American Museum of Natural History

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Study Suggests that Magma Composition Drives Volcanic Tremor

Daily ashfall sampling at Cumbre Vieja volcano in the Canary Islands demonstrates potential for near-real-time eruption monitoring and forecasting tool

A new study based on the sampling and analysis of volcanic ash at Cumbre Vieja volcano in the Canary Islands, located off Africa's northwest coast, suggests that the composition of magma could drive tremors during volcanic eruptions. The findings, which are detailed today in the journal *Nature Geoscience* in a paper led by scientists at the American Museum of Natural History and the City University of New York (CUNY), highlight the potential of volcanic ash analysis as a monitoring and forecasting tool.

"The volcano research community has gotten much better in recent years at forecasting the start of a volcanic eruption, but it's still hard to predict eruption style and duration," said study co-author Samantha Tramontano, a Kathryn W. Davis Postdoctoral Fellow at the Museum. "If our findings hold true for other volcanoes, we might be able to monitor interior magma properties from the surface of an eruption, and that could be very important for hazard assessment."

In September 2021, after lying dormant for 50 years, the Cumbre Vieja volcano on La Palma island, in Spain's Canary Islands, erupted, causing the evacuation of thousands of residents. Over the next 85 days, it destroyed more than 3,000 buildings and hundreds of acres of farmland. Tramontano and her advisor at the time, CUNY's Marc-Antoine Longpré, set up a system to collect near-daily samples of ashfall during the three-month eruption with help from colleagues at the Instituto Volcanológico de Canarias and the Instituto Geográfico Nacional.

The samples, which captured 94 percent of the eruption timeline, were sent back to the Museum for chemical analysis of the glass within the ash, which originated from the rapidly cooled magma being ejected from the volcano, using an electron microprobe. The resulting dataset was a daily time series of the composition of the liquid part of the magma, the first of its kind.

The study revealed changes in the amount of silica in the samples, a compound that makes magma more viscous. More viscous magma is usually associated with more explosive eruptions. The researchers found that silica content was high in the eruption's first week, then gradually decreased until a sharp reversal two weeks before the eruption's end, likely marking the cutoff of the mantle magma supply.

The researchers then compared this chemical record to physical observations being made at the same time, finding a correlation between silica content and the strength of the volcano's tremor, a seismic "rattling" associated with liquid and gas movement beneath the surface. Based on modeling and further analysis, the research team proposes that the presence of more viscous magma with high silica content causes increased volcanic tremor amplitude, although further research is needed to confirm this mechanism.

In addition to offering new clues into the cause of volcanic tremor, which is a key eruption monitoring parameter, the study shows the benefit of combining petrological data collection—like ashfall—with geophysical data to improve eruption forecasting, hazard assessment, and decision-making during volcanic crises.

"A big challenge for petrological monitoring is the coordination of fieldwork and sample transfer during eruption crises to enable fast analysis," Longpré said. "Careful pre-planning and technological developments should make efficient, near-site sample analysis possible in the future, better supporting timely interpretation of geophysical data."

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ABOUT THE AMERICAN MUSEUM OF NATURAL HISTORY (AMNH)
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Images:
Left, study co-author Samantha Tramontano measuring the accumulation of ash at the Cumbre Vieja volcano three weeks after the eruption began in 2021; Right, a field of volcanic ash during the eruption of the Cumbre Vieja volcano in the Canary Islands, located off Africa's northwest coast.