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Genesis of small-volume alkali-tholeiitic basalts: Implications for the geochemical continuum of intraplate basalts

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Intraplate basalts generally show a geochemical continuum from alkali to tholeiitic basalts. However, the genetic link between these two types of rocks has remained controversial[1]. The Early Jurassic Karamay basalts in the West Junggar terrane, southern Central Asian Orogenic Belt (CAOB), erupted as a small-volume outcrop in the stable continental intraplate region. In contrast to the chemically and petrographically well-defined alkali and tholeiitic basalts, the Karamaybasalts exhibit transitional compositions spanning from alkali to tholeiitic. Additionally, the rocks are characterized by aphyric textures without any visible phenocrysts, implying their compositions close to that of primary melt. Thus, the Karamay alkali-tholeiitic basalts can provide an important case to address the geochemical continuum of intraplate basalts. Similar to the alkali basalts in eastern China, the Karamay basalts have significantly lighter Mg (δ^{26}Mg = -0.54‰ to -0.34‰) and heavier Zn (δ^{66}Zn = 0.36–0.46‰) isotopes than the normal mantle, suggesting a contribution of sedimentary carbonate recycling. However, they also display positive anomalies of Nb-Ta-Ti-Zr-Hf, inconsistent with melts derived from a carbonated mantle source. This decoupling can be reconciled by considering the metamorphic decarbonation reaction between carbonates (i.e., dolomite and magnesite) and co-existing eclogite in the subducted oceanic slab at pressure >5 GPa, leaving light Mg and heavy Zn isotope signatures in the stagnant eclogite residue in deep mantle. Through comparing the geochemical compositions of our samples with the previous results of melt-peridotite reaction experiments[2], we conclude that the Karamay basalts might have originated from the interaction of silica-rich tholeiitic melt derived from the recycled decarbonated eclogite with fertile peridotite during its ascent. Our studyhighlights that intraplate alkali basalts, especially the silica-rich ones (e.g., with SiO_2>45 wt.%), can be transformed from tholeiitic melts through interaction with peridotite mantle, and demonstrates that deeply recycled oceanic crust can serve as one of main sources for alkaline lavas.

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[2] Mallik and Dasgupta (2012) Earth Planet. Sci. Lett. 329-330, 97-108.