No Redoubt: Volcanic eruption forecasting improved

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Astronaut photo of ash cloud from Mount Cleveland, Alaska, USA. Image: NASA

Forecasting volcanic eruptions with success is heavily dependent on recognizing well-established patterns of pre-eruption unrest in the monitoring data. But in order to develop better monitoring procedures, it is also crucial to understand volcanic eruptions that deviate from these patterns.

New research from a team led by Carnegie's Diana Roman retrospectively documented and analyzed the period immediately preceding the 2009 eruption of the Redoubt volcano in Alaska, which was characterized by an abnormally long period of pre-eruption seismic activity that's normally associated with short-term warnings of eruption. Their work is published today by *Earth and Planetary Science Letters*.

Well-established pre-eruption patterns can include a gradual increase in the rate of seismic activity, a progressive alteration in the type of seismic activity, or a change in ratios of gas released.

"But there are numerous cases of volcanic activity that in some way violated these common patterns of precursory unrest," Roman said. "That's why examining the unusual precursor behavior of the Redoubt eruption is so enlightening."

About six to seven months before the March 2009 eruption, Redoubt began to experience long-period seismic events, as well as shallow volcanic tremors, which intensified into a sustained tremor over the next several months. Immediately following this last development, shallow, short-period earthquakes were observed at an increased rate below the summit. In the 48 hours prior to eruption both deep and shallow earthquakes were recorded.

This behavior was unusual because precursor observations usually involve a transition from short-period to long-period seismic activity, not the other way around. What's more, seismic tremor is usually seen as a short-term warning, not something that happens months in advance. However, these same precursors were also observed during the 1989-90 Redoubt eruption, thus indicating that the unusual seismic pattern reflects some unique aspect of the volcano's magma system.

Advanced analysis of the seismic activity taking place under the volcano allowed Roman and her team to understand the changes taking place before, during, and after eruption. Their results show that the eruption was likely preceded by a protracted period of slow magma ascent, followed by a short period of rapidly increasing pressure beneath Redoubt.

Elucidating the magma processes causing these unusual precursor events

could help scientists to hone their seismic forecasting, rather than just relying on the same forecasting tools they're currently using, ones that are not able to detect anomalies.

For example, using current techniques, the forecasts prior to Redoubt's 2009 eruption wavered over a period of five months, back and forth between eruption being likely within a few weeks to within a few days. If the analytical techniques used by Roman and her team had been taken into consideration, the early risk escalations might not have been issued.

"Our work shows the importance of clarifying the underlying processes driving anomalous volcanic activity. This will allow us to respond to subtle signals and increase confidence in making our forecasts." Roman said.

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