Volatiles in olivine-hosted melt inclusions in HIMU basalts from Raivavae, South Pacific

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Volatile cycle in the mantle has been poorly constrained because of limited number of studies thus far on volatile compositions in the mantle-derived ocean island basalts. We performed in-situ geochemical analyses on the olivine-hosted melt inclusions (MI) from Raivavae Island in the South Pacific. MIs were homogenized on the heating stage before chemical analyses. Compositions of major elements, trace elements, volatile elements, and Pb isotopes were determined by the combination of analytical techniques using EPMA, LA-ICP-MS, and SIMS. Carbon dioxide is distributed in both glasses and shrinkage bubbles in MI. We measured CO_2 density in bubbles using micro Raman spectrometry and determined the volume ratio between bubbles and MI applying micro X-ray CT technique to calculate CO_2 in bubbles, which is added to CO_2 in glasses measured with SIMS to determine the total CO_2 in MI. The basalts from Raivavae are classified into two groups in terms of Pb isotopes. Most MI in less radiogenic-Pb basalts have similar Pb isotopic compositions to host basalts. MI in radiogenic-Pb basalts generally exhibit radiogenic (HIMU) character, but they show larger isotopic variation than the host basalts. It is notable that small number of MI have different Pb isotope ratios from host basalts, suggesting mingling of radiogenic melts and less radiogenic melts during olivine crystallization. Despite some exceptions, MI with radiogenic Pb isotopes are characterized by lower SiO_2 and higher CaO, La/Yb, and Nd/Hf than MI with less radiogenic Pb. These facts suggest that the radiogenic-Pb (HIMU) melts were formed by low-degree partial melting of carbonated source. MI with radiogenic Pb clearly show elevated Cl/Nb and F/Nd relative to MI with less radiogenic Pb. Enrichment of Cl and F in radiogenic-Pb melts implies that these elements have been transported into the mantle via subduction of hydrothermally altered oceanic crusts. The correlation of H_2O/Ce and CO_2/Nb with Pb isotopes is somewhat blurred, probably owing to degassing and diffusive loss of CO_2 and H_2O. However, MI with the most radiogenic Pb have the lowest H_2O/Ce and the highest CO_2/Nb, which may also reflect the feature of the basalt source.

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