Modeling flank motion at Kilauea volcano (Hawai'i): Insights in the dynamic interaction between tectonic and magmatic driving forces for volcano deformation

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Volcanic hazard arises from magmatic processes, such as effusive and explosive eruptions, as well as from tectonic processes, such as earthquakes, landslides, and catastrophic flank collapse. The latter can also cause devastating tsunamis. A prime example for a volcano where all these processes have been observed is Kilauea, Hawai'i, which is also the most active volcano in the world. In the past, large magnitude 7 earthquakes, associated to volcanic flank motion have occurred (Lipman et al., 1985) along a subhorizontal fault beneath the volcano (decollement). It has also been suggested that dike intrusions can trigger fault slip associated to volcanic flank motion (Brooks et al., 2008; Montgomery-Brown et al., 2010). We developed a 2D finite element model to study the dynamic interaction between tectonic (gravitational) and magmatic (e.g. dike intrusion along the rift zone) driving forces. The model simulates volcanic flank motion from tectonic (gravitational) driving forces, considering the presence of a deep subhorizontal fault (decollement) beneath Kilauea volcano, which is free-to-slip or partially locked by frictional properties, as well as a riftzone with low shear strength. We compare the model surface velocities to space-geodetic data. The model investigates the tensile stresses (indicating the likelihood of passive magmatic intrusions) from flank motion dynamics. In particular, we test the response to changes in the frictional properties along the decollement. The model also investigates the slip response along the decollement fault from active magmatic intrusions. Our preliminary model results provide insight into the deformation dynamics at Kilauea, such as triggering of volcanic eruptions from flank motion, and vice versa.