

Iron isotope evidence in continental intraplate basalts for mantle lithosphere imprint on heterogeneous asthenospheric melts

RONG XU

Institute of Geochemistry, Chinese Academy of Sciences
(IGCAS)

Iron isotope studies on ocean island basalts (OIBs) and mid-ocean ridge basalts (MORBs) have disclosed the contribution of pyroxenite lithologies in the generation of basaltic magmas. Whether Fe isotopic compositions of continental intraplate basalts can be applied to trace lithological heterogeneity within the mantle source regions remains poorly investigated. To explore the systematics of stable Fe isotopes as a potential probe of lithological heterogeneity in the source of continental intraplate basalts, we present twenty-four Fe isotope data on a suite of well-characterized Cenozoic basalts from SE China. The samples show a large range of Fe isotope values ($\delta^{56}\text{Fe} = +0.09\text{‰}$ to $+0.20\text{‰}$), which correlate with SiO_2 , $\text{CaO}/\text{Al}_2\text{O}_3$, Ti/Eu , Hf/Hf^* , Zr/Nb , Dy/Yb , La/Yb , Nb/Y , K/La , Sr/Ce , $\delta^{66}\text{Zn}$ and estimated equilibrium pressures. The samples with the highest $\delta^{56}\text{Fe}$ values represent early-stage low-silica basalts with moderately enriched Sr-Nd isotope ratios and high $\delta^{66}\text{Zn}$ values, while the late-stage high-silica basalts display a broad $\delta^{56}\text{Fe}$ decrease with increasing $^{87}\text{Sr}/^{86}\text{Sr}$ and with decreasing ϵ_{Nd} and $\delta^{66}\text{Zn}$. We demonstrate that the heaviest Fe isotope signatures cannot be derived from a pure peridotite source and require a pyroxenite component in the source. Combined with other geochemical proxies, we show that the heaviest basalt compositions are consistent with low-degree melts produced by the adiabatic decompression of a carbonated pyroxenite-bearing asthenospheric mantle. Mixing of these hybrid melts with melt produced from in-situ melting of the subduction-modified subcontinental lithospheric mantle (SCLM) reproduces the Fe-isotope variability of the late-stage basalts. Our results demonstrate the significance of lithological heterogeneity in the mantle source of continental intraplate basalts and highlights the subsequent imprint of mantle lithosphere in the evolution of their Fe isotope compositions. Finally, this study exemplifies the potential of the Fe-Zn stable isotope pair for mantle geochemistry; coupled with more traditional radiogenic isotopes and major and trace element concentrations, they formed an efficient tool to trace the nature and the contribution of the mantle source components in the formation of intraplate basalts.

Rong Xu et al., Iron isotope evidence on continental intraplate basalts for mantle lithosphere imprint on heterogeneous asthenospheric melts. *Earth and Planetary Science Letters*. 2024; 625, 118499