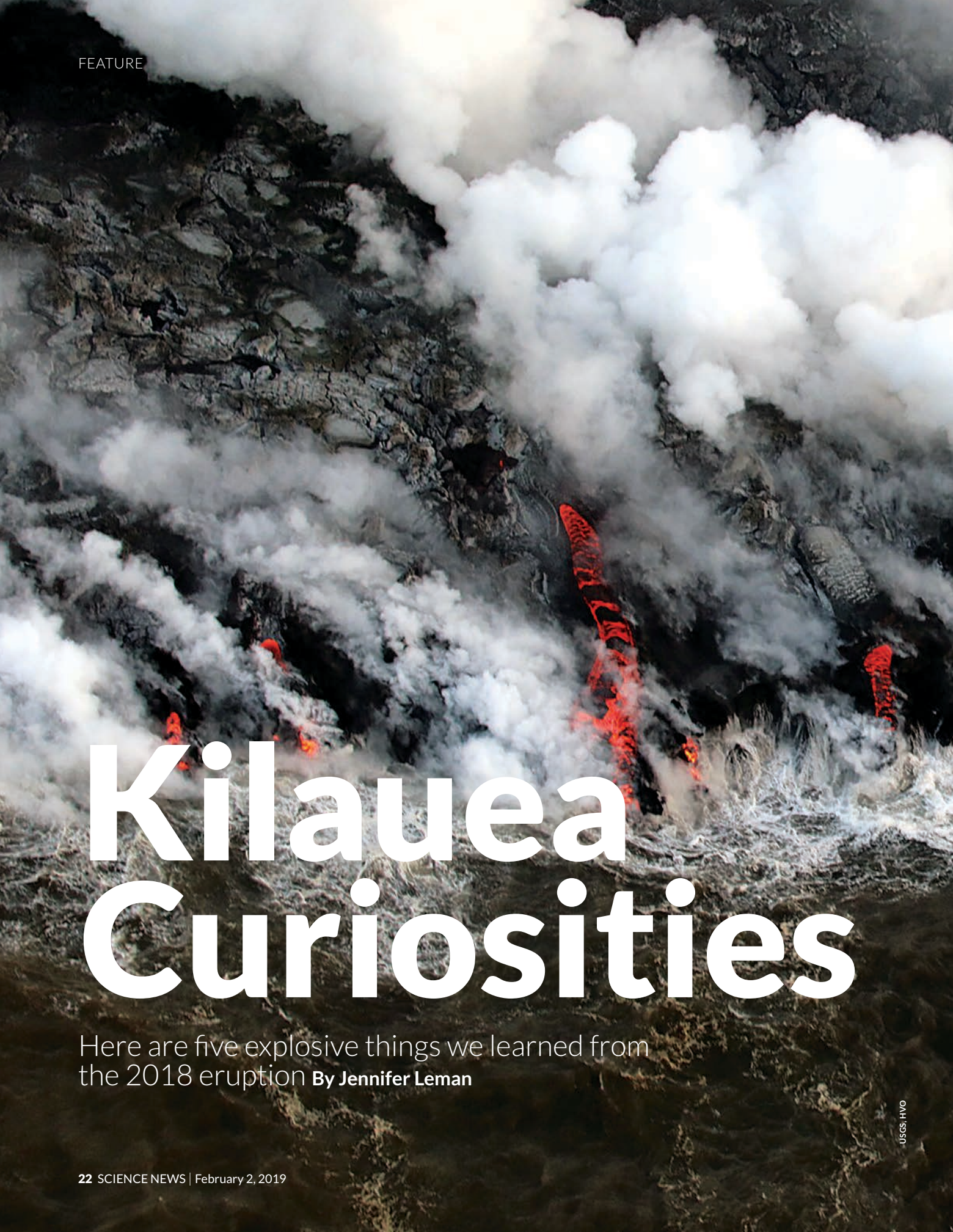


USGS, HVO

Kilauea Curiosities

Here are five explosive things we learned from the 2018 eruption **By Jennifer Leman**

Fire and fury Kilauea's eruption this summer, its largest in 200 years, gave scientists a front row seat to the volcanic processes that power our planet. In this August 5 image, lava at 1000 degrees C pours into the Pacific Ocean, sending a mixture of volcanic gases and evaporated seawater into the air.

After a stunningly explosive 2018, Hawaii's Kilauea volcano, which holds the title of world's longest continuously erupting volcano, finally seems to be taking a break. Following 35 years of nonstop activity, no lava is currently flowing from the Big Island's most famous volcano.

Scientists thought they knew Kilauea pretty well. It's one of the most closely monitored volcanoes in the world, with instruments watching every move since the 1800s. But the 2018 eruption still managed to offer up surprises.

"Everybody's chewing on all the great data collected from this eruption," says Christina Neal, the head scientist at the U.S. Geological Survey's Hawaiian Volcano Observatory. "That will go on for years and years." Neal coauthored a study published online December 11 in Science describing some of the inital findings.

The latest episode started last May, as lava drained from the summit crater. The molten rock gushed through underground tunnels and out linear eruption vents, or fissures, along an area called the lower East Rift Zone. All that lava flowed at a rate of about 50 meters per day. By the time the eruption ended in August, Kilauea had destroyed more than 700 houses, covered 35.5 square kilometers of land and added almost 300 hectares of terrain along the island's east coast.

In addition, more than 825 million cubic meters of earth from the area around the summit crater, known as the caldera, had collapsed. That's enough material to fill 300,000 Olympic-sized swimming pools, Kyle Anderson, a USGS geophysicist in Menlo Park, Calif., said December 11 at an American Geophysical Union meeting in Washington, D.C. As a result of the massive collapse, the cliff-hugging Jaggar Museum, Hawaii Volcanoes National Park's popular museum and research station, is now in an even more precarious position and closed indefinitely.

No one knows what's next for the volcano, but scientists are weaving together reams of data from the eruption. Here are five early findings from Kilauea's outburst:

Explore more

- Christina A. Neal et al. The 2018 rift eruption and summit collapse of Kilauea Volcano. Science. December 11, 2018.

Energetic andesite
Most of the fissure eruptions along the lower East Rift Zone produced incandescent spouts of molten basalt lava (left). Silica-rich andesite rocks, however, rocketed out of nearby fissure 17 (right), producing more explosive eruptions.

USGS

1. Really old lava explains why some eruptions were extra explosive

On May 13, lava suddenly exploded from a new fissure along the lower East Rift Zone. "There was this really loud banging that sounded like cannon fire," says Christoph Kern, a geochemist at the USGS Cascades Volcano Observatory in Vancouver, Wash., who was working in the rift zone at the time. Blocks of rock and ash flew hundreds of meters into the air. "It was reminiscent of a war zone."One man, who had not evacuated from his nearby home, suffered a shattered leg after he was struck by molten rock blasted from the fissure.

When the lava cooled enough that researchers could collect samples hours later, the scientists were shocked. Kilauea "erupted a magma like we've never seen before" in Hawaii, says Cheryl Gansecki, a volcanologist at the University of Hawaii in Hilo. "When I first got the analysis back, I told my student, 'You've made a mistake, go do it again.'" The molten rock was andesite, which is not usually found in Hawaii.

The Hawaiian Islands are dominated by basalt, a dark volcanic rock rich in iron and magnesium. Andesite contains more silica and more gas bubbles, which make eruptions extra explosive. Andesite is commonly ejected from volcanoes in regions where tectonic plates slip beneath one another, such as in the Andes in Chile or the Cascades in the Pacific Northwest. Hawaii isn't near a tectonic plate boundary; its volcanoes are fueled by a "hot spot," a plume of magma that rises from Earth's interior.

The andesite was also much older than lava erupted from nearby fissures, Gansecki says. She suspects the andesite might have evolved from magma that was trapped underground during a previous eruption or from molten rock that crept up closer to Earth's surface from deeper in Earth's interior gradually over time. When basalt magma cooks beneath Earth's surface for a long time, different crystals, including silica, have time to form, and the rock's composition changes.

"We kind of knew that these magmas were sitting around a little bit and then getting pushed to the surface," but we've never seen a lava type with minerals this changed, Gansecki says. Being aware that these pockets of older, gas-rich magma exist will help scientists better understand the potential hazards of Kilauea's anomalous explosive fissure eruptions.

Fume side of the fissure Plants downwind of the lava flow in the lower East Rift Zone, were choked with toxic gases and quickly died (left side of image). Upwind, tropical vegetation largely escaped the harsh conditions, remaining lush (right).

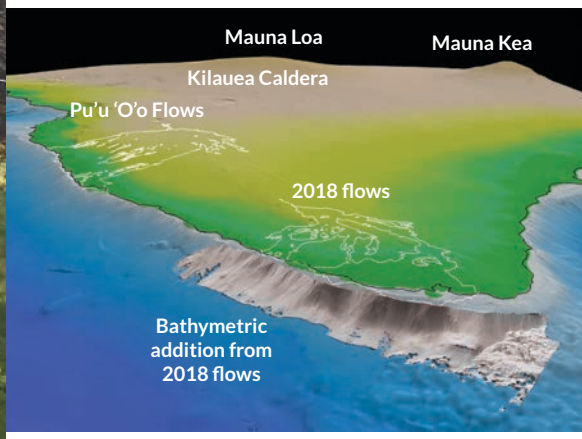
ADAM SOULE/WOODS HOLE OCEANOGRAPHIC INSTITUTE

2. Kilauea revealed its strangely predictable ways

This most recent activity gave scientists a rare chance to study the collapse of a caldera. Only seven other caldera collapses have been observed worldwide since 1900 — and never with this level of detail, Anderson says. In 2014, for instance, Iceland's Bárdarbunga volcano experienced a similar "piston-style" caldera collapse, in which a large block of land sinks down into a volcano's magma chamber below. But that collapse was obscured by roughly 700 meters of snow and ice, making it difficult to monitor.

Surprisingly, 62 small collapses rattled Kilauea from mid-May to late August rather than a single big one. Each collapse spurred more than 700 earthquakes and caused the crater floor to sink further, pushing the surrounding land out and up. By the end, the center of the volcano was as much as 500 meters lower than when it started — more than the height of the Empire State Building.

The collapses seemed to happen at regular intervals — roughly every 25 to 35 hours, Kern says. That was the amount of time it took for enough pressure to build inside the magma chamber, at which point, gas escaped through cracks around the summit crater, sending rock and ash into the air. With the pressure release, the caldera sank further.



Flowing far On Hawaii's Big Island, Kilauea's caldera, drained of its lava lake in early May, spurred months of eruptions 40 kilometers down a system of fissures spanning the southeastern part of the island. The lava produced more than a cubic mile of new land (gray) along the southern coast.

Going, going, gone
The lava lake that once bubbled inside Kilauea's summit crater (left, pictured on April 13, 2018) drained in early May, spurring a series of collapse events that = created a pit more than 500 meters deep, (right, on July 28).

USGS

3. Lava traveled far and fast through the fissures

The 2018 eruption peeled back Earth's layers, revealing that the famously active volcano's plumbing system — from the summit crater to all 24 fissures —was very clearly connected, says geophysicist Ingrid Johanson of the USGS Hawaiian Volcano Observatory.

Scientists tracked the volcano's activity in exquisite detail. Within minutes of a collapse at the summit, tiltmeters, which measure small vertical shifts in Earth's surface, registered pressure pulses along the East Rift Zone. Within hours, scientists saw increased levels of lava gushing out of fissures more than 40 kilometers from the summit.

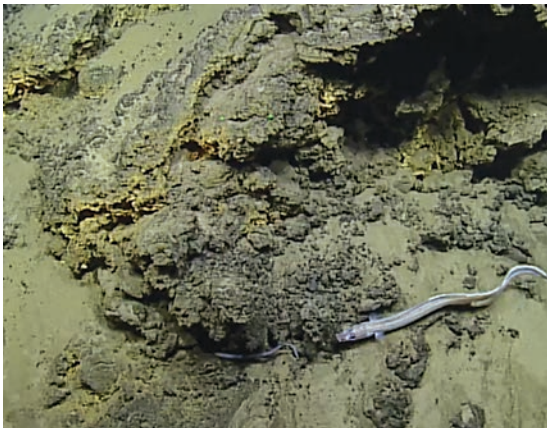
Volcanologists witnessing collapses at the summit were able to warn colleagues who were inspecting lava flows along the lower East Rift Zone. "Word would go out to the field geologists: 'Be on guard in a couple of hours; we think there's going to be a pulse,'" Johanson says. Surges in lava flow can cause a river of molten rock to spill over the sides of a fissure's channel — a danger to geologists working nearby. Fortunately, no one was injured.

4. Microbes moved in fast

Where the eruption flowed into the ocean, marine life sprouted along newly deposited lava flows surprisingly quickly. Using a remotely operated vehicle to explore the seafloor, researchers in September found bright yellow, potentially iron-oxidizing microbes in areas of hydrothermal activity about 650 meters deep, just offshore.

"I wondered if we were in the right place," says Chris German, a geologist at Woods Hole Oceanographic Institution in Massachusetts. "But I could see the fresh walls of lava still steaming on the shoreline." It had only been 100 days since lava first entered the water. "We really were in the right place and it had been colonized," he says. German and colleagues are now trying to identify the species of microbe.

Studying these new ecosystems may help explain how life could form in hydrothermal environments elsewhere in the solar system, such as Saturn's moon Enceladus (SN: 5/13/17, p. 6). On Earth, hydrothermal activity is common where tectonic plates meet — not a good analog for alien worlds, which appear to lack plate tectonics. But other worlds can be volcanically active, German says. Observing hydrothermal systems fueled by Kilauea and other volcanoes that aren't along tectonic boundaries could reveal a lot about other celestial bodies.



New life Kilauea dumped twice as much lava into the ocean as on shore. Just months after the lava reached the sea, yellow tufts of microbes lined the edges of the freshly deposited earth.

Gurgling gases A scientist with the U.S. Geological Survey measures fumes along a fractured, ash-covered road in the Leilani Estates. Noxious gases, such as sulfur dioxide and carbon dioxide, caused closure of Hawaii Volcanoes National Park from May 11 to September 22

FROM TOP: OCEAN EXPLORATION TRUST; USGS

5. Sulfur dioxide gas levels went through the roof

In 2018, Kilauea belched out some of the highest levels of sulfur dioxide ever measured at the volcano. The island was swamped by high levels of the gas prompting Hawaii's Civil Defense to issue island-wide air quality warnings.

"That's something that we don't often see," Kern says. Volcanic smog, also called vog, is a gaseous mixture composed mostly of water vapor, sulfur dioxide and carbon dioxide. One of many hazards associated with volcanic eruptions, the emission of sulfur dioxide can irritate the skin and eyes and, if inhaled, choke airways (SN: 7/7/18, p. 32).

In some instances, as much as 100 to 200 kilotons of the gas was released per day. Before the heightened activity, Kilauea emitted roughly five kilotons of sulfur dioxide per day, mostly through the summit crater's lava lake.

Today, in its new hiatus, Kilauea is producing much less sulfur dioxide, about 35 tons per day, and seismic activity has nearly ended. There hasn't been much land movement, save for swelling around the East Rift Zone's Puu Oo vent, which indicates that magma could still be creeping deep below. But nobody expects the volcano to stay quiet forever, Neal says. "We're in this lull, and we just don't know what is going to happen next."