Supervolcanoes likely triggered externally

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Summary:

Supervolcanoes, massive eruptions with potential global consequences, appear not to follow the conventional volcano mechanics of internal pressure building until the volcano blows. Instead, a new study finds, such massive magma chambers might erupt when the roof above them cracks or collapses.

FULL STORY

Mt St Helen's. When Mount St. Helen's erupted recently it ejected about one cubic kilometer of material, so a supervolcano is more than five hundred times larger.

Credit: © Matt Bullard / Fotolia

Supervolcanoes, massive eruptions with potential global consequences, appear not to follow the conventional volcano mechanics of internal pressure building until the volcano blows. Instead, a new study finds, such massive magma chambers might erupt when the roof above them cracks or collapses.

Knowledge of triggering mechanisms is crucial for monitoring supervolcano systems, including ones that lie beneath Yellowstone National Park and Long Valley, California, according to the study led by Patricia Gregg, University of Illinois professor of geology, in collaboration with professor Eric Grosfils of Pomona College and professor Shan de Silva of Oregon State University. The study was published in the *Journal of Volcanology and Geothermal Research*. Gregg also presented the findings this week at the annual meeting of the Geological Society of America.

"If we want to monitor supervolcanoes to determine if one is progressing toward eruption, we need better understanding of what triggers a supereruption," Gregg said. "It's very likely that supereruptions must be triggered by an external mechanism and not an internal mechanism, which makes them very different from the typical, smaller volcanoes that we monitor."

A supervolcano is classed as more than 500 cubic kilometers of erupted magma volume. For comparison, Gregg said, Mount St. Helen's ejected about one cubic kilometer of material, so a supervolcano is more than five hundred times larger.

"A typical volcano, when it erupts, can have lasting impacts across the globe," Gregg said. "We've seen that in Iceland when we've had large ash eruptions that have completely disrupted air traffic across Europe. A supereruption takes that to the nth degree."

The new study's findings are contrary to a pair of papers published in the journal *Nature Geoscience* in 2014 that claim a link between eruption likelihood and magma buoyancy. The magma byouancy hypothesis suggested that magma may be less dense than the rock surrounding it and therefore could push up against the roof, like an ice cube bobbing in water, increasing the pressure within the chamber and triggering an eruption.

"Typically, when we think about how a volcanic eruption is triggered, we are taught that the pressure in the magma chamber increases until it causes an explosion and the volcano erupts," Gregg said. "This is the prevailing hypothesis for how eruptions are triggered. At supervolcanic sites, however, we don't see a lot of evidence for pressurization. When I incorporated buoyancy into my numerical models, I couldn't reproduce the 2014 studies."

Gregg's numerical model incorporates all of the physics -- conserving mass, energy and momentum -- to calculate what would happen if a large buoyant magma body were to form in the shallow crust. The model showed that even when the chamber was huge and the difference in density was very large between the magma and he surrounding rock -- an unlikely scenario -- buoyancy added very little pressure to the system.

"The fact that my numerical model was not agreeing with their analytical solution suggested that there was something missing from the analytical solution. So that prompted me to look closer," Gregg said. "What they miss in the buoyancy model is Newtonian physics: The magma may push up, but the roof pushes back down."

The new study found that the size of the magma chamber is a much greater factor in generating supervolcanic eruptions. The buoyancy studies suggested that this correlation was due to having more material pushing up, but the Illinois-led study found that the size of the chamber affects the stability of the rock containing the chamber.

"Previous studies have found that as a magma chamber expands, it pushes the roof up and forms faults," Gregg said. "As these very large magma chambers grow, the roof above may become unstable and it becomes easier to trigger an eruption through faulting or failure within the rock. "

According to the model, if a crack or fault in the roof penetrates the magma chamber, the magma uses the crack as a vent to shoot to the surface. This could trigger a chain reaction that "unzips" the whole supervolcano.

Next, Gregg's group hopes to take advantage of the advanced computing facilities available at the University of Illinois, such as the Blue Waters supercomputer at the National Center for Supercomputing Applications. The researchers are working to create 4-D models that track the evolution of the Long Valley magma chamber over time in greater detail.

"If we see a correlation between magma chamber size and the ability to erupt, it is important to know if supervolcano eruptions are triggered by internal factors or by foundering and faulting in the roof. It may mean that we have to monitor these volcanoes differently," Gregg said. "If the trigger is an external force, whether it be an earthquake or a fault, then we should look at seismicity, what types of faults are being developed, what is the stability of the roof, and what kinds of activities are happening on the surface that could cause faulting."

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Story Source:

The above post is reprinted from materials provided by **University of Illinois at Urbana-Champaign**. *Note: Materials may be edited for content and length.*

Journal Reference:

1. Patricia M. Gregg, Eric B. Grosfils, Shanaka L. de Silva. **Catastrophic caldera-forming eruptions II: The subordinate role of magma buoyancy as an eruption trigger**. *Journal of Volcanology and Geothermal Research*, 2015; 305: 100 DOI:10.1016/j.jvolgeores.2015.09.022