Temporal variation in magma system of Kutcharo caldera volcano, eastern Hokkaido

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Kutcharo volcano started the activity ca. 0.4 Ma to erupt Furu-ume pyroclastic flow (FW), and had repeated caldera-forming plinian eruptions until 35 ka. After the formation of Kutcharo caldera, post-caldera activity of Atosanupuri volcanoes began at the center of the caldera. In this study, we investigate temporal change of magma system of caldera-forming and post-caldera stages during 0.4 My. The activity of FW can be distinguished from the other activities, because its petrological features, mineral assemblage and magmatic chemical compositions, are distinctive. In addition, there existed a long dormancy of nearly 0.2 My between FW and following caldera-forming eruption (KpVIII). Since the eruption of KpVIII, plinian eruption had repeated six times with 20 to 30 ky dormancy. These eruptions have been named as from KpVIII to KpI in the ascending order. However, it has been revealed that KpII and KpIII are the products of the same eruption episode (KpII/III).

The rocks of the caldera-forming stage are mainly dacite and rhyolite accompanied with small amount of andesite and basaltic andesite in KpVIII and KpIV. In these two eruptions, banded pumice is common. In addition, magnesian olivine phenocryst is recognized in rhyolite pumice of KpI unit. These features suggest that magma mixing occurred between mafic and felsic magmas. Difference in ratios of incompatible elements between mafic and felsic magmas of KpVIII and KpIV could not be formed by fractional crystallization of phenocrystic minerals from the mafic magma. This indicates that the felsic magma could be produced by partial melting of crustal materials, and that mafic magma played as a heat source for the melting. Dacite and rhyolite magmas after FW show possible temporal change in petrological features from KpVIII to KpII/III. K_2O contents at a given SiO_2 systematically decreased with time, whereas magmatic temperature systematically increased. These changes could be explained not by fractional crystallization of the initial felsic magma (KpVIII) but by successive partial melting of similar crustal materials. In this case, KpVIII magma was the product with the lowest degree of melting, which shows the lowest magmatic temperature and the highest K_2O contents. On the other hand, KpIV and KpII/III magmas show the highest temperature and the lowest K_2O content due to the highest degree of melting. This temporal increasing of the degree of partial melting could be supported by temporal variations in ratios of incompatible elements (Rb/Zr). The final caldera-forming eruption (KpI) occurred in 35 ka, and has been followed by the post-caldera activity (Atosanupuri volcano). Compared with KpIV and KpII/III, K_2O content and magmatic temperature of KpI pumice abruptly increased and decreased respectively. In the post-caldera activity, those values have gradually decreased and increased with time. These temporal changes are similar with those from KpVIII to KpII/III. Therefore KpI and the post-caldera activity might have been derived from the same magma system, suggesting that magma system has changed after KpII/III eruption. In summary, silicic magma system of Kutcharo volcano has changed three times; FW, KpVIII - KpII/III, and KpI - Atosanupuri. In climactic caldera-forming stage, it seems that silicic magma had erupted without a long period of stagnation after the partial melting of crustal materials. Thus magma had showed temporal change of degree of partial melting in crust.