# Relating vesicle shapes in pyroclasts to eruptions styles

Pranabendu Moitra[1], Helge M Gonnermann[1], Bruce F Houghton[2], Thomas Giachetti[1]

[1]Department of Earth Science, Rice University, USA, [2]Department of Geology and Geophysics, University of Hawai'i at Manoa, USA

E-mail: pm10@rice.edu

Pyroclasts provide a direct record of magma ascent and a key feature of pyroclasts is the shape of vesicles· For explosive eruptions vesicle shapes are the integrated result of magma deformation, bubble growth and bubble coalescence· Here we focus on vesicles that bear little evidence for shear deformation and examine vesicle shapes with the objective of relating shape to magma expansion· We use a shape factor $\Omega$, which quantifies the degree of complexity of a vesicle′s bounding surface· Among the samples analyzed, we find a clear distinction between Hawaiian and Strombolian eruptions and Vulcanian, Plinian and ultraplinian eruptions, with the former having a larger value of $\Omega$ than the latter ⟨Moitra et al·, 2013⟩· We interpret this difference in vesicle shapes as a consequence of the relative importance of structural changes during magma decompression and bubble growth, such as coalescence and shape relaxation of bubbles by capillary stresses· This force balance can be expressed by the capillary number, Ca, based on the expansion velocity and obtained from bubble growth modeling· Small values of Ca are estimated for Hawaiian and Strombolian eruptions ⟨Ca«1⟩, indicating that capillary forces dominate bubble shapes· In contrast, Ca»1 for eruptions with smaller values of $\Omega$· Interestingly, we also find that the basaltic Plinian eruptions of Mt· Etna, Italy ⟨122BC⟩ and Mt· Tarawera, New Zealand ⟨1886⟩ are characterized by relatively low values of $\Omega$ and predicted values of Ca»1, similar to Vulcanian, Plinian and ultraplinian eruptions of more silicic magmas· We interpret this to be the result of syneruptive magma crystallization, ensuing high magma viscosity and reduced rates of bubble growth· Our model results indicate that during these basaltic Plinian eruptions bubble growth was viscously limited, so that they remained at sufficiently high pressure for brittle magma fragmentation·

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