Primary boninite magmas explored from melt inclusions

Keitaro Kitamura, Susumu Umino, Kyoko Kanayama

Department of Earth Sciences, Kanazawa University, Japan

E-mail: keitarou@stu.kanazawa-u.ac.jp

Boninite melt inclusions were analyzed in Cr-spinel collected from beach sand from Mukojima, Chichijima, Anijima and Ototojima, Bonin Islands. The common constituents of the inclusions are quenched glass, daughter minerals which grew after trapping, and euhedral crystals of olivine, orthopyroxene and clinopyroxene that were trapped with the surrounding melt, and shrinkage bubbles. We classified the inclusions into 6 types (Type-A–F) based on the combination of the constituents and their textures. The difference in these inclusion types inherited from the melt compositions and the cooling history dependent on the mode of occurrence of the host rocks. Because of the homogeneity of the glass in inclusions and the host spinel adjacent to the inclusion walls, the bulk compositions of quench glass with or without quench crystals (Type-A, B, E and F) are considered to represent the liquid compositions when captured by the host spinel. Major and trace element compositions of melt inclusions show a wide range of boninitic compositions with SiO_2 53-63 wt.%, TiO_2 0.02-0.25 wt.%, Al_2O_3 6-13 wt.%, MgO 8-23 wt.%, CaO 4-11 wt.%, Zr/Ti 0.01-0.04, Gd/Lu 2.4-7.2 and Gd/La 0.24-0.87. We classified the compositions of melt inclusions into five types. BIC (Boninite Inclusion Compositions)-1 is characterized by a low-SiO_2 trend and belongs to high-CaO boninite series. It has a subhorizontal chondrite-normalized pattern with high REE abundances. These features are similar to low-Si boninite by Kanayama et al. (2012). BIC-2 is characterized by relatively high CaO content and low Zr/Ti, which resembles to high-Si type 2 boninite by Kanayama et al. (2012). BIC-3 shows a low-Ca and low-SiO_2 trend. BIC-4 and BIC-5 are typical low-Ca boninite with high Zr/Ti ratios and high SiO_2 contents. However, BIC-4 has a lower Al_2O_3 content than BIC-5 and a U-shaped chondrite-normalized REE pattern and is mostly sampled from Mukojima. On the other hand, BIC-5 shows a characteristic V-shaped chondrite-normalized REE pattern. In general, BIC-types show a systematic relationship with the host Cr-spinel compositions. BIC-1, 2 and 3 are hosted by low-Cr# spinel, whereas BIC-4 and 5 are hosted by high-Cr# spinel. I have estimated the pressures and temperatures for the most primitive melt inclusions in each BIC type to have been in equilibrium with the mantle peridotite under anhydrous or hydrous conditions by using the olivine-liquid geothermometer by Putirka et al. (2007) and the olivine-orthopyroxene-liquid geobarometer by Putirka (2008). As a result, it is shown that BIC-1 type was generated in higher pressure condition than other BIC types.