

The iron isotope composition of the Earth's lower mantle

H.M. WILLIAMS¹, H. RIZO², I. S. PUCHTEL³

¹The University of Cambridge, UK; hmw20@cam.ac.uk

²Geotop-Université du Québec à Montréal, Québec, Canada; rizo.hanika@uqam.ca

³Department of Geology, University of Maryland, USA; ipuchtel@umd.edu

Core formation is a key process in the evolution of terrestrial planets that imparts characteristic geochemical fingerprints on the remaining silicate mantle. Recent studies have exploited the potential of high-pressure, high-temperature equilibrium stable isotope fractionation driven by differences in element redox state and bonding environment to constrain planetary accretion and differentiation and core composition [e.g. 1-4].

The caveat to these studies is that there must exist some means of directly comparing the predicted isotopic variations with the observed compositions of planetary mantles. This is difficult for the Earth because most primitive magmas are derived from the upper mantle and may not provide a true window into metal-silicate equilibrium at the base of a magma ocean. For example, the heavy Fe isotope compositions of terrestrial basalts relative to basaltic meteorites from Mars and Vesta can be interpreted in multiple ways: as a function of the low Ni content of the Earth's core [4], planetary accretion processes [1, 3] or the disproportionation of ferrous iron (Fe²⁺) into ferric iron (Fe³⁺) and metallic iron during bridgmanite crystallisation in the lower mantle [2].

To address this issue, we present new Fe isotope data for Archean mafic rocks and komatiites that are considered, on the basis of decoupled initial ϵNd and ϵHf radiogenic isotope signatures to be derived from deep-seated mantle source regions that experienced bridgmanite and Ca-perovskite fractionation at an early magma ocean stage [5-7]. Preliminary data suggests significant differences in Fe isotope systematics between the studied komatiitic and basaltic systems, providing evidence for Fe isotope heterogeneity in the early terrestrial mantle, probably inherited from core formation and early mantle differentiation processes.

[1] Sossi et al., . EPSL 449, 360–371 (2016). [2] Williams et al., (2012) EPSL 321, 54–63. [3] Dauphas et al., (2014) EPSL. 398, 127–140. [4] Elardo and Shahar (2017) Nat. Geosci. in press. [5]. Rizo et al., (2011) EPSL 312, 267–279. [6] Puchtel et al., (2013) GCA 108, 63-90. [7] Puchtel et al., (2016) Geochem. Geophys. Geosyst., 17, 2168–2193.