What lurks beneath: Learning from lava ooze-outs

VOLCANO WATCH | HAWAIIAN VOLCANO OBSERVATORY

BY KENDRA LYNN

HAWAIIAN VOLCANO OBSERVATORY

Halema‘uma‘u has been progressively filled by six eruptions at the summit of Kilauea since 2020, and it continues to accumulate new lava with each successive fountaining episode of the ongoing eruption. Let’s dive beneath the solidified crust on the floor of the crater to explore the complicated mix of molten material below.

Kilauea has had six summit eruptions inside Kaluapele in the past four years: 20202021 (five months), 2021-2022 (1.25 years), January to March 2023 (three months), June 2023 (1.5 weeks), September 2023 (one week), and the ongoing 2024-2025 eruption (five months so far). Each of these eruptions has filled the area that collapsed in 2018, and lava now reaches more than 425 meters (1,394 feet) deep (for comparison, the Empire State Building is 380 meters or 1250 feet tall).

During many of these eruptions, USGS Hawaiian Volcano Observatory field crews have documented “ooze outs”—where lava squeezes out from underneath the solidified surface crust onto the floor of the crater, usually in places that are far away from where eruptive vents are located. These ooze outs tell us that despite the solid crust at the surface, some portions of the interior have remained molten, even in the periods between eruptions.

In the earlier eruptions, field crews had limited access to sample the eruptions in Halema‘uma‘u due to vents being located deep inside the collapsed area of Kaluapele. As the surface of the crater, and thus the elevation of the vents, rose and expanded laterally through time with every eruption since 2020, safe opportunities to sample lava flows became possible.

With permission and coordination from Hawaii Volcanoes National Park, HVO field crews have recently been able to directly sample the lava ooze outs for the first time since 2020. As part of HVO’s agreement with Hawaii Volcanoes National Park, HVO staff are typically available at the Volcano House and Wahinekapu (Steaming Bluff) overlooks during overflight missions in which conditions are safe for sampling, to answer questions about our work and field operations.

The location of ooze outs are documented with photographs and thermal images. The thermal images are used to create a thermal map, which often show the ooze outs occurring on the eastern side of Halema‘uma‘u, far from active surface flows that are being fed by lava fountains. These different types of lava flows can be seen from public overlooks at many points around Kaluapele in Hawaii Volcanoes National Park (sometimes, even during periods between the eruptive episodes).

Ooze-out lavas are spiny pahoehoe; they have a rough surface texture compared to fresher pahoehoe fed by hot lava fountains. These spiny flows are more viscous (they flow more slowly) because they have had time to cool. They also have lower gas contents (are denser) and analysis in the laboratory shows that they are also very crystal rich.

The most common mineral in Hawaiian eruptions is olivine (which is green), but other minerals are found in lavas that have had more time to cool (such as white plagioclase and dark green/ brown pyroxene). The ooze out lavas collected from Halema‘uma‘u are dominated by clots of plagioclase and pyroxene with minor amounts of small (<0.5 mm or 0.02 inches) olivine crystals.

Ooze outs also contain larger (1-2 mm or 0.04-0.08 inches) olivine crystals that have been recycled from previous eruptions or episodes. Originally these larger crystals were formed in the magma reservoirs underneath Kaluapele. They were erupted in one of the previous lava lakes, and then were re-erupted in a recent ooze out.

We know these crystals had this complex history because of careful laboratory work by two University of Hawaii at Hilo undergraduate students examining samples from the January to March 2023 and June 2023 Halema‘uma‘u eruptions. Their work has documented minerals found in those eruptions, and they have identified lakerecycled minerals through chemical and textural analysis, similar to what we see in the recent ooze-outs.

Additional clues will come from comparing the recent ooze-out samples to rock core drilled from the Kilauea Iki lava lake in the 1960s and 1970s. Studies on these found that the lava lake interior, fed by 17 episodes during the 1959 Kilauea Iki eruption, took decades to cool resulting in crystallization of a variety of minerals.

Each eruptive episode, and successful sampling mission, provides further insights into how Halema‘uma‘u is evolving and helps us understand eruptive behavior of Kilauea.

Volcano activity updates

Kilauea has been erupting episodically within the summit caldera since Dec. 23, 2024. Its USGS Volcano Alert level is WATCH.

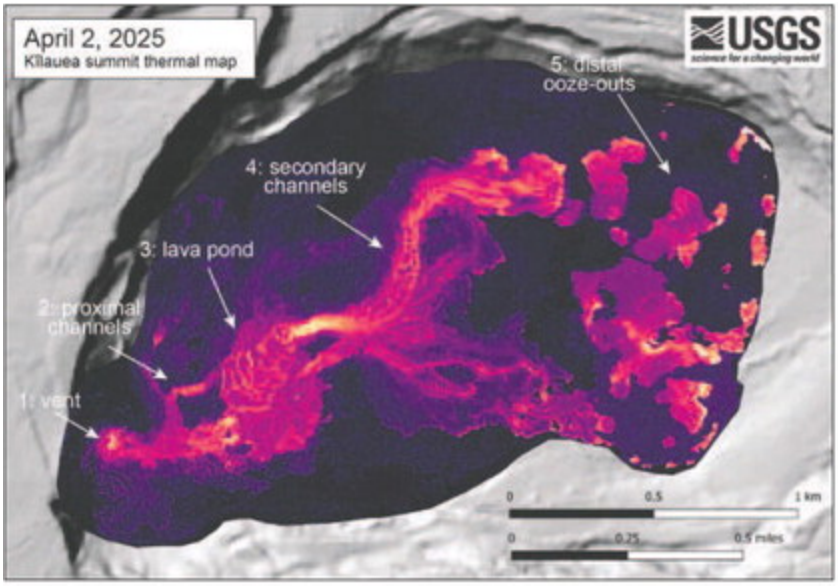
Episode 21 of the Kilauea summit eruption in Halema‘uma‘u crater occurred on May 11, with approximately eight hours of fountaining primarily from the north vent. Strong glow visible in both the north and south vents and summit region inflation since the end of episode 21 suggests that another episode is possible. Sulfur dioxide emission rates are elevated in the summit region during active eruption episodes. No unusual activity has been noted along Kilauea’s East Rift Zone or Southwest Rift Zone.

Mauna Loa is not erupting. Its USGS Volcano Alert Level is at NORMAL.

Three earthquakes were reported felt in the Hawaiian Islands during the past week: a **M2**
.8 earthquake 23 km (14 mi) SSE of Waimea at 14 km (8 mi) depth on May 14 at 11:08 p.m., a **M3**
.3 earthquake 16 km (9 mi) WSW of Kailua-Kona at 6 km (3 mi) depth on May 14 at 12:16 a.m., and a **M3**
.6 earthquake 24 km (14 mi) ESE of Leilani Estates at 42 km (26 mi) depth on May 13 at 8:01 a.m.

Kendra Lynn is an HVO geologist.

Please visit HVO’s website for past Volcano Watch articles, Kilauea and Mauna Loa updates, volcano photos, maps, recent earthquake information, and more. Email questions to askHVO@usgs.gov.



A thermal map of Halema‘uma‘u surface is shown on April 2 (episode 16). Primary, lava fountain fed flows reached to the east (annotations 1-4), next to the region where patchy distal ooze outs were being squeezed from below the crust (annotation 5). During episode 16, HVO field crews sampled both the fountain-fed flows and a nearby ooze-out for analysis in the lab. COURTESY PHOTO/ USGS/ HVO