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Nanostructure reveals REE mineral crystallization mechanisms in granites from a heavy REE deposit, South China

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Abstract

Weathering crusts after granites are the most important source of heavy rare-earth elements (HREE) worldwide. Although HREE in these deposits is known to be inherited from parental rocks, the origin of HREE enrichment and the reasons why it is rare outside of China remains unclear. Here, we report the occurrence of variably organized nanoparticles of Ce-poor (<0.2 wt%), Nd-Y-rich bastnäsite-(La), and associated cerianite in parental granites from a HREE deposit, South China. The mineral contains high-HREE abundances (up to 13 wt% Y_2O_3). Synchrotron radiation-induced X-ray diffraction and high-resolution transmission electron microscopy analyses suggest that the mineral grew as disordered nanocrystals and (nearly) coaligned nanoparticle aggregations, thus supporting "nonclassical" crystallization mechanisms by particle attachment under hydrothermal conditions. The nanocrystalline Ce-poor, Nd-Y-rich bastnäsite-(La) precipitated at rapidly decreasing temperature related to the influx of externally derived fluids, which caused CO_2-H_2O immiscibility and REE supersaturation. This interpretation is supported by petrographic data and microthermometric analysis of fluid inclusions in quartz. Unusually high f_{O_2} resulted in Ce oxidation and decoupling from trivalent lanthanides, producing polycrystalline mineralization.

Keywords: Ce-poor and Nd-Y-rich bastnäsite-(La), nanoparticles, crystallization by particle attachment, oxygen fugacity, REE deposits, South China granite