Geochemical and Nd, Sr, Ca isotopic study of leached and whole-rock carbonatites

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Carbonatites are unique igneous rocks with more than 50% modal carbonate (C) minerals. The commonly found non-carbonate (NC) minerals of carbonatites include ortho- and clino- pyroxenes, phlogopites, apatites and other oxides. Whole-rock (WR) carbonatites are characterized by high concentrations of Ca, Sr and LREEs. It has been suggested that HFSEs (e.g., Zr, Nb, Ta) are primarily hosted in the NC phases while Nd and Sr are hosted in the C phase of carbonatites[1,2] and that Nd and Hf isotopic disequlibrium exits between these phases [2]. Hence, it has been suggested that the C phase reflects are the 'true' composition of the parent carbonatite magma.

In this study, we investigate the purported compositional differences between WR carbonatites and the leached carbonate phases. We carried out time based leaching experiments of four carbonatites using 10% (v/v) acetic acid, 1M and 2.5M HCl. Based on the relative concentrations of Fe, Al, P and Ti of the leachates, we suggest that 10% (v/v) acetic acid is more suited for selectively leaching the C phases while dilute HCl also leaches out phosphates and oxides in addition to the carbonates. The acetic acid leaching experiments performed on multiple carbonatites of different eruption ages show that the C phases control the Ca and Sr budget where as the HFSE and REE budgets are controlled by the NC phases. The C phases show lower Rb/Sr and higher Sm/Nd, Ba/Nb and Sr/Nb than the NC residue. In a plot of $\varepsilon_{Nd(t)}$ versus $^{87}Sr/^{86}Sr_{(t)}$, C and WR carbonatites show similar $^{87}Sr/^{86}Sr_{(t)}$, however, some samples show different $\varepsilon Nd_{(t)}$. $\delta^{44/40}Ca$ (w.r.t SRM915a) of WR carbonatites and C phases of most of the samples show similar values within the analytical uncertainty. Based on these, we suggest that $^{87}Sr/^{86}Sr_{(t)}$ and $\delta^{44/40}Ca$ of C phases and WR carbonatites closely approximate each other; however, a Nd isotopic disequilibrium is observed between them in some samples.

References:

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