Tracking the hydraulic connection between Kilauea's summit and rift zones using lava level

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A magmatic connection between Kilauea Volcano's summit and rift zones has been inferred for decades, even centuries, based on the temporal relationship of changes during discrete events in these two areas of the volcano, but continuous tracking of the fluid connection has not been possible in modern times until just recently. We track the fluid lava levels at Halema'uma'u and Pu'u 'O'o craters and demonstrate that a state of dynamic hydraulic equilibrium exists between Kilauea's summit and east rift zone. The hydraulic head loss in the system was used with the Darcy-Weisbach equation to infer that the conduit feeding the east rift zone eruption is <5 m in diameter, and the rate of draining of the summit lava lake in March 2011 was modeled with the Poiseuille equation to infer that the conduit supplying lava to Halema'uma'u is also <5 m wide. During 2011, rising lava levels at both Halema'uma'u and Pu'u 'O'o, inflation of the summit and east rift zone and increasing numbers of earthquakes along the upper east rift zone presaged several rift zone eruptive events, consistent with rising hydraulic head pressure in the summit-rift magmatic system that triggered the rift activity and draining of the summit magma reservoir. The summit lava level closely tracked tiltmeter and GPS measurements of summit deformation (during both inflation and deflation), indicating that the lava level within Halema'uma'u Crater is a reasonable proxy for pressurization of the magmatic system. The Halema'uma'u lava lake level therefore serves as a convenient gauge for judging the likelihood of future eruptive or intrusive events along the rift zones. Historical summit lava level data from the 1800s and early 1900s confirms that rift eruptions were usually preceded by rising, elevated lava levels in the summit. The patterns from 2011 reaffirm the usefulness of lava level in forecasting rift activity and provide an improved picture of how lava level relates to precursory trends observed in modern geophysical data. Forecasting eruptive potential from lava level likely has value at other open-vent basaltic volcanoes around the world.