Estimation of the origin of Pitcairn Island OIB by Independent Component Analysis

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Ocean island basalts (OIB) are thought to bring information concerning geochemistry and material cycling of the deep mantle. For this reason, OIB have been studied extensively, among which Pitcairn Island in the South Pacific is regarded as a unique and important location as a hotspot volcano. Previous studies reported that the lavas in Pitcairn involve multiple components from DM (depleted mantle) to EM1 (enriched mantle) (Woodhead & McCulloch, 1989), of which EM1 component has been argued to originate from recycling oceanic plate, delaminated lower crust, continental marine sediment and others (Eisele et al., 2002; Garapic et al., 2015). The mechanism to produce the specific isotopic composition of EM1 is still under extensive debate.

We analyzed concentrations of major elements, volatile elements (CO_2, H_2O, F, S, and Cl), and trace elements, as well as lead isotopic ratios, by using SIMS, EPMA and LA - ICP - MS for melt inclusions contained in olivine from basalt and pyroclastic rock in Pitcairn Island. Melt inclusions are thought to retain the volatile elements without losing them upon eruption, which is suitable for discussing the origin of the EM1 component. In this study, four lavas (PC-2, PC-16, PC-38, and PC-40) and a pyroclastic rock collected from the Tedside formation of Pitcairn Island were analyzed. The whole-rock composition of these lavas show EM1 signatures. Melt inclusions in olivine are crystallized, but those of pyroclastic rock are all glassy and homogeneous as they are. The crystalized melt inclusion samples from the four lavas were homogenized at the individual liquidus temperatures (1150 degrees and 1175 degrees). A small amount of H2O loss was found for 10 min heating for homogenization, by comparing the analyses of both melt inclusion with/without reheating of the pyroclastic rock samples. On the other hand, virtually no effect was seen for F and Cl.

Multivariate statistical analysis is useful to extract the geochemical features from these data set. McKenzie et al. (2004) identified the coherence between the trace element concentrations and the isotopic ratios, and argued that such coherence must indicate multiple sources of different origin. Instead of Principal Component Analysis (PCA) as used by McKenzie et al. (2004), we utilize Independent Component Analysis (ICA) to extract geochemically independent features. At the same time, we also performed k-means cluster analysis on the whitened data set (Iwamori et al., 2017) to clarify the multiple sources hidden in the lavas from a small area within the Pitcairn Island. In this paper, we will present the results of the geochemical analyses and statistical analyses to identify and discuss the nature of the sources involved in the Pitcairn volcanism.

