

Heterogeneity of source material beneath an ocean island: A preliminary case study of Rarotonga Island

*Moriyama Hamada¹, Takeshi Hanyu¹, Takahiro Ozawa², Takayuki Ushikubo³, Kenji Shimizu³, Motoo Ito³, Qing CHANG¹, Jun-Ichi Kimura¹, Hikaru Iwamori^{1,2}

1.Department of Solid Earth Geochemistry, Japan Agency for Marine-Earth Science and Technology, 2.Department of Earth and Planetary Sciences, Tokyo Institute of Technology, 3.Kochi Institute for Core Sample Research, Japan Agency for Marine-Earth Science and Technology

[Introduction]

Geochemical endmembers of Earth's mantle, such as HIMU and enriched mantles (EM1 and EM2), have been identified based on the systematics of radiogenic isotopes such as Sr, Nd and Pb isotopes in ocean island basalts (OIBs). Instead of previous whole-rock geochemical studies of OIBs, melt inclusions in OIBs are intensively analyzed to constrain the concentration and isotopic composition of volatiles in primitive melt derived from each geochemical endmember in the mantle. Here, we report the preliminary analytical results of melt inclusions collected from Rarotonga Island of the Cook-Austral archipelago in the South Pacific.

[Studied samples and analytical methods]

We analyzed olivine-hosted melt inclusions in Rarotonga basalts that erupted during an earlier stage of volcanism at 2.3-1.6 Ma. Melt inclusions were found to be suffering from 5-15 wt.% post-entrapment overgrowth of olivine and post-entrapment crystallization of daughter minerals such as clinopyroxene. We examined the analytical results, taking such post-entrapment geochemical modifications into consideration.

First, we analyzed the volatile concentrations and Pb isotopic compositions of the glass phase of five melt inclusions using a secondary ion mass spectrometer (SIMS). Then, we analyzed the major element compositions of the glass phase of melt inclusions using an electron probe micro analyzer (EPMA). Finally, we analyzed the trace element compositions and Pb isotopic compositions of melt inclusions using a laser ablation inductively coupled plasma mass spectrometer (LA-ICP-MS).

[Analytical results]

Various geochemical data (major elements, trace elements, volatiles and Pb isotopic compositions) have been obtained from two melt inclusions (rtg13-mi2 and rtg41-mi1) to date. The saturation pressures of rtg13-mi2 and rtg41-mi1 are >10 MPa and >12 MPa, respectively, based on systematics of CO₂ and H₂O concentrations of the melt inclusions, which suggests that these degassed melt inclusions were trapped in olivine at shallow crustal levels. We cannot exclude the possibility that Cl and H₂O concentrations were modified to a greater or lesser extent due to assimilation by seawater and/or brines and degassing. In this paper, we focus on the ratio of F to Nd (F/Nd), because F is unlikely modified by assimilation and/or degassing, and Nd has a similar mineral-melt partition coefficient to F during mantle melting and magmatic differentiation processes. The values of F/Nd are 17 and 28 for the melt inclusions rtg13-mi2 and rtg41-mi1, respectively, which differ significantly from each other (Figure).

As regards Pb isotopic compositions, $^{208}\text{Pb}/^{206}\text{Pb}=2.0888\pm0.0026$ and $^{207}\text{Pb}/^{206}\text{Pb}=0.8355\pm0.0015$ for rtg13-mi2 and $^{208}\text{Pb}/^{206}\text{Pb}=2.1078\pm0.0035$ and $^{207}\text{Pb}/^{206}\text{Pb}=0.8504\pm0.0029$ for rtg41-mi1. These values are also significantly different from each other, though they are within the reported variation of whole-rock Pb isotope compositions of Rarotonga basalts (Figure).

[Discussion]

The difference in F/Nd values for two melt inclusions cannot be explained by differences in the degree of melting and/or degree of crystallization, but could reflect differences in F

concentration in the source materials. A possible explanation for the differences in the F/Nd ratio and the Pb isotopic compositions between the two melt inclusions is that recycled slabs with different degrees of dehydration are involved with source materials beneath Rarotonga Island, which produces geochemical heterogeneity of volatile and Pb isotopic compositions. The two melt inclusions from Rarotonga Island have similar geochemical features to those of Pitcairn Island (EM1) but could also be influenced by other geochemical endmembers such as EM2 (e.g., Society Islands) and/or HIMU (e.g., Mangaia Island) (Figure).

Keywords: Ocean Island Basalt, Rarotonga Island, Secondary Ion Mass Spectrometry

