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Isotopic characterisation of the sub-continental lithospheric mantle beneath Zealandia, a rifted fragment of Gondwana

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The greater New Zealand region, known as Zealandia, represents an amalgamation of crustal fragments accreted to the paleo-Pacific Gondwana margin and which underwent significant thinning during the subsequent split from Australia and Antarctica in the mid-Cretaceous following opening of the Tasman Sea and the Southern Ocean. We present Sr, Nd and Pb isotopes and laser ablation trace element data for a comprehensive suite of clinopyroxene separates from spinel peridotite xenoliths (lherzolite to harzburgite) from the sub-continental lithospheric mantle across southern New Zealand. These xenoliths were transported to the surface in intra-plate alkaline volcanics that erupted across the region in the Eocene and Miocene (33-10 m.y.a.). Most of the volcanic suites have similar geochemical and isotopic properties that indicate melting of an OIB-like mantle source in the garnet stability zone and that contained a HIMU component. The volcanics have tapped two adjacent but chemically contrasting upper mantle domains: a fertile eastern domain and an extremely depleted western domain. Both domains underlie Mesozoic metasedimentary crust. Radiogenic isotope compositions of the clinopyroxene have $^{87}Sr/^{86}Sr$ between 0.7023 to 0.7035, $^{143}Nd/^{144}Nd$ between 0.5128 and 0.5132 (corresponding to εNd between +3 and +13) with a few samples extending to even more depleted compositions, $^{206}Pb/^{204}$ Pb between ca. 19.5 to 21.5 and $^{208}Pb/^{204}$ Pb between ca. 38.5 to 40.5. No correlations are observed between isotopic composition, age or geographical separation. These isotopic compositions indicate that the sub-continental lithospheric mantle under southern New Zealand has a regionally distinct and pervasive FOZO to HIMU – like signature. The isotopic signatures are also similar to those of the alkaline magmas that transported the xenoliths and suggest that most of the HIMU signature observed in the volcanics could be derived from a major source component in the sub-continental lithospheric mantle. Trace element abundances in clinopyroxene are highly heterogeneous and vary from LREE-enriched, relatively flat and MORB-like, strongly LREE-depleted, through to patterns displaying evidence for depletion and subsequent re-enrichment. These variations occur throughout the region and also between different xenoliths from a single eruption site. There are no clear correlations between REE characteristics and isotopic composition suggesting that much of the depletion and re-enrichment is relatively recent. A broad scatter of increasing $^{143}Nd/^{144}Nd$ with increasing Sm/Nd, plotting broadly between 150-350 Ma isochrons, may provide some constraints on these events.