

Calcium isotope compositions of abyssal peridotites: $\delta^{44/40}\text{Ca}$ of oceanic mantle and fractionation during seafloor alteration

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Calcium (Ca) isotopes are widely used to study mantle evolution and global Ca cycling. While previous studies have mainly focused on sub-continental peridotites, the Ca isotope composition of the oceanic mantle and Ca isotope behavior during seawater-peridotite interaction remains poorly understood. This study investigates the Ca isotopes in oceanic peridotites from the Gakkel Ridge and the Southwest Indian Ridge. The less altered samples, characterized by LOI < 2 wt.% and a normalized CaO/SiO₂ ratio < 0.1, exhibit $\delta^{44/40}\text{Ca}$ values ranging from 0.74 to 1.04‰, overlapping with the Bulk Silicate Earth (BSE) value (~ 0.94‰). These samples represent the least altered oceanic mantle, with only minor Ca isotope heterogeneity. Potential mechanism for the variation in Ca isotope composition in the oceanic mantle include partial melting, crustal material recycling, and melt refertilization. In contrast, the highly altered peridotites, with high LOI values and elevated normalized CaO/SiO₂ ratios, show significantly lighter Ca isotope compositions with $\delta^{44/40}\text{Ca}$ ranging from -0.15 to 0.82‰. This signature cannot be attributed to serpentinization, mineral dissolution, or adsorption. Instead, the precipitation of aragonite during marine weathering may lead to the enrichment of light Ca isotopes in peridotites. Using a two-endmember mixing model, the negative correlation between $\delta^{44/40}\text{Ca}$ and normalized CaO/SiO₂ ratio can be explained by the precipitated aragonite with $\delta^{44/40}\text{Ca}$ ranging from -1.5 to 0.05‰. Overall, our findings suggest that marine weathering can lower the $\delta^{44/40}\text{Ca}$ values of seafloor ultramafic rocks, and their subsequent subduction may contribute to Ca isotope heterogeneity in Earth's mantle.