Genesis of high magnesium andesites with high Nb/La ratio from Saga-Futagoyama, Northwest Kyushu, Southwest Japan

Hidehisa Mashima[1]

[1] Tono Geoscience Center, JAEA

Aqueous fluids and/or hydrous felsic melts derived from the subducting slab are believed to play essential roles in the genesis of high magnesium andesite (HMA) magmas distributed in southwest Japan. However, HMAs are also distributed in northwest Kyushu where no subducting slab extends. Origins of the NW Kyushu HMAs are important not only for understanding HMA magmatisms from an earth scientific viewpoint but also for building confidence of evaluation methodologies of the long-term stability of the geological environment for geological disposal of high-level radioactive waste.

Basaltic andesites distributed at Saga-Futagoyama, northwest Kyushu, southwest Japan are HMAs originally equilibrated with Fe-rich mantle. The reasons for thinking so are twofold. The andesites contain orthopyroxene phenocrysts with Mg/(Mg+Fe) = 0.8. The bulk rock Mg-Fe-Ni compositions suggest that the andesite magmas could equilibrate with mantle olivines. Hydrous components derived from the subducting slab played an insignificant role in the genesis of the Saga-Futagoyama HMA magmas. Lines of evidence for this interpretation are following. KDCa-Na=1.25 between plagioclase and melt suggests that the HMA magmas originally contain less than 1.8 wt. % H2O. Nb/La of the Saga-Futagoyama samples is higher than one and has an insignificant correlation with SiO2. All of previously reported mantle xenoliths from NW Kyushu have anhydrous mineral assemblages. The subducted Philippine Sea plate does not extend to NW Kyushu. HMA magmas could also be formed by partial melting of recycled basaltic oceanic crust at high pressures. Since experiments suggest that the residues of oceanic crust equilibrated with HMA magmas consist of cpx + plagioclase +- garnet, Ni in HMA magmas should behave as an incompatible or weak compatible element. However, the Saga-Futagoyama HMAs show a clear positive Ni-MgO correlation, suggesting a strong compatible behavior of Ni. Thus, partial melting of recycled oceanic crust would also not explain the genesis of the Saga-Futagoyama HMA magmas. According to melting experiments, partial melting of anhydrous mantle at very low pressures could form HMA magmas. Normative Jd+CaTs-Ol-Qz compositions of the HMA suggest that they were separated from their source mantle at 0.5 GPa. Thus, the Saga-Futagoyama HMA magmas would be formed by partial melting of relatively anhydrous mantle at very low pressures. Saga-Futagoyama is located on the Hatashima-Ariake Sea fault which is a major tectonic line of NW Kyushu and is the boundary of Tertiary Karatsu-Sasebo Basin and the Sefuri highlands composed of Cretaceous granites. During the basin formation, the lithosphere beneath the basin would have eroded and renewed to reduce its lithospheric strength. On the other hand, The Sefuri highlands insignificantly subsided to maintain its original lithospheric strength. Therefore, a large contrast of lithospheric strength would have developed between the basin and the highlands. When the mantle upwelled, the upwelling would have concentrated at such a mechanically weak geologic suture zone. As the result, the mantle would have upwelled to very low pressure revels to form the HMA magmas. For further examinations of this hypothesis, detailed observations of the lithospheric structure in NW Kyushu and other areas of HMA distribution are required.