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Continuous gravity monitoring tracks dynamic processes beneath Kilauea Volcano, Hawai'i

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Since May 2010, two continuously recording gravimeters have been operating at the summit of Kilauea Volcano, Hawai'i. The purpose of the deployment is to detect rapidly evolving mass changes associated with volcanic activity. One gravimeter is located on the west rim of Kilauea caldera (about 2 km from the summit eruptive vent), and records data at a 10-second interval. The second gravimeter was deployed on the floor of Kilauea caldera, just east of the rim of Halema'uma'u Crater (about 150 meters from the summit eruptive vent), and records data at 2 Hz.

An analysis of the data acquired in May 2010 from both instruments reveals oscillations with period of about 150s. The oscillations are not related to inertial accelerations caused by seismic activity, but instead indicate fluctuations in subsurface mass. Source modeling suggests that the oscillations are caused by density inversions in a magma reservoir located about 1 km beneath the east margin of Halema'uma'u Crater in Kīlauea caldera — a location of known magma storage. This result may represent rare geophysical evidence of convection in a shallow magma chamber. Continuous microgravity measurements may therefore provide a geophysical method for detecting and characterizing magma convection in subsurface reservoirs, which previously has only been inferred indirectly from geochemical observations.

Gravity variations have also accompanied changes in lava level within the summit eruptive vent. Throughout the second half of 2010, the summit lava level experienced cycles of rise and fall, over periods between several minutes and a few hours. The signal from the gravimeter closest to the active vent showed increases and decreases in gravity during lava level rise and drop, respectively, of a few microGals, implying small mass changes during the rise/fall cycles. Webcam images allow for comparison between gravity and lava level changes, providing an opportunity to constrain the density of the fluid beneath the lava crust. A strong gravity decrease of about 150 microgals occurred on 5 March 2011, when magma drained from the summit eruptive vent and shallow storage reservoir to feed a fissure eruption along Kilauea's east rift zone. These observations demonstrate the ability of continuous gravity measurements to offer insights into volcanic activity that is difficult or impossible to infer from other datasets.