

Geochemical study of the mafic rocks from Hokkaido, northern Japan: Spatial variations in the wedge mantle and the magma-generation processes at an arc-arc junction

Ayumi Kosugi, Mitsuhiro Nakagawa

Department of Natural History Sciences, Graduate School of Science, Hokkaido University, Japan

E-mail: kosugi@mail.sci.hokudai.ac.jp

Hokkaido Island is a junction between the Northeast Japan (NEJ) and the Kuril arcs, where the extensive arc volcanism has continued at least since late Miocene. We newly investigate the spatial geochemical variation of mafic rocks (<1.7Ma). We focus on the rocks with $\text{SiO}_2 < 54\%$ for avoiding the effect of crustal assimilation. Based on the spatial compositional variations of the volcanic rocks, the junction can be divided into four volcanic regions: the trench (T-SWH) and the rear (R-SWH) sides of the southwestern Hokkaido in NEJ arc, and the central Hokkaido (CH) and the eastern Hokkaido (EH) in Kuril arc. Across-arc compositional variations of the rocks, such as the increase of K_2O contents from low-K to medium-K rocks toward the back-arc side, can be clearly recognized in SWH and EH. The low-K rocks from these regions are characterized by the obvious Pb and Ba spikes in spidergrams and flat REE patterns. However, low-K rocks in the EH show extreme negative anomaly of Nb and Ta, and depletion of LREE. On the other hand, there exist no low-K rocks in CH. In addition, across-arc variations are not clearly recognized. In a Nb/Y-Zr/Y diagram, the rocks from four regions show distinct linear and parallel trends, respectively, and can be divided into three groups, T-SWH, R-SWH and CH, and EH. This indicates that there exists compositional heterogeneity of the wedge mantle, which cannot be explained by the degree of melting from a single mantle source. The degree of depletion in the mantle increases from T-SWH to EH. According to these Nb/Y values at similar Zr/Y, we assume the Enriched-DMM (depleted MORB mantle), DMM and Depleted-DMM of Workman and Hart (2005) for T-SWH, R-SWH and CH, and EH as the source mantle compositions, respectively. Then, degree of melting (F) for primary magmas in each region is calculated by the contents of fluid-immobile elements. Next, using these F values, we determine a metasomatized mantle source compositions for each region. Contents of fluid-mobile elements of a metasomatized mantle source show positive, various correlations in Th and U vs. F diagrams. These data indicate that there exists the difference of subduction components among these regions.

Four volcanic regions in Hokkaido can be extended to the main parts of NEJ and Kuril arcs. In NEJ arc, two distinct regions similar in Hokkaido continue to northern Honshu. Thus, the wedge mantles are distinct between the trench and rear sides in NEJ arc. On the other hand, the rocks from Kuril Islands have similar or more depleted composition compared with those from EH. Thus the wedge mantle slightly changes to become more depleted in Kuril Islands. Although low-K tholeiitic rocks occur in trench-side volcanoes of both arcs, the origins of these rocks are different. Low-K rocks are produced by lower degree of melting more depleted mantle in Kuril arc and by higher degree of melting of enriched mantle in NEJ arc.