Jurassic-Cretaceous Evolution of the Czorsztyn Unit (Pieniny Klippen Belt, Western Carpathians): New Aspects

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Pieniny Klippen Belt represents a tectonic zone, separating the externides of the Western Carpathians (Outer Carpathians) from the internides (Central and Inner Western Carpathians). This very complex zone involves many tectonic units belonging either to the Pienidic units or to the Central Western Carpathians. The Czorsztyn Unit represents a shallow-water Pienidic unit. Its sedimentary record reflects the evolution of the Czorsztyn Swell (Birkenmajer 1977, Mišík 1994) on which it was deposited. A classical scheme of this evolution, introduced by Birkenmajer (1963, 1977), was mostly inferred from the Polish part of the Pieniny Klippen Belt. In the last decade, new data from the western part of the Pieniny Klippen Belt complemented the previous knowledge. A following model of evolution has been reconstructed:

Until Early Bajocian, deposition of black shales (Skrzypny Fm., Harcygruund Fm.) and marls dominated in the whole Pienidic basin. Since Bajocian, rising of the Czorsztyn Swell started which differentiated the sedimentary area into two separate troughs: Magura Trough on the north and Pieniny Trough on the south. The swell rise was likely induced by crustal tilting in an extensional tectonic regime (Aubrecht et al., 1997), related to oceanic rifting of Northern Tethys (Ligurian-Penninic Ocean). In this time, subtidal crinoidal limestones (Smolegowa and Krupianka formations) were deposited. Their deposition was accompanied by clastic influx, mostly at the western part of the swell, where clastics reach the size up to 10 cm. Rising of the Czorsztyn Swell induced formation of cliff breccias to megabreccias (Wapiennik and Krasín breccias). There were some signs of karstification and fresh-water cementation revealed in the Krasín Breccia which testifies and emersion and subaerial erosion of the crinoidal limestones still in Bajocian time (Aubrecht, 1997). Since the Late Bajocian to Callovian, a diachronic facies change took place, when the crinoidal limestones were replaced by neritic/pelagic ammonitico rosso facies (Czorsztyn Limestone Fm., Rakús, 1990, Wierzbowski et al., 1999) or by non-nodular, massive red micritic limestones (Bohunice Fm.). The latter probably represent mud-mounds that grew in the environment of condensed sedimentation (Aubrecht et al., 2002a, c). On the most elevated parts, coral bioherms arose in Oxfordian (Vršatec Lst., Mišík, 1979). According to paleomagnetic results of Lewandowski et al. (2003, 2003a), the Czorsztyn Ridge (likely with the whole Pienidic crustal segment) underwent a surprisingly rapid and long southward wandering in the Callovian for a distance of almost 1000 km in 9 Ma. This big “jump“ coincides well with the maximum extension of the Penninic ocean and with the large global sea-level rise at this time. The Callovian extension is also documented by neptunian dykes with the original orientation in NE-SW main direction, indicating the NW-SE oriented extension (Aubrecht and Túnyi, 2001).

The deposition of Czorsztyn and Bohunice limestones continued by Tithonian-Early Cretaceous Dursztyn Formation, including variable micritic limestones with rich benthic and planktonic fauna. In Valanginian-Hauterivian, deposition of crinoidal limestones repeated once again (Spisz Lst., Krobicki, 1996). Afterwards, there was a hiathus encompassing almost the whole Barremian and Aptian. A nature of this hiathus was for a long time discussed. Most authors favored a submarine non-deposition and erosion (Birkenmajer, 1958, 1973), only some of them proposed an emersion of the ridge (Mišík, 1994). In the last years, unequivocal signs of subaerial exposure, heavy erosion and karstification were revealed below the overlying Albian marsltones which provides a clue for final resolving of this problem (Aubrecht et al., 2002b). The succeeding deposition was deep-water, documented by Albian marlstones and limestones with pelagic fauna, deep-water stromatolites and oncoids. This suggests a very rapid relative sea-level rise, most likely due to a marine ingression. A tectonic platform collapse and drawning is not excluded. In the Albian sediments, detrital admixture containing chrome spinels was found (Jablonský et al., 2001). Such minerals, derived from an unknown ophiolitic source are common in the Albian deposits of Klape Unit, Tatric and Fatric units. The ophiolitic admixture found in the Czorsztyn Unit contradicts to the classical paleogeographic scheme where the Czorsztyn Swell still in Albian formed an isolated ridge, surrounded by deep troughs.

Since Albian, sedimentation of red pelagic Couches Rouges facies (in Cenomanian with radiolarian cherts – Sýkora et al., 1997) continued up to the Campanian-Maastrichtian time, when the first phase of tectonic collision (Laramian) started to destruct this sedimentary basin.

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Regional Trends in Thermal Maturity of Paleozoic Rocks of the Moravo-Silesian Basin: a Combined Study of Conodont Alteration Index (CAI), Vitrinite Reflectance and Rock Eval Pyrolysis

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Dispersed organic matter in Devonian to Lower Carboniferous carbonates (Líšeň and Macocha Fms) below the Upper Silesian Basin and in the Moravo-Silesian Basin was studied to characterise regional patterns of thermal maturity in the SE part of the Bohemian Massif. Study of conodont colour alteration (CAI) was recently introduced in the thermal maturation studies of the area under question in an attempt to quantify the conodont colour using image analysis, calibrate it with other thermal maturation indicators and apply it as an alternative and inexpensive paleothermometric indicator.

Vitrinite reflectance (R_r) and RockEval pyrolysis (T_{max}, °C) data from deep boreholes show the following trends. Below the Upper Silesian Basin, the R_r values range from 1.06 to 1.23 %. Both vitrinite reflectance (R_r) and RockEval pyrolysis (T_{max}) show continuous increase with depth within the Tournaisian and Devonian carbonates. In the borehole Potštát-1 situated south of the Upper Silesian Basin, the R_r values range from 2.93 to 3.34 %. In the northern Drahany Upland (Konice-Mladeč area) the R_r values are high ranging from 5.6 to 6.0 %. In boreholes, thermal maturity does not show any significant depth trend. The central Drahany Upland region, vitrinite reflectance values are lower ranging between 1.34 and 2.66 %, which is typical of late diagenesis and transition to very low-grade metamorphism. In the SE margin of the Bohemian Massif (SE part of the Drahany Upland and deep boreholes in the Outer Western Carpathians) the reflectance (R_r) values in the Paleozoic units are even lower (0.73 to 1.89 %) corresponding to dry gas generation phase of diagenesis.

CAI values were measured using the standard approach of comparison with published colour standards according to Epstein et al. (1977). Colour composition of representative CAI