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Abstract of Doctoral Dissertation

博士の専攻分野の名称　博士（理 学）　　氏　名　　ベルガル-クビカス オリガ
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学 位 論 文 題 名
Title of Doctoral Dissertation

Geochemical studies of volcanic rocks from the northern part of Kuril-Kamchatka arc: Tectonic and structural constraints on the origin and evolution of arc magma
（クリル・カムチャッカ弧北部の火山岩に関する地球化学的研究：
深部構造が島弧マグマの起源および進化に与える影響について）

The Kurile-Kamchatka arc (KKA) locates at the northeastern convergent boundary of the Eurasian and Pacific plates. Although the Pacific plate has subducted beneath the arc to cause intensive arc-type volcanism, the basement of the arc largely change from south to north. The central part of Kuril arc has oceanic crust with a back-arc basin, whereas continental crust dominates from the northern part of Kuril islands to Kamchatka peninsula. In addition, the northern end of the arc is the junction with Aleution, in which special conditions, such as the slab window and/or collision and subduction of seamount. This dissertation consists of two parts. In the part 1, geochemical study of Klyuchevskoy volcano situated at the northern end of the arc. In the part 2, spatial geochemical variations of several volcanoes from the northern end of Kuril islands, which locates between continental and oceanic arcs. In these studies, new geochemical data are presented, such as major and trace elements by XRF, REE and trace elements by ICP-MS, Sr-Nd isotopes by TIMS and Pb isotopes by MC-ICP-MS. Based on these data, this dissertation could reveal the relationship between magma generation and tectonic and structural setting.

The Klyuchevskoy volcano (altitude ~ 4750 m, volume ~ 250 km^3) is a voluminous stratovolcano with numerous cinder cones on the slope. Geochemical analysis of major and trace elements, REE and Sr-Nd-Pb istopes for systematically collected samples since the last 3000 years is carried out. The rocks of the volcano are mainly basalt and basaltic andesite, ranging from SiO_2=51 to 55 wt. % Based on distinct chemical trends on K_2O – Zr and –MgO diagrams, the rocks can be grouped into two types, low-K and high-K ones. Each magma typevaries from primitive to evolved rocks. Each primitive magma shows higher contents of MgO (>9.5 wt. %), whereas K_2O contents of each one are distinct, low-K with K_2O=0.5~0.6 wt.% and high-K types with K_2O=0,9 wt.%. In addition, these two magmas shows different Nd and Pb isotopes and K/Ba ratios. These strongly suggest that these high MgO magmas are different primary magmas which were derived from distinct source mantles. Considering low Nb and Ta contents of these two magmas, the source mantle of two primary magmas should be similar depleted MORB mantle (DMM). However, high-K primary magmas show higher Ba/La and Th/Y ratios compared with those of low-K ones. Thus, the source DMM for the high-K magma was contaminated more by sedimentary component from slab. This is also consistent with different Pb isotopes of these two primary magmas. Evolved two types of magma could not be produced by simple fractional crystallization of each primary magma. In comparing with trends variations of Pb isotopes of low-K and high-K types, it is suggested that these evolved magmas were contaminated with upper crustal materials in low-K type and with mid-lower crustal ones in high-K type, respectively. During the last 3000 years, primitive magma of the high-K type had firstly

occurred in AD 1932. Although both low-K and high-K types magmas erupted in AD 1937-1938, evolved magma of high-K type had erupted from AD 1945 to 1966. After AD 1966, evolved magma of low-K type has erupted until now. The temporal change of magma type could possible reflect the eruption mode and rate of the volcano. Small scale of summit eruptions had continued before AD 1932, whereas frank fissure eruptions of voluminous magma had started since AD 1932. Mode of eruption and eruption rate had increased from AD 1932 to 1945 with eruption of high-K type magma. This could indicate that addition of slab derived material had controlled magma production processes during early 20^{th} century.

In the part 2, geochemical analysis for major, trace, REE and Sr-Nd isotopes of 10 volcanoes (Chikurachiki, Ebeko, Fussa, Alaid, etc.) at the northern part of Kuril islands. Rocks of these volcanoes belong to a typical arc type with Ta and Nb depletion, and show across-arc compositional change, such as increasing of LIL elements and L-REE toward the back arc zone. According to this spatial variation, these volcanoes can be divided into three zones: frontal, transitional and rear ones. Although rocks from the volcanoes in frontal and transitional zones (SiO_2=49 – 63 wt.%) are mainly andesite, basaltic rocks (SiO_2=48 – 53 wt.%) are dominant in the rear zone. The rocks from the frontal zone are characterized by lower contents of LIL elements (e.g. Rb, Ba, K), L-REE (e.g. Nd, Ce) and higher $^{87}Sr/^{86}Sr$ ratio (0.7031-0.7034). Toward the back-arc side, contents of LIL elements and L-REE increase toward the rear zone, whereas $^{87}Sr/^{86}Sr$ (0.7029-0.7031) ratios decrease. The basaltic rocks of the rear zone are characterized by high Nb contents. Nb/Zr ratios of basaltic rocks from the frontal zone are low and similar to depleted MORB source, whereas those from the rear zone are obviously high. These indicate that the wedge mantle beneath the northern Kuril islands is heterogeneous. The source mantle consists of depleted MORB one beneath the frontal zone, whereas that is slightly enriched mantle beneath the rear zone. In addition, chemical variations of fluid-mobile elements (e.g. Cs, Ba, U, Th, Sr) and immobile elements (e.g. Nd, Nb, Zr, Hf) of the mafic rocks will be explained by different types of subduction components. In summary, the following parameters have mainly affected the observed geochemical zonation across the arc in the primary magma; variably depleted and enriched mantle source: the different type fluid flux from the slab to the mantle wedge. The presence of enriched source in the rear zone suggests that wedge mantle of KKA has shown the structural variations along the arc.