UNIVERSITÉ DE GENÈVE

PRESS RELEASE

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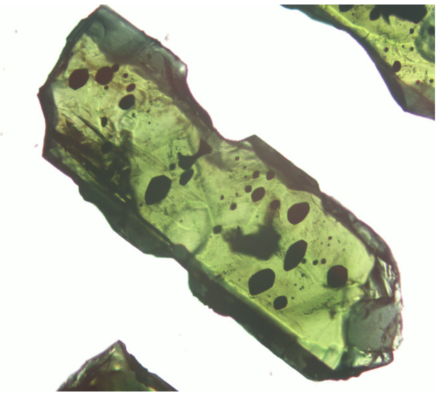
This volcano's explosive eruptions defy predictions

Colli Albani, an Italian volcano, has experienced major eruptions thousands of years ago that don't fit with current models. Using 3D imaging, a team from UNIGE has unraveled this phenomenon, paving the way for improved volcanic hazard mitigation.



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Photomicrograph of a clinopyroxene crystal. This mineral formed in a magma chamber. Melt Inclusions (in black) are present in these crystals.

High resolution pictures

More than 800 million people live near an active volcano. Some of these volcanoes still defy existing models, making it impossible to predict their eruptions with complete accuracy. This is the case of Colli Albani in Italy, which has produced major explosions in the past despite its magma typically being associated with mild effusive eruptions. An international team led by the University of Geneva (UNIGE) is shedding light on this mystery using an innovative approach: analyzing crystals that retain traces of the last eruption. Published in the *Journal of Petrology*, this study paves the way for new analytical methods in volcanology and strengthens hazard mitigation.

Monitoring volcanoes to anticipate their potentially devastating effects requires a deep understanding of the precursory signals of an eruption. However, this task becomes challenging when a volcano defies predictive models—such as Colli Albani, located only 20 kilometers from Rome. In theory, its magmatic composition should result in low-intensity eruptions. Yet, its past eruptions tell a different story.

Magma contains volatiles (mainly water and carbon dioxide). Like when opening the cap of a soda bottle, as magma rises toward the surface, it releases these volatiles. The more viscous the magma, the harder it is for gas to escape. The retention of gas results in a progressive increase of pressure which eventually leads to violent explosive eruptions. In theory, Colli Albani should not pose this risk as its magma is not very viscous. Yet, it has produced several violent, large-volume explosive eruptions, the most recent occurring 355,000 years ago, when it spewed up to 30 km^3 of scorching ash and molten rock into the atmosphere.

To learn more, a team from UNIGE analyzed "melt inclusions" from the magma of the last eruption. These tiny droplets of magma, measuring just one-hundredth of a millimeter, were sealed inside crystals before the explosion, preserving valuable clues about the magma's chemistry, its water and carbon dioxide content—key factors in its explosiveness—as well as its temperature and pressure. In total, 35 crystals containing 2,000 inclusions were studied.

An Innovative Approach to Probing Magma

UNIGE scientists collaborated with several institutions, including the Deutsches Elektronen-Synchrotron (DESY), the Universities of Roma Tre and Bristol, and the Helmholtz-Zentrum Hereon. Using the PETRA III particle accelerator ring at DESY in Hamburg, the team was able to obtain high-resolution 3D images of magma inclusions. PETRA III generates intense X-rays to study matter on a nanometric scale at a variety of experiment stations, such as the one where the experiment took place.

"This approach is innovative in volcanology, particularly in the study of melt inclusions. It opens up new perspectives in the field," explains Corin Jorgenson, first author of the study and a doctoral student at the Department of Earth Sciences of the UNIGE Faculty of Science at the time of the research, now a postdoctoral researcher at University of Strathclyde in Scotland.

Valuable Results for Risk Prevention

One of the major discoveries was the presence of numerous large-volume bubbles of water and carbon dioxide within the inclusions. This indicates that, when they were trapped, the Colli Albani reservoir already contained substantial amounts of gas. "The excess gas made the magma similar to a sponge, compressed when additional magma accumulated in the reservoir, and rapidly expanding at the onset of eruption, both essential ingredients for the unexpectedly large and highly explosive eruption of Colli Albani," explains Luca Caricchi, full professor of Petrology and Volcanology at the Department of Earth Sciences of the UNIGE Faculty of Science, who led the research.

These results shed light on the mechanism behind the Colli Albani eruptions and highlight the importance of synchrotron-based 3D imaging techniques in volcanology. This approach, applicable to other volcanoes, will deepen our understanding of magma storage and degassing, while improving volcanic hazard mitigation.

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