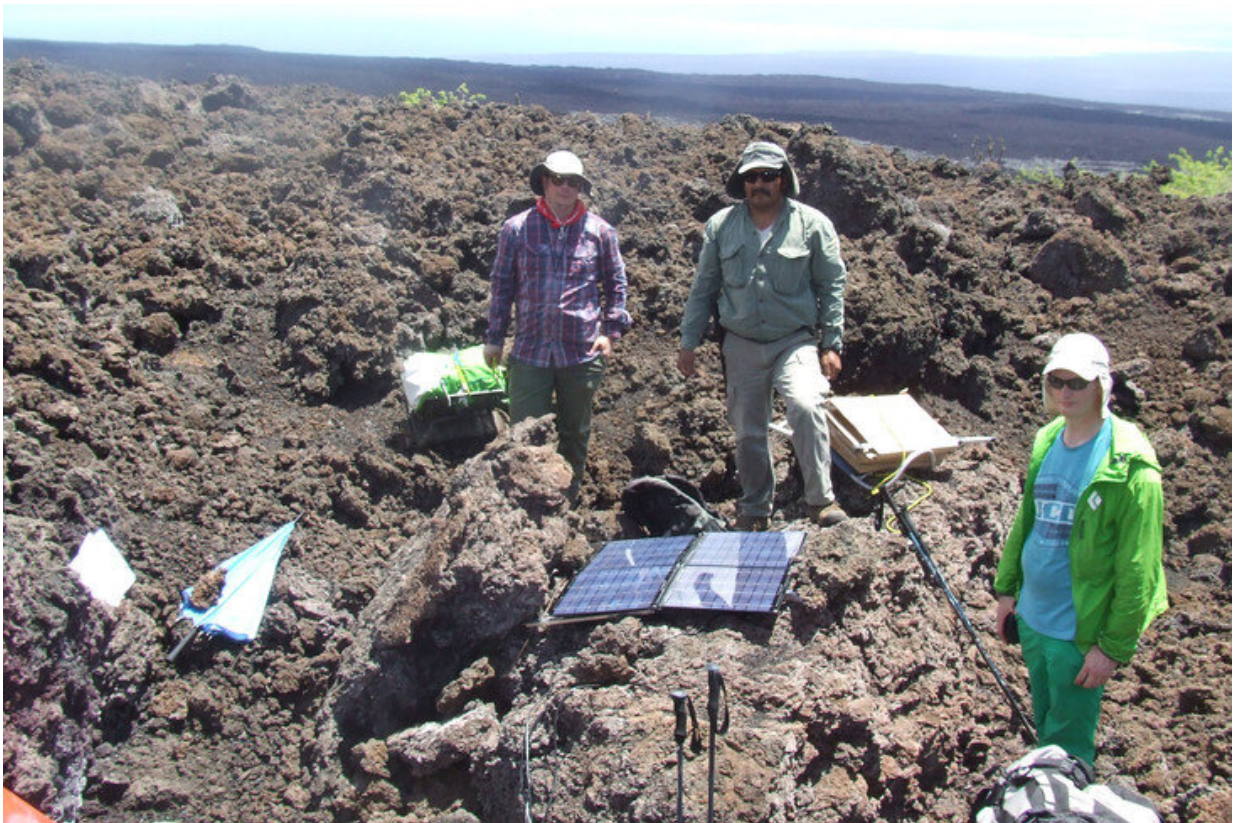


# Lead up to volcanic eruption in Galapagos captured in rare detail

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Field crew downloading data from a continuously operating Global Positioning station in the Sierra Negra caldera, Galapagos Islands, Ecuador. Credit: Keith Williams (UMAVCO, Inc).

Hours before the 2018 eruption of Sierra Negra, the Galápagos Islands'

largest volcano, an earthquake rumbled and raised the ground more than 6 feet in an instant. The event, which triggered the eruption, was captured in rare detail by an international team of scientists, who said it offers new insights into one of the world's most active volcanoes.

"The power of this study is that it's one of the first times we've been able to see a full eruptive cycle in this detail at almost any [volcano](#)," said Peter La Femina, associate professor of geosciences at Penn State.

"We've monitored Sierra Negra from when it last erupted in 2005 through the 2018 eruption and beyond, and we have this beautiful record that's a rarity in itself."

For nearly two months in 2018, lava erupted from the volcano, covering about 19 square miles of Isabela Island, the largest island in the Galápagos and home to about 2,000 people and endangered animal species like the Galápagos giant tortoise.

"The 2018 eruption of Sierra Negra was a really spectacular volcanic event, occurring in the 'living laboratory' of the Galápagos Islands," said Andrew Bell, a volcanologist at the University of Edinburgh. "Great teamwork, and a bit of luck, allowed us to capture this unique dataset that provide us with important new understanding as to how these volcanoes behave, and how we might be able to better forecast future eruptions."

While Sierra Negra is among the world's most active volcanos, its remote location previously made monitoring difficult. Scientists now use networks of ground-based seismic and GPS monitoring stations and satellite observations to observe the volcano.

"Based on constant monitoring of activity of Galapagos volcanoes, we detected a dramatic increase of seismicity and a steady uplift of crater floor at Sierra Negra," said Mario Ruiz, director of the Ecuador

Geophysical Institute, the country's national monitoring agency. "Soon we contacted colleagues from the United Kingdom, United States and Ireland and proposed them to work together to investigate the mechanisms leading to an impending eruption of this volcano. This research is an example of international collaboration and partnership."

The scientists captured data over 13 years as the volcano's magma chamber gradually refilled following the 2005 eruption, stressing the surrounding crust and creating earthquakes. This continued until June 2018, when an earthquake occurred on the calderas fault system and triggered the subsequent eruption, the scientists said.

"We have this story of magma coming in and stressing the system to the point of failure and the whole system draining again through the eruption of lava flows," La Femina said. "This is the first time anyone's seen that in the Galápagos to this detail. This is the first time we've had the data to say, 'okay, this is what happened here.'"

Often during volcanic eruptions, as magma chambers empty the ground above them sinks and forms a bowl-like depression, or a caldera. But Sierra Negra experienced a caldera resurgence, leaving this area higher in elevation than it was before the eruption, the scientists said.

Inside the Sierra Negra caldera is a "trap-door fault," which is hinged at one end while the other can be uplifted by rising magma. The scientists found the fault caused hills inside of the six-mile-wide caldera to lift vertically by more than 6 feet during the earthquake that triggered the [eruption](#).

Caldera resurgence, important to better understanding eruptions, had not been previously observed in such detail, the scientists reported in the journal *Nature Communications*.

"Resurgence is typical of explosive calderas at volcanoes like Yellowstone, not the kind of shield volcanoes we see in the Galápagos or Hawaii," La Femina said. "This gives us the ability to look at other volcanoes in the Galápagos and say, 'well that's what could have happened to form that caldera or that resurgent ridge.'"

The scientists said the findings could help their counterparts in Ecuador better track unrest and warn of future eruptions.

"There are people who live on Isabella Island, so studying and understanding how these eruptions occur is important to manage the hazards and risks to local populations," La Femina said.

**More information:** Andrew F. Bell et al. Caldera resurgence during the 2018 eruption of Sierra Negra volcano, Galápagos Islands, *Nature Communications* (2021). DOI: 10.1038/s41467-021-21596-4 , [dx.doi.org/10.1038/s41467-021-21596-4](https://doi.org/10.1038/s41467-021-21596-4)

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