Geodetic and seismic models of the 2007 May 24 earthquakes at Kilauea Volcano, Hawai'i

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For two days beginning on June 17 (Father's Day), 2007 and following a four-year-long period of summit inflation, magma intruded into Kilauea's East Rift Zone and erupted through a new vent near Makaopuhi Crater, 7 km west of the long-lived Pu'u O'o eruptive vent. On the basis of concurrent summit deflation and observations of lava chemistry and temperature, the June 17-19 Father's Day event has been interpreted as the result of forcible intrusion driven by high magma pressure at the summit, as opposed to a passive response to rifting. The Father's Day event was preceded by two shallow M4+ earthquakes (M4.7 and M4.1) along the outermost caldera faults on May 24, 2007. The earthquakes have been interpreted as a response to inflation of and heightened magma pressure within Kilauea's summit magma reservoir system. Although earthquakes often occur in response to magma intrusion, it is rare for them to have magnitudes larger than M3. Here, we use a combination of geodetic and seismic analysis, as well as geodetic and Coulomb stress modeling, to investigate the links between summit inflation, the May 24 earthquakes, and structural features on Kilauea. The deformation field created by the May 24 earthquakes is visible in multiple Interferometric Synthetic Aperture Radar (InSAR) images (interferograms). Six interferograms were subsampled and inverted with a near-neighborhood algorithm. The best-fit model to the InSAR data includes almost pure right-lateral slip on a NE-oriented caldera-bounding fault and inflation of a pressure source south of Kilauea Caldera. Double-couple focal mechanisms calculated for the two May 24 earthquakes show pure strike slip motion along NE- or SW-oriented faults and are consistent with our best-fit geodetic model. Stress analysis suggests that magma supply to the south caldera reservoir resulted in strong Coulomb stress increases for both earthquakes, indicating that inflation of a shallow magma chamber beneath Kilauea's summit may have promoted slip on the faults.