Volatile element compositions of HIMU basalts; a study of Raivavae in the South Pacific

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Volatile budget in the mantle reserovoirs have been poorly constrained because of limited number of studies thus far on volatile concentrations in the mantle-derived ocean island basalts (OIBs). We present preliminary results of in-situ geochemical analyses on the olivine-hosted melt inclusions (MIs) from Raivavae Island in the South Pacific to provide new constraints on volatile composition in the HIMU mantle reservoir that is considered to have formed by storage of ancient subducted slabs in the mantle. Raivavae is unique in that the basalts are classified into two groups in terms of Pb isotopes, suggesting that the basalts with radiogenic Pb isotopes involve more recycled slab materials in the source than those with less-radiogenic Pb isotopes. The MIs analyzed in this study were chosen from the two basalt groups. Volatiles together with major and trace elements and Pb isotopes were measured on the same MI through a series of analyses using SIMS, EPMA, and LA-ICP-MS. We prepared two sample sets; these were the natural MIs with crystalline phases inside and the homogenized glassy MIs that were reheated on the heating stage. The natural MIs show larger variation in volatile and trace element compositions than the homogenized MIs owing to the heterogeneous distribution of crystalline phases. This was confirmed by mapping of the volatiles in the natural MIs, where dendritic clinopyroxenes are depleted in volatiles while H_2O and F are concentrated in amphiboles that occur in some MIs. Most MIs have Pb isotope compositions indistinguishable from their host basalts, but one MI has Pb isotope compositions close to that from another group, suggesting an episodic cross-talk of the melts between the two groups. The MIs with less-radiogenic Pb exhibit larger variations in volatile and trace element compositions than the MIs with radiogenic Pb. Notably, some MIs with less-radiogenic Pb isotopes are associated with highly depleted incompatible element composition. Such compositions have never been observed in any bulk rocks on the island. Nevertheless, all the MIs, including the unusually depleted MIs, display broad correlations between volatiles and trace elements with similar incompatibility. Linear variations of H_2O/Ce with 1/Ce and F/Nd with 1/Nd are best explained by mixing of the melts with different H_2O/Ce and F/Nd. In these plots, the MIs with radiogenic Pb tend to have low H_2O/Ce (50-100) and low F/Nd (20-40), implying that the melt derived from the HIMU reservoir had lower H_2O/Ce (~200) than and similar F/Nd (~20) to the ordinary mantle peridotite.

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