Eruption sequence and magma plumbing system during Kutcharo caldera-forming eruption (KpIV), eastern Hokkaido, Japan

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Kutcharo caldera, located in eastern Hokkaido, has been formed by nine explosive eruptions during 340-30 Ka. Kutcharo Pumice Flow Deposit IV (KpIV) is the largest one, erupted at 110 Ka. Katsui & Sato (1963) found that Kutcharo Scoria flow Deposit (Ksfl), which is characterized by blackish-colored and non- to strongly welded facies, covered KpIV in the north to east of the caldera. Okumura (1991) indicated that KpIV and Ksfl were derived from the same eruption because scoriae in Ksfl were the same composition as pumices in KpIV and there were no bed boundary between them. To reexamine the complex eruption sequence of KpIV, we carried out the geological investigation around Kutcharo caldera. Moreover, we examined the magma plumbing system based on the petrological features of the juvenile materials.

KpIV activity is divided into two stages: Stage-I, plinian eruption followed by large-volume pumice flow to all around; Stage-II, a small-scaled scoria flow to northeast. Between two stages, there exists a remarkable flow-unit boundary cutting the gas segregation pipe structures of Stage-I.

Stage-I: The deposits cover Pink-ash (Okumura, 1991), which is a keybed in this area. Plinian fall deposits are distributed in the NE-E of the caldera. Remarkable flow-unit boundary is not recognized within the pumice flow deposits. The deposits often show the lower white and upper darkish facies. Especially in the NE-E of the caldera, the pyroclastic flow deposits are thick and strongly welded due to damming by old lavas of Mt. Shari. The juvenile materials are composed of white pumice (ca. 95 wt.%) and a minor amount of well-vesiculated scoria and banded pumice. Scoria is divided into two types based on their compositions: one is a relatively mafic scoria (Scoria-I); the other is a blackish pumice with the same composition as the co-existing white one (black pumice). Scoria-I and banded pumice are found in the N-E of the caldera. The amount of Scoria-I increases ca. 0.5 to 5 wt.% in ascending order. Black pumice found on all around the caldera shows the same petrological features as white pumice, except for the brown-colored matrix glass.

Stage-II: Distribution of the deposit is limited to the NE of the caldera. The juvenile materials consist of white pumice and a large amount of low-vesiculated scoria (Scoria-II, ca. 70 wt.%). Scoria-II often includes some silicic inclusions.

The phenocryst contents of pumice and scoria are ca. 10 vol.% and -5 vol.%, respectively, whereas mineral assemblages of phenocrysts are common in all the juvenile materials. On whole-rock chemistry, SiO_2 contents of white and black pumices show homogeneity (ca. 73-75 wt.%). However, Scoria-I and -II range ca. 63-70 wt.% and 58-65 wt.%, respectively. Banded pumices show intermediate compositions between white pumice and Scoria-I. On several Harker diagrams, the juvenile materials draw one linear trend. However, on SiO_2-MnO and -P_2O_5 diagrams, they draw two linear trends, to converge and diverge in the felsic and mafic sides, respectively. Scoria-I and banded pumice draw higher trends, whereas Scoria-II does lower ones.

The existence of banded pumice and silicic inclusions indicates that magma mixing had occurred during KpIV activity. Two linear trends converging in the felsic side suggest the existence of one silicic and two mafic magmas. There is no sample showing the homogeneous mixing between silicic and mafic magmas. Also, two mafic magmas have no mixing trends on Harker diagrams of whole-rock chemistry. These features indicate that three magmas had been isolated and they mixed just before the eruption. In conclusion, KpIV products erupted not from the normally zoned magma chamber, where mafic magma lay beneath large silicic one, but from the large magma chamber that was successively injected by two mafic magmas just before the eruption. These mafic magmas would inject into northeastern part of the chamber, resulting in the limited distribution of scoria.