Rare earth element enrichment in the Cserkút uranium ore deposit (Mecsek Mts., S-Hungary)

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The uranium deposit of the Mecsek Mts. is located in a sandstone series and belongs to the so-called tabular subtype. The ore is found in a greenish coloured Permian sandstone sequence of fluvial origin, between the underlying grey and the overlying red sandstone series (Barabás, 1957). Northeast from this area is located the Variscan granitoid of the Mórágy Complex. This granitoid is syncollision-type magmatic rock with a monzonitic suite (Buda & Nagy, 1995). According to an earlier study, several minerals and rock fragments of the Permian sandstone originated from this granitoid body (Barabás, 1957).

The rare earth element (REE) content of the uranium deposit of the Mecsek Mts. has been studied since the 1960s. Those studies have drawn the attention to the REE anomaly, but did not explain the possible relationship of REEs- and the uranium content and there was no agreement about the origin of the anomaly (Fazekas, 1967).

Two of the new boreholes of Wildhorse Energy Hungary Ltd. were studied in details in the frame of this research. The cores from Cserkút represent the upper level of the ore body, thus conclusions can be drawn on the REE anomaly related to this less reduced (Fazekas, 1967) part of the mineralization.

The studied boreholes penetrated the Permian sandstone, in which siltstone, fine-, medium-, coarse-grained and brecciated sandstone beds can be distinguished. The grains are mostly composed of quartz (with zircon and apatite inclusions), perthitized K-feldspar and plagioclase (suffered from sericitization), but a small amount of muscovite, biotite, rock fragments (altered granite, aplite) and accessory zircon and apatite can also be recognized. Disseminated pyrite, chalcopyrite and galena appear as epigenetic minerals as well. The matrix of the sandstone is composed mostly of sericite and microcrystalline quartz.

Chemical analyses were done to determine the uranium content, and in some cases, the REE content of the mineralized zone. In general, the more incompatible light-REEs are more enriched, than the heavy-REEs. However, in some well established zones in the upper part of the productive zone, the uranium content correlates well with the REE content. This supports the earlier assumption, that not only placer minerals of alluvial origin contain REE, but they can occur also in minerals precipitated from the uranium-bearing fluid.

In the above mentioned, well correlated zones recognized in the boreholes, the U containing minerals were found as small grains or veinlets in the matrix or in quartz and albite grains. They can be identified as U-phosphates and U-silicates (most likely autunite $Ca[UO_2xPO_4]x10H_2O$, coffinite $U(SiO_4)$, soddyite $(UO_2)_2SiO_4x2H_2O$), while U-oxides were not detected.

The REE containing minerals were found disseminated or in veinlets together with the sericitized matrix or the K-feldspar grains. Florencite ($CeAl_3(PO_4)_2(OH)_6$), monazite ($Ce(PO_4)$), xenotim ($Y(PO_4)$), zircon ($ZrSiO_4$) and apatite ($Ca_5(PO_4)_3(F,Cl,OH)$) were identified. The florencite and the monazite are enriched in light REE (La, Ce, Nd), while the xenotime is enriched in heavy REE. However, florencite may contain also some Sr and U. Furthermore the apatite and the zircon are enriched in La, Pr, and Y.

According to their textural features, the REE containing minerals may occur not only as alluvial grains, but also syngenetically with the U containing minerals.

Based on the EPMA measurements, there is a difference between the REE content of the epigenetic and detrital minerals. The results from the detrital apatite and zircon show a good correlation with the compositions measured by Buda & Nagy (1995), Buda & Pál-Molnár (2012), and Buda (2014) from the Mórágy Complex. In contrast the REE content of the epigenetic apatite is different (higher Ce, Nd, Y and lower Pr concentrations).

According to these data the source region of the detrital apatite and zircon of the Permian sandstone is most likely the Mórágy Complex. In contrast the epigenetic minerals show different REE content though their components may also have originated from the granitic body, but more research is needed to prove this.

The epigenetic U and REE bearing minerals occur together with some gangue minerals, like Sr-bearing barite and Ba-bearing celestite.

The epigenetic association of all these minerals together in the upper zone of the mineralization can occur only under rather narrow pH and redox conditions. More precisely, slightly oxidizing and neutral-to weakly alkaline environment is assumed.

On the contrary, the deeper parts of the borehole look slightly different; coffinite and U-oxides occur, accompanied by florencite and monazite of mostly alluvial origin.

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