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Na-Fe-Ca Alteration and LREE (Th-Nb) Mineralization in Marble and Granitoids of Sierra de Sumampa, Santiago del Estero, Argentina

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Abstract

The Jasimampa area in the Sierra Norte de Córdoba of Argentina contains light rare earth element (LREE: Th-Nb) mineralization associated with several stages of carbonates and widespread fenitization of marble, granite (496 ± 2.9 Ma), and alkaline and siliceous igneous comendite dikes (U/Pb zircon age of 390 Ma) derived from fractionation of oceanic island basalts. This is the third discovery of LREE mineralization in Argentina and marks a new alkaline intracontinental magmatic event of Devonian age.

Albite (Ab_{97-99}) + aegirine ($Ae_{70-92}Ja_{1-11}Q_{6-19}$) ± hematite ± Mg-arfvedsonite ± fluorine-rich apatite and late Ca-Fe-Mn carbonates ± monazite ± pyrochlore overprint and crosscut granite and comendite outcrops in a 15 km^2 area; locally, the Na-rich assemblage is pervasive and results in total destruction of host rocks. Na-Fe metasomatism near granite and comendite produced aegirine ($Ae_{86-91}Ja_{1-8}Q_{6-11}$) ± Mg-arfvedsonite and minor albite (Ab_{98-99}) in adjacent marble, with multiple stages of late Ca-Mn-Mg-Fe carbonates associated with iron and manganese oxides, hematite, and traces of sulfides (sphalerite, pyrite, galena). Monazite (Ce > La) is the main LREE-bearing mineral and occurs with minor ferrocolumbite, pyrochlore, strontiopyrochlore, and apatite associated with a second generation of fine-grained hematite, barite, and celestine. Structural controls on Na-Fe-Ca alteration and LREE mineralization in granitoid and marble protoliths include brittle-ductile shear zones, brittle fracture systems, and a series of monolithologic and heterolithologic breccias with hydrothermal aegirine, carbonate, and chalcedony matrices that occur at granite-marble-comendite contacts. Fragments of multiple breccia types within breccias indicate multiple episodes of brecciation, alteration, and mineralization.

The fluid responsible for early fenitization of granite and comendite was aqueous-carbonic with CO_2 of relatively high density (between 0.85 and 0.95 g/cm^3), salinity near 9 wt percent NaCl equiv, and minimum temperatures in the range of 250° to 280°C. Pervasively altered comendite and granite have high total REE content (1,750 ppm and 2,126 ppm, respectively), mainly LREE. Early banded and mottled aegirine ± arfvedsonite replacements of marble have high absolute REE abundance (2,513–4,663 ppm) compared to the least altered marble (476 ppm). Subsequent hydrothermal stages with carbonates, hematite, pyrolusite,

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monazite, and subordinate celestine and barite caused alteration of marble that was accompanied by an increase in absolute REE abundance, up to 15.45 wt percent, and high Sr (10.5 wt %), Th (4,390 ppm), and Ba (1.8 wt %).

Alteration and mineralization at Jasimampa are the result of late-stage carbonatitic magma fractionation and fluid exsolution. This is indicated by the strongly alkaline character of early alteration, the composition of the hydrothermal carbonates, apatite, and LREE-Sr- and Ba-rich minerals, the chondrite-normalized REE patterns showing strong LREE enrichment without an Eu anomaly, and the replacement of marble by assemblages with very high Ba, Th, LREE, and Sr, and strong K, Zr, and Ti depletions. The alteration style and mineralization at Jasimampa are similar to the giant Fe-LREE-Nb deposit Bayan Obo and other hydrothermal LREE deposits hosted in carbonatites of China.