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 using high temperature experiments. Six isothermal experiments at temperatures between 1255-1207°C produced crystal fractions between ~17-42% over 3-30 hrs, with observed textures similar to lava flows. Four isothermal experiments at ~950°C produced crystal fractions ranging between ~42-80% over 0-2 hours, with observed textures similar to micro-crystals within lapilli samples.

Magma rheology was measured over a range of temperature, and strain rates for each of the crystal fractions. Rheological measurements are best fit with a power-law at up to 30% crystals, with higher contents up to 42% crystals requiring a Herschel-Bulkley flow. Even at 42% crystals, the yield strength was only 140 Pa. Currently available models for predicting liquid and magma viscosity do not predict the measurements very well, and are especially poor at low temperatures and high crystal contents.

Field and laboratory observations were used 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 27th, lateral vents continued to tap deeper levels of the magma chamber producing more mafic flows.