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Joint analysis of deformation, gravity, and lava lake elevation reveals temporal variations in lava lake density at Kilauea Volcano, Hawaii

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We find a tight correlation between (i) changes in lava level within the summit eruptive vent at Kilauea Volcano, Hawaii, observed for at least 2 years since early 2011, and (ii) ground deformation in the vicinity of the vent.
The observed correlation indicates that changing pressure within the shallow magma reservoir feeding the lava lake influences both deformation and lava level. However, those two parameters are related to chamber pressure through different properties, namely, the density of the lava filling the vent (for the lava level) and the size/position of the reservoir plus the elastic parameters of the host rock (for the deformation).
Joint analyses in the time and frequency domains of lava level (determined from thermal camera imagery of the lava lake) and tilt measured on a borehole instrument ($\sim$2 km from the summit vent) reveal a good correlation throughout the studied period. The highest correlation occurs over periods ranging between 1 and 20 days. The ratio between lava level and tilt is not constant over time, however. Using data from a continuously recording gravimeter located near the rim of the summit eruptive vent, we demonstrate that the tilt-lava level ratio is controlled by the fluctuations in the density of the lava inside the vent (i.e. its degree of vesicularity).
A second continuous gravimeter was installed near the summit eruptive vent in 2014, providing a new observation point for gravity change associated with summit lava lave activity to test models developed from the previously existing instrument. In addition, a continuous gravimeter was installed on the rim of the Puu Oo eruptive vent on Kilauea's East Rift Zone in 2013. Puu Oo is connected via the subvolcanic magma plumbing system to the summit eruptive vent and often deforms in concert with the summit. This growing network of continuously recording gravimeters at Kilauea can be used to examine correlations in gravity change associated with variations in eruptive activity across the volcano.