American Mineralogist, Volume 110, pages 364–377, 2025

Groundmass pyroxene crystal habits (trachts) record syneruptive magma dynamics in glassy pyroclasts

Shota H. Okumura[1,*], Satoshi Okumura[2], and Akira Miyake[1]

[1]Department of Geology and Mineralogy, Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University, Kitashirakawaoiwake-cho, Sakyo-ku, Kyoto 606-8502, Japan
[2]Division of Earth and Planetary Materials Science, Department of Earth Science, Graduate School of Science, Tohoku University, 6-3 Aoba, Aramaki-aza, Aoba, Sendai 980-8578, Japan

Abstract

Explosive eruptions produce various types of pyroclasts, including those containing a small number of groundmass crystals. The textural variation, such as the number, density, size, and volume of groundmass crystals, is expected to reveal the complex magma dynamics during syneruptive ascent in conduits; however, we have no quantitative method to investigate the magma dynamics based on crystal texture when the pyroclasts show glassy texture with a small number of microlites. Here we show that the variation of the combination of crystallographic faces (i.e., tracht) of groundmass pyroxene crystals enables us to derive the degree of effective undercooling (ΔT_{eff}) and magma ascent histories even from the glassy pyroclasts. We conducted decompression experiments and analyzed trachts of groundmass pyroxene crystals in the run products and those in natural pumices from the 1914 Plinian eruption of the Sakurajima volcano. These results show that the glassy white pumices experienced higher ΔT_{eff} than the crystal-rich gray pumice and corroborated that they originate from the magmas at different positions from the conduit walls. The estimate on ΔT_{eff} implies that the magma rapidly ascended in the center of the conduit might experience cooling because of volatile exsolution and expansion.

Keywords: Pyroxene, crystal habit, crystal size distribution, nanolite, magma ascent