Dynamics of Kilauea's magmatic system imaged using a joint analysis of geodetic and seismic data

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InSAR (Interferometric Synthetic Aperture Radar) provides high-spatial-resolution measurements of surface deformation with centimeter-scale accuracy. At Kilauea Volcano, Hawai'i, InSAR analysis shows complex processes that are not well constrained by GPS data (which have relatively poor spatial resolution). However, GPS data have higher temporal resolution than InSAR data, allowing for better imaging of time-dependent processes. The two data sets are thus complementary. To overcome some of the limitations of conventional InSAR, which are mainly induced by temporal decorrelation, topographic and orbital errors, and atmospheric delays, a Multi-Temporal InSAR (MT-InSAR) approach can be used to integrate multiple SAR acquisitions over the same area. Here, we apply conventional InSAR and the "StaMPS" ("Stanford Method for Permanent Scatterers") technique, which incorporates both persistent scatterer and small baseline approaches, to RADARSAT-1, ENVISAT and ALOS data spanning 2000 to 2010, to analyze subsidence of Kilauea's southwest rift zone (SWRZ). The SWRZ "background deformation" is characterized by broad subsidence of a few cm/yr, except during periods of magma accumulation in the subsurface. In addition to the broad subsidence, the rift zone hosts two linear subsidence features that are clear in interferograms spanning long time periods (usually several years). Based on daily GPS solutions, we define three "background deformation" periods, during which no abnormal eruptive activity or unrest influences the deformation behavior of the SWRZ. The first period spans July 2000 to September 2003 and is covered by a highly coherent RADARSAT-1 interferogram. The second background period spans October 2006 to March 2007, just a few months before an east rift zone intrusion and eruption in June 2007. The third period spans December 2009 to June 2010. We speculate that broad SWRZ subsidence is caused by the same processes that trigger subsidence of Kilauea's east rift zone - namely deep rift opening and basal fault slip - whereas narrow, linear subsidence features might be due to the stiffness contrasts between cracked areas in the SWRZ and old intrusions beneath the ground surface. A 3D Mixed-Boundary Element model including deep rift-zone opening (running from 3 to 9 km depth beneath Kilauea's east and southwest rift zones) as well as slip on the decollement fault that underlies the volcano's south flank (at 9km depth) can explain broad SWRZ deformation imaged from RADARSAT-1 data for the first background period. This model will be refined by inversions and compared to simpler kinematic analytical models involving distributed Okada, and tested against the other background deformation periods. In addition, we will include seismic data to help constrain the models.