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Vein-plus-wall rock melting model for the origin of Early Paleozoic alkali diabases in South Qinling Belt, Central China

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Early Paleozoic mafic dykes are widespread in South Qinling Belt, central China. In this study, we present new major element, trace element, zircon U–Pb age and Sr–Nd–Hf isotopic results of Early Paleozoic diabases dykes in the South Qinling Belt to explore nature of the mantle source. The South Qinling Belt diabases have low SiO₂ (42.1–49.5 wt%) high TiO₂ (2.89–5.17 wt%), variable MgO (4.0–9.4 wt%) contents. In primitive mantle normalized multielement diagrams, all samples are strongly enriched in the majority of incompatible trace elements but systematic depletion in Rb, K, Pb, Zr and Hf. The negative K and Rb anomaly together with high TiO₂ and high Na₂O/K₂O character suggest magma was derived from a source rich in amphibole. Partial melting modelling indicate 20–36% partial melting of amphibole-clinopyroxene-phlogopite veins with subsequent dissolution of ~30% orthopyroxene from the wall-rock peridotite within spinel stability field can produce the observed compositions of diabases. Additionally, South Qinling Belt diabases are characterized by moderately depleted Nd ($\epsilon_{Nd(t)} = +2.2$ to 3.3) and Hf ($\epsilon_{Hf(t)} = +6.2$ to 7.2) isotopic compositions without pronounced isotope decoupling, indicating mantle metasomatism occurred shortly prior to Early Paleozoic magmatism. It is proposed that low-degree silicate melts released from asthenosphere infiltrated and solidified within lithospheric mantle, forming non-peridotitic lithologies rich in amphibole clinopyroxene and phlogopite. Subsequent lithosphere extension caused the melting of the most easily fusible material in the lithosphere, which gave rise to the Early Paleozoic alkaline magmatism in South Qinling.