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Combining Experimental Petrology and 3D Imaging to Gain Insight into Syn-eruptive Conditions of the Bishop Tuff, California

Archer Chattin (1), Ayla Pamukcu (2), James Gardner (3), and Guilherme Gualda (4)

(1) Vanderbilt University, Nashville, Tenessee, United States (archer.e.chattin@vanderbilt.edu), (2) Brown University, Providence, Rhode Island, United States (ayla.s.pamukcu@vanderbilt.edu), (3) University of Texas, Austin, Texas, United States (gardner@jsg.utexas.edu), (4) Vanderbilt University, Nashville, Tenessee, United States (g.gualda@vanderbilt.edu)

The Bishop tuff is a rhyolitic ignimbrite deposited by a supereruption 0.76 million years ago that formed the Long Valley Caldera in California, USA. Pamukcu et. al (2012) identifies two distinct crystal populations present in the Bishop Tuff, the first being a long-lived, large phenocryst population that records storage conditions, and the second a rapidly nucleated, quickly staunched microlite population thought to result from eruptive decompression. Laboratory experiments to reproduce this quickly grown population may help constrain the conditions and rates under which decompression took place. Rapid nucleation of microlites is accompanied by just as rapid bubble nucleation when volatiles exsolve during decompression; the size distribution of vesicles in eruptive products may thus provide important information on syn-eruptive processes. In this study we combine information from vesicle size distributions on natural pumice with data on experimentally produced microlite crystals with the goal of better understanding the syn-eruptive evolution of a supereruption-forming magma body.

Decompression experiments are run using a natural Bishop tuff pumice clast ground and melted in the presence of water to obtain a melt representative of late-erupted Bishop Tuff (LBT) magmas. Experimental charges were subjected to decompression at varying rates and initial temperatures. At this time five experiments have been completed. All decompression experiments start at 130MPa, consistent with water concentration in LBT glass inclusions, and end at 10 MPa. Initial temperatures are either 710°C or 785°C, while decompression rates are 20 MPa/hr, 5.5MPa/hr, or 1.7MPa/hr Experimental products were compared to natural products using Scanning Electron Microscopy to document eventual crystal rims and microlites. We have been successful in causing limited feldspar crystallization, but have yet to generate quartz microlites.

Bubble size distributions are obtained by analyzing x-ray tomograms of pumice pieces. We image four progressively larger pieces of the same pumice clast. We use the volume calculated from the tomogram and the mass of the pumice piece to calculate the bulk porosity of each piece. A cumulative-like vesicle size distribution can then be generated by combining the bulk porosity of the four pieces with the sizes of tomograms analyzed. Clasts analyzed thus far exhibit a counterintuitive vesicle size distribution that is inconsistent with the expected cumulative character. We are currently investigating the source of this discrepancy.

Ongoing work on this project will focus on understanding and explaining vesicle size distributions as well as continuing to fine-tune decompression experiments to produce comparable microlite populations.

References

Pamukcu, AS, Gualda, GAR, Anderson, AT Jr., Crystallization stages of the Bishop Tuff magma body recorded in crystal texture in pumice clasts, Journal of Petrology, 53, 3, p. 589-609, 2012.