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Insights into the Formation and Evolution of 3-Billion-Year-Old Greenland Carbonatites Using Fe Stable Isotopes.

SÉGOLÈNE RABIN[1], HELEN M. WILLIAMS[1] AND PROF. SEBASTIAN TAPPE, PHD[2]

[1]University of Cambridge
[2]Technical University Bergakademie Freiberg

Carbonatites are of great interest as these carbonate-rich igneous rocks host the largest resources of REE. However, processes related to carbonatite formation are still controversally discussed between: 1) direct melting of carbonate-bearing peridotites, 2) liquid immiscibility of carbonated silicate melts, and 3) fractional crystallization of carbonated silicate melts [1]. Iron stable isotopes represent a promising tool to trace magma interactions because of their high sensitivity to redox and compositional changes [2 ; 3].

We present a new Fe isotope dataset generated from two of the oldest known carbonatites on Earth, namely Tupertalik (3 Ga) and Singertat (2.7 Ga). We observe a large range in magmatic δ^{57}Fe values in agreement with the strong variability of Fe isotope compositions observed for carbonatites from locations worldwide [5]. For the first time, we show that large Fe isotope variations, from light to heavy δ^{57}Fe values, are recorded within a single carbonatite complex. While most of the carbonatites investigated display δ^{18}O and δ^{13}C compositions within the range of primitive mantle values [6], the negative covariations of δ^{18}O and δ^{13}C values in our sample suite are interpreted to be related to CO_2 degassing [7].

From these results, we discuss the influence of CO_2 degassing on the Fe isotope signatures of carbonatite melts (1), the evolution of oxygen fugacity from carbonatite melt generation to magma emplacement (2), as well as the roles of para- and synmagmatic fluids on the δ^{57}Fe systematics of carbonatites (3). This work provides an important step towards further understanding of Fe isotopes behaviour during carbonatite magma formation and evolution, including ascent through the lithosphere and emplacement into Earth's crust, followed by post-magmatic processes.

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