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# Origins of Mt. St. Helens Cataclasites: Experimental Insights

L.A. Kennedy and J.K. Russell
University of British Columbia, Earth & Ocean Sciences, Vancouver, Canada (lkennedy@eos.ubc.ca)

Thick (1-3 m) layers of fault rocks that formed during the 2004-2006 dome building events are interpreted to be linked to the "drumbeat" microseismicity associated with dome building (Iverson et al. 2006). We experimentally deformed Mt. St. Helen's dacite with the intent of reproducing the fault textures observed in nature and placing further constraints on their conditions of formation. Experiments were run at confining pressures of 0, 25, 50, and 75MPa, at room temperature and strain rate of $\sim$ 1 x 10-4 $s^{-1}$. The dacite starting material has low porosity (7.3 and 7.7%), a uniform bulk composition (65 wt% SiO2), is highly crystalline, containing 41-45% euhedral to subhedral phenocrsyts and microphenocrysts of plagioclase, hypersthene and amphibole set in a microcrystalline matrix. The experimental run products show a progressive increase in peak strength with increasing confining pressure and all show brittle behavior, characterized by a rapid stress drop. Run products contain macroscopic fractures with deformation extremely localized around the shear fractures. Natural and experimentally deformed dacites show extreme grain size reduction. Total grain size distribution plots (wt%) show that natural gouge sieved to $<$63 $\mu$m contains a sharp peak at 1.9 $\mu$m and has a second, broad peak, at $\sim$4 $\mu$m. The experimentally derived gouge has a peak at 1.5 $\mu$m. Our experiments were performed dry and at room temperature, whereas the temperature measured at fissures in the dacite domes at Mt. St. Helens, was $\sim$ 730˚C (Iverson et al., 2006). Despite the low temperature, the microstructures from our run products are remarkably similar to those developed at Mt. St. Helens. Mode I fragmentation and shear fracture of grains and matrix, with subsequent cataclastic flow and grain size comminution occurred in both natural (Cashman et al. in press) and experimental fault rocks. Following Iverson et al (2006), we propose that the fault rocks generated at Mt. St. Helen's formed incrementally by rapid, small displacement faults, and that temperature did not greatly affect the mode of failure. We compare our experimental data (e.g. displacement, shear zone thickness, strain rate) to that obtained from Mt. St. Helen's to place constraints on the mechanisms of formation of the fault rocks. To evaluate the role of porosity on failure mechanisms, Augustine dacite from the 2006 eruption (Power et al. 2006) was also deformed. The Augustine starting material is porous ($\sim$20 - 24%) with a glassy matrix. In contrast to Mt. St. Helen's dacite, the Augustine dacites deformed by ductile strain. The mechanism of deformation for Augustine dacites is a combination of localized shear fracturing and cataclastic flow. We suggest that porosity is the most important factor in promoting distributed cataclastic flow (Augustine) over wholesale localized faulting (Mt. St. Helen's).

Cashman et al, in press. USGS Prof. Paper.

Iverson et al, 2006, Nature 444, 439-444.

Power et al, 2006, EOS Trans, AGU 87, no. 37.