

The textural analysis of pumice from the Plinian eruption of Taupo volcano: implications for tube pumice

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Tube pumice is characterized by aligned highly elongated bubbles and is a common product of explosive silicic eruptions. This bubble texture is thought to reflect shear deformations during flow in a conduit (Marti et al., 1999). Therefore, quantitative measurements of tube pumice texture can inform conduit flow models. Recent development in X-ray tomography allows us to measure bubble shapes in 3D pumice accurately (e.g., Dingwell et al., 2016). In addition to the microscopic structures of individual pumices, the abundance of tube and non-tube pumices in the stratigraphy is important in inferring temporal and spatial variations in a conduit flow. This study aims at quantifying micro-structural and stratigraphic features of pumice from the 1.8 ka eruption of Taupo volcano, New Zealand.

The 1.8 ka eruption is the most recent large eruptive event from Taupo volcano. It is characterized by various eruptive styles, including three phreatomagmatic fall deposits (units 1, 3, 4), Hatepe plinian fall deposit (unit 2), Taupo plinian fall deposit (unit 5), and Taupo ignimbrite (unit 6) (Houghton et al., 2010). Since those deposits show chemically uniform pumices and melt inclusions, the great diversity of bubble textures in pumices may reflect purely physical processes in the eruption. We collected samples from the units of the two plinian eruptions (units 2 and 5) and the ignimbrite (unit 6), and measured bubble textures and vesicularities. Among those units, we focused on unit 5 to investigate the transition from plinian fall to ignimbrite. For this purpose, a detailed sampling of unit 5 was conducted at an outcrop about 25 km away from the vent, where the unit consists of a fine lower part (40 cm) and a coarse upper part (180 cm). We sampled clasts from the bottom to top of the unit 5 layer at 20cm interval. The bubble textures of more than 1000 pumice samples were measured by a digital microscope (VHX-1000, Keyence) with variable illumination function. The illumination was optimized to make good luminance contrast between the flat surface and bubbles for image analysis.

The image analysis shows that bubbles in unit 5 are more elongated than those in unit 2 and less elongated than those in unit 6. The average values of bubble elongation in unit 2 and 6 are proportional to those of vesicularity. In contrast, bubble elongation and vesicularity are uniform within unit 5. The component analysis over unit 5 shows that the weight percentage of lithics is also uniform except in the lowest part. The relatively high lithic content in the lowest part suggests vent widened or shifted location at the beginning of the Taupo plinian event.

Previous studies in other volcanoes suggest that bubbles in the pre-ignimbrite phase become more elongated toward the flow stage (Taddeucci and Wohletz 2001, Polacci et al., 2003). The increased amount of tube pumice is thought to reflect a gradual transition from fallout to ignimbrite, and it was interpreted as a result of increased erosive activity near the conduit wall, or a greater conduit area available for shearing (Polacci et al., 2003). In contrast, no such variation of bubble texture is observed in Taupo plinian event (unit 5), which implies that a steady conduit flow was sustained during the pre-ignimbrite fallout eruption. The ignimbrite (unit 6) might not simply be the result of a collapsing plinian eruption column. It is also possible that the topmost part of unit 5 had been eroded by and/or mixed with the pyroclastic flow that deposited the subsequent ignimbrite (unit 6).

Keywords: bubble texture, tube pumice, Taupo