[EE] Evening Poster | S (Solid Earth Sciences) | S-VC Volcanology

[S-VC39]Pre-eruptive magmatic processes: petrologic analyses, experimental simulations and dynamics modeling

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Processes leading to volcanic eruptions are central and yet still enigmatic issues in volcanology. Recent advances in understanding thermo-mechanical and open-system behavior of magma reservoirs and mineral zoning stratigraphy allow us to take a step forward to reveal the complex incubation processes during volcanic dormancy and following magma chamber tapping. This session aims at putting together recent knowledge on magmatic processes including 1) magma chamber evolution through magma reintrusion, crystallization-induced volatile exolution, magma mixing and gas fluxing, 2) externally-driven eruption trigger mechanisms, and 3) conduit processes and controls on eruption styles such as outgassing, dehydration-induced crystallization, fragmentation and rheological transition of ascending magmas. We welcome contributions based on petrological, mineralogical and geochemical analyses of pyroclasts and volcanic gasses, experimental simulations of magma reservoir conditions and conduit flow dynamics, and numerical modeling to integrate the elementary processes.

[SVC39-P07]Pre-eruptive processes of Goshikidake pyroclastic rocks unit 4-5 deposits, Zao volcano, Japan: Zoning profiles of orthopyroxene phenocrysts

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Introduction

Zao volcano is an active volcano in central part of volcanic part of NE Japan arc. Precursor phenomena have been observed since 2013, thus it is very important to understand pre-eruptive magmatic processes for past eruptions in predicting future eruptions. The newest eruption products, the Goshikidake pyroclastic rocks (ca. 2 ka), were formed by magma mixing between high temperature (high-T) and low temperature (low-T) magmas. To understand pre-eruptive processes, it is necessary to examine magma mixing process in more detail. We examined unit 4-5 product of the Goshikidake pyroclastic rocks, based on detailed analysis on zoning profiles of orthopyroxene phenocrysts.

Results

The Goshikidake pyroclastic rocks are divided into 5 units, and unit 4 is sub-divided into 4-1 to 4-5. The unit 4-5 is composed of piles of pyroclastic surge deposits with periodically existing bomb concentrated layers. We sampled these bombs for this study. Rocks are basaltic andesite to andesite, having plagioclase, orthopyroxene, clinopyroxene, magnetite, ±olivine as phenocryst. Total amount of phenocrysts is ca. 35 to 40 vol.%. Rocks belong to medium-K calc-alkaline series, showing narrow compositional range (SiO_2 = around 57.5 wt.%). Based on textural and chemical compositional features, following six zones are recognized in the orthopyroxene phenocryst. Zone-P: Mg-poor (Mg# = 62-66) core which is usually homogeneous but has weak (Mg# = ±2) oscillatory and/or normal zoning. Zone-P’: Very Mg-poor (Mg# = 54-55) core. Zone-H: Mg-rich (Mg# = 71-76) compositionally heterogeneous core or zone with many melt inclusions. Zone-R: Gradually reverse zoned zone (Mg# = 64-66 to 66-69), ca. 10-100 μm in width. Zone-M: Mg-rich (Mg# = 71-76) zone near the rim, ca. ~3μm in width. Thin reverse zoning can be observed in inner parts of zones H and M, while very thin normal zoning can be observed in outer parts of zones R and M. Zone-O: Mg-poor (Mg# = 64-68) zone in outermost rim, usually very thin. The most common phenocryst zoning type is P-M (-O), which is followed by P-R (-O) and P-R-M (-O). Zoning types of P (-O), P-H-M (-O), H-O and H-M-O are subordinary observed. P’-R-M-O type is rarely observed.

Formation of each zone of the orthopyroxene phenocrysts

Based on the chemical compositions, it is deduced that zone-P grew in low-T magma, while zone-P’ in very low temperature magma. Zone-O might grow just before or during the eruption. Thus, the orthopyroxene with Mg# of 66-69 would crystallize from well mixed magma. The Mg-rich part of the zone-R shows Mg# of 68, therefore this zone would originally crystallize from well mixed magma. The reverse zoning would result from elemental diffusion during residence of the orthopyroxene in the mixed magma from the crystallization of initial zone-R to the eruption. Judged by Mg# of 71-76, the zone-H and -M would originally grow from mixed magmas (Mg-rich mixed magma) which is slightly Mg-richer than the well mixed magma. The Mg-rich mixed magma would form in initiation of the mixing of the injected high-T magma with low-T magma. The reverse zoning of inner parts of zones H and M would result from elemental diffusion in the well mixed magma.

Timescale from magma-mixing to the eruption

Comparing the calculated diffusion profiles to the observed ones of zone-R and inner part of zone-M, we estimated residence times of orthopyroxene phenocrysts from the mixing to the eruption. The diffusion coefficients of Mg/Fe in orthopyroxene were calculated assuming the temperature of the well mixed magma was 1025 ℃ and oxygen fugacity was NNO buffer. The estimated residence times of zone-M are 1.5 days to several weeks, and those of zone-R are 5 to 20 years. These results show that pre-eruptive mixings started long time before eruption and the mixing triggered the eruption occurred just before the eruption.