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# Supervolcanoes erupt by their own rules

**Mega-eruptions and smaller volcanoes are triggered by different mechanisms.**

Alexandra Witze

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Luca Caricchi

Eruptions of small volcanoes like Italy's Stromboli are driven by pressure generated as molten rock accumulates underground.

Huge volcanic blasts occur less frequently than scientists would expect, and now volcanologists think they can explain why: super-eruptions and smaller eruptions are triggered by fundamentally different processes.

Small volcanoes, such as Italy's Stromboli, erupt when molten rock rises from deep within Earth and then stalls in an underground chamber until enough pressure builds to blast it out to the surface. But the magma chambers of giant volcanoes — such as the one that erupted 2 million years ago beneath what is now Yellowstone National Park in the western United States — are too large for pressure from magma squirts to cause an eruption.

Instead, the molten rock accumulates until its sheer buoyancy creates a different kind of stress, one that cracks open the top of the chamber and starts an eruption, researchers report[1].

“Essentially we identify two different trigger mechanisms for eruptions — one for small ones up to about 500 cubic kilometres of magma, and one where we can generate super-eruptions,” says Luca Caricchi, a volcanologist at the University of Geneva in Switzerland.

Caricchi and his colleagues describe the scenario today in *Nature Geoscience*[1].

Big eruptions are less common in the geological record than scientists would expect if they were to simply extrapolate from the number of small eruptions that go off over time. That difference could be due to a sampling bias[2] or to a fundamental difference between big and small eruptions[3].

Caricchi and his team used modelling and simulations to study the many factors that go into an eruption, from the heat of rising magma to the forces required to crack the top of a chamber. For small volcanoes, the scientists confirmed that the pressure of magma rising from below was enough to trigger an eruption. “It’s like blowing inside a little balloon — if you blow fast enough you can make it explode," says Caricchi.

But adding magma to a much larger chamber would be like blowing fruitlessly into a hot-air passenger balloon. Instead, a supervolcano accumulates a huge amount of magma, which is less dense than the surrounding rock and hence more buoyant. At some threshold, Caricchi says, there is enough magma in the chamber for its buoyancy to crack the rock above it and trigger an eruption.

The idea is bolstered by a laboratory study, also published today in *Nature Geoscience*[4]. A team led by geoscientists Wim Malfait and Carmen Sanchez-Valle, of ETH Zurich in Switzerland, measured the density of molten rock chemically similar to that found at many volcanoes. The scientists used the European Synchrotron Radiation Facility in Grenoble, France, to re-create the high pressures and temperatures found inside Earth.

From the density measurements they could determine the magma's buoyancy. "The bigger a magma chamber gets, the more buoyancy will start to play in," says Malfait.

Caricchi and his team have also worked out how big a magma chamber could theoretically get. The maximum size for an unerupted chamber of magma depends on a balance between its thickness and its horizontal extent: a chamber that is too thick will erupt, and a chamber that is too wide will start to cool and crystallize at its edges.

The biggest chamber possible would be about 90 kilometres across and contain about 35,000 cubic kilometres of magma, Caricchi says. That's seven times the amount of magma spewed out during the largest eruption known — from the La Garita caldera 28 million years ago in what is now Colorado.

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## References

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