Investigating the source mechanisms of deflation-inflation events at Kilauea Volcano, Hawai'i

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The summit of Kilauea Volcano, Hawaii, is characterized by frequent cyclic deflation-inflation ("DI") events that are best recorded on tiltmeters, reflecting pressure perturbations in the shallow magma plumbing system. Most DI events begin with quasi-exponential deflation at the summit, that lasts 8-80 hours, followed by inflation that is initially rapid but wanes over the course of 12-48 hours as the net deformation approaches pre-event levels. This gives the tilt time series a V- or U-shaped appearance, depending on the onset deflation rates. DI events are also manifested at the Puu Oo eruptive vent on Kilauea's east rift zone, about 20 km along the rift from the summit. The tilt change at Puu Oo usually lags behind summit deformation by approximately 30-200 minutes. DI tilt events have become more common since the onset of Kilauea's summit eruption in March 2008, increasing from about 5-15 per year before 2008 to more than 100 in 2012. DI events often occur back-to-back and follow similar patterns, suggesting that the causal mechanism is repetitive and non-destructive. DI events also seem to be less frequent during times of increased summit inflation rate, suggesting that an increase in pressurisation rate or magma supply impedes the mechanism of DI events.

We construct multiphysics finite element models (FEMs) to simulate pressure changes and deformation to link the observations to the physical magmatic processes that drive DI events. The FEMs allow us to investigate realistic 3D model configurations including topography, distributions of rheological properties, and multiple deformation sources. Crucially, the models also allow for temporal variation of fluid flow and subsurface pressurization, which will provide insights into the unique patterns of tilt at Kilauea. Preliminary results suggest that the exponential shape of DI events may be a manifestation of the pressure changes within the magma reservoir due to restriction of flow into the chamber, causing episodic supply. Two possibly inter-related mechanisms have been suggested to explain the restriction of magma flux: (1) blockage and subsequent clearing of the transport pathway that feeds the shallow summit magma system and conduit to Puu Oo, and (2) convective overturns caused by replacement of degassed magma with gas-rich magma.which could be due to either a blockage or a convective overturn.