Boron Isotopic Investigation of the Bayan Obo Carbonatite Complex

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Earth's largest Rare Earth Element (REE) ore deposit at Bayan Obo, China is hosted in a dolomite marble of Mid-Proterozoic age. The genesis of the latter remains highly debated, whether it is of sedimentary or igneous origin. Additionally, evidence of later, Caledonian-age metasomatic and recrystallization events further complicates the interpretation of geochemical data from this complex. The intricate history of this deposit has been previously explored through investigations involving mineralogic and petrographic evidences, major and trace geochemistry, geochronology, and radiogenic and stable isotopic data.

This study provides new insight into the complex petrogenetic history of the Bayan Obo carbonatite through the use of boron isotope data. Boron is a highly mobile element that has been proven to be a powerful isotopic tracer, especially in fluid-mediated processes. The large natural variation in $\delta^{11}B$ (~100‰) due to the relatively high mass difference between ^{10}B and ^{11}B leads to a distinct depletion in the mantle (-7‰) and strong enrichment in crustal sources (up to +26‰). Additionally, boron's link to the carbon cycle makes it a valuable tool in investigating the source region of mantle-derived, carbonate-rich rocks[1].

Here, traditional radiogenic (Sr, Nd, Pb) and stable (C, O) isotope systematics are combined with new B isotopic data in order to obtain a better understanding of the ore-forming processes. In-situ Sr and Pb isotope signatures define a wide range of values ($^{87}Sr/^{86}Sr$ = 0.70292-0.71363, $^{208}Pb/^{204}Pb$ = 35.45-39.75), which have been attributed to carbonatite magmatism followed by Caledonian-age metasomatism. Boron abundances of the investigated samples are ~5 ppm, which are significantly enriched compared to known values for carbonatites worldwide (<1 ppm)[1]. $\delta^{13}C$ (-2.3 to +0.6‰) and $\delta^{18}O$ (+12.1 to +14.5‰) values plot outside of the "primary igneous carbonate box" and overlap with reported values[2].

1. Hulett, S., et al. *Nature Geoscience*. Vol. 9. Pp. 904-908. 2016.

2. Yang, X., et al. *Precambrian Research.*. Vol. 288. Pp. 39-71. 2017.