Permeability of dictytaxitic part of the Ogurayama lava dome, Towada volcano

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Lava dome formation is one of the most frequent eruptive modes of subduction zone volcanism. Although it is classified as a non-explosive eruption, lava domes often cause an explosion during its formation along with pyroclastic flows (Newhall et al., 1987). Therefore, understanding the explosivity of lava domes is a crucial issue. The driving force of the lava dome explosion can be 1)vesiculation of the conduit magma and 2) the excess bubble pressure accumulated in the lava dome itself. On the other hand, degassing or expansion of dome lava suppress the explosion through pressure relaxation. Therefore, the permeability structure of the lava dome is essential for understanding explosiveness. This study conducted petrography and a permeability measurement on Ogurayama dome lava, Towada volcano, which erupted in the post-caldera period (7.6 cal kyr BP; Kudo, 2010). Inside of the bottom of the lava dome is exposed. This lava dome is known to partially exhibit a porous matrix structure called the dictytaxitic structure (Miyagi and Kudo 2013). The dictytaxitic structure is always accompanied by silica minerals precipitated from volcanic gas, and whether the silica mineral increases or decreases the permeability has been debated. We corrected samples from an outcrop with a height of ~50 m in the south-southeast part of the cliff at the dome edge. Outcrops and samples show a light gray to dark gray, reddish-brown heterogeneity in appearance. We cut a slab ~1 cm thick out from a sample cross-section of ~15 ×10 cm and trimmed nine adjacent areas of about 9 mm cubes. EPMA analysis revealed many silica minerals and the interstitial pores of plagioclase laths 10-100 μm in length. On the surface of the silica mineral, concentric spiral growth with uniform step spacing was observed, indicating that the silica mineral grew from a low-density gas phase. The sample was highly inhomogeneous, and the part where the permeability was below the detection limit and the part where the permeability was very high (4.6×10^{-8} to 2.1×10^{-6} m^2; porosity 15 to 33%) were adjacent to each other. The permeability against porosity was higher than the value of Tuffisite (Kendrick et al., 2016), which is regarded as a degassing pathway on the dome surface. It was ~2 to 4 orders of magnitude higher than the value of Kushnir (2016), indicating that the structure may be an important factor controlling the explosiveness of the lava dome. It has been experimentally confirmed that such a structure is formed in the evaporation-precipitation process of magma in the final stage of crystallization under the temperature and pressure conditions inside the lava dome (Sakurai et al. 2019JpGU). The highly porous dictytaxitic structure necessarily accompanies the impermeable groundmass with silica minerals. Therefore, silica precipitation will not reduce the permeability of the lava dome. Since volcanic ashes from active volcanoes such as Sakurajima often contain cristobalite, the evaporation-condensation process also contributes to the magma degassing of active volcanoes.

Keywords: lava dome, degassing, permeability, dictytaxitic, cristobalite, evaporation-condensation

