Geochemical composition of rhyolitic magma from the Hime-shima volcanic group: contribution of crustal material

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Generation of rhyolitic magmas in the shallow crust is an important, yet enigmatic, process in worldwide (Watts, 2011). The generation of rhyolitic magmas has been explained by fractional crystallization or assimilation fractional crystallization (AFC) process from basaltic magmas (e.g. Bowen, 1928; Tuttle and Bowen, 1958; Depaolo, 1981) or partial melting of the basaltic lower crust (Dufek and Bergantz, 2005). By these processes, however, it is difficult to explain the large amounts of basaltic magma, which in required long and large-volume silicic eruption (e.g., Beard and Lofgren, 1991). When rhyolitic magmas are produced by recycling as melt of shallow crustal materials (silicic or intermediate protoliths), the amount of basalt required become significantly small (e.g., Bindeman and Simakin, 2014). This study deals with the recycling of these crustal materials as genetic mechanism of rhyolite for Hime-shima volcanic group. The Hime-shima volcanic group is composed of dacites and rhyolites, and is located offing of Kunisaki Peninsula, Kyushu, Japan, where the Philippine Sea Plate is subducting. The volcanic rocks of the Himeshima volcanic groups were thought to be formed by magma mixing of dacitic and rhyolitic magma, on the bases of disequilibrium amphibole in rhyolitic and the linear trend of major element contents respects to the SiO_2. A possibility of involvement of crustal materials is suggested from the occurrence of crustal xenoliths in the dacite (Shibata et al., 2014, 2016) and of residual material of crustal melt in the rhyolite (Hirayama et al., 2018). However, no quantitative discussion for genesis of rhyolitic endmember have been made. Therefore, we determined trace element compositions of rhyolites to discuss the genesis of rhyolitic magma.

The Primitive Mantle normalized multi element pattern of rhyolite from Hime-shima shows negative Th, Sr, Zr, Eu anomaly and positive U, Nd, Sm anomaly relative to neighboring elements. These geochemical features differ from Hime-shima dacite and other silicic magmas from North Kyushu. Those patterns are similar to the patterns of rhyolites from Northeastern New Brunswick (Lentz, 1997). The genesis of felsic magma is interpreted as a product of fusion of supracrustal rocks, associate with heat advection from intruding continental back-arc mafic magma. Although Hime-shima and Northeastern New Brunswick have different tectonic settings, geochemical features of rhyolites from those of the areas show similar characteristics. Geochemical features of rhyolites from Hime-shima and Northeastern New Brunswick shows low Zr (30 ppm degree) and Y contents (10 ppm degree), high Nb/La (>2.0) and Rb/Sr ratios (>1.0). From the characteristics of geochemistry, we will discuss the genesis of rhyolitic magma.

Keywords: magma genesis, Hime-shima volcanic group, rhyolitic magma