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Geochemistry and Provenance of Carboniferous Sandstones: A Case Study in Boreholes and Redeposited Pebbles in Miocene Conglomerate (Tisza Unit, S Hungary)

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An integrated petrological and whole-rock geochemical study of the Upper Carboniferous alluvial-lacustrine sandstones and their redeposited pebbles (S Hungary) was carried out to obtain more information about their provenance and geochemistry.

Because of the fact that there is not any outcrop of Carboniferous clastic sedimentary rocks in South Hungary, our study deals with a comparison between the Upper Carboniferous sandstone pebbles of Lower Miocene conglomerate series (Szászvár Formation, Western Mecsek Mountains) and Westphalian Téseny Sandstone Formation from boreholes Siklósbodony (Sb-1) and Bogádmindszent (Bm-1), in the Görcsöny Ridge 15-20 km southward from the location of the Szászvár Formation.

Sandstones studied consist of compositionally immature arkoses, sub-arkoses, litharenites and sub-litharenites. The average grain composition of the Upper Carboniferous sandstone pebbles of the Lower Miocene conglomerate is $Q_{74}F_{13}L_{12}$ ($Q_{52\text{-}89}F_{3\text{-}28}L_{5\text{-}21}$). The main compositions of the samples of the boreholes Sb-1 and Bm-1 are $Q_{71}F_{7}L_{22}$ ($Q_{60\text{-}85}F_{0\text{-}13}L_{9\text{-}36}$) and $Q_{67}F_{18}L_{15}$ ($Q_{52\text{-}85}F_{3\text{-}31}L_{6\text{-}27}$), respectively. On the basis of detrital framework analysis (Dickinson et al., 1983), we propose that the main clastic source of the sandstones was a recycled orogenic area with collision suture and fold-thrust belt. It was associated with an old (perhaps Variscan) magmatic arc, as indicated by the volcanic rock clasts. According to our studies, the framework composition of the Upper Carboniferous sandstones from Miocene conglomerate and from borehole Bm-1 are fairly similar, however the sandstones of borehole Sb-1 are a little different. The samples of borehole Bm-1 and from the Miocene conglomerate have more feldspars and acidic volcanic rock fragments, on the other hand the samples of borehole Sb-1 contain more metamorphic clasts compared to above mentioned ones.

The average value of the Chemical Index of Alternation (CIA; Nesbitt & Young, 1982) is 72 in the Carboniferous sandstone pebbles from the Miocene conglomerate. This is almost the same as in boreholes Sb-1 (CIA=75) and boreholes Bm-1 (CIA=70), which suggests moderately weathered sources for the sandstones. It means that the Carboniferous samples from boreholes and their redeposited pebbles are comparable without any doubt.

The results of major and trace element analysis illustrate similar element composition of all samples indicating constancy of provenance. The sandstones are substantially depleted in CaO and Sr relative to the average composition of Upper Continental Crust (UCC). It is caused by the lack of neutral and basic plagioclase. Minor variations in the chemical composition reflect changes in the mineralogical composition: the observed differences seem to be caused by grain-size effect. Fine-grained sandstones have higher concentrations of Al_2O_3, Fe_2O_3, TiO_2, K_2O, Rb, Ba, Ni, Cr, Zr and Y in accordance to the high amount of phyllosilicates and heavy minerals (mainly zircon).

On the basis of abundances of the element Sc and the elemental ratios of La/Th, La/Sc, La/Co and Th/Sc, we propose that the chemical composition of the Carboniferous sandstone pebbles of the Miocene conglomerate and from borehole Bm-1 are similar in comparison to the samples from borehole Sb-1.

The chondrite-normalised REE abundances of sandstone pebbles of the Miocene conglomerate and selected sandstones from borehole Bm-1 and their ratios of La_N/Yb_N show relatively enriched concentrations of the light REE compared to the average composition of UCC. The samples studied from borehole Sb-1 display similar overall distribution pattern of REE abundances to the average composition of UCC.

TiO_2-Ni (Floyd et al., 1989) and La/Th-Hf (Floyd & Leveridge, 1987) diagrams show that the source of these immature sediments are dominantly acidic magmatic areas comparable to the average composition of UCC. Normalised multi-element patterns for the sandstones and the triangular-plots of La-Th-Sc and Th-Sc-Zr/10 are characteristic of the continental arc/active margin tectonic environment (Bhatia & Crook, 1986; Floyd et al., 1991).

Concluding the studied Upper Carboniferous sandstone pebbles from the Miocene conglomerate and the sandstones from borehole Sb-1 and Bm-1 are petrographically and chemically very similar. Minor differences are due to sedimentation 1) within different part of a retroarc foreland basin or 2) within a retroarc foreland basin (Bm-1 and sandstone pebbles from the Miocene conglomerate) and a peripheral foreland basin (Sb-1). The redeposited Upper Carboniferous sandstone pebbles from the Miocene conglomerate are available to reconstruct the original Carboniferous tectonical and sedimentological environments.

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