Petrological and chronological study of primitive high-Mg andesite from monogenetic volcanoes in the fore-arc region of northern Kamchatka Peninsula

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Primitive high-Mg andesites (HMA) exhibit low FeO*/MgO (FeO* , total iron) and high Mg# (=100×Mg/(Mg+Fe)), and are thought to be generated by hydrous mantle melting (Kushiro, 1969). HMA, including sanukitoids of the Setouchi volcanic belt, have been recognized in many orogenic belts of various ages, and in several cases, constitute a part of ophiolite (Tatsumi, 2003). Therefore, occurrence of HMA in northern Kamchatka may have important implications on the tectonic setting of the peninsula and/or the melting condition underneath.

HMA are seen in several different regions of the peninsula, including Central Kamchatka Depression (CKD) of Kamchatka peninsula, especially, in the northern part of CKD, around the vicinity of slab edge of the Pacific Plate (Yogodzinski et al., 2001, Portnyagin and Manea, 2008, Bryant et al., 2011). On the other hand, monogenetic volcanoes on the northward extension of the Eastern Volcanic Front (EVF), ‘Kumroch range’, exist and studied in 1960s (Fedorenko, 1969), and these volcanic rocks were also reported as high-Mg basalts (HMB) to HMA (Uspensky and Shapiro, 1984). The reported eruption ages of these volcanic rocks are middle to late Pleistocene by morphology and by studying of ice pebbles (Uspensky and Shapiro, 1984), but instrumental measurements have not been done. In addition, these rocks have not been studied for constraints on melting P-T-H_2O conditions in the mantle wedge.

In the summer of 2013, we have identified 15 monogenetic volcanoes (hereafter ‘East Cone volcanic group’, EC) in the Kumroch range based on the stereogram and had

investigated 8 volcanoes by using a helicopter. The present-day slab depth beneath the monogenetic volcanoes is about 60 km (Gorbatov et al., 1997), and the crustal thickness is about 25-30 km (Pavlov and Semakin, 1972, Balesta, 1991).

To reveal the origin of the EC lavas, we have first examined the mineral assemblages under optical microscope and analyzed the whole rock major element compositions by XRF, the trace element compositions by ICP-MS, and the ages by K-Ar dating. 16 samples which were collected from 8 cones are classified as basalt or basaltic andesite, of which the two lavas contain xenoliths. All but one, oxidized sample are fresh. The rocks contain plagioclase, clinopyroxene, olivine, spinel, and are divided into four groups by the textural and the mineralogical differences.

The silica contents of all samples exceeds 50 wt.%, with the FeO*/MgO ratio around unity for most of HMB and HMA, indicating relatively undifferentiated characteristics. The major element composition is uniform for each individual volcano, supporting that EC are monogenetic volcanoes. The trace element compositions of EC show arc signatures with Nb and Ta depression and Pb and Sr spikes on the spidergram, confirming uniformity for each individual volcano, with noticeable differences for the central part of the studied area in terms of the highly to moderately incompatible elements. It is also noted that heavy REE abundances are similar for all the samples, suggesting a common mantle source (likely to be a depleted MORB-source mantle, DMM) fluxed by variable amounts of slab-derived fluids.

Sanukitoids of the Setouch volcanic belt have been experimentally studied with respect to their melting temperature, pressure, and H_2O content (Tatsumi, 1981, 1982). These rocks are divided into two groups, CPX-HMA and OPX-HMA, according to the type of pyroxene crystallized subsequent to olivine. In this regard, the EC lavas are classified as CPX-HMA, and the melting condition is estimated to be 1030 ℃ at 1.5 GPa, under water-saturated conditions.

We have estimated the melting degree and H_2O content of the EC source mantle, based on the geochemical data obtained in this study. We simultaneously estimate the degree of melting and the amount of slab-derived fluid added to the mantle wedge by fitting a calculated melt composition to the observed composition as follows. Assuming the compositions of DMM, a slab-derived fluid (PAC-fluid, Nakamura and Iwamori, 2013), the partition coefficient $K_d^{rock/melt}$ (Kimura et al., 2009), and the melting pressure of 1.5 GPa, the calculated melt composition fits the observed EC composition with the melting degree of 13.8 % and the H_2O content in the source mantle of about 2 wt.%. However, the misfit between the calculated and the observed melt compositions is relatively large for the incompatible elements, and further inspection on the mantle and the fluid compositions are required to examine feasibility of the model.

The K-Ar age of EC lavas ranges from 0.37-0.12 Ma, middle to upper Pleistocene. This

age corresponds to the results of previous studies (Uspensky and Shapiro, 1984), and it is comparatively younger than the reported oldest age of the EVF volcanoes (3.71 Ma, Bindeman et al., 2010). According to Volynets et al. (2010) who argue that the subduction zone had shifted to the east during Kronotsky terrain accretion in 7 to 2 Ma (Lander and Shapiro, 2007), the tectonic setting by which the EC magmas were generated is thought to be the same as the present day. Therefore, the estimated melting condition of EC should be reconciled with the present-day slab configuration, including the subduction angle, velocity and age of the subducting slab in the northern Kamchatka peninsula.

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