Isotopic and paleomagnetic studies of the Middle and Upper Jurassic carbonates in the Pieniny Klippen Belt: environmental and paleogeographic implications for the Northern Tethys

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The Pieniny Klippen Belt was formed during the Late Cretaceous-Cenozoic tectonic movements due to the closure of the Pieniny Klippen Basin (PKB), a former part of northern sector of the Tethys Ocean. Geophysical and geological data show PKB trusted onto the southern margin of Paleozoic formations of the Eurasia craton. However, paleomagnetic results from the Middle and Upper Jurassic rocks from the Veliky Kamenets section, Western Ukraine to the Western Slovakia speak in favor of significant paleogeographic dispersion of the units, currently incorporated into PKB. Most of the late Jurassic basins, according to data in hand, developed at much lower latitudes than those inferred for the south/southwestern margin of Eurasia continent. Paleomagnetically evidenced shallowing of paleolatitude, amounting 10^{o} between the Lower Callovian and the Middle Oxfordian (ca. 10 Ma), could be caused by a fast and a long-range drift of PKB basement, rifted off the northern European Craton toward the South. Sedimentary record for this time is lacking, a hiatus having different range but generally embracing the Middle Callovian/Late Jurassic time span.

Apart from the paleomagnetic data, we have attempted to collect independent evidence for paleogeographic changes in PKB during mid-to-late Jurassic time. In our study, we have sampled carbonate rocks underlying and overlying the hiatus, following the same outcrops that were sampled for paleomagnetic studies. Some samples from the manganese crusts were also collected. We performed geochemical studies including REE analysis using ICP-OES and ICP-MS techniques, which demonstrated higher concentrations of REE and U, Th, K, Nb, Zr and Hf in samples collected from limestones underlying the hiatus, as well as a significantly different concentrations of La/Yb-Sc/Ni and Zr/Th between the Callovian and the Oxfordian limestones. We tentatively interpreted this record as an effect of change in a source of elemental alimentation for the PKB that took place between Batonian and Oxfordian time, the latter including more mafic components.

We were also able to demonstrate change of the oceanic environment of PKB using Nd and Sr isotopic composition of the carbonate and silicate fractions. Analyses were performed using Finnigan MAT 261 MC-MS at the Isotope Lab., UAM, Poznań (Poland).

Neodymium isotopic composition of the carbonate fraction analyzed from the strata bracketing the hiatus is regarded as a direct record of the contemporaneous composition of the seawater. It shows no evidence for localized input of old continental Nd from the adjacent land areas. Our analyses revealed that both the early Callovian and the late Oxfordian seawaters of eastern part of the Pieniny Klippen Basin were isotopically homogeneous in each case. The main result is, however, that a significant exchange of the seawater happened between Early Callovian and Middle Oxfordian time. Samples collected from strata below the hiatus yielded ε_{Nd} values ranging from -6.6 to -7.0. These isotopic signatures are identical to those known from the Alpine part of the Tethys. Above the hiatus, however, the ε_{Nd} values are constantly higher, between -5.3 and -5.8, marking opposite trend in ε_{Nd} evolution than postulated for the Western Tethys in the same time span. Our data, therefore, record enter of more radiogenic oceanic waters into the basin. Because the seawater in the western segment (Alpine-Penninic) of the Tethys was predominantly less radiogenic during the Middle Oxfordian, we speculate that oceanic waters could be introduced into the Pieniny Basin from the Pacific Ocean. This event could be causally linked to a rapid rifting process and dramatic widening of the Pieniny Basin, in line with the scenario of the substantial paleogeographic change indicated by paleomagnetic results.

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