Volcano 'libraries' could help plan for future volcanic crises

May 24 2018

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Crystals from the 2010 Eyjafjallajökull eruption have demonstrated a new way to recognise pre-eruption signals at Eyjafjallajökull and potentially other, similar volcanoes around the world.

A team of volcanologists from the University of Leeds, Iceland and the British Geological Survey have studied the chemistry of the crystals flung out during the early stages of the 2010 airline-grounding eruption in Iceland. Because the eruption was so well-monitored, the geologists knew precisely when their samples were erupted to within a six-hour eruption window.

By analysing the records in the crystals and working back from the time of eruption, they were able to read the magma's history in time and location, which allowed them to interpret how the volcano behaved, and magma built up, in the six months beforehand. Their reconstruction of what was happening deep underneath the ground aligns with observations made at the surface at the same time. This opens up the possibility of studying other, older erupted materials to get a long term record of how the volcano has typically behaved in the run-up to previous eruptions.

The same techniques could potentially be applied to numerous other volcanoes, creating a 'library' of volcano histories and could greatly improve understanding of the critical, pre-eruptive phase of volcano activity, which is key in making accurate forecasts of eruptions.

Study lead author Dr. Matt Pankhurst conducted the research at the University of Leeds. He is now based at INVOLCAN in Spain.

He said: "There is no theoretical limit to how far back these volcano histories can be read. As long as there are crystals, the rocks can be used, because the records are literally set in stone.

"The biggest questions concerning the impact of volcanism are always 'when will it erupt?', 'how can we tell?' and 'will we have enough time to respond?' A comprehensive library of a volcano's activity in the past could go a long way to answer those questions in the future."

The project was led by Dr. Daniel Morgan, from the School of Earth and Environment at Leeds, together with Prof. Thorvaldur Thordarson of the University of Iceland and Dr. Sue Loughlin of the BGS, and studied the chemical patterns inside the crystals that Eyjafjallajökull spat out over the course of March and April 2010.

Dr. Morgan said: "This eruption of the Eyjafjallajökull produced crystals of the mineral olivine. These crystals contain chemical variations that record their environment, but also record the time elapsed. By reading back this time record, we can work out where and when the magma was moving and crystallising before and during the eruption.

"Olivine crystals are common in basaltic eruptions, allowing us to potentially apply these techniques to volcanoes with similar chemistries around the world."

The essential method for how crystal chemistry can be used to piece together physical histories is not limited to olivine crystals or basaltic rocks. Applying these techniques to all types of volcanic activity is an active topic of research and development at the University of Leeds and elsewhere.

More information: Matthew J. Pankhurst et al, Magmatic crystal records in time, space, and process, causatively linked with volcanic unrest, *Earth and Planetary Science Letters* (2018). DOI: 10.1016/j.epsl.2018.04.025

Provided by University of Leeds