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Discrete Zr and REE mineralization of the Baerzhe rare-metal deposit, China

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Abstract

Although REE (lanthanides + Sc + Y) mineralization in alkaline silicate systems is commonly accompanied with Zr mineralization worldwide, our understanding of the relationship between Zr and REE mineralization is still incomplete. The Baerzhe deposit in Northeastern China is a reservoir of REE, Nb, Zr, and Be linked to the formation of an Early Cretaceous, silica-saturated, alkaline intrusive complex. In this study, we use in situ laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) analyses of zircon and monazite crystals to constrain the relationship between Zr and REE mineralization at Baerzhe.

Three groups of zircon are identified and are differentiated based upon textural observations and compositional characteristics. Type Ia zircons display well-developed oscillatory zoning. Type Ib zircons are darker in cathodoluminescence images and have more irregular zoning and resorption features than type Ia zircons. In addition, type Ib zircons can locally occur as overgrowths on type Ia zircons. Type II zircons contain irregular but translucent cores and rims with oscillatory zoning that are murky brown in color and occur in aggregates. Textural features and compositional data suggest that types Ia and Ib zircon crystallized at the magmatic stage, with type Ia being least-altered and type Ib being strongly altered. Type II zircons, on the other hand, precipitated during the magmatic to magmatic-hydrothermal transition. Whereas the magnitude of the Eu anomaly is moderate in the barren alkaline granite, both magmatic and deuteric zircon exhibit pronounced negative anomalies. Such features are difficult to explain exclusively by feldspar fractionation and could indicate the presence of fluid induced modification of the rocks. Monazite crystals occur mostly through replacement of zircon and sodic amphibole; monazite clusters are also present. Textural and compositional evidence suggests that monazite at Baerzhe is hydrothermal.

Types Ia and Ib magmatic zircon yield ^{207}Pb-corrected $^{206}Pb/^{238}U$ ages of 127.2 ± 1.3 and 125.4 ± 0.7 Ma, respectively. Type II deuteric zircon precipitated at 124.9 ± 0.6 Ma. The chronological data suggest that the magmatic stage of the highly evolved Baerzhe alkaline granite lasted less than two million years. Hydrothermal monazite records a REE mineralization event at 122.8 ± 0.6 Ma, approximately 1 or 2 million years after Zr mineralization. We therefore propose a model in which parental magmas of the Baerzhe pluton underwent extensive magmatic differentiation while residual melts interacted with aqueous hydrothermal fluids. Deuteric zircon precipitated from a hydrosilicate liquid, and subsequent REE mineralization, exemplified by hydrothermal monazite, correlates with hydrothermal metasomatic alteration that postdated the hydrosilicate liquid event. Such interplay between magmatic and hydrothermal processes resulted in the formation of discrete Zr and REE mineralization at Baerzhe.

Keywords: Textural relationship; zircon and monazite; in situ LA-ICP-MS analysis; Baerzhe REE-Nb-Zr-Be deposit