Ce ANOMALIES IN MONAZITE, FLUORITE AND AGATE FROM PERMIAN VOLCANICS OF THE SAXOTHURINGIAN (GERMANY)

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Despite numerous published REE distribution patterns in rocks and minerals, little is known about the behaviour of Ce in different geological systems. Most publications are focused on the marine environment where strong positive or negative anomalies can be observed. Experimental as well as empirical studies have shown that the tetravalent state of Ce, which causes anomalous distribution patterns, occurs only in low-temperature, high-oxygen and neutral to alkaline environment. According to Dubinin (1996), Ce is fractionated between suspended material in shallow seawater (positive Ce anomalies) and deep-sea sediments influenced by hydrothermal activities (negative Ce anomalies). Another mechanism suggested involves cerianite formation in different rock types during weathering (e.g., Cotten et al., 1995; Bea, 1996).

However, Ce anomalies were also detected in certain volcanic rocks (basalts and rhyolites) which were assumed to be related to intense secondary low-temperature rock alteration. Apart from REE and Nd isotope behaviour, no evidence for such alteration was found. Zones or phases with complementary Ce enrichment or depletion were only assumed (Cotten et al., 1995; Poitasson et al., 1995).

In rhyolitic tuff from Lauterbach/Thuringia (Permian), negative Ce anomalies were detected in monazite enclosed in zircon from an agate-quartz nodule. The rhyolitic tuff at the contact to the agate, which was influenced by hydrothermal fluids, shows a distinct positive Ce anomaly in contrast to the fresh host rock (Fig. 1A). Additionally, anomalous behaviour of Ce was observed in agate and fluorite from acidic volcanics of the Sub-Erzgebirge basin, although agate and fluorite from the same localities can also exhibit REE distribution patterns without Ce anomalies (Fig. 1B).

Based on these results, we conclude that Ce anomalies in minerals and rocks of volcanic origin may result not only from secondary processes but can also be explained by mixing of extremely different substances (magma, volatiles, surface water) during volcanic eruptions under near water-surface conditions. This conclusion is corroborated by Sm–Nd isotope data for the investigated volcanic fluorites from the Sub-Erzgebirge basin. The sample points plot on a mixing line in the isochron diagram which is similar to the Sm–Nd behaviour reported by Poitasson et al. (1995) for rhyolitic obsidians from Estérel, France.

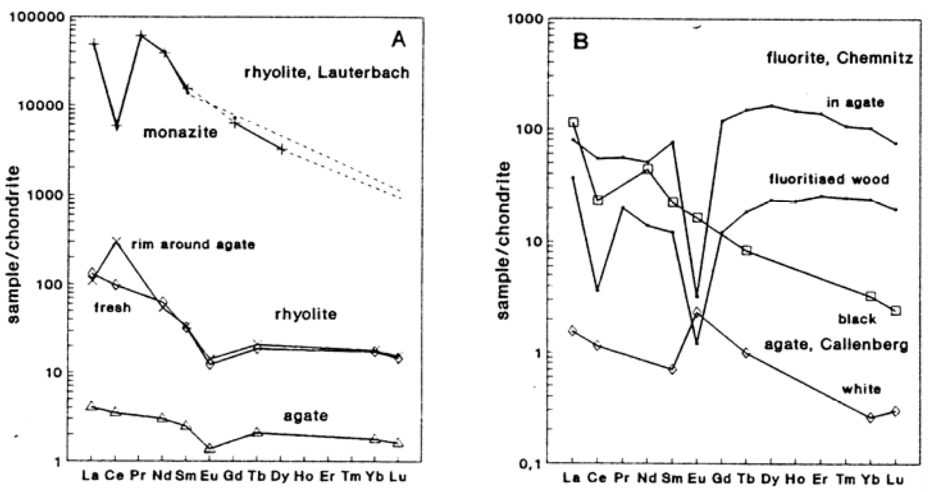

Fig. 1. REE distribution patterns for monazite, agate and host rhyolite from Lauterbach (Germany; Fig. 1A) and for fluorite and agate from acidic volcanics of the Sub-Erzgebirge basin (Germany; Fig. 1B).