A core formation Ni isotope signature in Earth's mantle

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Earth's core is an Fe-Ni alloy that contains up to 10 wt.% of a lighter element. Even after decades of research, elemental partitioning and geophysical studies yield a family of solutions where the nature of the light element is a trade-off between multiple parameters [e.g., 1, 2]. Mass-dependent ("stable") isotope fractionation studies provide a novel way to resolve the current deadlock, in particular since recent experimental work has revealed that the magnitude of metal-silicate Fe fractionation is dependent on the light element budget of the metal phase [e.g., 3]. Interpreting these experimental calibrations for Fe is, however, difficult because of the poorly constrained difference in Fe isotope composition between Earth's core and primitive mantle.

We have turned our attention to Ni, which is the ideal element to use as an isotopic proxy of core formation. Its single valence state in the mantle means that Ni is not affected by magmatic processes to the extent of Fe. Hence, a core formation signature, if present, should be readily identifiable in Earth's mantle. Using a high-precision double spike analytical protocol, we have determined the Ni isotope composition of the bulk silicate Earth (BSE) and compare this to chondritic meteorites.

Fresh, unmetasomatized mantle peridotites (xenoliths, massif peridotites) have a homogeneous Ni isotope composition. Given the lack of observed fractionation during melt depletion, consistent with olivine dominating the Ni budget, the average of the peridotite samples is taken to be representative of the BSE. The BSE has 0.09 ‰ lower $\delta^{60/58}$Ni than chondritic meteorites and, through a mass balance, Earth's core. The observed fractionation between mantle and core is of the right sign as predicted by experimental studies with pure Ni metal [4], but of significantly larger magnitude. This likely reflects a similar compositional dependency as found for Fe, which makes Ni isotopes a promising tracer of the composition of the core.

[1] Badro *et al.* (2014) *PNAS* **111**, 7542-7545. [2] Fischer *et al.* (2015) *EPSL* **167**, 177-194. [3] Elardo *et al.* (2019) *EPSL* **513**, 124-134. [4] Lazar *et al.* (2012) *GCA* **86**, 276-295.