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Magma mixing processes and origin of mafic inclusions for the Mikurasawa lava in the Taisetsu volcano, Hokkaido, Japan

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The Mikurasawa lava, in the Taisetsu volcano is a lava flow erupted from the outside in southeastern the Ohachidaira caldera. Most of the lava consist of andesite (SiO_2=60.6-57.3 wt. %). Some parts of the lava consist of dacite (SiO_2=63.6-62.4 wt. %) and banded lava constructed with andesite and dacite. In addition, the andesite has some mafic inclusions (SiO_2=58.0-51.3 wt. %). The Mikurasawa lava is a rare because of coexisting banded lava and mafic inclusion. This study elucidates magma mixing processes and origin of mafic inclusions of the Mikurasawa lava by petrological method.

I considered that the andesite of the Mikurasawa lava formed by magma mixing on account of existing of banded lava and mafic inclusions, coexisting of plagioclase which have different composition and showing reverse zoning in plagioclase phenocryst. Many plagioclase in the andesite show resorbed texture in core and reverse zoning in rim. It indicates that the andesite experience several times of injection of mafic magma. I estimate that a period from initial inject to eruption was about 60-600 years by element diffusion rate. The phenocrysts in the andesite are classified into two crystal groups (type-A and -B) by the core composition. The phenocrysts of each crystal groups derived from same magmas because they form crystal clots each other. Type-A crystal group consists of high-An plagioclase, high-Mg♯ orthopyroxene, high-Al_2O_3 clinopyroxene and olivine. These crystals were derived from mafic magma. Type-B crystal group consists of low-An and low-MgO plagioclase, low-Mg♯ orthopyroxene and low-Al_2O_3 clinopyroxene. These crystals were derived from felsic magma. I estimated the temperature of the mafic and felsic magmas by two-pyroxene thermometer. The results are about 1000 ℃ and 900 ℃.

The mafic inclusions in the Mikurasawa lava show various texture and composition. I classified them into three types (Type-1, -2 and -3) by size of plagioclase. Type-1 mafic inclusion has fine-grained acicular plagioclase in groundmass. Type-2 mafic inclusion has coarse-grained tabular plagioclase in groundmass. Type-3 mafic inclusion consists of bigger plagioclase than the other mafic inclusions most of which are phenocrysts.

I considered the origin of each types of mafic inclusions from texture and composition. The type-1 mafic inclusion is characterized by fine-grained crystals and these compositions which are similar to those of microphenocrysts of the andesite. Therefore, it seems that this mafic inclusion formed by quenching of hybrid layer magma between mafic and felsic magma in the reservoir. The type-2 mafic inclusion is characterized by coarse-grained groundmass crystals and these compositions which are similar to those of crystals of dacite. Therefore, it seems that this mafic inclusion formed by disruption and inclusion of crystal mush layer of felsic magma during eruption. The type-3 mafic inclusion is formed by inclusion of mafic magma because of being composed of type-1 crystal group.

I considered magma mixing processes in magma reservoir of the Mikurasawa lava based on above date. First, felsic magma reservoir having crystal mush layer was injected by mafic magma. This injection occurred partial melt of plagioclase in felsic magma, forming resorbed texture. Furthermore, at a boundary between felsic and mafic magma, hybrid layer was formed by magma mixing. After 60-600 years, reinjection of mafic magma occurred eruption. During eruption, andesitic magma formed by mixing of mafic and felsic magmas. Felsic magma which was not affected by mafic magma formed dacite and banded lava. Hybrid layer and mafic magma included in andesitic magma, forming Type-1 and Type-3 mafic inclusions respectively. Crystal mush layer was disrupted during magma ascent. The fragment was included in andesitic magma, forming Type-2 mafic inclusion.

Keywords: magma mixing, mafic inclusion, Taisetsu volcano, Mikurasawa lava, plagioclase phenocrysts