FORMATION OF DENSE PYROCLASTS BY SINTERING OF ASH PARTICLES DURING THE 1991 MT. PINATUBO PRECLIMACTIC ERUPTIONS

Yining Wang

ABSTRACT

Volcanic eruptive behavior varies from explosive tephra or effusive lava, and is controlled largely by subsurface degassing style. Dense cognate lithic pyroclasts are poorly vesicular products of some eruptions. Their textures and dissolved volatile signatures preserve important information about their formation processes and are thus used to infer pre-eruptive and syn-eruptive conduit dynamics. Dense cognate lithics from the 1991 Mt. Pinatubo pre-climactic surge events were analyzed in terms of their vesicular and crystal textures, and dissolved H_2O and CO_2 concentrations. The ubiquitous occurrence of sub-millimeter-sized crystal fragments in matrix glass is an intriguing feature not observed in the pumice counterpart of the Mt. Pinatubo deposits. Existing models of permeable foam behavior cannot explain the fragmentation and reincorporation processes necessary for the formation of these fragments. On the other hand, sub-millimeter scale heterogeneity in dissolved volatile content (0.9 wt.% difference in H_2O within 500 μm) in matrix glass is observed. Those heterogeneities argue that different parts of these dense pyroclasts must have formed at various depths and then need to be physically sutured together. Greater vesicularities and increased vesicle sizes and number densities are observed around large crystals and a similar texture was produced by sintering experiments using bimodelly-sized ash particles within a timeframe similar to that of the 1991 Mt. Pinatubo eruptions. Furthermore, an increasingly larger proportion of elongated and stretched vesicles towards the later surge events is also observed, which parallels the increasingly shorter hiatus time between Mt. Pinatubo surges. Paired with the lack of equilibration in volatile contents, the textures lead us to propose an ash particle sintering model in deciphering the formation mechanism of these dense lithics in rather short period of time, supposedly syn-eruptively, where ash particles sourced from various depths collide, shear, break up, and sinter on or near the conduit walls beyond the fragmentation level in a repetitive manner. We conclude that sintering is the main mechanism forming the dense lithic materials from the 1991 Mt. Pinatubo pre-climactic surge deposits, and is responsible for vesicle, crystal, and volatile signatures preserved and observed in this study, and potentially in other volcanic systems around the world.

Advisor: Dr. James Gardner