

Emanated carbonatite fluids for REE mineralization: from fenitization to late-stage metasomatism

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Carbonatite melts are highly enriched in incompatible elements, which results in carbonatites as important critical metal resources. The carbonatite fluids emanated from the melt or evolved from carbonatites in the late stage transport high quantities of volatiles and also REE. Fenitization and/or metasomatism play important roles in the formation of carbonatite related REE deposits, especially those in cratonic margins and orogenic belts (e.g., Bayan Obo and Miaoya).

Fenitization is widely distributed both around the carbonatite dykes and in the ores at the Bayan Obo REE-Nb-Fe deposit. Bulk rock chemical compositions suggest that the initial alkali fluids derived from the Wu calciocarbonatite dyke exhibit enrichments in Ca, Sr, Ba, Mn, REE and Nb. Of interest, from the central carbonatite to the outer low-grade fenite, REE content decreased whereas HREE abundance increased in the high-grade and medium-grade fenites. The HREE enrichments are associated with apatite mineralization which contains hundreds ppm of HREE. This suggests that the carbonatite-emanated (carbo)-hydrothermal fluids can remobilize and fractionate REE.

Calcite in metasomatic carbonatite from the Miaoya REE-Nb deposit located in the South Qinling orogen displays relatively flat to upwards convex patterns with positive Eu anomaly. In situ Sr and C isotopic compositions show a large variation from 0.70346 to 0.70524 and -7.02 to -2.19‰. The detailed geochemical investigation indicates that REE in calcite can be leached, remobilized, and redeposited in late-stage metasomatic processes. Off-craton zones are commonly associated with multiple-stage tectono-thermal events, which triggers carbonatite metasomatism leading to the remobilization and redeposition of REE.