

# NOVEMBER 2012 REPORT OF TASK GROUP TO REDEFINE THE DEVONIAN-CARBONIFEROUS BOUNDARY

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## Introduction and general activities

Members of the task group for the redefinition of the Devonian-Carboniferous (D-C) boundary are conducting paleontologic and multi-disciplinary research on several continents. Their work focuses on goals defined near the project's onset (Richards and task group, 2010) and at the task-group workshop held during the 2010 Third International Palaeontological Congress (IPC3) in London, United Kingdom (Aretz, 2011). During the fiscal year, the group continued with its primary tasks – the search for a suitable criterion for the redefinition of the D-C boundary and the hunt for a suitable section for the GSSP. Studies by Ji *et al.* (1989) and subsequent analysis (Kaiser, 2009) demonstrated severe problems exist with the D-C boundary GSSP (Paproth *et al.*, 1991) at La Serre Hill, France. The boundary at La Serre is currently defined by the first evolutionary occurrence of the conodont *Siphonodella sulcata* (Huddle, 1934) in the lineage *Siphonodella praesulcata* Sandberg, 1972 to *S. sulcata* but both the definition and the section are considered deficient. The current search for a boundary index is focused on conodonts and the geochemical-sedimentologic events in the multi-phase Hangenberg Event (Kaiser, 2005; Kaiser *et al.*, 2008). More data on the precise timing of phases of the Hangenberg and the correlation of the biostratigraphic, geochemical, sedimentologic and sequence stratigraphic patterns within it are needed to evaluate the potential of the event for boundary definition. The group has been gathering such data and plans to present the results at a major D-C boundary workshop in Morocco from (March 22<sup>nd</sup> to March 29<sup>th</sup>, 2013). A few task-group members attended the 34<sup>th</sup> International Geological Congress in Brisbane where a short discussion of research activities around the D-C boundary occurred during the SDS business meeting.

## Progress reports from members

**J. Kalvoda (Bruno).** Czech researchers have been working in Central and Western Europe and are accumulating large multidisciplinary datasets for key sections in different facies and countries. The group comprises J. Kalvoda, T. Kumpan (bio- stratigraphy of foraminifers and conodonts), J. Frýda (isotope geochemistry), T. Grygar (element geochemistry) and O. Bábek (petrophysical logging, sedimentology, sequence- stratigraphic interpretation). The results of their multidisciplinary correlation of the D-C boundary sections from the Moravian Karst (Czech Republic) and the Carnic Alps (Austria) have been submitted to the Geological Magazine. Their study focused on the interval from the Middle *Palmatolepis gracilis expansa* Zone (late Famennian) to the *Siphonodella sandbergi* Zone (early Tournaisian). In the Lesní lom quarry (Moravian Karst), a positive O<sup>13</sup>C excursion in the *Bisphatodus costatus* – *Protognathodus kockeli* interregnum (part of middle *Siphonodella praesulcata* Zone) from a laminated carbonate horizon was correlated to the Grüne Schneid section, Carnic Alps by using a carbon-isotope excursion. The carbonates in the Lesní lom section were interpreted as being equivalent to the Hangenberg black shales and a local expression of the global Hangenberg Event. Higher values of the Mn/Al ratio were documented from the level in the Moravian Karst (Lesní lom quarry, Mokrá) and Carnic Alps (Grüne Schneid). Up section in the Moravian Karst sections (Lesní lom quarry, Mokrá, Křtiny), a significant increase in the terrigenous input, which is inferred from the gamma-ray signal and elevated concentrations of terrigenous elements (Si, Ti, Zr, Rb, Al, etc.), provided a correlation tie line interpreted as the equivalent of the Hangenberg sandstone. The presence of Famennian foraminiferal genus *Quasiendothyra* was documented up to the

Tournaisian *Siphonodella bransoni* Zone in the Moravian Karst where the FAD of *Tournayellina beata pseudobeata* was recognized. The latter foraminifer, also reported from Belgium (Poty *et al.*, 2006), the Urals (Reitlinger & Kulagina, 1987; Pazukhin *et al.*, 2009) and China (Hance *et al.* 2011), represents an important event close to the D-C boundary. In contrast to the other sections, the Moravian sections enable the precise establishment of its FAD to the upper part of the *Bispathodus costatus* – *Protognathodus kockeli* interregnum.

Recent studies (Aretz and task-group, 2011) demonstrated there are serious issues with using conodonts for boundary definition because of taxonomic problems within the earliest siphonodellids and they are strongly facies dependant; in addition, the protognathodids, the other conodont group with some potential for boundary definition, are commonly rare at the D-C boundary level. Because of the shortcomings of the conodonts, the correlative potential of geochemical and petrophysical signatures of phases in the Hangenberg event offer an alternative to the refining of the problematic biostratigraphic definition of the D-C boundary. The results obtained by the Czech team support the views of Walliser (1984) who regarded the Hangenberg Event as worldwide, synchronous, and a natural D-C boundary.

Studies similar to those of the Czech researchers have been started in sections in the Namur-Dinant Basin (Gendron-Celles, Rivage and Avesnois) of Belgium in cooperation with task-group member Eddy Poty and in the French Pyrenees (Miles, Saubette) and the Montagne Noire (La Serre, Puech) in cooperation with Markus Aretz. First results from the Namur-Dinant Basin show a distinct positive  $\delta^{13}\text{C}$  excursion in the basal part of the Avesnelles Limestone in Avesnois and the Hastiere Limestone in the Gendron-Celles section, which is different from the excursion in the *Bispathodus costatus* – *Protognathodus kockeli* interregnum. In the Avesnois the basal part of the Avesnelles Limestone contains advanced *Chernyshyshinella* foraminifers indicating a higher level in the lower Tournaisian than the *Bispathodus costatus* – *Protognathodus kockeli* interregnum.

### **C. Corradini (Cagliari)**

Carlo Corradini has several ongoing projects related to the D-C boundary study in various part of northern Gondwana. In Sardinia (Italy) the Monte Taccu section has been resampled, and a new section has been measured in the Clymeniae limestone of the southwestern part of the island. Further studies of D-C sections are being conducted in Iran (collaboration with A. Bahrami) and in the Montagne Noire (collaboration with C. Girard).

### **T. Becker (Münster) and research group**

Thomas Becker and his researchers continued their investigation of the Lalla Mimouna North section at the northern margin of the Maider region, SE Anti-Atlas, Morocco and report the following progress. All conodont samples collected during 2011 and the spring of 2012 have been picked but not fully identified. The full set of identifications will be included in the Field Guide for the March 2013 field symposium in Morocco as an update to the preliminary reports in the SCCS and SDS Newsletters (Becker *et al.*, 2011; 2012). D. Brice submitted a faunal list of the brachiopods from the Hangenberg Sandstone interval (Fezzou Formation tongue), situated between the local pre- and post-Hangenberg Event crinoidal limestones. A new collection of ammonoids from the overlying *Gattendorfia* shale increases the number of basal Tournaisian ammonoid taxa and includes the first *Eocanites* from the section. The Münster isotope laboratory provided stable- carbon and oxygen-isotopes data for all beds sampled for conodonts and for samples from the adjacent section with “Stockum level” goniatites. In the latter section, a dark marker bed containing *Postclymenia evoluta* (*kockeli* Zone) produced an unusual, strong negative carbon isotope signal, which suggests a substantial influx of diagenetically mobilized and recycled organic carbon. Thin sections of all beds have been produced and will be subject to detailed microfacies analyses.

Becker (2012) listed poorly known and recent publications on D-C boundary sections in southern Saskatchewan of Canada (Bakken Fm.), Iran, Russia (Moscow Syncline, southern

Urals, Vaygach Island), Azerbaijan, China (Hainan Island), and Vietnam. The task group leadership thinks it is important to involve the various authors listed in the work of the group.

Colleagues from Malaysia, especially Hakif Hassan Meor (Kuala Lumpur, University of Malaya), contacted Becker's group in relation to the succession of the Perlis region, where an occurrence of deposits that overly the Chepor Formation (Meor and Lee, 2005) and contain “*Posidonia*” (probably *Guerichia*) and ammonoids may lie within the Hangenberg Black Shale level. The deposits have been mostly overlooked by other D-C boundary workers but cooperation concerning underlying Famennian conodont faunas was agreed upon and the conspicuous black shale will be sampled for palynomorphs.

In the frame of the Convention of cooperation between Germany and Morocco [DFG-CNRST (Maroc)] project on the Eovariscan evolution of the southern and northern external margins of the Variscides, Becker and colleagues took some preliminary samples from several sections across the D-C boundary in the Moroccan Meseta. All sections are in clastic facies but palynomorphs may provide some biostratigraphic control. The Meseta lacks potential for a conodont-defined boundary but may provide important auxiliary clastic sections.

Becker and associates assisted H. Tragelehn to finish photographing his important early siphonodellids and related new genera from the pre-Hangenberg limestones of Franconia and Thuringia. He commented on the contemporaneous and closely related new forms from the Wocklumian (Upper Devonian VI) of the Tafilalt region in Morocco (Hartenfels and Becker, 2012), which will be published in detail in 2013. These forms further underline the taxonomic complexity at the transition from polygnathids to siphonodellids in the uppermost Devonian, with implications for our understanding of the siphonodellid lineage through the Hangenberg Crisis and into the post-event radiation phase.

For his M.Sc. research, T. Fischer is investigating the ontogenetic morphometry of uppermost Famennian ammonoids from Morocco, Franconia (eastern part historic Duchy of Franconia in Germany), and other parts of Germany. First results show that the early ontogenetic opening of the umbilicus is not restricted to the *Acutimitoceras* group during and after the Hangenberg Event Interval but is already rather wide-spread in specific Prionoceratidae (“imitoceratids”) before the event. This has implications for understanding the phylogeny of ammonoids across the D-C interval, with possible implications for the stratigraphic significance of some taxa.

A new monograph on the Lower Carboniferous trilobites of southern Morocco (Hahn *et al.*, 2012) includes new records of a few rare taxa from just before or within the wider Hangenberg Event Intervall (*Pudoproetus zhorae* from Mkakrig, eastern Tafilalt, *Pseudowaribole conifer* aff. *Pseudowaribol gibber* from Kheneg Lakahal, western Dra Valley). The first implication of the trilobite study is that *Pudoproetus* can be used to locate the initial phase of the post-Hangenberg transgression in Morocco, thereby extending the known region impacted by the event into northern Gondwana. The second major impact of the study is that it suggests all of the Maader Talmout Member of the Tazout Formation, including the characteristic, supposed basal Tournaisian brachiopod fauna 2 of Brice *et al.* (2005, 2008), still falls in the pre-Hangenberg Event Interval. *Pudoproetus* has significant implications for the brachiopod stratigraphy across the Hangenberg Event Interval and D-C boundary. Its presence suggests a correlation of the subsequent, unfossiliferous, marginal-marine Kheneg Lakahal Member of the Tazout Formation with the Hangenberg Regression.

### **B. Ellwood (Baton Rouge, U.S.A.)**

Brooks Ellwood and colleagues are working on D-C boundary intervals in the Woodford Shale of Oklahoma, where there is fair knowledge of the conodont biostratigraphy (from J. Over). They have been sampling and measuring magnetic susceptibility on collected samples, and obtained gamma-ray measurements from outcrops and collected samples. Although they are working in silicified shale with limited biostratigraphic information, the sections are easily

correlated over a distance of about 100 km using geophysical data. Such data may provide good, diagnostic secondary parameters for correlation among other sections.

**Ji Qiang (Beijing, China)** and his research group have worked in recent years on the D-C boundary and the phylogeny of *Siphonodella* in South China. The principal results of their work are outlined below.

1. Three D-C boundary sections in Muhua area of Guizhou Province are being re-studied, and additional conodont samples collected from them. According to the morphology, ornamentation and symmetry of the platforms, the ratio of platform to anterior blade dimensions, and the size, morphology and position of the basal cavity, four new genera of siphonodellids can be differentiated: *Protosiphonodella* n. gen., *Siphonodella*, *Eusiphonodella* n. gen. and *Eosiphonodella* n. gen. (Ji *et al.*, in progress). Among them, only *Eosiphonodella* can be found in shallow-water facies.
2. The phylogeny of the siphonodellid group is restudied, and the D-C boundary can be defined by the first occurrence of *Siphonodella sulcata* morphotype 1.
3. The elements of *Protognathodus* are very rare in China, and it is difficult to recognize the D-C boundary based on the first occurrence of either *Protognathodus kockeli* (Bischoff, 1957) or *Protognathodus kuehni* Ziegler & Leuteritze 1970.
4. A bentonite layer occurs in bed E of the Dapoushang Member of the Wangyou Formation, and has provided a radiometric age of 359.6 Ma (Liu *et al.*, 2012). The age of the D-C boundary at Dapoushang, Guizhou province, South China, is estimated at 358.6 Ma or 359.58 Ma.

**Barry Richards (Calgary, Canada)** and colleagues continued their studies of the upper Famennian to lower Tournaisian (includes Exshaw, Bakken, Three Forks, and Banff formations) in the Western Canada Sedimentary Basin (WCSB) and adjacent Montana to see if the main events in the multi-phase Hangenberg Event Interval (Kaiser *et al.*, 2008), can be more precisely located in the region using a multidisciplinary approach. The year's activities included the measurement of surface sections in Alberta and study of several bore-hole cores from southern Alberta in preparation for a core conference. For comparative purposes and to assist with Global correlations, the group measured and sampled the GSSP section at La Serre, France during December 2011 for geochemistry, sedimentology and conodonts. The work in Canada is part of a broader investigation intended to access the extensive conventional and non-conventional hydrocarbon resources of the interval in Western Canada.

Conodont data from the Exshaw and high-resolution U-Pb dates from its black shale member (Richards *et al.*, 2002; Johnston *et al.*, 2010) indicate the onset of wide-spread anoxia in the WCSB and main phase of black shale deposition occurred prior to the Middle *praesulcata* Zone and the transgressive phase of the Hangenberg Event in Western Europe. In much of the basin, anoxia continued into the *Siphonodella duplicata* Zone and the position of the maximum flooding surface is highly diachronous. The implications are the onsets of the Hangenberg transgression and subsequent regression are highly diachronous in the WCSB and not primarily the result of eustatic events.

Knowledge of the succession's conodont biostratigraphy was greatly advanced by Johnston *et al.* (2010). The conodont data indicate the contact between the Devonian and Carboniferous lies in the upper part of the black shale member of the Exshaw at its type section and some other localities; but the position of the D-C boundary has not been precisely located. It is anticipated that data from a multidisciplinary approach including stable-isotope geochemistry and radiometric dating will more tightly constrain the position of the boundary.

## **Outlook**

The results presented at the Morocco workshop in March 2013 will determine the future steps and directions of the task group's work in the next years. The primary task of the group remains – to locate either a suitable event horizon or a suitable event in a biological lineage to define the D-C boundary. Recent progress shows that new detailed correlations and agreements on taxonomy

and temporal distribution of many taxa are needed, especially when the Global correlations are still primarily based on either the *Siphonodella praesulcata* – *S. sulcata* lineage or on protognathodids. The problems outlined by Kaiser and Corradini (2011) and Corradini *et al.* (2011) have to be fully integrated in the current discussions. The paradigm that conodonts are the best markers boundary definition cannot be upheld and the task group needs to reevaluate the potential of other fossil groups.

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