Metasomatism induced REE mineralization in off-craton carbonatite

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Most of carbonatite-related REE deposits are found in cratonic margins and orogenic belts (i.e. off-craton), and metasomatism/hydrothermal alteration is common in these deposits. The role of metasomatic/hydrothermal processes invovled in the formation of the carbonatite REE deposits remains unclear. Here, we present a comprehensive in-situ chemical and isotopic (C-Sr) investigation of the Miaoya carbonatite complex in South Qinling orogenic belt, aiming to comstarain the role of late-stage metasomatic processes.

The Miaoya carbonatites are divided into three types based on metasomatism and REE mineralization. Type I carbonatite occurs as a massive carbonatite body and displays monazite mineralization in the rim of apatite. Calcite in Type I carbonatite contains the highest Sr and REE contents with nearly flat REE patterns. In-situ C and Sr isotope compositions ($^{87}Sr/^{86}Sr$= ~0.7035; $\delta^{13}C$= ~-6.0 ‰) of calcite are relatively homogeneous and consistent with a mantle origin. Type II carbonatite occurs as lenses in contact with carbonated syenite and contains variable monazite, bastnäsite, parisite and allanite. Sr and REE contents decrease from weakly to strongly altered calcite in Type II carbonatite. In-situ Sr and C isotopic compositions for these calcite show a large variation from 0.70351 to 0.70473 and -5.97 to -2.19 ‰, indicating metasomatic fluids enriched in CO_2 with contamination of surrounding crustal rocks. Type III carbonatite composes of altered and ductile calcite and monazite minerazation is commonly associated with apatite, albite and biotite. Calcite in Type III carboantite displays chemical variations similar to those in Type II carbonatite, but consists of higher $^{87}Sr/^{86}Sr$ (0.70346 ~ 0.70524) and lower $\delta^{13}C$ (-6.47 ~ -4.11 ‰), suggesting that metasomatic fluids are evolved from more radiogenic Sr crustal rocks and depleted in CO_2.

The detailed geochemical investigation indicates that REE in the dominant calcite within carbonatite can be leached, remobilized and redeposited in late-stage metasomatic/hydrothermal processes, and the combined in situ C and Sr can be used to trace the sources of the metasomatic/hydrothermal fluids.