Stable Cr isotope systematics of carbonatites from the East African Rift

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Chromium is among key elements for deciphering processes such as magmatic differentiation, crustal contamination, low-temperature alteration etc. Carbonatites are generally considered to represent lower-temperature derivative melts from the mantle but the source of carbon may, in part, be located in a subducting assemblage. Irrespective of their likely mantle origin, the ultimate source of carbonatites can potentially be tested using stable Cr isotope systematics because ocean floor carbonates may acquire isotopically fractionated Cr compared with the original unmodified lithology. If subducted into the mantle, these rocks could plausibly introduce measurable Cr isotope effects in geologically opportune situations although low-temperature carbonates commonly are depleted in Cr and much of Cr would be buffered by silicates.

Here, we report on the preliminary results of the determination of Cr contents and stable δ^{53}Cr compositions using a double-spike approach, combined with TIMS analysis, in a suite of carbonatites from Uganda, associated with the East African Rift (EAR). Carbonate fractions (released using HCl leaching) often have higher Cr contents than the non-carbonate residual phase (occasionally up to ~10×). In rare cases, non-carbonate fractions were enriched in Cr. For all samples from EAR, carbonate fractions show slightly higher δ^{53}Cr values than the coexisting silicate fractions; however, in all cases, their δ^{53}Cr values are entirely in the range of the upper mantle. High-temperature stable Cr isotope fractionation between carbonate and non-carbonate portion $\Delta^{53}Cr_{C\text{–}NC}$ = 0.04–0.08‰. This indicates derivation of carbonatitic magmas at EAR from the mantle, with a limited influence of other reservoirs. In contrast, selected samples from south India and Oka (Canada) show much higher $\Delta^{53}Cr_{C\text{–}NC}$ >0.12 and up to 0.29, clearly attesting to either a different source of carbonate or disequilibrium between carbonate and non-carbonate portions. In particular, a carbonatite sample from Mountain Pass shows strongly shifted δ^{53}Cr values in both carbonate and non-carbonate fraction, far above the commonly accepted mantle range, and reversed $\Delta^{53}Cr_{C\text{–}NC} = -0.16$‰.

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