THE MAY 2010 ERUPTION OF PACAYA VOLCANO, GUATEMALA: AN EXPERIMENTAL STUDY OF SUBLIQUIDUS MAGMA RHEOLOGY

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ABSTRACT

Pacaya volcano, Guatemala, erupted in May 2010 with two lava flows from lateral vents preceding a violent Strombolian eruption from the central vent. Compositions and textures of lava flow and tephra samples suggest a layered magma chamber and a range of cooling rates.

The effects of crystallization on magma rheology were investigated through a series of high temperature experiments. Six isothermal experiments at temperatures between 1255 and 1207˚C produced crystal fractions between ~17 and ~42% over 3-30 hrs, with textures similar to those observed in lava flows. Four isothermal experiments at ~950˚C produced a range in crystal fractions between ~42 and 80% over 0-2 hours. The crystal textures resemble those in lapilli tephra samples, but are smaller (≤1μm).

Magma rheology was measured over a range of temperature, and strain rates for each of the partially crystalline samples. The results were used to test the accuracy of current models that predict magma viscosity. Rheological measurements are best fit as a shear thinning non-Newtonian flow with a power-law equation at up to 30% crystals, with higher contents up to 42% crystals requiring determination of a yield strength and the use of a Herschel-Bulkley flow equation. Even at 42% crystals, the yield strength was only 140 Pa. Currently available models

for predicting liquid and magma viscosity do not accurately predict the measurements, and are especially poor at low temperatures and high crystal contents.

Field and laboratory observations were combined to formulate a model for the May 2010 eruption, in which early-erupted more silicic magma tapped from the upper magma chamber either remains trapped under a rheological plug in the main conduit, or escapes to erupt at lateral vents. Following rupture of the plug in the violent strombolian eruption of May 27thth, lateral vents continued to tap deeper levels of the magma chamber producing more mafic flows.