

## FORMATION OF AUTHIGENIC MONAZITE AND XENOTIME IN VERY LOW-GRADE METASEDIMENTS: ROLE OF THE CHEMICAL COMPOSITION OF HOST ROCK

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Monazite (monoclinic  $\text{LREEPO}_4$ ) and xenotime (tetragonal  $\text{YPO}_4$ ) are common accessory minerals in medium- to high-grade metamorphic rocks, however, studies dealing with formation of monazite and xenotime at diagenetic to low-grade metamorphic conditions are rather sporadic.

Irregular aggregates of authigenic monazite (up to 150  $\mu\text{m}$ ) and xenotime (typically < 30  $\mu\text{m}$ ), have been found in shales and graywackes from the Moravo-Silesian Culm Basin (Bohemian Massif, Czech Republic). The Moravo-Silesian Culm Basin belongs to the Variscan foreland basin deposited as an axial turbidite system at ~ 330–325 Ma ago. Xenotime is far less common (1:10). Both Y+REE phosphates can intergrow. Monazite and xenotime aggregates enclose a variety of authigenic (quartz, anatase, Fe-oxide/hydroxide, chlorite, illite) and detrital minerals (quartz and K-feldspar) identical to those of the sediment matrix. Rarely, authigenic monazite encloses relics of detrital monazite with a chemical composition typical for high-grade monazite.

Authigenic monazite and xenotime growth was almost synchronous and they formed in relation to deep burial and very low-grade metamorphism of basin sediments at a maximum temperature ~200–300°C in the southern part of the Moravo-Silesian Basin (Drahany Upland) and ~200–350°C in the northern part of the Moravo-Silesian Basin (Nížký Jeseník Mts.). Monazite and xenotime precipitation can relate to decreasing  $\text{REEPO}_4$  solubility in aqueous solutions with increasing temperature in this temperature range 200–300°C (WOOD & WILLIAMS-JONES, 1994; POITRASSON *et al.*, 2004). Authigenic monazite and xenotime appears only in Ca-poor rocks (< 0.5 wt% CaO), which underwent a temperature overprint corresponding to very low-grade metamorphism in the presence of REE-remobilization. In Ca-rich graywackes and shales (0.60–2.70 CaO), which underwent the same low-temperature metamorphic overprint and REE remobilization, authigenic synchysite-(Ce) or parisite-(Ce) are common instead. Decreasing the thermal overprint of shales and graywackes to T ~150–200°C decrease also remobilisation of REE's and authigenic monazite and xenotime did not precipitate even in the Ca-poor sediments. These results along with data from RASMUSSEN & MUHLING (2009); ČOPJAKOVÁ *et al.* (2011) indicate that

metamorphic monazite and xenotime in sub-amphibolite-facies siliciclastic sediments is stabilized by a low whole-rock Ca content. The presence of authigenic monazite and xenotime does not show any apparent relationship to the whole-rock  $\Sigma\text{REE}+\text{Y}$  and REE patterns, or to the whole-rock variability in other major elements (Al, Fe, Mg).

Chemical composition of low-grade authigenic monazite and xenotime differs from that of higher temperature magmatic or metamorphic monazite and xenotime. Authigenic monazite shows low concentrations of Th, U, Ca, Y+HREE, and a low Eu anomaly. The central parts are enriched in Nd + MREE, whereas the outer parts are enriched in La and Ce. Zoning pattern in monazite and textural relation between monazite and xenotime suggest an evolution in fluid chemistry during diagenesis/very low-grade metamorphism or it relates to different solubility of the individual REE phosphates. Very low-grade xenotime is enriched in MREE and HREE (0.18–0.28 *apfu*) and shows flat chondrite normalized REE pattern from Gd to Lu with high Gd/Yb ratio (avg. 1.4) and a weak negative Eu anomaly. Authigenic xenotime typically has low concentrations of Th and U with relatively high Th/U ratio (0.4–2). The major source of REE's in the pore fluids are probably detrital minerals mainly monazite. A portion of the Y+REEs may have originated from other partly dissolved detrital minerals (xenotime, allanite, titanite, garnet). Other minor sources of REE's probably include Fe-oxide/hydroxide and/or clay minerals, which could have contributed to the Nd + MREE-rich cores in the authigenic monazite.

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