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Positive correlations of heavy Fe-Zn-Mo isotopes with incompatible element abundances and Sr-Nd-Hf radiogenic isotope enrichments in MORB melts

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MORB samples from seamounts flanking the East Pacific Rise at 5-15°N and Mid-Atlantic Ridge at 33-35°N have been shown to have large correlated variations in terms of incompatible element abundances and Sr-Nd-Hf radiogenic isotopes **[1-5]**, which is understood as resulting from melting-induced mixing of a two-component mantle with the enriched component dispersed as dikes/veins in a more depleted peridotite matrix. Compared to the depleted matrix, the enriched dikes/veins are enriched in incompatible elements and more so for the more incompatible elements with high $^{87}Sr/^{86}Sr$, low $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$. They are of low-degree melt origin, invading into or developing together with the depleted matrix **[1-5]**. Such a two-component mantle is likely developed at the lithosphere-asthenosphere boundary (LAB) beneath ocean basins, where incipient melt enriched in volatiles and incompatible elements in the low-velocity zone accreting to the thickening oceanic lithosphere **[6]**, making deep portions of the oceanic lithosphere highly enriched geochemical reservoirs **[7]**. This process is occurring today and must also have taken place in Earth's history, producing compositional heterogeneities on varying small scales in the MORB mantle. It follows that such a low-degree melt process at the LAB also causes Fe-Zn-Mo isotopic fractionation. Our data on these samples show that heavy Fe-Zn-Mo isotopes are characteristic of enriched samples **[8-13]**. We predict that heavier isotopes of the same incompatible elements are in general more "incompatible" than lighter ones in low-degree melt processes (e.g., Ti, Zr, Hf). Is the opposite true for isotopes of highly compatible elements (e.g., Mg, Ni, Cr)?

[1] Niu & Batiza, 1997, EPSL, 148, 471-483;**[2]** Niu et al., 2002, EPSL 199, 327-345;**[3]** Zhang et al., 2016, Lithos 262, 107-119;**[4]** Niu et al., 2001, EPSL 186, 383-399;**[5]** Guo et al., 2021, GCA 307, 72-85;**[6]** Niu & Green, 2018, ESR 185, 301-307;**[7]** Niu & O'Hara, 2003, JGR, 108, ECV 5 1-19;**[8]** Sun P. et al., 2020, GCA 286, 269-288;**[9]** Guo et al., 2023, EPSL 601, 117892;**[10]** Chen et al., 2022, EPSL 578, 117283;**[11]** Sun et al., 2024, in preparation **[12]** Guo et al., 2024, in preparation;**[13]** Guo et al., 2023, GRL 50, e2022GL102264.