Early indicators of magma viscosity could help forecast a volcano's eruption style

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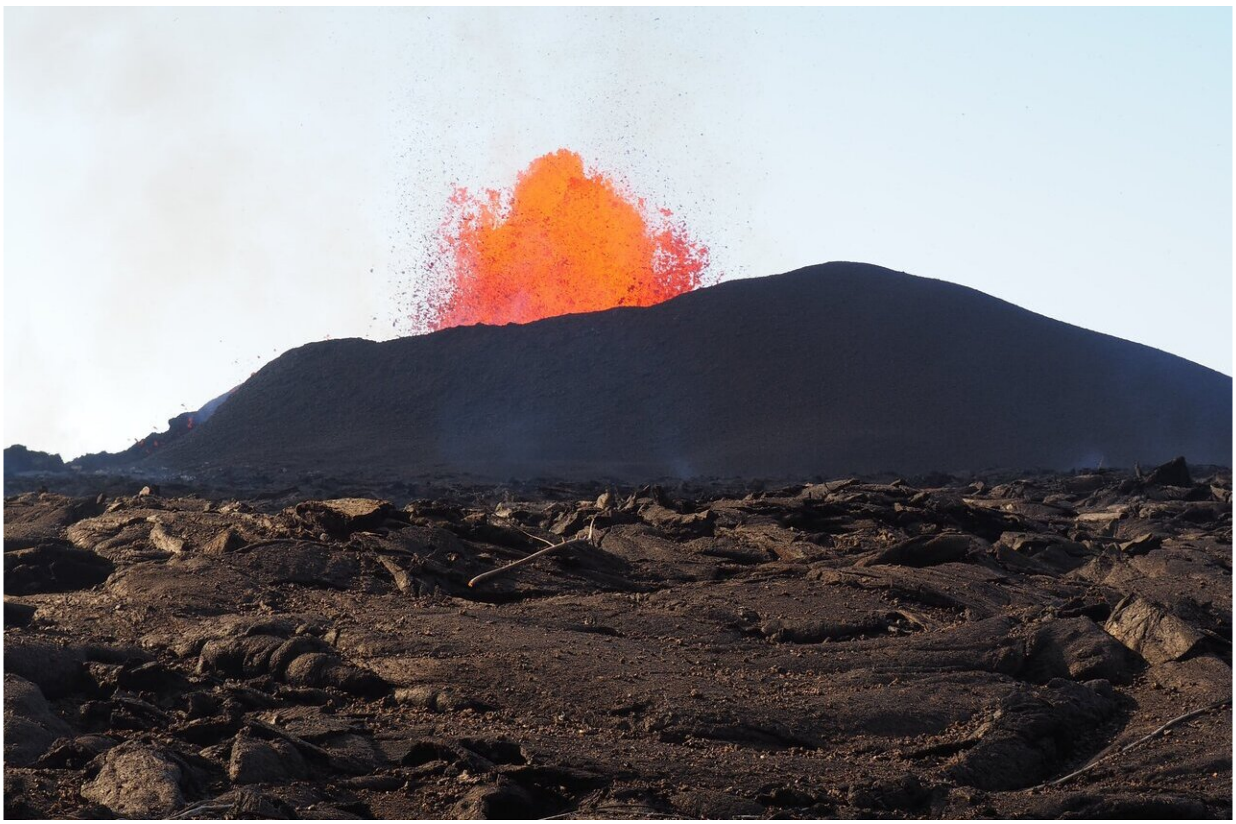


Lava fountaining from the most productive eruptive fissure, called fissure 8 at the time and now named Ahu'aila'au, built a cinder cone 55 meters high, about the height of a 10-story building. Most of the 2018 lower East Rift Zone eruption's 0.8 cubic kilometers of lava erupted from this point. Credit: B. Shiro, USGS

The 2018 eruption of Kīlauea Volcano in Hawai'i provided scientists with an unprecedented opportunity to identify new factors that could help forecast the hazard potential of future eruptions.

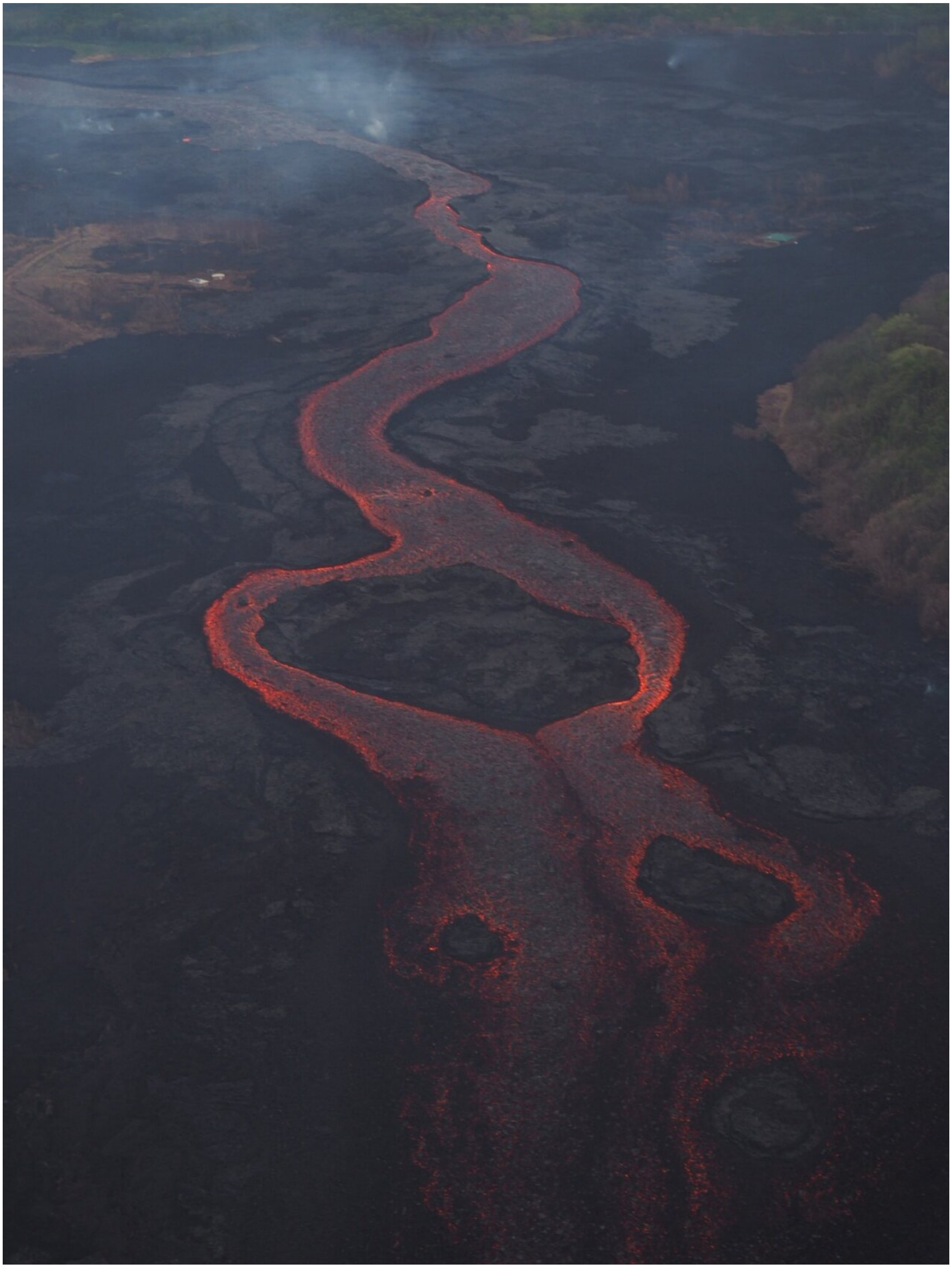
The properties of the magma inside a volcano affect how an eruption will play out. In particular, the viscosity of this molten rock is a major factor in influencing how hazardous an eruption could be for nearby communities.

Very viscous magmas are linked with more powerful explosions because they can block gas from escaping through vents, allowing pressure to build up inside the volcano's plumbing system. On the other hand, extrusion of more viscous magma results in slower-moving lava flows.

"But magma viscosity is usually only quantified well after an eruption, not in advance," explained Carnegie's Diana Roman. "So, we are always trying to identify early indications of magma viscosity that could help forecast a volcano's eruption style."

She led new work identifying an indicator of magma viscosity that can be measured before an eruption. This could help scientists and emergency managers understand possible patterns of future eruptions. The findings are published in *Nature*.

The 2018 event included the first eruptive activity in Kīlauea's lower East Rift Zone since 1960. The first of 24 fissures opened in early May, and the eruption continued for exactly three months. This situation provided unprecedented access to information for many researchers, including Roman and her colleagues—Arianna Soldati and Don Dingwell of Ludwig-Maximilians-University of Munich, Bruce Houghton of University of Hawai'i at Mānoa, and Brian Shiro of the U.S. Geological Survey's Hawaiian Volcano Observatory.

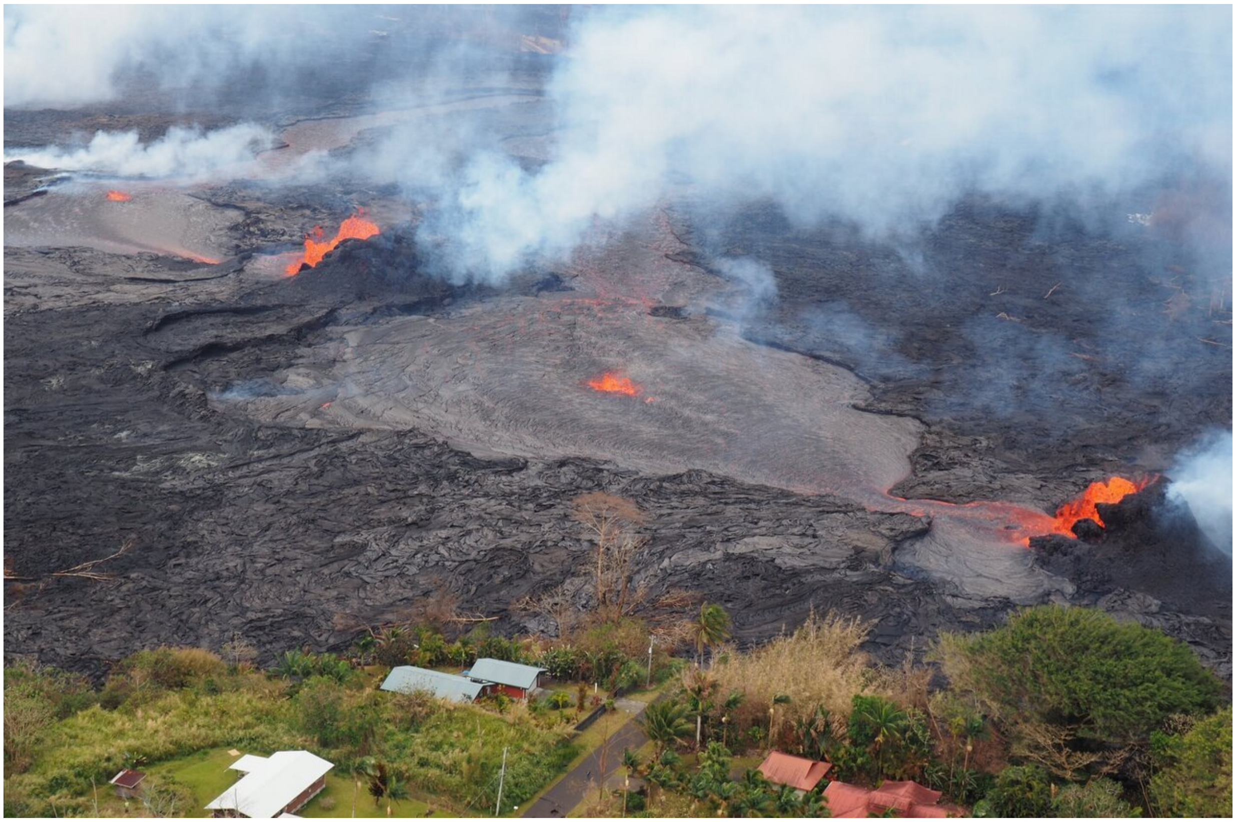


A fast-moving lava channel flowed from the Ahu'aila'au cone about 10 kilometers away to the ocean, where it covered about 36 square kilometers of land along the way and created 3.5-square-kilometers of new land along the coast. Where the channel slowed down in flat areas, it spread out and formed a braided pattern, seen here. Credit: B. Shiro, USGS

The event provided a wealth of simultaneous data about the behavior of both high- and low-viscosity magma, as well as about the pre-eruption stresses in the solid rock underlying Kīlauea.

Tectonic and volcanic activity causes fractures, called faults, to form in the rock that makes up the Earth's crust. When geologic stresses cause these faults to move against each other, geoscientists measure the 3-D orientation and movement of the faults using seismic instruments.

By studying what happened in Kīlauea's lower East Rift Zone in 2018, Roman and her colleagues determined that the direction of the fault movements in the lower East Rift Zone before and during the volcanic eruption could be used to estimate the viscosity of rising magma during periods of precursory unrest.



In May 2018, eruptive fissures opened and deposited lava within the Leilani Estates subdivision on the Island of Hawaii. Over 700 homes were destroyed, displacing more than 2,000 people. Credit: B. Shiro, USGS

"We were able to show that with robust monitoring we can relate pressure and stress in a volcano's plumbing system to the underground movement of more viscous magma," Roman explained. "This will enable monitoring experts to better anticipate the eruption behavior of volcanoes like Kīlauea and to tailor response strategies in advance."

More information: Earthquakes indicated magma viscosity during Kīlauea's 2018 eruption, *Nature* (2021). DOI: 10.1038/s41586-021-03400-x

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