New geochemical classification of global boninites

Kyoko Kanayama, Keitaro Kitamura, Susumu Umino

Department of Earth Sciences, Kanazawa University, Japan

E-mail: ka78ma@stu.kanazawa-u.ac.jp

Boninite is an important volcanic rock type associated with the initiation of a subduction zone. It is generally defined as a variety of high-magnesian andesites with SiO_2 >52 wt%, MgO >8 wt% and TiO_2 <0.5 wt%. Compilation of the global data on bulk geochemistry of boninites defined as such shows a broad compositional range consisting of a number of regional trends which are characteristic to the individual volcanic suites, suggesting that the genetic conditions of boninite magmas are highly variable dependent on the tectonomagmatic situations. Therefore, re-evaluation of the classification scheme of global boninites is crucial to understand the genetic conditions of boninite magmas and their relationships with the tectonomagmatic settings.

Boninite is usually a part of volcanic rock suites which forms a continuous fractionation trend from magnesian (MgO >20 wt%) boninite through less magnesian andesite to dacite and rhyolite. These regional fractionation trends form subparallel curves on a SiO_2-MgO plot, namely boninite series, that differ from volcanic suites to suites. We advocate to classify these boninite-series rocks into high- and low-Si boninites by a discrimination line running through points of SiO_2 = 55 wt% at MgO = 20 wt% and SiO_2 = 59 wt% at MgO = 8 wt% on a SiO_2 vs. MgO plot. Boninites from Ogasawara (Bonin) Islands on the Izu-Ogasawara (Bonin)-Mariana forearc and western Pacific ophiolites in Papua New Guinea and New Caledonia show compositional trends of high-Si boninite series which are controlled by crystal fractionation of olivine and orthopyroxene. Whereas, boninites from Tonga arc, DSDP Site 458 and Guam, and Neo-Tethys ophiolites such as Oman and Troodos show low-Si boninite series trends controlled by olivine, orthopyroxene and clinopyroxene fractionation. Low-Si boninite-series rocks do not evolve across the discriminate line by crystallization differentiation. Primary magmas of Low-Si boninites are characterized by enhanced LILEs and LREEs by slab-derived H_2O-rich fluids. Melting experiments of peridotites have demonstrated that low-Si boninite-like melts with SiO_2 <54 wt%, MgO <23 wt% could be produced under 1-2.5 GPa and dry and water-undersaturated conditions. On the contrary, SiO_2-rich (SiO_2 >54 wt%) melts like high-Si boninites have never been produced by peridotite melting experiments. Instead, highly depleted REEs and high Zr/Ti ratios of high-Si boninite magmas require slab-derived felsic melts that reacted with the depleted harzburgite in the mantle wedge.