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Nd isotopes and HFSE concentrations trace delamination of ancient lithosphere in Kamchatka

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The Sredinny Range of Kamchatka, situated in the back-arc of an active subduction system, hosts voluminous geochemically enriched Quaternary mafic volcanism whose origin has long been debated. Here we present a regional dataset of Sr–Nd–Pb isotopes, major and trace element compositions, and K–Ar ages for representative back-arc volcanic rocks of the Sredinny Range [1, 2], integrated with previously published data. This comprehensive dataset is used to resolve mantle source heterogeneity in both space and time and to refine the mechanisms responsible for variable enrichment signatures (elevated large-ion lithophile element (LILE) concentrations and $^{87}Sr/^{86}Sr$ versus elevated high-field-strength element (HFSE) concentrations and lowered $^{143}Nd/^{144}Nd$, compared to depleted MORB mantle) in Miocene-Quaternary volcanic rocks. Our dataset shows that Sr isotopic ratios and LILE abundances primarily reflect contributions from subduction-derived fluids. In contrast, Nd isotopic compositions together with HFSE and rare-earth element systematics indicate spatially and temporally variable enriched mantle domains. These signatures cannot be explained by fluid metasomatism alone. We argue that lithospheric delamination is the principal mechanism responsible for the enriched geochemical character of the Sredinny Range magmatism, which supports our previous conclusions based on melt inclusion studies [3, 4]. We argue that significant variations in Nd isotopic ratios reflect differing ages of separation of the lithosphere from the mantle. The combined Nd–HFSE systematics thus provide a sensitive tracer for enriched mantle domains, the influence of the older lithospheric blocks on melting and an indication of the timeframes for the involvement of these sources in magma generation.

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