[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-P13]Pre-eruptive process of the 1991-1995 eruption at Unzen volcano,Japan : constraints from amphibole phenocrysts

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1. Introduction

Unzen volcano is one of the typical arc volcanoes located in NW Kyushu, Japan. The latest eruption of the volcano occurred at 1991-95. This eruption is characterized by continuous growth of dacitic lava domes and pyroclastic flows caused by collapse of the lava domes. During the eruption, two vulcanian eruptions were recognized. Previous studies proposed that magma mixing between nearly aphyric, mafic and crystal-rich, silicic end-members occurred in the magma chamber at the depth of ~10km (e.g., Sato et al., 1999).

The 1991-95 dacites contain amphibole phenocrysts. Recent studies demonstrated that igneous amphiboles are powerful tools to constrain pre-eruptive magmatic conditions (e.g., Ridolfi and Renzulli, 2012; Putirka, 2016). For example, empirical equations relating temperature and SiO_2 content of co-existing melt with amphibole composition were proposed by Putirka (2016). By using these equations, we can constrain physicochemical conditions of melts in which individual phenocryst crystallized. Therefore, analyses of amphiboles may offer useful information for understanding pre-eruptive magmatic processes of the Unzen 1991-1995 eruption.

In this study, we aimed to reevaluate pre-eruptive processes of 1991-1995 eruption in terms of amphibole mineralogy. First, we analyzed amphibole phenocrysts in the 1991-95 dacites. In addition, we analyzed amphiboles, plagioclases, and interstitial glasses in crystal clots. Then, we estimate temperatures and SiO_2

contents of melts in equilibrium with amphiboles.

2. Methods

We used 6 dacitic samples erupted at different times during the 1991-95 eruption. All of these samples contain amphibole phenocrysts, and two of these samples contain crystal clots composed of amphiboles, plagioclases, Fe-Ti oxides and interstitial glass. The major element compositions of amphibole phenocrysts and constituent minerals and glasses in crystal clots were measured by using EPMA at ERI, University of Tokyo. In addition, temperature and SiO_2 content conditions of melts coexisted with amphiboles were estimated from amphibole compositions by using the empirical equations of Putirka (2016).

3. Results

Amphibole phenocrysts are classified into magnesiohornblende and tchermakite based on their compositions. There is an apparent compositional gap between these two clusters. All amphiboles in crystal clots are magnesiohornblende. Crystallization temperatures are estimated to be ~750-800ºC and ~870-950ºC for magnesiohornblendes and tchermakites, respectively. Amphiboles in crystal clots reveal temperatures of ~750-800ºC. Estimated SiO_2 contents of melts coexisted with amphiboles (SiO_2^{melt}) are ~66-73wt.% and ~60-65wt.% for magnesiohornblendes and tchermakites, respectively. For amphiboles in crystal clots, SiO_2^{melt} is estimated to be ~71-72wt.%. On the other hand, SiO_2 contents of interstitial melts are ~68-72wt.%, which is consistent with SiO_2^{melt} estimated from amphiboles in crystal clots.

4. Discussion

Previous studies proposed that the 1991-95 magma was formed by magma mixing between crystal-rich, silicic and nearly aphyric, mafic endmembers (T~1050 ºC, SiO_2~50wt.%, Holtz et al., 2005, Browne et al., 2006). Temperatures estimated from magnesiohornblende phenocrysts and also amphiboles in crystal clots are consistent with the proposed temperature of the silicic endmember magma (Holtz et al., 2005). In addition, SiO_2^{melt} estimated from these amphiboles are consistent with compositions of interstitial melts in crystal clots. Moreover, H_2O saturation depth estimated for the interstitial melt compositions are consistent with that of C-magma chamber in which the silicic endmember magma was thought to be stored. These results suggest that interstitial melts in crystal clots represent the silicic endmember melt.

Temperatures estimated from tchermakite phenocrysts are apparently lower than that of the mafic endmember magma proposed in previous studies. In addition, temperature gap is found between tchermakites and magnesiohornblendes. These results suggest that an unrecognized magma with T~920ºC and SiO_2^{melt} ~63wt.% contributed as the 3^{rd} endmember to form the 1991-95 magma. We estimated the mixing ratio of the three end-members based on the estimated T-SiO_2^{melt} conditions, to be ~11wt.%, ~54wt.% and ~35wt.% for the mafic, the 3^{rd} and the silicic endmembers, respectively. Our results suggest that the 1991-95 magma was formed by three-component mixing, in which contribution of the newly-recognized 3^{rd} endmember magma in largest and that of the mafic endmember magma, which has been thought to be a major component, is relatively minor.