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Highly enriched and depleted melt sources in mantle plumes recorded in olivine-hosted melt inclusions in Raivavae ocean island basalts

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Ocean island basalts (OIBs) are generally considered to be fed by upwelling mantle plumes sourced from deep mantle domain. Geochemical variation observed in OIBs should reflect chemically heterogeneous deep mantle materials including subducted slabs. Recent in-situ geochemical analyses on OIBs and mid-ocean ridge basalts (MORBs) unravel greater chemical variation in phenocryst-hosted melt inclusions than the bulk rocks, suggesting the presence of melts from different mantle sources in magmas where phenocrysts crystallize. Melt inclusions potentially provide us better understanding of the magma sources that may not be acquired from bulk rocks.

We present geochemical composition of olivine-hosted melt inclusions in HIMU-type OIBs from Raivavae, South Pacific. The basalts can be separated into radiogenic-Pb group and less radiogenic-Pb group. Lead isotope ratios of melt inclusions but one plot within Pb isotopic range defined by the two group of basalts. Most melt inclusions (here referred to as normal melt inclusions) show trace element abundance pattern overlapping with that of their host basalts. However, a small number of melt inclusions exhibit unusual trace element abundance pattern. Some (referred to as highly depleted melt inclusions) have much lower incompatible element concentration than the normal melt inclusions. Although the depleted melt inclusions are generally small, one of them, which was large enough to perform in-situ Pb isotope measurement, has Pb isotope ratios close to the depleted MORB mantle. We suggest that depleted mantle component was involved in the magma of Raivavae. Other type (referred to as highly enriched melt inclusions) shows unsmooth trace element abundance pattern with spikes at Rb, Th, U, and Pb, troughs at Ba and Sr, and depletion in rare earth elements. While Cl is well correlated with Th, F is low for a given Th relative to the normal melt inclusions. Lead isotope ratios of the highly enriched melt inclusions overlap with those of the normal melt inclusions. The element abundance pattern cannot be reproduced by crustal contamination or sulfide addition/subtraction. Such melt could be generated by low degree partial melting with amphibole residue. We suggest that melt with radiogenic-Pb isotopes was sourced from subducted crustal component with and without amphibole.