American Mineralogist, Volume 95, pages 503–509, 2010

Cooling-induced crystallization of microlite crystals in two basaltic pumice clasts

Lindsay Szramek,[1,*] James E. Gardner,[1] and Matthias Hort[2]

[1]Department of Geological Sciences, Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas 78712-0254, U.S.A.
[2]Institute of Geophysics, University of Hamburg, D-20146 Hamburg, Germany

Abstract

Microlites in pumice fragments can record the rate of magma decompression and ascent, but only if none grow while those fragments cool in the atmosphere. For highly viscous silicate melts, such crystallization is unlikely, but more basic melts are known to crystallize rapidly, and thus could partially crystallize during cooling and overprint decompression textures. To examine whether post-fragmentation crystallization can occur, we examined two basaltic pumice clasts from the sub-Plinian April 1999 eruption of Shishaldin volcano, Alaska. Radial sectioning shows that microlite content doubles from rim to core in both, mainly from growth of plagioclase. Dendrite magnetite also increases greatly in content, but only within the larger pumice clast. Such radial textures demonstrate that crystallization occurred after fragmentation and before deposition (no welding occurred). Using a conductive cooling model coupled with a model for temperature in the eruption column, we estimate that rims of the pumice clasts cool to their glass-transition temperature in ~100–200 s, but their cores take ~500–2000 s to cool, which translates into cooling rates of ~0.2 to 2.5 °C/s. Using a conservative assumption that all plagioclase nucleated before cooling began, we estimate that both short and long axes grew at ~4.8 (±2.7) $\times 10^{-7}$ cm/s. Such rates match those determined experimentally for basaltic melts at similar cooling rates. Magnetite grew only at the slowest cooling rates, and the rate of bulk magnetite crystallization equals that of plagioclase. Our results demonstrate that groundmass crystallization can occur in basic melts on the timescale of explosive eruptions, and so pumice clasts from such eruptions must be viewed with caution before being used to infer eruption dynamics.

Keywords: Crystal growth, plagioclase, cooling, igneous petrology, basaltic pumice, microlites