BEHAVIOUR OF THE RARE EARTH ELEMENTS IN KARSTIC ENVIRONMENT

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The study of REE in the karstic environment is important both for scientific and practical reasons. These elements are extremely useful in helping to understand and quantify numerous geological processes, including the genesis of karst-bauxites and karstic nickel deposits. Practical reasons consist in the increased interest in REE in lateritic weathering crusts and karst-bauxite deposits. Several studies on karst-bauxites in SE Europe revealed high concentrations of REE in some deposits. Other studies on lateritic weathering crusts have shown that about 50–90 % of the total REE can be extracted by an ion-exchange process.

Geochemical studies of the vertical profiles through karst-bauxites and karstic nickel deposits clearly indicated that these deposits display a downward enrichment, culminating at the base of the deposit, of a particular group of "mobile" trace elements. This distribution pattern appears to be most prominent for nickel and REE. It was caused by percolating waters in a highly drained karstic environment. This typical distribution pattern can change only if the accumulation was re-deposited but other processes, for example metamorphism, do not change the pattern. The REE were transported into karstic environment mainly as adsorbed ions on clay particles. In this form they were readily leached, moved downwards and subsequently concentrated on the geochemical barrier of the footwall carbonate rocks. The degree of concentration in the basal parts of the deposits, however, varies over an extremely wide range: from 180 ppm of the total REE in the karstic nickel deposit Aghios Ioannis in Greece to about 7 % in the Upper Jurassic bauxite deposits of Montenegro. It depends on the total REE content in the original clayey material deposited in karstic depressions and sinkholes, and on the intensity of leaching. The available evidence indicates that authigenic RE minerals were formed when the total REE content of the initial material was greater than 1000 ppm. The REE can be also transported into karstic depressions as resistant accessory minerals. These minerals may survive bauxitization and can be used to identify the source material of the deposits.

The most abundant authigenic RE minerals are members of the bastnäsite group. Relatively rare are the RE phosphates. So far the following RE minerals have been found in the karst-bauxites of Yugoslavia, Greece and Hungary: monazite-(Nd), monazite-(La), Nd-goyazite, synchysite-(Nd), bastnäsite-(Ce), bastnäsite-(La), hydroxyl-bastnäsite-(Nd), hydroxyl-bastnäsite-(La), hydroxyl-carbonate-(Nd).

Both LREE and HREE were "mobile" during the formation of karstic deposits. In the majority of these deposits the $\sum$LREE/$\sum$HREE and La/Y ratios decrease downwards, showing enrichment of the HREE relative to LREE. On the other hand, a strong fractionation of the REE took place in the formation of authigenic RE minerals, which exhibit a very high enrichment of the LREE relative to HREE.