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Magma differentiation-induced zinc isotopic variation: Insights from gabbro cumulates in ultra-slow spreading ridge

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The recycled oceanic crust can significantly elevate the zinc isotopic composition ($\delta^{66}Zn$) of the mantle. However, whether the mid-oceanic crust basalt (MORB) is suited or not for representing the $\delta^{66}Zn$ of the bulk oceanic crust is poorly constrained because the voluminous gabbros in the lower section of the oceanic crust is often not taken into account, and the effects of magmatic differentiation on Zn isotopes in the process of gabbro formation remains unclear. Here, we investigate $\delta^{66}Zn$ in a series of 37 gabbros from the IODP U1473A hole drilled into the gabbroic lower crust at Southwest Indian Ridge (SWIR), along with 12 MORBs from East Pacific Rise (EPR) and South Mid-Atlantic Ridge (SMAR) to address this issue. The varied Mg# (64-79) for each event of magma supply shows strong magmatic differentiation of gabbros. Their $\delta^{66}Zn$ range from 0.11± 0.02‰ to 0.34 ± 0.02‰, suggesting significant Zn isotopic fractionation during magmatic differentiation. MORBs from the EPR and SMAR exhibit $\delta^{66}Zn$ values (0.27 ± 0.04‰, 2sd, n = 8) and (0.26 ± 0.06‰, 2sd, n = 4), which are comparable with MORBs from other localities and heavier than the average value of the gabbros (0.22 ± 0.11‰). Combined with the mantle value (0.16 ± 0.06‰), the $\delta^{66}Zn$ of gabbros and MORBs in this study reveal that the Zn isotopes progressively become heavier during oceanic crust formation. The weighted average $\delta^{66}Zn$ of gabbros and MORBs (0.23‰) is better to represent the Zn isotopic composition of ocean crust, and also reconcile with predicted primary melt values from mantle melting. The new estimate is lower by ï½ž0.05‰ than the MORB-based average and enhances the difference from intraplate alkali basalts and some ocean island basalts (0.3-0.77‰), which thus further strengthens previous models of recycling of surficial carbonates into their mantle sources (e.g. Beunon et al., 2020; Liu et al., 2016).

Beunon H., Mattielli N., Doucet L. S., et al. (2020). Earth-Sci.

Liu S.-A., Wang Z.-Z., Li S.-G., et al. (2016). Earth Planet. Sci. Lett.