Zn and Sr-Nd-Mg isotope in ferrotephrite dykes from the Tarim Large Igneous Province: implications for plume interaction with subduction system

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The complex lithological associations in the relatively long-lived Tarim Large Igneous Province (TLIP) in China have remained enigmatic in relation to classic plume models. Here we investigate ferrotephrite dykes from Wajilitag in the northwestern margin of the TLIP. These dykes are composed of alkali feldspar, plagioclase, clinopyroxene with minor Fe-Ti oxide and nepheline. The rocks display co-variations between MgO and other oxides, which suggest significant fractional crystallization of olivine, pyroxene and Fe-Ti oxide with minor feldspar. The dykes are enriched in large-ion lithophile elements (LILFs, e.g., Rb, Ba, Th, U), light rare earth elements (LREE) and Nb, Ta, but depleted in Ti, K and P. They have OIB-like Sr–Nd isotopic compositions with initial $^{87}Sr/^{86}Sr$ and $\varepsilon_{Nd}(t)$ values ranging from 0.70368 to 0.70629 and -0.25 to 4.64, respectively. The $\delta^{26}Mg$ values range from -0.23 to -0.34‰ (average $\delta^{26}Mg$ = -0.28‰, n = 8, 2sd), and are similar to that of the normal mantle (-0.25 ± 0.07‰). However, the whole rock and pyroxene $\delta^{66}Zn$ values range from +0.28 to +0.46 ‰ and +0.30 to +0.39 ‰, respectively, heavier than the primitive mantle (+0.16 ± 0.06‰). Our data show decoupling Zn and Mg–Sr–Nd isotopes in these rocks which we correlate with slab-derived fluids and magnesite involved in the mantle source. The fluids with heavy Mg and light Zn isotopic compositions metasomatized the lithosphere. The carbonates, in the form of magnesite, with heavy Zn and light Mg isotopic compositions, were converted to carbonated eclogite during deep subduction. Melts derived through small degree melting of the carbonated eclogite migrated into the lithosphere and formed amphibole-rich metasomes. Eventually, heat input from the hot Tarim mantle plume triggered high-degree melting of the amphibole-rich metasomes generating the silica-undersaturated primary melt of the ferrotephrite which also reacted with the surrounding fluid-metasomatized lithospheric peridotite during ascend.