Lava ejected during Cumbre Vieja eruption was unusually fluid

June 28 2022

Cumbre Vieja lava fountain on 18 November 2021. Credit: Jonathan Castro

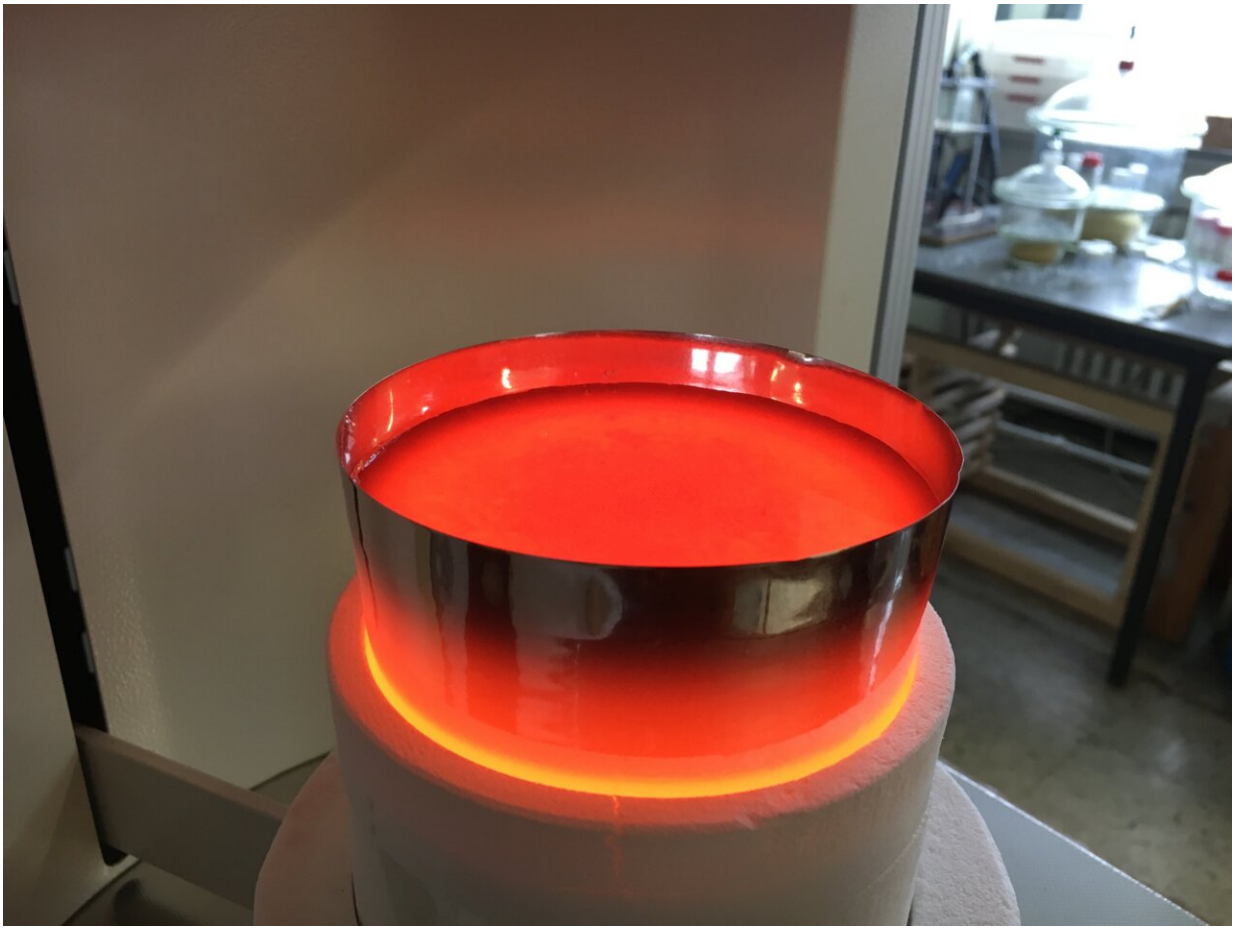
The Cumbre Vieja eruption in 2021 was the most protracted and

disruptive volcanic eruption in the recent history of the Canary Island of La Palma. More than 1,600 structures, including about 1,300 residential buildings, were destroyed or damaged. Pictures of lava flowing through settlements and out into the sea were seen around the world. Researchers at Johannes Gutenberg University Mainz (JGU) in Germany have now established that one of the reasons the destruction was so devastating was that the lava ejected during the eruption was exceptionally low in viscosity, causing it to flow very rapidly.

"The lava's viscosity was among the lowest ever observed for a basaltic eruption," said Yves Feisel, a doctoral candidate in Professor Jonathan Castro's research group at the JGU Institute of Geosciences. Castro and Feisel measured the viscosity of the Cumbre Vieja lava in the laboratory and published their findings in *Nature Communications*.

"It was actually possible from the footage of the lava flows on TV and online to see how fast the lava was moving and thus deduce its low viscosity," said Feisel. Based on the filmed images, the researchers calculated that, in some cases, the exit speed of the lava was greater than ten meters per second. In addition, the researchers were able to observe phenomena in the lava flows that are normally more characteristic of turbulent flowing fluids, such as those within bodies of water, for example, so-called hydraulic jumps or standing waves.

To determine the viscosity of the lava more precisely, the researchers collected solidified ash particles as they fell from the sky on La Palma. Back at Mainz University, they were able to determine the temperature of the eruption by chemically analyzing these samples, revealing that the magma must have been in the range of approximately 1,150 to 1,200 degrees Celsius. They also melted some of the samples and measured the viscosity of the melt at these temperatures using a device known as a rheometer.



A sample of the lava remelted at Mainz University. Credit: Caroline Scholl-Poensgen

"Shortly after the eruption began, the lava had a viscosity of about 10 to 160 Pascal seconds," Feisel explained. "That is a figure 10 times lower than, say, the viscosity of the lava discharged from Kilauea in Hawaii in 2018." According to Feisel, the Cumbre Vieja lava was so fluid primarily due to its specific chemical composition, in particular its relatively low silica content and the way in which this melt crystallized: "When the lava cooled, crystals were formed and this likely helped retain the low silica (SiO_2) content of the lava, allowing it to maintain its low

viscosity over a longer period of time."

These research results may help to mitigate damage caused by volcanic eruptions in the future. "It is always very difficult to predict when and how volcanoes will erupt," Feisel admitted. Nevertheless, the information on lava viscosity may prove useful since fluid lava such as that from Cumbre Vieja is usually discharged from a variety of locations, some of which may vary over time. Knowing that the lava is low in viscosity and will flow rapidly can, among other things, help integrated eruption and terrain models to better predict the course and evolution of future lava flows.

More information: Jonathan M. Castro et al, Eruption of ultralow-viscosity basanite magma at Cumbre Vieja, La Palma, Canary Islands, *Nature Communications* (2022). DOI: 10.1038/s41467-022-30905-4

Provided by Universitaet Mainz