Effect of volatiles, crystallization, and lava dome effusion rate on pyroclastic surge dispersal at Merapi volcano, Java, Indonesia

Kimberly Genareau[1], Shane J. Cronin[2], Gert Lube[2]

[1]Lehigh University, U.S.A., [2]Massey University, New Zealand

E-mail: kig210@lehigh.edu

The behavior of volatile elements in an erupting magma will have direct effects on the rheology of effused lavas and the dynamic properties of pyroclastic density currents resulting from dome collapse and explosive activity. Pyroclastic density current deposits from the October/November 2010 surge-producing events at Merapi volcano, Java, Indonesia were examined using a combination of scanning electron microscopy (SEM), stereo-scanning electron microscopy (SSEM), secondary ion mass spectrometry (SIMS), and electron microprobe (EMP) analyses. Samples from the two climactic and lethal surge events on 26 October and 5 November were examined, in addition to several intermediate surges, taken from a series of transects between 3 and 8 km from source. Microtextural and geochemical properties of the tephras reveal variations in volatile behavior that influenced the physical properties of the resulting pyroclastic surges. The number density of plagioclase feldspar microlites is ten times higher in the 5 November event, while the number of pyroxene/Fe-oxide microlites is fifteen times higher compared to the 26 October event. SSEM analyses of the intermediate surges reveal variations in vesicle morphology during the transition between the two main surge-producing events. EMP analyses indicate synchronous growth of feldspar microlites and phenocryst rims in both phases of dome effusion. Degassing of the 26 October dome at relatively greater depths in the plumbing system lead to a significant shift of the feldspar liquidus, resulting in alkali-rich compositions compared to the dominantly plagioclase compositions found in the 5 November lava crystals. Despite efficient degassing of the earlier dome, enough volatiles remained in the interstitial melt to cause sudden, significant vesiculation of the residual melt following decompression. In addition, CO_2 contents of groundmass glasses in the 26 October dome material is significantly higher (2-3 times) than that of the 5 November lavas. Textures within lapilli of the 5 November surge deposits revealed the development of permeable vesicle pathways, enabling efficient degassing and decompression-induced crystallization of phenocryst rims and microlite phases in the shallow conduit in a few days prior to collapse. Trends in volatile elements during the final stage of feldspar phenocryst growth will be presented. Variations in lava textural and chemical characteristics are a function of lava effusion rate and decompression path between the different effusive stages. The behavior of volatile elements, mainly H_2O, CO_2, and Li, between the main surge-producing events of 26 October and 5 November, 2010, affected magma rheology over several days during an increased rate of lava dome effusion, altering the composition of the products, the generation of fine ash, and the transport properties (total volume, run-out distance) of resulting pyroclastic density currents.