GEOLOGY

Estimating rates of decompression from textures of erupted ash particles produced by 1999–2006 eruptions of Tungurahua volcano, Ecuador

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Abstract

Persistent low- to moderate-level eruptive activity of andesitic volcanoes is difficult to monitor because small changes in magma supply rates may cause abrupt transitions in eruptive style. As direct measurement of magma supply is not possible, robust techniques for indirect measurements must be developed. Here we demonstrate that crystal textures of ash particles from 1999 to 2006 Vulcanian and Strombolian eruptions of Tungurahua volcano, Ecuador, provide quantitative information about the dynamics of magma ascent and eruption that is difficult to obtain from other monitoring approaches. We show that the crystallinity of erupted ash particles is controlled by the magma supply rate (MSR); ash erupted during periods of high magma supply is substantially less crystalline than during periods of low magma supply. This correlation is most easily explained by efficient degassing at very low pressures (<<50 MPa) and degassing-driven crystallization controlled by the time available prior to eruption. Our data also suggest that the observed transition from intermittent Vulcanian explosions at low MSR to more continuous periods of Strombolian eruptions and lava fountains at high MSR can be explained by the rise of bubbles through (Strombolian) or trapping of bubbles beneath (Vulcanian) vent-capping, variably viscous (and crystalline) magma.

Available in:

Geology, 2012, vol. 40, no 7, p. 619-622.

DOI: 10.1130/G32948.1

http://geology.gsapubs.org/content/40/7/619.short