Estimation of the re-equilibrium depths of the Sakurajima vulcanian eruption magma from 2010 to 2015

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Recent studies on melt inclusions (MIs) revealed that phenocrysts are not a perfect containers of volatile components; especially water diffuses out through crystal upon decompression quickly (Mann et al.,2013). Water contents in MIs therefore record final storage pressure at which magmas were stagnant in a duration longer than that required for MIs to be reequilibrated with surrounding melts in terms of water fugacity. In the Sakurjima volcano, vulcanian explosions have occurred repeatedly since 1955. Determination of magma storage depths just prior to the explosions is useful to understand the eruption mechanisms. In this study we analyzed water contents and major element compositions of MIs in juvenile pumices from vulcanian eruptions from 2010 to 2015. The water contents of MIs were analyzed with FT-IR micro-reflectance spectroscopy (Yasuda, 2014). Most of the MIs have dacitic to rhyolitic compositions. Water contents of the MIs were mostly less than ca. 1 wt.%. Assuming water solubility of rhyolitic melt (Newman and Lowenstern, 2002) and density of the overlaying magma in the conduit to be 2400 kg/m^3, this water content corresponds to below a few hundred meters.
Based on the geohygrometry of Putirka (2008), the equilibration between MIs and their host plagioclase was finally established at water contents of 1.3–2.8 wt %; this range is higher than the directly analyzed water contents of MIs, and the corresponding saturation depths were calculated to be 0.5–1.7 km. The difference from the final water reequilibration depth (< a few hundred meters) shows that the growth of plagioclase did not catch up with the magma ascent and resultant decompression and degassing prior to the explosions.
The depths of pressure sources of explosion earthquakes were estimated at 1–3 km from the crater (Iguchi, 2013), which is in between the water-reequilibration and plagioclase-reequilibration depths. Because the magma residence time at this depth is shorter than that required for the plagioclase reequilibration, degree of magma outgassing might be limited. This suggests a possibility that degassing of stagnated magma may causes pressurization to drive vulcanian explosions.

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