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Submicrometer yttrian zircon coating and arborescent aeschynite microcrystals on truncated bipyramidal anatase: An electron microscopy study of miarolitic cavities in the Cuasso al Monte granophyre (Varese, Italy)

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Abstract

In this paper, we describe a unique occurrence of submicrometer polycrystalline zircon and arborescent aeschynite microcrystals on anatase with truncated bipyramidal habit, which were formed during low-temperature hydrothermal alteration of miarolitic cavities in a granophyre from Cuasso al Monte (Italy). The results suggest that temperatures in the range 100–250 °C and acidic conditions characterized the formation of anatase and that the preservation of this metastable phase was due to the presence of Nb (Nb/Ti atomic ratio ~0.032). We also detected an increase in the Nb content along the anatase rim. This is related to the incipient segregation of Nb driven by the transition toward the thermodynamically more stable rutile phase, which is possibly arrested by cooling below the diffusion blocking temperature. In these samples, zircon clearly postdates anatase and predates aeschynite. The resulting possible scenario is that F-rich hydrothermal fluids altered primary minerals at relatively high temperature and then, on cooling below 250 °C, deposited in the following sequence: anatase, zircon, and aeschynite, which reflects both elemental saturation and fluid fractionation with decreasing temperature. Finally, the aeschynite identified in this study through TEM-EDS shows an unusual chemical composition $[(Fe_{0.35}Ca_{0.22}Th_{0.15}U_{0.13}Y_{0.10}Pb_{0.11})_{\Sigma 1.06}(Nb_{1.05}Ti_{0.69}Al_{0.14}As_{0.06})_{\Sigma 1.94}O_6]$, which cannot be reconciled with any known aeschynite sub-species. Conventional classification suggests that it should be called niobioaeschynite-(Y), although Y is present at only 0.10 apfu, and Fe (0.35 apfu) predominates in the A-site. This suggests that the aeschynite-group mineral classification system should be re-considered.

Keywords: Anatase, zircon, aeschynite, transmission electron microscopy (TEM), electron diffraction tomography (EDT)