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Petrology of pre-caldera eruption of Shikotsu volcano (Shadai pyroclastic flow), South-western Hokkaido

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Shikotsu volcano started large-scale eruption at 60ka, and erupted scoria fall and scoria flow (Shadai pyroclastic flow=Shadai pfl) deposits. The volcano repeated explosive eruptions every several thousands years, and after 10ky dormancy, caldera-forming eruption took place at 40ka. Eruptive volume of pre-caldera eruption is less than 50km^3 and that of caldera-forming eruption is ca. 400km^3 (Yamagata, 1994). We collect samples of Shadai pfl from continuous boring core, 5km-south of lake Shikotsu (JMA-V05), and clarify petrological characters to compare with those of caldera-forming eruption.

The boring core consists of soil (0-1.8m), reworked deposits (1.80-2.60m depth), Shadai pfl (2.60m-3.40m), reworked deposits (3.40m-4.25m), Shadai pfl (4.25m-18.15m), reworked deposits (18.15m-19.90m) and Shadai pfl (19.90m-101.00m), and the lowest part of pfl cannot be seen (Takarada and Furukawa, 2010). Shallow part of Shadai pfl ($<$18.15m) is non-welded. Juvenile materials consist mainly of banded pumice and small amount of white pumice. Weakly to strongly welded parts exist in the deeper part (53.40m-72.00m and $>$80.90m are strongly welded). Most of the juveniles of these parts are scoria and banded pumice.

Juvenile materials of Shadai pfl are SiO_2=53-62wt% andesite and dacite. They contain 20-40vol% phenocrysts of plagioclase, orthopyroxene, clinopyroxene and oxides (sometimes accompanying olivine). Banded pumice is heterogeneous in microscopic order. They usually make linear trends on Harker diagrams. SiO_2 contents of white pumice are $SiO_2>$60wt%, and most of scoria are $SiO_2<$56wt%. Furthermore, SiO_2 contents changes with depth. Rocks of $<$18.15m consist only of SiO_2=60-62wt% dacites, but SiO_2-poor materials appear from 19.90m. Andesites of $SiO_2<$53wt% are often found in 53.40m-72.00m and compositional range becomes the maximum. Then, SiO_2 contents concentrate to 55-62wt% in $>$72.00m. REE contents increase with SiO_2, however chondrite-normalized REE patterns are scattered in LREE. Ratios of MREE/LREE and HREE/LREE, together with Y/Rb, Zr/Rb and Ba/Rb, decrease as increasing SiO_2. Isotopic ratios of Sr and Nd are nearly constant for wide SiO_2 range.

Existence of banded pumice, heterogeneous texture under microscope and linear compositional trends suggest that Shadai pfl is produced mainly by magma mixing of mafic and felsic magmas. Difference of compositional range of each depth reflects that mixing ratios has changed with time. According to the constant isotopic ratios and decreasing of MREE-HREE/LREE, Y/Rb, Zr/Rb, Ba/Rb with increasing SiO_2, end-member magmas cannot be produced by simple crystal differentiation but by different degree of partial melting from the same crustal material.

Caldera-forming eruption of 40ka started with phreato-magmatic eruption and then occurred plinian eruption to flowed down the pyroclastic flow. The juveniles are classified into 2 types; dacitic to rhyolitic A-type ($<$5vol% phenocrysts, SiO_2=74-78wt%) and andesitic to dacitic P-type (7-45wt% phenocrysts, SiO_2=57-72wt%). A-type rocks can be seen throughout the caldera-forming eruption, but P-type exists only in the upper unit of pyroclastic flow (Nakagawa et al., 2013). Phenocryst assemblage is plagioclase, orthopyroxene, clinopyroxene, hornblende and oxides. There are evidences of magma mixing for both A and P types, however end-member magmas are different from each other. Nakagawa et al. (2010) shows that felsic magma of Shadai pfl is similar to P-type dacite of caldera-forming eruption, and suggests that the felsic magma mixes with mafic magma of low Sr isotope. As we reanalyze REE compositions and isotopic ratios of caldera-forming eruption, Sr isotopic ratio of Shadai pfl is slightly lower and Nd ratio is higher than caldera-forming eruption and Nd isotope of these eruptions make parallel trends. These suggest that origin of these eruptions is different and new magma should be produced after pre-caldera eruption.

Keywords: Shadai pyroclastic flow, pre-caldera eruption, caldera-forming eruption, magma mixing, origin of magmas