

## Stable cerium isotopes as a tracer of crustal recycling

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The redox-dependent behaviour of cerium (Ce) has proven a powerful tool for studying the redox conditions of paleoenvironments and their surface materials. Elemental Ce anomalies are an established proxy, but high precision measurements of Ce isotopes ( $\delta^{142}\text{Ce}$  (‰) =  $[(^{142}\text{Ce}/^{140}\text{Ce})_{\text{Sample}} / (^{142}\text{Ce}/^{140}\text{Ce})_{\text{STD}} - 1] \times 1000$ ) using a multicollector inductively coupled plasma mass spectrometer (MC-ICP-MS) and a  $^{136}\text{Ce}$ - $^{138}\text{Ce}$  double spike (DS) have now become possible [1]. Studies have shown that Ce isotopes are fractionated by varying redox conditions and during oxidation reactions [2], so the potential exists to apply Ce stable isotopes as a tracer of crustal recycling into mantle reservoirs, particularly as other redox-sensitive stable isotope systems, such as uranium, have been used to fingerprint recycled oceanic crust in mantle source regions [3]. Surprisingly, the stable U isotope compositions of MORB suggest that their depleted mantle source was contaminated by the addition of oceanic crust that had experienced alteration under oxidising conditions < 600Ma [3].

To test this hypothesis and determine if the Ce stable isotope composition of the depleted mantle reservoir has varied through time, we measured the Ce isotope composition of 11 ophiolite samples from ~1998Ma to ~400Ma, with samples spanning a range of basins. Preliminary data shows minimal variation relative to the basaltic geostandard measured. This lack of variability could indicate that the Ce isotope composition of the depleted mantle has remained constant through time, irrespective of the crustal recycling process. The lack of Ce isotope variation could also indicate limited mobility of Ce during oceanic crust alteration in contrast to U [3]. However, for the  $^{142}\text{Ce}/^{140}\text{Ce}$  ratio, the mass dependent and nuclear field shift (NFS) effects act in opposite directions [4], which raises questions around the invariant  $\delta^{142}\text{Ce}$  signatures observed. To resolve these opposing effects, additional ophiolite samples will be measured alongside MORB samples, using an approach that will discriminate NFS from mass-dependent stable isotope fractionation.

[1] Hu et al (2023), *ACS Earth Space Chem* 7, 2222-2238.

[2] Bonnand et al (2023), *Geochemical Perspectives Letters* 28, 27-30.

[3] Andersen et al (2015), *Nature* 517, 356-359.

[4] Nestmeyer & McCoy-West (2025), *Geochimica et Cosmochimica Acta* 388, 236-252.