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INVESTIGATING PETROLOGIC INDICATORS OF MAGMATIC PROCESSES IN VOLCANIC ROCKS

Prevalence of growth twins among anhedral plagioclase microlites†

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Abstract

Crystal textures of volcanic rocks record the processes involved in magma storage and eruptive ascent. Syn-eruptive crystallization, in which groundmass crystals form and grow according to environmental factors such as thermodynamic undercooling, strongly influences the texture of erupted magma. This stage is difficult to isolate for study in natural rocks, but well-suited for laboratory experiments because the chemical compositions and crystallization timescales of eruptive processes can be emulated. This study examines the incipient stages of plagioclase crystallization in hydrous rhyodacite magma undergoing decompression-driven degassing. Experimental samples in which crystal growth at both near-equilibrium and far-from equilibrium conditions were examined using electron backscatter diffraction (EBSD) analysis to ascertain crystallographic lattice orientations of individual crystals. The crystal orientation investigation affirms a common assumption invoked in textural studies of crystal number density: contiguous crystals with parallel faces are crystallographically continuous, whereas contiguous crystals with non-parallel faces have unrelated crystal lattice orientations and as such, represent separate crystals. In the highly undercooled sample, twinning is identified in ~87% of the crystals examined; in the near-equilibrium sample, 38% of the crystals are twinned. We find that the observed twinning is unlikely to be the result of deformation, transformation, or synneusis, but rather a result of growth defects introduced during the incipient stages of crystallization. We suggest internal structural defects (twins) control macroscopic morphological defects (embayments, swallowtails, and melt inclusions) as a result of the high energy of the twin plane boundary. Formation of twins during the incipient stages of plagioclase crystallization is the single most important factor contributing to anhedral morphologies of feldspar microlites growing during magma decompression, and plays a role in the development of some plagioclase-hosted melt inclusions.

Keywords: Electron backscatter diffraction, plagioclase, growth twinning, crystal morphology