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Possible early mantle differentiation recorded in Fe isotopes of primitive OIB lavas

OLIVER NEBEL[1], SASKIA RUTTOR[1], ANGUS ROGERS[1] AND DR. MARK A KENDRICK[2]

[1]Monash University

[2]University of Queensland

Presenting Author: oliver.nebel@monash.edu

Ocean island lavas with $^{3}He/^{4}He$ well above depleted mantle values are sourced from mantle plumes with a presumed deep mantle origin. Combined with radiogenic isotopes they are part of a mantle component that is probably common among global OIB and considered a primitive mantle-like matrix in which enriched plume components reside. This component is often termed FOZO for a **fo**cal **zo**ne in multiple radiogenic isotope space. In a chondritic Earth model, radiogenic isotopes [1], however, indicate that this reservoir is not primitive in nature, which is in line with noble gas systematics [2], and calls for an alternative origin of this mantle plume component. Here, we compile Fe isotopes for ocean island lavas that resemble respective FOZO components for various mantle plumes with elevated (primordial) $^{3}He/^{4}He$. We selected primitive lavas with e_{Nd} values of either ~+1-+2 (FOZO A) or +6-+7 (FOZO-B) from Hawaii, Reunion Island, Samoa, Pitcairn, and Iceland for which Fe isotope data is available. The primitive Fe isotope compositions of these plumes, i.e., corrected for crystal fractionation and thus representative for the plume source, show co-variations with Nd isotopes that indicate a deep mantle dichotomy for global mantle plumes. A near-chondritic Fe isotope reservoir ($d^{57}Fe$~0) with e_{Nd} ~+6-+7 [1] contrasts with a heavy Fe isotope reservoir ($d^{57}Fe > +0.2$) with near-chondritic e_{Nd} values at ~ 0. No co-variations with He isotopes are observed. The Fe-Nd isotope systematics suggest that the reservoir with non-chondritic Nd formed by very early mantle differentiation towards higher Sm/Nd at constant Fe isotope compositions. Subsequent crustal contamination led to non-chondritic, heavy Fe isotopes for the second reservoir with Nd isotopes reversing towards near chondritic values by crustal material with lower, time-integrated Sm/Nd.

[1] Jackson et al., 2007, EPSL 264, [2] Day et al.,2022, ChemGeol 587