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Rounding of pumice clasts during transport: field measurements and laboratory studies

Michael Manga (1), Ameeta Patel (1), and Josef Dufek (2)

(1) Earth and Planetary Science, UC Berkeley, California, USA, manga@seismo.berkeley.edu, (2) School of Earth and Planetary Sciences, Georgia Tech, Atlanta, Georgia, USA

The volcanic clasts in many pyroclastic density currents are notably more round than in corresponding air fall deposits. This rounding has long been interpreted as evidence for comminution and abrasion during transport. Such comminution can be a secondary source of fine ash that in turn can influence the runount distance, deposit sorting, and the volume of ash introduced into the upper atmosphere. Information about ash production during transport should be preserved in the roundness of clasts.

We performed experimental measurements to determine an empirical relationship between particle roundness (measured in two-dimensions by comparing the ratio of each particle's area and perimeter squared with the equivalent ratio for a sphere) and mass loss caused by particle-particle interactions. We consider, as examples, pumice from four volcanoes: Medicine Lake, California; Lassen, California; Taupo, New Zealand; Mount St Helens, Washington. We find that average sample roundness reaches a maximum value once particles lose between 15 and 60% of their mass. The most texturally homogeneous clasts (Taupo) become the most round. We compare our experimental measurements with the roundness of clasts in one of the May 18, 1980 pyroclastic density current units at Mount St Helens, deposited 4-8 km from the vent. The roundness measurements of these clasts are close to the experimentally determined maximum values, suggesting that a significant amount of ash may have been produced in-situ during transport. For a much smaller deposit from the 1915 Lassen eruption, clast roundness is closer to the value for air-fall pumice and suggests that only a few volume percent of large clasts were comminuted. In neither field deposit do we see a significant change in roundness with increasing distance from the vent. We suggest that this trend is recorded because much of the rounding and ash production occur in proximal regions where the density currents are the most energetic. As a result, all clasts that are deposited have experienced similar amounts of comminution in the proximal region, and similar amounts of abrasion as they settle through the dense, near-bed region prior to final deposition.