

Plagioclase crystal shape variability in volcanic rocks and its petrological significance

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Crystal morphology has long been recognised to reflect magmatic conditions during nucleation and growth. Specifically, crystal shapes are often used to assess magma undercooling, with higher undercoolings thought to result in increasingly elongate shapes [1,2]. Caveats to this interpretation are the effect of crystal number densities on crystal shapes [3,4] as well as the observation that plagioclase microlites change shape from prismatic to tabular as they increase in size [4]. To date, a deeper understanding of the petrological significance of crystal morphologies is hindered by the relative scarcity of published crystal shape data across crystal sizes in natural volcanic rocks. Here, we present a compilation of new shape data for plagioclase (micro-)phenocrysts in dacite and basalt lavas as well as in quenched magmatic inclusions from Mt St Helens (USA). Plagioclase in quenched inclusions commonly exhibits tabular shapes with 3D short-to-intermediate axis aspect ratios (S/I) of 0.25 to 0.4, similar to unzoned phenocrysts in the 1980 dacite. By contrast, plagioclase from ‘mushy’ inclusions show significantly more prismatic (equant) crystal cores and overall shapes, with S/I ~0.6, similar to zoned phenocrysts in the 1980 dacite with one or more resorption horizons (S/I = 0.65 – 0.8). We speculate that episodes of resorption (for example due to recharge-induced temperature fluctuations) are a primary cause for changes in plagioclase phenocryst shapes in the magma reservoir, and that 3D shape may be a useful source of information about the sources and magmatic histories of crystal components making up the erupted magma. These results provide important new context for the interpretation of crystal morphologies in volcanic rocks.

[1] Hammer & Rutherford (2002), *J Geophys Res*, 107.B1.

[2] Holness (2014), *Contrib Min Pet* 168, 1-19.

[3] Lofgren (1974), *Am J Sci* 274(3), 243-273.

[4] Mangler et al. (2022), *Contrib Min Pet* 177(6).