Persistent predator-prey dynamics revealed by mass extinction. - Proceedings for the National Academy of Sciences of the United States of America, 108: 8335-8338.

SEPKOSKI, J.J. (2002): A compendium of fossil marine animal genera. - Bulletins of American Paleontology, 363, 560 p.

WATERS, J.A. & WEBSTER, G.D. (2009): A reevaluation of Famennian echinoderm diversity: implications for patterns of extinction and rebound in the Late Devonian. - Geological Society, London. Special Publications 2009, 314: 149-161.

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

An approach for paleoclimatic conditions for the formation of Lower Givetian ironstones within carbonate platform succession in NW Anatolia

YILMAZ, I.O.[1], GÖNCÜOGLU, M.C.[1], TÜRKMENOGLU, A.G.[1] & SAYDAM-DEMIRAY, G.[2]

(1) Middle East Technical University, Department of Geological Engineering, Ankara, Turkey;
ioyilmaz@metu.edu.tr; *mcgoncu@metu.edu.tr*; *asumant@metu.edu.tr*
(2) M.T.A., Geol. Res. Dept, Ankara, Turkey; *dgsaydam@mta.gov.tr*

The iron bearing successions are studied by two measured stratigraphic sections in the Kabalak Dere and Ferizli areas in the Camdag region (NW Anatolia). These successions lie within the Istanbul Terrane (GÖNCÜOGLU & KOZUR 1998) which is considered as an eastern continuation of the Avalonian Terrane (OKAY *et al*. 2008).

Ironstones recognized in the Ferizli Formation are characterized by alternation of red and green mudstones and sandstones at the bottom, and followed by a series of dolomite, dolomitic limestone with oolitic ironstones and chamositic mudstones at the top (Ironstone member of KIPMAN 1974). The Ferizli formation is underlain by the Findikli Formation characterized by alternation of limestones with brachiopods and echinoids and black shales/mudstone and overlain by the Manastır Member of the Yilanli Formation which is characterized by alternation of marly limestones, nodular limestones and dolomitic limestones with abundant corals, brachiopods, bivalves and echinoids.

In the Ferizli area, eleven separate bands of red colored, iron rich, medium-bedded, oolitic limestones/dolomites and oolitic ironstones were recognized along the studied succession. These levels are mined locally for iron-ore in the area and can be followed towards the East of Safranbolu, central northern Anatolia. Oolitic grainstones, bioclastic grainstones, bioclastic packstones and wackestones are commonly observed microfacies of limestones alternating with mudstones along the section. Alternating red colored, iron rich limestones and mudstones form cyclic couplets through the sections. Mineralogically, the carbonate part is dominated by goethitized and chamositized fossil fragments and chamositic oolites. The oolitic ore is made up of goethite, brown iron-silicates, chamosite, sideritic oolites, quartz clasts and brachiopods.

In the Kabalak Dere, similar facies are recognized along the section, but iron rich bioclastic grainstones were more dominant than iron rich oolitic grainstones and mudstones were less frequently observed compared to the Ferizli section. A well sorted, white colored, cross laminated quartz arenite succession lies at the top of the section.

Recent conodont findings in the first limestone bands beneath the ironstones in Kabalak Dere section indicate the *ensensis* and *hemiansatus* zones of Lower Givetian (BONCHEVA *et al*. 2009).

Partial iron precipitation within microborings or precipitation along the spine holes on echinoid grains are observed in the bioclastic grainstone (Dunham)/ biosparite (Folk) facies. Iron was also involved in the ooid formation and can be observed as concentric laminae and nuclei. Iron peloids are also recognized in the grainstone facies. Iron could not be observed as replacing the sparry cement, therefore occurrence of iron is not related to late diagenesis. Iron precipitation could be explained as precipitation of transported dissolved iron from terrestrial environment under the wet/subtropical climate within oxidizing and increased PH conditions, or dissolved iron transported by upwelling currents over the shelves and precipitated under oxidizing environment. Alternation of iron rich limestones and mudstones display cyclic nature in the Ferizli section. The cyclic occurrence of primary iron in marine carbonate environment and extensive distribution over large areas display that controlling mechanism for iron rich carbonates and mudstones could be related to cooperation of climate, sea level and oceanographic changes in the Givetian.

References

BONCHEVA, I., GÖNCÜOGLU, M. C., LESLIE, S.A., LAKOVA, I., SACHANSKI, V., SAYDAM, G., GEDIK, I. & KÖNIGSHOF, P. (2009): New conodont and palynological data from the Lower Palaeozoic in Northern Çamdağ, NW Anatolia, Turkey. - Acta Geologica Polonica, 59, 2: 157-171.

GÖNCÜOGLU, M.C. & KOZUR, H. (1998): Remarks on the pre-Variscan development in Turkey. - *In*: LINNEMANN, U., HEUSE, T., FATKA, O., KRAFT, P., BROCKE, R. & ERDTMANN, B.T. (eds.): Prevariscan Terrane Analyses of "Gondwanean Europa". - Proceedings, Schriften des Staatl. Mus. Min. Geol. Dresden, 9: 137-138.

KIPMAN, E. (1974): Geology of the marine iron deposits in Sakarya Çamdağ. - *I.Ü.F.F.* Monographies Ser. 25: 1-72.

OKAY, A, BOZKURT, E., SATIR, M., YIGITBA, E., CROWLEY, Q.G. & SHANG, C.K. (2008): Defining the southern margin of Avalonia in the Pontides: Geochronological data from the Late Proterozoic and Ordovician granitoids from NW Turkey. - Tectonophysics, 461: 252-264.

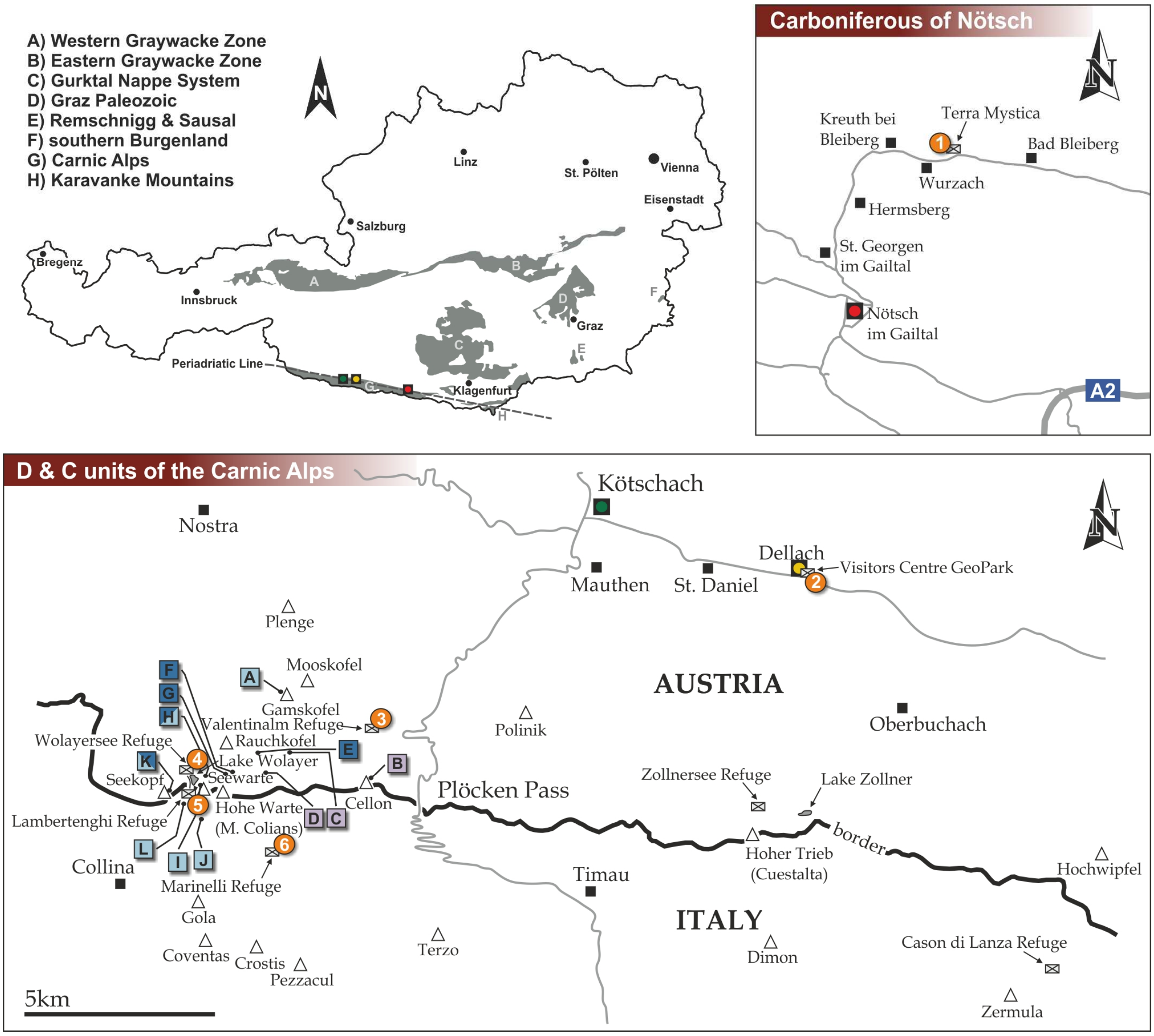
Field-Workshop

Devonian and Carboniferous of the Carnic Alps

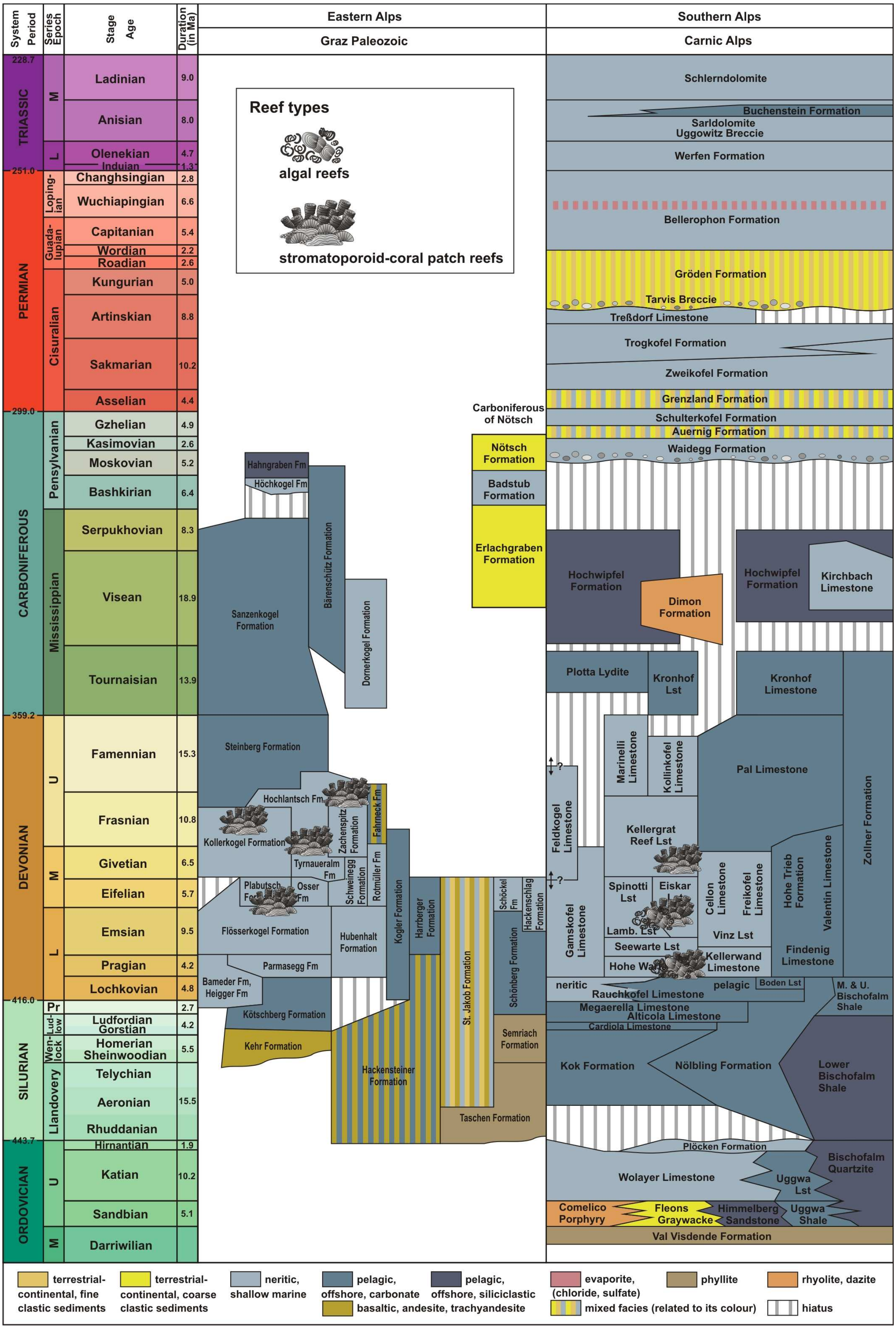
SUTTNER, T.J.[1] & KIDO, E.[1]

(1) Austrian Academy of Sciences (CPSA) c/o University of Graz, Institute for Earth Sciences (Geology & Paleontology), Heinrichstrasse 26, A-8010 Graz, Austria; *thomas.suttner@uni-graz.at*; *erika.kido@uni-graz.at*

Within the frame of the IGCP 596 field-workshop, Devonian and Carboniferous outcrops mainly of the southalpine sequence of the Carnic Alps will be discussed in field. The following figures and shortcuts of lithostratigraphic units shall provide an overview for a better understanding of the regional geological settings. Apart from this the most important key sections of the central Carnic Alps are compiled under *Geological Highlights*.



Locality maps of Devonian & Carboniferous units of the Carnic Alps north (Carboniferous of Nötsch, upper right map) and south (central Carnic Alps, lower map) of the Periadriatic Line.



Lithostratigraphic units of the Graz Paleozoic & the Carnic Alps (Austrian Stratigraphic Chart, 2004).

Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Devonian & Carboniferous units of the Carnic Alps

Short characterisation of Devonian and Carboniferous units of the Carnic Alps deposited south of the Periadriatic Line. This summary mainly follows PÖLSLER (1969a, b), KRAINER (1992), SCHÖNLAUB *et al.* (1980), SCHÖNLAUB (1985a), KREUTZER (1992a, b), HUBMANN *et al.* (2003), SCHÖNLAUB *et al.* (2004) and FORKE *et al*. (2006), where further details on the single units are provided.

DEVONIAN SEQUENCE

NORTHERN SHALLOW WATER FACIES (FELDKOGEL NAPPE)

Feldkogel Limestone
Lithology: algal laminite with dolomite layers
Fossils: conodonts, foraminiferans, ostracods, stromatolites
Chronostratigraphic age: Eifelian - Upper Devonian
Biostratigraphy: Upper Devonian is based of the occurrence of *Palmatolepis* sp. from sediments of the Mooskofel
Thickness: >330 m

SOUTHERN SHALLOW WATER FACIES (KELLERWAND NAPPE)

Gamskofel Limestone
Lithology: algal laminite with *Amphipora* limestone and loferite layers
Fossils: algae, brachiopods, corals, foraminiferans, ostracods
Chronostratigraphic age: Pragian - Givetian(?)
Biostratigraphy: -
Thickness: approx. 800 m

Rauchkofel Limestone (neritic)
Lithology: lithoclastic limestone, dark nodular limestone, mega-conglomerate horizon, well bedded dark grey crinoidal limestone
Fossils: brachiopods, conodonts, crinoids, gastropods
Chronostratigraphic age: Lochkovian - Pragian
Biostratigraphy: ?*woschmidti*, *delta*, *pesavis*, and *steinachensis* conodont zones
Thickness: about 180 m

Hohe Warte Limestone
Lithology: massive, light grey limestone
Fossils: brachiopods, algae, conodonts, corals, crinoids, cyanobacteria, gastropods, stromatoporoids
Chronostratigraphic age: Pragian
Biostratigraphy: ?*serratus* - *celtibericus* conodont zones
Thickness: 350 m

Seewarte Limestone
Lithology: black bituminous limestone
Fossils: algae, bivalves, corals, crinoids, gastropods, ostracods
Chronostratigraphic age: Lower Emsian
Biostratigraphy: -
Thickness: 40 m

Lambertenghi Limestone
Lithology: well bedded laminated limestone, birdseye limestone, crinoidal debris limestone
Fossils: algae, bivalves, brachiopods (e.g. *Karpinskia consuelo*), corals, echinoderms, foraminiferans, gastropods, ostracods, stromatoporoids
Chronostratigraphic age: Emsian
Biostratigraphy: -
Thickness: 130 m

Spinotti Limestone
Lithology: massive limestone, layers of crinoidal debris and *Amphipora* limestone, birdseye limestone
Fossils: algae, bivalves, brachiopods, corals (rugose and tabulate corals), echinoderms, gastropods, stromatoporoids
Chronostratigraphic age: Eifelian - Lower Givetian
Biostratigraphy: -
Thickness: 220 m

Eiskar Limestone
Lithology: bioclastic limestone, birdseye limestone
Fossils: algae, bivalves, corals, echinoderms, gastropods
Chronostratigraphic age: Emsian - Lower Givetian
Biostratigraphy: -
Thickness: 330 m

Kellergrat Reefal Limestone
Lithology: massive reef limestone
Fossils: brachiopods, calcareous algae, calcispheres, conodonts, corals, ecinoderms, gastropods, stromatoporoids

Chronostratigraphic age: Lower Givetian - Frasnian
Biostratigraphy: *gigas* conodont zone
Thickness: >180 m

Marinelli Limestone
Lithology: loferites and crinoidal debris limestone
Fossils: calcareous algae, conodonts, echinoderms, gastropods
Chronostratigraphic age: uppermost Frasnian - Famennian
Biostratigraphy: -
Thickness: 10 - 20 m

Kollinkofel Limestone
Lithology: dark brachiopod-rich limestone (rhynchonellids) with sparry lithoclastic layers
Fossils: brachiopods, conodonts, echinoderms
Chronostratigraphic age: uppermost Frasnian - Famennian
Biostratigraphy: *gigas* to *postera* conodont zones
Thickness: >40 m

TRANSITIONAL FACIES (CELLON NAPPE)

Rauchkofel Limestone (pelagic)
Lithology: dark, platy limestone
Fossils: acritarchs, brachiopods, chitinozoans, conodonts, crinoids, gastropods
Chronostratigraphic age: Lochkovian - Pragian
Biostratigraphy: *woschmidti* zone
Thickness: 80 – 120 m

Kellerwand Limestone
Lithology: yellow tentaculite limestone with bioclastic layers
Fossils: bivalves, brachiopods, conodonts, corals, echinoderms, ostracods, nautiloids, tentaculites, trilobites
Chronostratigraphic age: Pragian - Lower Emsian
Biostratigraphy: *serotinus* and *patulus* conodont zones
Thickness: max. 145 m

Vinz Limestone
Lithology: dark grey platy limestone with debris layers
Fossils: bivalves, cephalopods, corals, conodonts, ecinoderms, foraminiferans, ostracods, tentaculites
Chronostratigraphic age: Emsian
Biostratigraphy: -
Thickness: 120 m

Cellon Limestone
Lithology: massive grey limestone with pelagic biogenes with debris layers
Fossils: bivalves, cephalopods, corals, conodonts, echinoderms, foraminiferans, gastropods, stromatoporoids, trilobites
Chronostratigraphic age: Eifelian - Givetian
Biostratigraphy: *partitus*, *costatus*, and *varcus* conodont zones
Thickness: 210 m

Freikofel Limestone
Lithology: light red to greyish pelagic limestone
Fossils: cephalopods, conodonts, corals, crinoids, trilobites
Chronostratigraphic age: Eifelian - Givetian
Biostratigraphy: *costatus* conodont zone
Thickness: >100 m

PELAGIC CARBONATE FACIES (RAUCHKOFEL NAPPE)

Boden Limestone
Lithology: light flaser limestone
Fossils: cephalopods (orthoconic and coiled nautiloids), conodonts, tentaculites (dacryoconarids)
Chronostratigraphic age: Lochkovian
Biostratigraphy: *delta* and *pesavis* conodont zones
Thickness: about 20 m

Findenig Limestone
Lithology: red flaser and nodular limestone
Fossils: cephalopods, conodonts, foraminiferans, ostracods, tentaculites
Chronostratigraphic age: Pragian - Emsian
Biostratigraphy: *serratus* and *kitabicus* conodont zones
Thickness: 40 - 60 m

Hohe Trieb Formation
Lithology: flaser and platy limestone with clay and chert layers
Fossils: cephalopods, conodonts, corals, crinoids, trilobites
Chronostratigraphic age: Eifelian - Givetian
Biostratigraphy: -
Thickness: 30 - 40 m

Valentin Limestone
Lithology: well bedded limestones (wackestone), nodular phosphorite horizon (at Givetian/Frasnian boundary)
Fossils: brachiopods, conodonts, echinoderms, gastropods, ostracods, styliolinids, trilobites
Chronostratigraphic age: Eifelian – Givetian

Biostratigraphy: *costatus* to early *hassi* conodont zones
Thickness: 15 m

Pal Limestone
Lithology: limestone beds (mudstone and wackestone), thin biosparitic and quartz-rich layers, black shale
Fossils: bivalves, clymeniids, conodonts, corals (rare), echinoderms, goniatites, ostracods, styliolinids, trilobites
Chronostratigraphic age: Frasnian - Famennian
Biostratigraphy: ammonoid zones (*acuticostata* and *piriformis Clymenia* zones; upper *paradoxa* and *prorsum Wocklumeria* zones); late *hassi* to *praesulcata* conodont zones
Thickness: >100 m

DISTAL SILICICLASTIC FACIES (BISCHOFALM NAPPE)

Middle and Upper Bischofalm Shales
Lithology: black alaun shale and lydites, greyish green shale
Fossils: conodonts, graptolites
Chronostratigraphic age: Ludlow to Pridoli (M. B. Shale); Pridoli to Lochkovian (U. B. Shale)
Biostratigraphy: M. B. Shale: *vulgaris*, *nilssoni*, *chimaera*, and *transgrediens* graptolite zones; U. B. Shale: *transgrediens*, *uniformis*, *praehercynicus*, and *hercynicus* graptolite zones
Thickness: 4 - 5 m (Middle Bischofalm Shale) and 10 m (Upper Bischofalm Shale)

Zollner Formation
Lithology: greyish green lydites and siliceous shales
Fossils: conodonts, radiolarians
Chronostratigraphic age: Lochkovian - Tournaisian
Biostratigraphy: -
Thickness: >100 m

CARBONIFEROUS SEQUENCE

Kronhof Limestone
Lithology: grey to reddish flaser limestone, black shale at the base ("Kronhof Shale")
Fossils: cephalopods, conodonts, trilobites
Chronostratigraphic age: Tournaisian
Biostratigraphy: *Gattendorfia* and *Merocanites* ammonoid zones; *sulcata* to *isosticha* conodont zone and *anchoralis* conodont zone
Thickness: 10 m (+ 0.2 m Kronhof Shale at the base of the unit)

Plotta Lydite
Lithology: discontinuous silcrete layers consisting of weakly bedded breccias or massiv and laminated cherts
Fossils: radiolarians?
Chronostratigraphic age: Tournaisian
Biostratigraphy: The above mentioned age is based on a mixed conodont fauna (*anchoralis* - *latus* zone) from the uppermost limestone bed disconformably overlain by the Plotta Lydite.
Thickness: approx. 3 m

Hochwipfel Formation
Lithology: turbidite sequence consisting of graded sandstones alternating with siltstone and shale, siliceous shale, lydites (breccias and conglomerates), tuffs
Fossils: plants, spores
Chronostratigraphic age: Tournaisian - Visean
Biostratigraphy: *anchoralis* to *texanus* conodont zones
Thickness: approx. >1000 m

Dimon Formation
Lithology: pillow lavas and breccias, vulcano-clastic sediments, green and red argilites
Fossils: -
Chronostratigraphic age: Visean
Biostratigraphy: -
Thickness: approx. 300 m

Kirchbach Limestone
Lithology: micritic, light grey nodular limestone; it occurs only in lenticular bodies which laterally grade into silty shale.
Fossils: conodonts, crinoids
Chronostratigraphic age: Visean
Biostratigraphy: according to SCHÖNLAUB (1985a), the conodont assemblage points to Visean age
Thickness: 8 - 10 m

Waidegg Formation
Lithology: breccia and conglomerate horizons, in upper part coarse clastic layers are intercalated by silty and sandy shale
Fossils: plants
Chronostratigraphic age: uppermost Moscovian - lowermost Kasimovian (age is

inferred on the above deposited and well constrained Auernig Formation)
Biostratigraphy: -
Thickness: 40 m

Auernig Formation
Lithology: quartz conglomerates, cross-bedded sandstones, bioturbated siltstones, and bedded, massive or nodular limestones
Fossils: calcareous algae, brachiopods, bryozoans, conodonts, echinoderms, foraminiferans (e.g. fusulinids), gastropods, ostracods, plants
Chronostratigraphic age: Kasimovian - Gzhelian
Biostratigraphy: *permirus* to *communis* fusulinid zones; *expansus* to *elegantulus* conodont zones
Thickness: 600 - 800 m

Schulterkofel Formation
Lithology: bedded and massive limestones (represented by up to 20 m thick *Anthracoporella* mounds), with subordinate silt- and fine-grained sandstones
Fossils: algae, brachiopods, bryozoans, echinoderms, foraminiferans (e.g. fusulinids), gastropods, ostracods
Chronostratigraphic age: Gzhelian
Biostratigraphy: *communis* to *versabilis* fusulinid zones
Thickness: 140 m

Carboniferous of Nötsch

The Carboniferous of Nötsch is located north of the Periadriatic Line and is subdivided into three units by SCHÖNLAUB (1985b). The sequence has become famous due to the occurrence of certain fossils like the well-known brachiopod species *Gigantoproductus giganteus*, abundant trilobites and ostracodes (SCHRAUT 1996, HUBMANN *et al.* 2003).

Erlachgraben Formation
Lithology: quartz conglomerates and sandy shales in the lower part of the unit; grey to dark grey siltstone, shale and limy marls in the upper part of the unit
Fossils: algae, bivalves, brachiopods (e.g. *Gigantoproductus*), cephalopods, corals, crinoids, foraminiferans, gastropods, plants
Chronostratigraphic age: Visean - Bashkirian
Biostratigraphy: *granosus* goniatite zone
Thickness: approx. 80 m

Badstub Formation
Lithology: breccia consisting of amphibolite, gneiss, granite, muscovite-rich shale, quartzite, marble, limestone clasts, intercalated by a few meters thick black graphite horizon in the lower part, and a 10 - 17 m thick fossiliferous shale horizon
Fossils: bivalves, brachiopods (e.g. *Gigantoproductus*), bryozoans, corals, echinoderms, gastropods, trilobites
Chronostratigraphic age: Bashkirian - Moscovian
Biostratigraphy: *nodosus* conodont zone
Thickness: 350 - 400 m

Nötsch Formation
Lithology: brown to dark grey sandy shale, sandstone, fine-grained to coarse conglomerates
Fossils: bivalves, brachiopods, bryozoans, corals, echinoderms, gastropods, ostracods, scaphopods, trace fossils, trilobites, plants
Chronostratigraphic age: Moscovian - Kasimovian
Biostratigraphy: -
Thickness: 400 - 600 m

References

HUBMANN, B., POHLER, S., SCHÖNLAUB, H.P. & MESSNER, F. (2003): Paleozoic Coral-Sponge Bearing Successions in Austria. - Berichte der Geologischen Bundesanstalt, 61: 1-91.

FORKE, H., SCHÖNLAUB, H.P. & SAMANKASSOU, E. (2006): The Late Paleozoic of the Carnic Alps (Austria/Italy): Guidebook; Field-trip of the SCCS Task Group to establish GSSP's close to the Moscovian/Kasimovian and Kasimovian/Gzhelian boundaries 31. July - 1. August. - Berichte der Geologischen Bundesanstalt, 70: 1-57.

KRAINER, K. (1992): Fazies, Sedimentationsprozesse und Paläogeographie im Karbon der Ost- und Südalpen. - Jahrbuch der Geologischen Bundesanstalt, 135 (1): 99-193.

KREUTZER, L.H. (1992a): Palinspastische Entzerrung und Neugliederung des Devons in den Zentralkarnischen Alpen aufgrund von neuen Untersuchungen. - Jahrbuch der Geologischen Bundesanstalt, 135 (1): 261-272.

KREUTZER, L.H. (1992b): Photoatlas zu den varizischen Karbonat-Gesteinen der Karnischen Alpen (Österreich/Italien). - Abhandlungen der Geologischen Bundesanstalt, 47: 1-129.

PÖLSLER, P. (1969a): Stratigraphie und Tektonik im Nordabfall des Findenigkofels (Silur bis Karbon; Karnische Alpen, Österreich). - Jahrbuch der Geologischen Bundesanstalt, 112: 355-398.

PÖLSLER, P. (1969b): Conodonten aus dem Devon der Karnischen Alpen (Findenigkofel, Österreich). - Jahrbuch der Geologischen Bundesanstalt, 112 (2): 399-440.

SCHÖNLAUB, H.P. (1985a): Das Paläozoikum der Karnischen Alpen. - *In*: DAURER, A. & SCHÖNLAUB, H.P. (eds.): Arbeitstagung der Geologischen Bundesanstalt 1985 in Kötschach-Mauthen. 1-87.

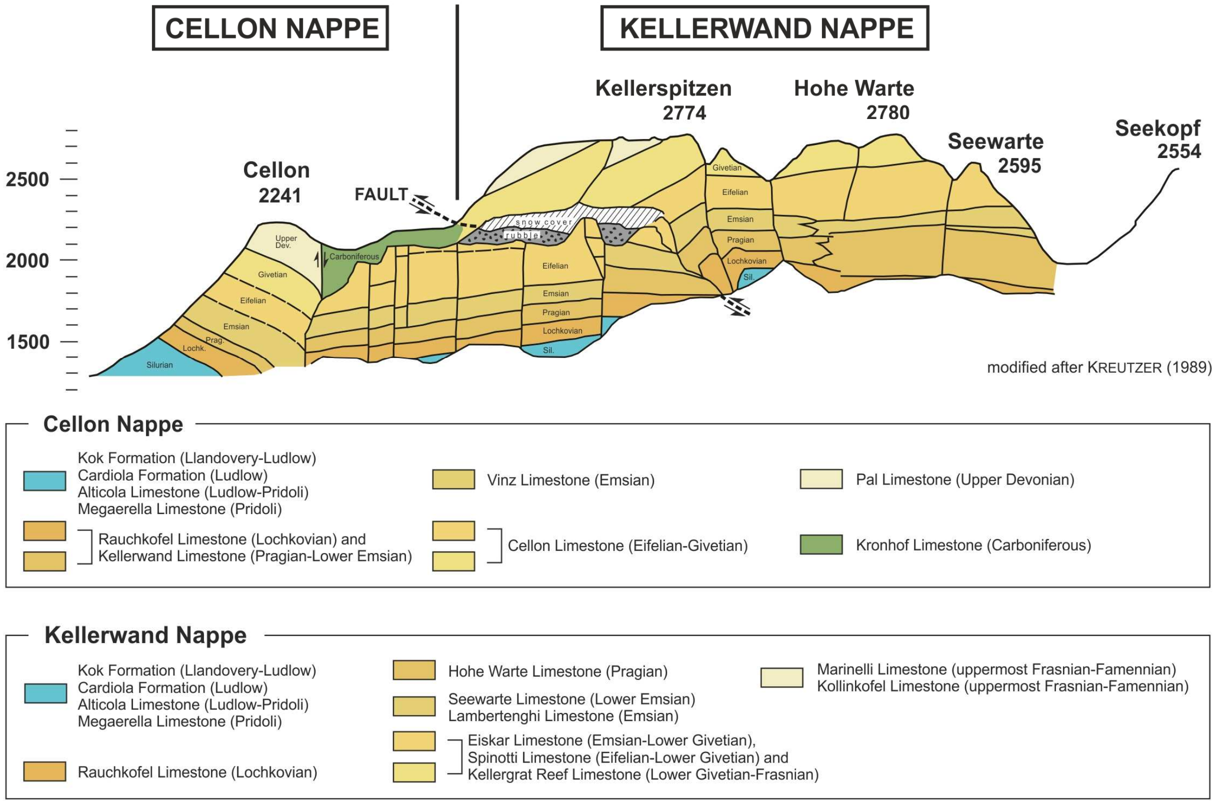
SCHÖNLAUB, H.P. (1985b): Das Karbon von Nötsch und sein Rahmen. - Jahrbuch der Geologischen Bundesanstalt, 127 (4): 673-692.

SCHÖNLAUB, H.P., HISTON, K. & POHLER, S. (2004): The Palaeozoic of the Carnic Alps. - *In*: SCHÖNLAUB, H.P. (ed.): Field Trip Carnic Alps Guidebook. June 23-24, 2004, Carinthia Austria. - Geologische Bundesanstalt, 40: 2-32.

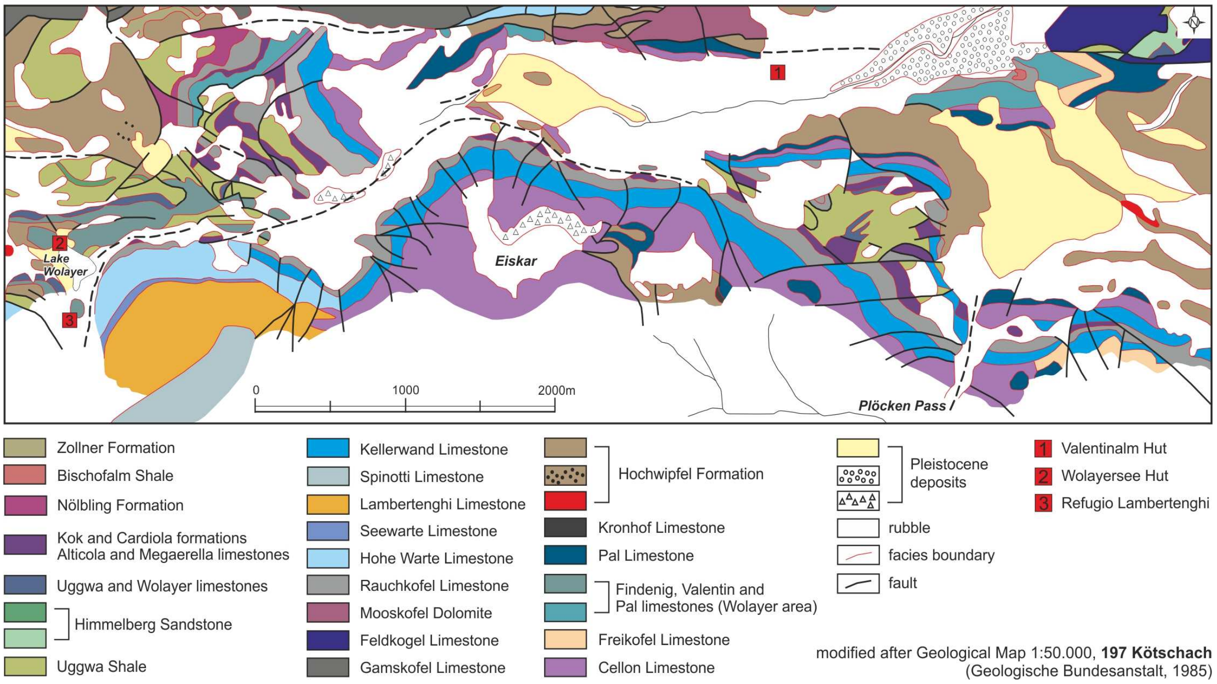
SCHÖNLAUB, H.P. with contributions from JAEGER, H., HOUSE, M.R., PRICE, J.D., GÖDDERTZ, B., PRIEWALDER, H., WALLISER, O.H., KŘÍŽ, J., HAAS, W. & VAI, G.B. (1980): Carnic Alps. Field Trip A. - *In*: SCHÖNLAUB, H.P. (ed.): Second European Conodont Symposium, ECOS II, Guidebook, Abstracts. - Abhandlungen der Geologischen Bundesanstalt, 35: 5-57.

SCHRAUT, G. (1996): Die Arthropoden aus dem Unterkarbon von Nötsch (Kärnten/Österreich). - Abhandlungen der Geologischen Bundesanstalt, 51: 1-193.

Field-Workshop: Regional Geology



modified after KREUTZER (1989)

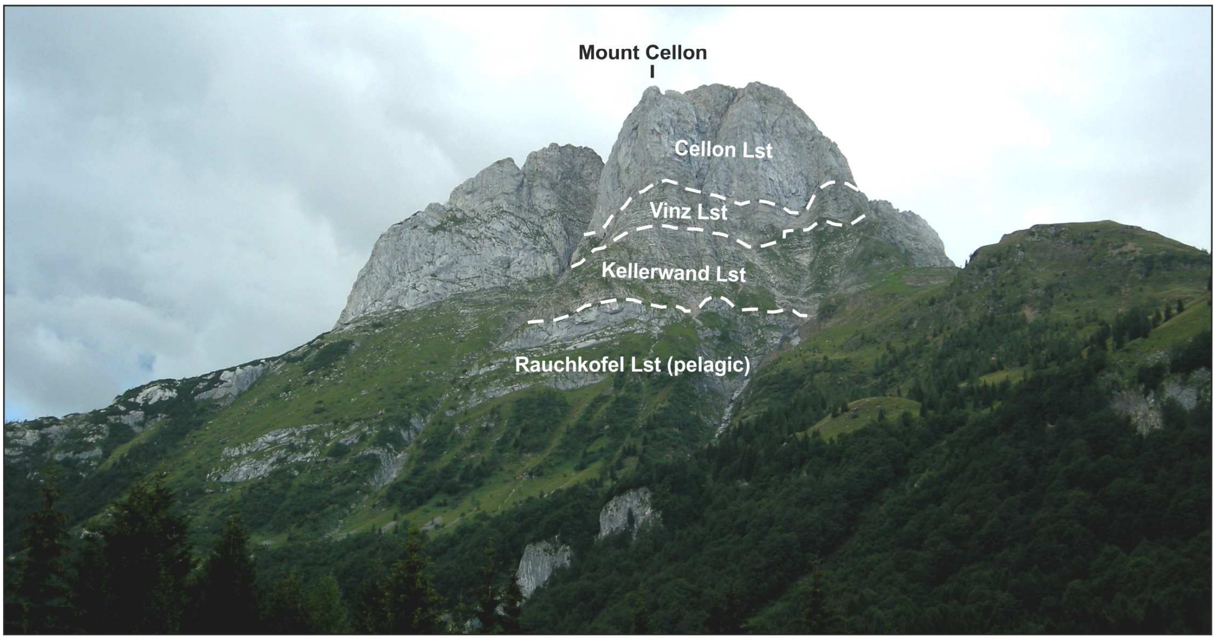


modified after Geological Map 1:50.000, **197 Kötschach**
(Geologische Bundesanstalt, 1985)

Field-Workshop: Geological Highlights

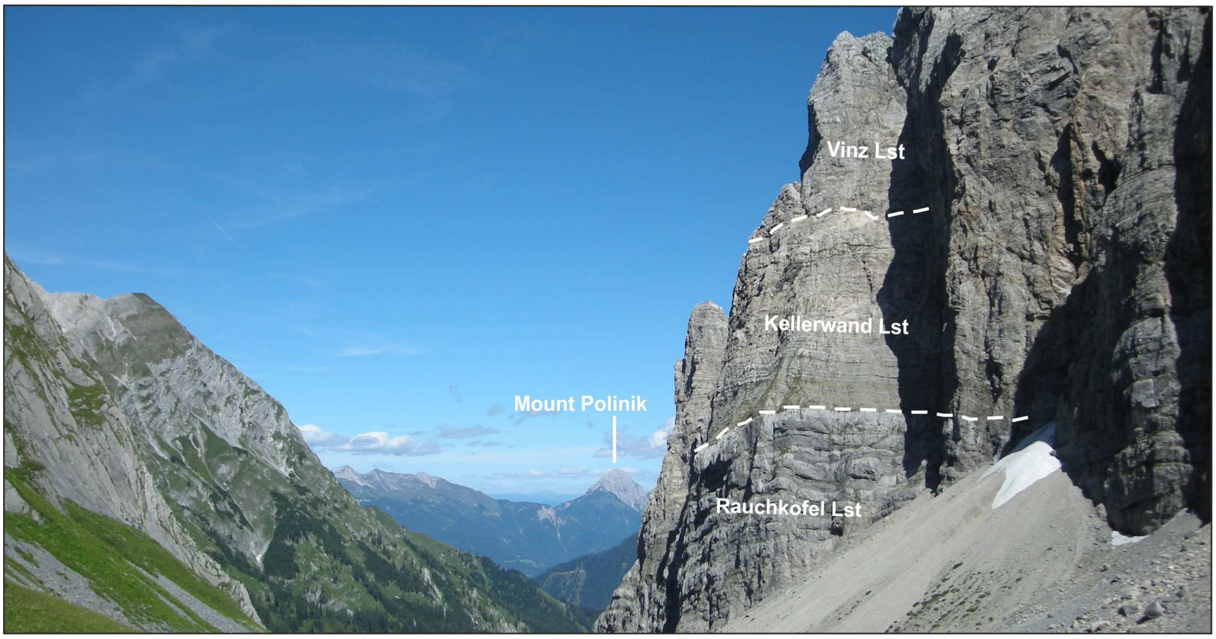
SOUTHERN SHALLOW WATER FACIES

A **KELLERWAND NAPPE**
Locality: Mount Gamskofel



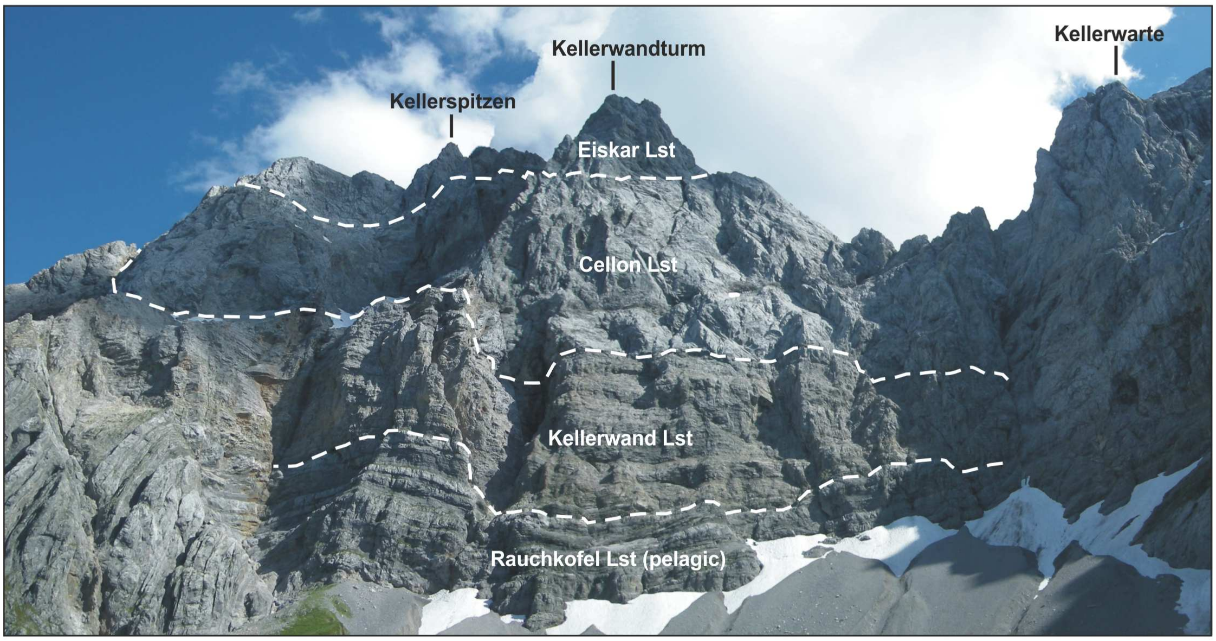
TRANSITONAL FACIES

B **CELLON NAPPE**
Locality: Mount Cellon



TRANSITONAL FACIES

C **CELLON NAPPE**
Locality: Kellerwand



TRANSITONAL FACIES

D **CELLON NAPPE**
Locality: Kellerwand

PELAGIC CARBONATE FACIES

E

RAUCHKOFEL NAPPE

Locality: Mount Rauchkofel

PELAGIC CARBONATE FACIES

F

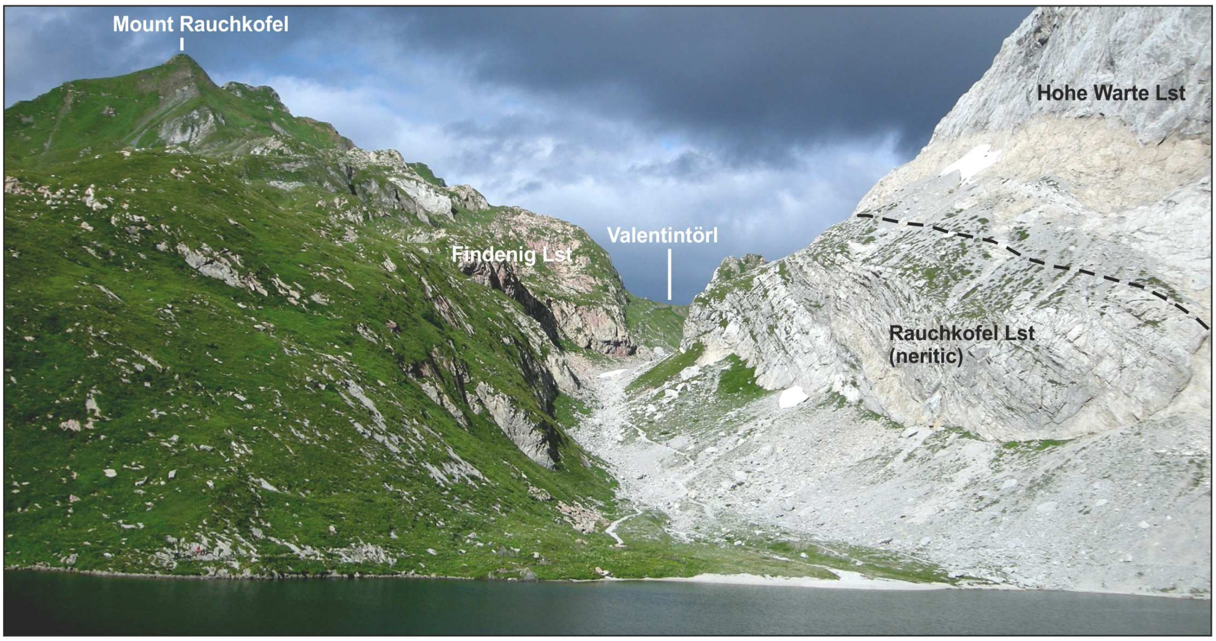
RAUCHKOFEL NAPPE

Locality: Valentintörl

PELAGIC CARBONATE FACIES

G **RAUCHKOFEL NAPPE**

Locality: Wolayer Glacier section



SOUTHERN SHALLOW WATER FACIES ⇄ PELAGIC CARBONATE FACIES

H **RAUCHKOFEL NAPPE / KELLERWAND NAPPE**

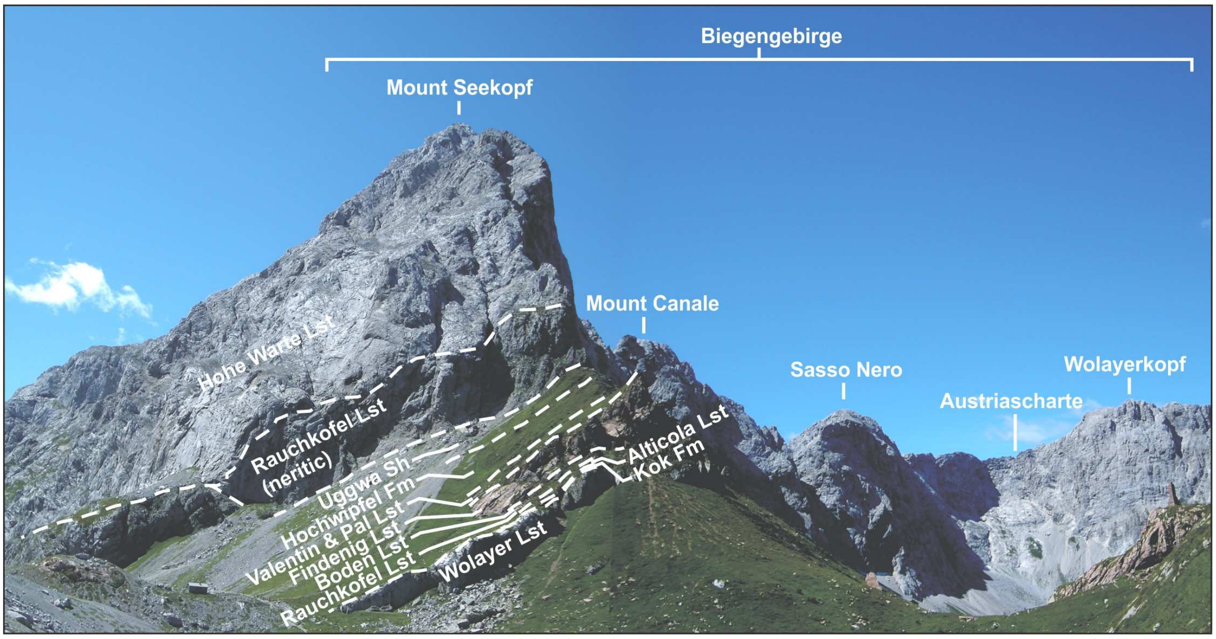
Locality: Mount Rauchkofel & Mount Seewarte

SOUTHERN SHALLOW WATER FACIES

I **KELLERWAND NAPPE**
Locality: Mount Seewarte

SOUTHERN SHALLOW WATER FACIES

J **KELLERWAND NAPPE**
Locality: Spinotti Trail



SOUTHERN SHALLOW WATER FACIES ⇄ PELAGIC CARBONATE FACIES

K **KELLERWAND NAPPE / RAUCHKOFEL NAPPE**
Locality: Mount Seekopf & Seekopfsockel

SOUTHERN SHALLOW WATER FACIES

L **KELLERWAND NAPPE**
Locality: Passo Volaia area (RLF III section)

Field-Workshop: Infrastructure

SBW Terra Mystica &
Montana Schaubergwerks-GmbH
Austria
email: office@terra-mystica.at

Contact
Michael Grafenauer
Terra Mystica & Montana Schaubergwerk
A-9531 Bleiberg-Nötsch 91
phone: +4342442255

Webpage
www.terra-mystica.at

Visitors Centre GeoPark Carnic Alps
Austria
email: office@geopark-karnische-alpen.at

Contact
Gerlinde Ortner & Hans Peter Schönlaub
Visitors Centre GeoPark Carnic Alps
A-9635 Dellach/Gail 65
phone: +43471830117

Webpage
www.geopark-karnische-alpen.at

Gasthof Valentinalm
Austria
email: muellmann@valentinalm.at

Contact
Fam. Müllmann Gabi & Walter
Valentinalm (1221 m)
A-9640 Kötschach-Mauthen
phone: +43471592215

Webpage
www.valentinalm.at

Wolayerseehütte
Austria
email: wolayerseehuette@gmx.at

Contact
Fam. Ortner Manuela & Helmut
Wolayersee (1960 m)
A-9640 Kötschach-Mauthen
phone: +43720346141

Webpage
www.wolayerseehuette.at

Rifugio Lambertenghi Romanin
Italy
email: info@lambertenghi.it

Contact
di Ianese Giampiero & De Rigo s.n.c.
Passo Volaia (1970 m)
33020 Forni Avoltri, Udine
phone: 347-2306246

Webpage
www.lambertenghi.it

Rifugio Giovanni e Olinto Marinelli
Italy
email: info@rifugiomarinelli.com

Contact
Fam. Tamussin Giorgio
Loc. Forcella Moraretto (2122 m)
33026 Paluzza, Udine
phone: +390433779177

Webpage
www.rifugiomarinelli.com

Addresses of authors

ABOUSSALAM, S. - Westfälische Wilhelms-University, Institute for Geology and Palaeontology, Corrensstr. 24, D-48149 Muenster, Germany; taghanic@uni-muenster.de

ANTOSHKINA, A.I. - Institute of Geology, Komi Science Centre, Ural Branch, RAS, 54 Pervomayskaya St., 167982 Syktyvkar, Russian Federation; Antoshkina@geo.komisc.ru

ARIUNCHIMEG,Ya. - Paleontological Center, Mongolian Academy of Sciences, Enkhtaivan evenue 63, Ulaanbaatar, Mongolia; ariuna_ya@magicnet.mn

ARTYUSHKOVA, O.V. - Institute of Geology, Ufa Scientific Centre, Russian Academy of Sciences, 16/2 Karl Marx street, Ufa, the Republic of Bashkortostan, 450077 Russian Federation; stpal@anrb.ru

BECKER, R.T. - Westphälische Wilhelms-Universität, Institut für Geologie und Paläontologie, Corrensstr. 24, D-48149 Münster, Germany; rbecker@uni-muenster.de

BELKA, Z. - Isotope Laboratory, Adam Mickiewicz University, 61606 Poznan, Poland; zbelka@amu.edu.pl

BERKYOVÁ, S. - Czech Geological Survey, P.O.B. 85, 118 21 Praha 1, Czech Republic; berkyova.s@seznam.cz

BONCHEVA, I. - Geological Institute, Bulgarian Academy of Sciences, Acad. G. Bonchev St., Bl. 24, 1113 Sofia, Bulgaria; boncheva2005@yahoo.com

BOULVAIN, F. - Petrologie sedimentaire, B20, Boulevard du Rectorat, Université de Liège, Sart Tilman, 4000 Liège, Belgium; fboulvain@ulg.ac.be

BÖHMOVÁ, V. - Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic; bohmova@gli.cas.cz

BUGGISCH, W. - GeoZentrum Nordbayern, University of Erlangen-Nuremberg, Schlossgarten 5, 91054 Erlangen, German; buggisch@geol.uni-erlangen.de

BULTYNCK, P. - Department of Palaeontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; pierre.bultynck@naturalsciences.be

CAPUTO, M.V. - Universidade Federal do Pará, Geologia, Av. Perimetral s/n, 66075-110 Belém-PA, Brazil; caputo@interconect.com.br

CARIDROIT, M. - Université de Lille-1, Sciences de la Terre, FRE 3298- CNRS, 'Géosystèmes', F-59655 Villeneuve-d'Ascq cedex, France; martial.caridroit@univ-lille1.fr

CARTA, N. - via Emilio Lussu 21, I-09040 Settimo S. Pietro (CA); nicola.carta1@virgilio.it

CASIER, J-G. - Institut royal des Sciences naturelles de Belgique, rue Vautier, 29, B-1000 Bruxelles, Belgique; casier@naturalsciences.be

CHEN, X.-Q. - Chinese Academy of Sciences, Nanjing Institute of Geology and Palaeontology, Department of Invertebrate Palaeontology, 39 East Beijing Road, Nanjing 210008, China; xqchen@nigpas.ac.cn

CLAEYS, Ph. - Earth System Sciences, Vrije Universiteit Brussel, B-1050 Brussels, Belgium; phclaeys@vub.ac.be

CORNET, P. - Sedimentary Petrology, B20, Université de Liège, Sart-Tilman 4000, Liège, Belgium; pierrejcornet@gmail.com

CORRADINI, C. - Università di Cagliari, Dipartimento di Scienze della Terra, via Trentino 51, I-09127 Cagliari, Italy; corradin@unica.it

CORRIGA, M.G. - Università di Cagliari, Dipartimento di Scienze della Terra, via Trentino 51, I-09127 Cagliari, Italy; maria.corriga@unica.it

CRUCIFIX, M. - Centre de recherche sur la Terre et le climat Georges Lemaître, Earth and Life Institute, Université catholique de Louvain, B-1348 Louvain-la-Neuve, Belgium; michel.crucifix@uclouvain.be

Da Silva, A.C. - Petrologie sedimentaire, B20, Boulevard du Rectorat, Université de Liège, Sart Tilman, 4000 Liège, Belgium; ac.dasilva@ulg.ac.be

DeReuil, A.A. - Department of Geology, Appalachian State University, Boone, NC 28608, USA

De Vleeschouwer, D. - Earth System Sciences, Vrije Universiteit Brussel, B-1050 Brussels, Belgium; dadevlee@vub.ac.be

Devleeschouwer, X. - Institut royal des Sciences naturelles de Belgique, rue Vautier, 29, B-1000 Bruxelles, Belgium; Xavier.Devleeschouwer@naturalsciences.be

Dojen, C. - Landesmuseum Kärnten, Museumsgasse 2, A-9021 Klagenfurt, Austria; claudia.dojen@landesmuseum.ktn.gv.at

Dopieralska, J. - Isotope Laboratory, Adam Mickiewicz University, 61606 Poznan, Poland; dopieralska@amu.edu.pl

Ernst, A. - Institut für Geowissenschaften der Christian-Albrechts-Universität zu Kiel, Ludewig-Meyn-Str. 10, 24118 Kiel, Germany; ae@gpi.uni-kiel.de

Gatovsky, Yu.A. - Department of Paleontology, Geological Faculty, Moscow State University, Vorob’evy Gory, 1, Moscow, 119991, Russian Federation; gatovsky@geol.msu.ru

Gouwy, S. - University of Missouri, 101 Geological Sciences Building, 65211 Columbia (MO), USA; sofiegouwy@yahoo.com

Göncüoglu, M.C. - Middle East Technical Univerity, Department of Geological Engineering, Ankara, Turkey; mcgoncu@metu.edu.tr

Hidaka, H. - Department of Earth and Planetary Systems Science, Hiroshima University. Higashi-Hiroshima 739-8526, Japan; hidaka@hiroshima-u.ac.jp

Hladil, J. - Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic; hladil@gli.cas.cz

Horie, K. - National Institute of Polar Research, 10-3, Midoricho, Tachikawa, Tokyo 190-8518, Japan; horie.kenji@nipr.ac.jp

Hubmann, B. - Karl-Franzens-Universität Graz, Institute for Earth Sciences, Heinrichstraße 26, A-8010 Graz; bernhard.hubmann@uni-graz.at

Izokh, N.G. - Trofimuk Institute of Petroleum Geology and Geophysics SB RAS, Acad. Koptyug Av., 3, Novosibirsk, 630090, Russia; IzokhNG@ipgg.nsc.ru

Joachimski, M.M. - GeoZentrum Nordbayern, University of Erlangen-Nuremberg, Schlossgarten 5, 91054 Erlangen, Germany; michael.joachimski@gzn.uni-erlangen.de

Kaneva, N.A. - Institute of Geology, Komi Science Centre, Ural Branch, RAS, 54 Pervomayskaya St., 167982 Syktyvkar, Russian Federation; nakaneva@geo.komisc.ru

Kido, E. - Austrian Academy of Sciences (CPSA) c/o University of Graz, Institute for Earth Sciences (Geology & Paleontology), Heinrichstrasse 26, A-8010 Graz, Austria; erika.kido@uni-graz.at

Kiessling, W. - Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin; Invalidenstraße 43, 10115 Berlin, Germany; wolfgang.kiessling@mfn-berlin.de

Koptiková, L. - Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic; Charles University in Prague, Faculty of Science, Albertov 6, Prague 2, 12843, Czech Republic; koptikova@gli.cas.cz

Königshof, P. - Senckenberg - Forschungsinstitut und Naturmuseum, Senckenberganlage 15, 60325 Frankfurt, Germany; peter.koenigshof@senckenberg.de

Kulagina, E.I. - Institute of Geology, Ufa Scientific Centre, Russian Academy of Sciences, Ufa, 450077, K. Marx St. 16/2, Russian Federation; kulagina@anrb.ru

KURIHARA, T. - Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan; tosiyuki@rj8.so-net.ne.jp

LIAO, J.-C. - Department of Paleontology, University Complutense, C/. Antonio Novais 2, E-28040 Madrid, Spain, Department of Geology, University of Valencia, c/Dr. Moliner 50, E-46100 Burjasot, Spain; jau.liao@uv.es

LUTAT, P. - Palaeontological Research and Education Centre, Mahasarakham University, Mahasarakham 44150, Thailand; petra.l@msu.ac.th

MABILLE, C. - Petrologie sedimentaire, B20, Boulevard du Rectorat, Université de Liège, Sart Tilman, 4000 Liège, Belgium; cmabille@ulg.ac.be

MAILLET, S. - Laboratoire de Paléontologie Stratigraphique, Université de Lille 1, 41 rue du Port, F-59046 Lille Cedex, France; sebastien.maillet@icl-lille.fr

MANCHUK, N. - School of Geology and Petroleum Engineering, Mongolian University of Science and Technology. P.O.Box 46/654, Ulaanbaatar 46, Mongolia 210646; manchukn@gmail.com

MASLOV, V.A. - Institute of Geology, Ufa Scientific Centre, Russian Academy of Sciences, 16/2 Karl Marx street, Ufa, the Republic of Bashkortostan, 450077 Russian Federation; stpal@anrb.ru

MATSUMOTO, A. - Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan

MAVRINSKAYA, T.M. - Institute of Geology, Ufimian Scientific Centre, RASK. Marx Str., 16/2, Ufa 450077, Russia; stpal@anrb.ru

MELO, J.H.G. - Petrobras/Cenpes/Pdgeo/Bpa, Av. Horácio Macedo 950, I. Fundão, 21941-915 Rio de Janeiro, Brazil; jhmelo@petrobras.com.br

MINJIN, Ch. - School of Geology and Petroleum Engineering, Mongolian University of Science and Technology, Ulaanbaatar, Mongolia; c_minjin@yahoo.com

NARKIEWICZ, K. - Polish Geological Institute-National Research Institute, Rakowiecka 4, 00-975 Warszawa, Poland; katarzyna.narkiewicz@pgi.gov.pl

NARKIEWICZ, M. - Polish Geological Institute-National Research Institute, Rakowiecka 4, 00-975 Warszawa, Poland; marek.narkiewicz@pgi.gov.pl

OTOH, S. - Department of Earth Sciences, Faculty of Science, University of Toyama, Toyama 930-8555, Japan; shige@sci.toyama-u.ac.jp

PAS, D. - Petrologie sedimentaire, B20, Boulevard du Rectorat, Université de Liège, Sart Tilman, 4000 Liège, Belgium; dpas@ulg.ac.be

PETITCLERC, E. - Institut royal des Sciences naturelles de Belgique, rue Vautier, 29, B-1000 Bruxelles, Belgique; petitclerc@naturalsciences.be

PONDRELLI, M. – Università D'Annunzio, International Research School of Planetary Sciences, viale Pindaro 42, I-65127 Pescara, Italy; monica@irsps.unich.it

PRÉAT, A. - Département des Sciences de la Terre et de l'Environnement, Université libre de Bruxelles, av. F. Roosevelt, 50, B-1000 Bruxelles, Belgique; apreat@ulb.ac.be

RACKI, G. - Department of Earth Sciences, Silesian University, 41-200 Sosnowiec, Poland; racki@twarda.pan.pl

RANDON, C. - UPMC Univ Paris 06, UMR 7207-CNRS, Centre de Recherche sur la Paléobiodiversité et les Paléoenvironnements, 4, Place Jussieu, Tour 56, 5e étage, case 104, 75252 Paris cedex, France; carine.randon@upmc.fr

SACHANSKI, V. - Geological Institute, Bulgarian Academy of Sciences, Acad. G. Bonchev St., Bl. 24, 1113 Sofia, Bulgaria; v_sachanski@geology.bas.bg

SARDSUD, A. - Department of Mineral Resources, Geological Survey Division, Bangkok 10400, Thailand; apsornsa@yahoo.com

SAVAGE, N.M. - Department of Geological Sciences, University of Oregon, Eugene Oregon 97405, USA; nmsavage@uoregon.edu

SAYDAM-DEMIRAY, G. - M.T.A., Geol. Res. Dept, Ankara, Turkey; dgsaydam@mta.gov.tr

SCHNABL, P. - Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic; Charles University in Prague, Faculty of Science, Albertov 6, Prague 2, 12843, Czech Republic; schnabl@gli.cas.cz

SERSMAA, G. - School of Geology and Petroleum Engineering, Mongolian University of Science and Technology, Ulaanbaatar; sers_gon@yahoo.com

SIMONETTO, L. - Museo Friulano di Storia Naturale, via Marangoni 39-41, I-33100 Udine, Italy; luca.simonetto@comune.udine.it

SKÁLA, R. - Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic; skala@gli.cas.cz

SLAVÍK, L. - Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic; slavik@gli.cas.cz

ŠLECHTA, S. - Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic; Charles University in Prague, Faculty of Science, Albertov 6, Prague 2, 12843, Czech Republic; slechta@gli.cas.cz

SPALLETTA, C. - Dipartimento di Scienze della Terra e Geologico Ambientali, Alma Mater Studiorum Università di Bologna, via Zamboni 67, I-40126 Bologna, Italy; claudia.spalletta@unibo.it

ŠT'ASTNÝ, M. - Institute of Geology ASCR, v.v.i., Rozvojova 269, Prague 6, 16500, Czech Republic

STREEL, M. - Department of Geology, University of Liege, Sart-Tilman B18, BE 4000 Liège 1, Belgium; Maurice.Streel@ulg.ac.be

SUTTNER, T.J. - Austrian Academy of Sciences (CPSA) c/o University of Graz, Institute for Earth Sciences (Geology & Paleontology), Heinrichstrasse 26, A-8010 Graz, Austria; thomas.suttner@uni-graz.at

SUZUKI, K. - Center for Choronological Research, Nagoya University. Chikusa, Nagoya 464-8601, Japan; suzuki@nendai.nagoya-u.ac.jp

TAGARIEVA, R.Ch. - Institute of Geology, Ufa Scientific Centre, Russian Academy of Sciences, 16/2 Karl Marx street, Ufa, the Republic of Bashkortostan, 450077 Russian Federation; stpal@anrb.ru

TAYLOR, P.M - Department of Palaeontology, Natural History Museum, Cromwell Road, London SW7 5BD, United Kingdom; p.taylor@nhm.ac.uk

TSUKADA, K. - Nagoya University Museum. Chikusa, Nagoya 464-8601, Japan; tsukada@num.nagoya-u.ac.jp

TÜRKMENOGLU, A.G. - Middle East Technical Univerity, Department of Geological Engineering, Ankara, Turkey; asumant@metu.edu.tr

ÜNLÜCE, O. - Middle East Technical Univerity, Department of Geological Engineering, Ankara, Turkey

VALENZUELA-RÍOS, J.I. - Department of Geology, University of Valencia, c/Dr. Moliner 50, E-46100 Burjasot, Spain; jose.i.valenzuela@uv.es

VINN, O. - Department of Geology, University of Tartu, Ravila 14A, 50411 Tartu, Estonia; olev.vinn@ut.ee

WALLISER, O.H. (+) - The Institute und Museum für Geologie und Paläontologie of the University of Göttingen, Germany

WATERS, J.A. - Department of Geology, Appalachian State University, Boone, NC 28608, USA; watersja@appstate.edu

YILMAZ, I.O. - Middle East Technical University, Department of Geological Engineering, Ankara, Turkey; ioyilmaz@metu.edu.tr

ZATOŃ, M. - Department of Palaeontology and Stratigraphy, Faculty of Earth Sciences, University of Silesia, Będzińska str., 60, 41-200 Sosnowiec, Poland; mzaton@wnoz.us.edu.pl

Index