EBSD Analysis of Crystal Clusters in Earthquake Flat Pumice
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Super volcanoes – those erupting volumes greater than 1000 km³ – are highly destructive. Super volcanic eruptions depend on the processes occurring within magma chambers. In one model, eruptible magma is extracted from crystal mush that is set on the chamber floor (Bachman and Bergantz, 2008). When an eruption takes place, the volcanic deposits provide a snapshot of the state of the magma chamber directly preceding the eruption, allowing us to test the model.

This summer, I began testing the model with deposits from Earthquake Flat, Taupo Volcanic Zone, New Zealand that formed during a 58.5 ka eruption (Wilson et al., 2007). The deposits contain quartz and plagioclase crystals (approximately 10%) within a porous matrix. In the pumice, many crystals form clusters of 2-8 grains, with approximately 15 plagioclase clusters and 5 quartz clusters per thin section (27mm x 46mm slice of rock). The presence of clusters suggests crystals may have settled and undergone compaction on the floor of the magma chamber. My data collection focused on identifying these clusters and acquiring the angles between adjacent grains to test the model of settling and compaction. This approach follows the study of Beane and Wiebe (2012) who interpreted systematic orientation of quartz crystals in clusters as evidence of compaction and rejuvenation within the Vinalhaven Granite, Maine.

I acquired orientations of plagioclase and quartz, with a focus on the more abundant plagioclase, using the Electron Backscatter Diffraction (EBSD) software on Bowdoin College’s Scanning Electron Microscope (SEM). Once a crystal cluster is identified and located on the thin section, a beam of electrons is fired at it. Electrons will diffract according to the orientation of the crystal lattice. For each orientation, the refracted electrons form unique Kikuchi bands that are used to index orientations. Acquiring usable EBSD data on plagioclase posed a problem because the Kikuchi bands produced from it are less crisp and therefore more difficult to index. My focus on plagioclase necessitated developing new methods in order to maximize the data I acquired, and I ran experiments to improve this indexing. This involved instrument calibration, changing the match unit compositions, and adjusting parameters such as the background, number of Kikuchi bands detected and number of points analyzed on a cluster in order to optimize the analyses.

Of the 70 pairs of plagioclase crystals I measured, most had alignment along at least one of the major crystal faces, supporting that compaction has taken place. In addition, I found an orientation between two crystals that was very common, where the main crystal axis was either at around 53° or 127°. To carry on my research, I would like to gather data from more Earthquake Flat samples in order to acquire a more statistically significant data set and further investigate the patterns I have found. Other tests can be run on these samples such as looking at the growth zoning of the crystals to aid in our interpretation of the magmatic history.
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References


Bachmann, O., and Bergantz, G., 2008, The Magma Reservoirs that Feed Supereruptions, Elements, v. 4, no. 1, p. 17-21