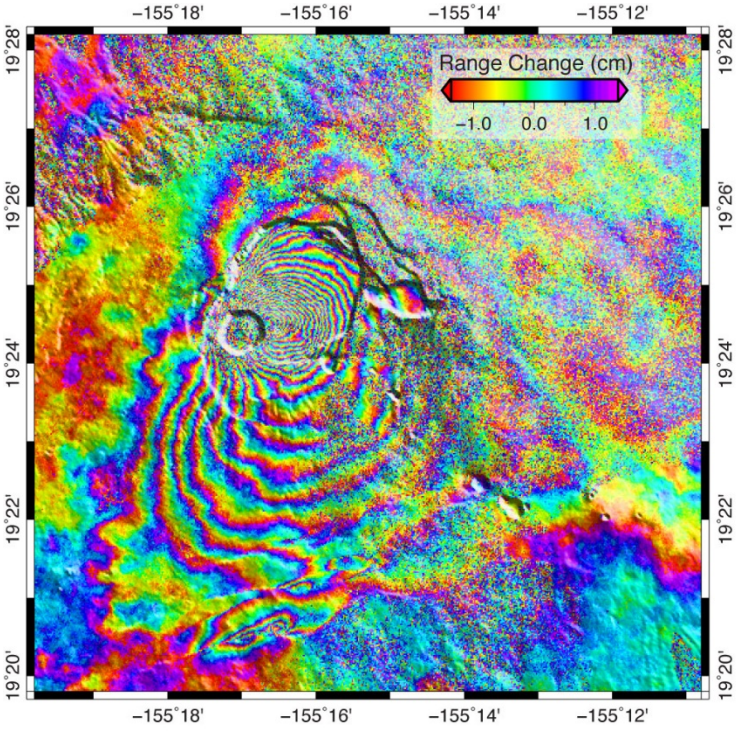
Why so many earthquakes in the Kīlauea summit area?

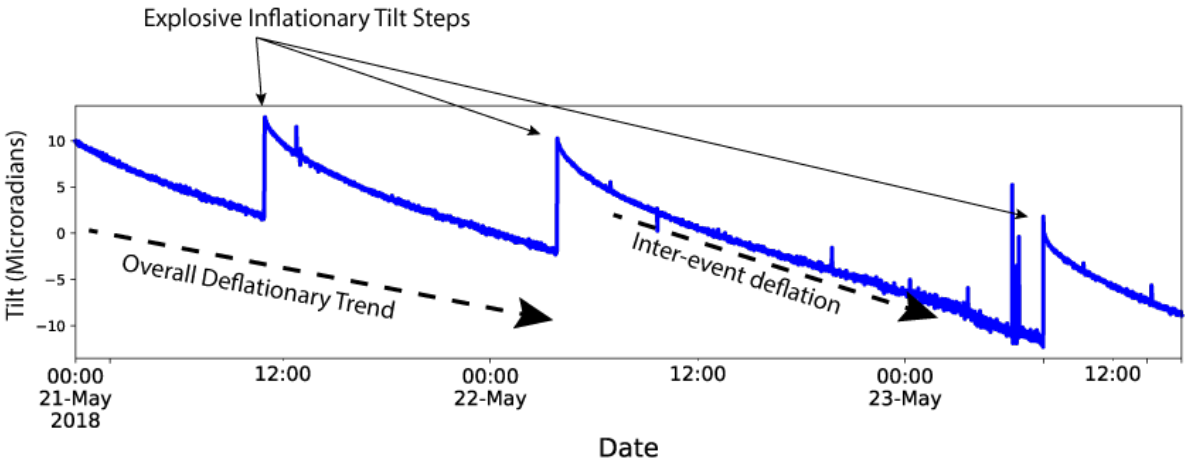
The floor of Kīlauea Caldera continues to subside as pressure in the magma reservoir decreases in response to withdrawal of magma towards the East Rift Zone. This is the same process that caused the summit lava lake to drop out of sight within the “Overlook vent” inside Halemaʻumaʻu Crater.

Deflation at Kīlauea’s summit has caused up to 1.5 meters (about 5 feet) of subsidence, which has stressed the faults around and within Kīlauea Caldera. This has led to numerous magnitude-3 or greater earthquakes, as well as many more smaller ones. The faults that are being stressed are shallow (likely less than 2 miles deep), so the earthquakes are shallow, which means that they have been widely felt by residents near the summit area.

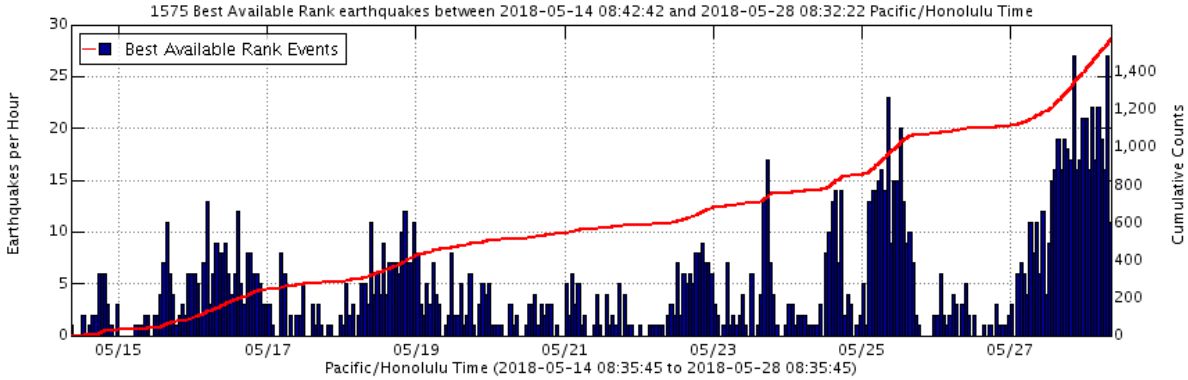


Interferogram from the European Space Agency’s Sentinel-1 satellite showing ground motion between May 11, 2018 and May 17, 2018. During the same time period, a GPS station on the caldera floor measured 65 cm (about 2 feet) of subsidence. Each colored “fringe” represents 2.7 cm (just over 1 inch) of motion between the ground and the satellite and are added up to determine the total displacement. The concentric fringes show deflation centered just east of Halemaʻumaʻu and roughly corresponds with the area under increased stress. Additional small, concentric fringe patterns in the south of this image are due to shallow earthquakes on the Koaʻe fault system.

Occasional larger ash explosions from Halemaʻumaʻu have resulted in abrupt increases in reservoir pressure (which appear as "inflationary steps" in ground tilt data); these inflations negate the effects of ongoing deflation for a period of hours to days. After each explosion, the faults within and around the caldera are less stressed and, therefore, produce fewer earthquakes. As time goes on, deflation again stresses the faults and the number of detected (and felt) earthquakes increases.



Ground tilt at the summit of Kīlauea recorded in a direction roughly between Jaggar Museum and the Overlook vent. A negative (downward) tilt indicates deflation of the magma reservoir beneath Halema‘uma‘u. Rapid increases in tilt are due to explosions at the summit.



Blue bar graph shows a plot of earthquakes per hour (all sizes) in the summit area over the past 14 days. Red line shows the cumulative number of earthquakes over that time (more than 1,500).

High rates of earthquake activity were observed during the 1924 summit eruption. Volcano resident Margaret Finch wrote to her father on May 15, 1924, "... *and the earthquakes were awful. Some were a slow swaying motion, while others gave you a nasty vicious shake. I hate them all. I want to run whenever I feel one. There must be at least a hundred quakes a day…and probably a great many more than that."*

It appears that a process similar to now was at work back then. We expect earthquake production to continue as long as the summit continues to deflate, but the rate and magnitude of earthquakes will vary in response to explosions.

In 1924, based on known historical records, no earthquakes related to summit subsidence caused significant damage. In 1960, earthquakes occurring in the summit area during subsidence caused some minor damage in Volcano. In 2018, the USGS Hawaiian Volcano Observatory and Hawai‘i Volcanoes National Park have seen some damage from these earthquakes, and the potential for damaging earthquakes during this eruption persists. In addition to preparing for ashfall, summit area residents should consider earthquake preparedness as part of their home and business safety plans.