Giant magma reservoir mapped deep beneath Yellowstone supervolcano

Amina Khan, Los Angeles Times, 4-24-15

You know that supervolcano in Yellowstone National Park? The one that, three times in the last 2 million years, spewed enormous amounts of ash over the North American continent? Scientists have discovered an enormous underground reservoir deep beneath the surface and have mapped it out for the first time.

Don't worry. There's not a lot of actual molten rock in there and it doesn't at all affect the likelihood of whether it will erupt anytime soon – the odds each year are still roughly 1 in 700,000. But the findings published online by the journal Science provide deeper (so to speak) insight on this mysterious supervolcano sitting in our backyard and on the inner workings of other supervolcanoes around the world.

"Now we really have a complete image of the Yellowstone plumbing system," study co-author Jamie Farrell, a geophysicist at the University of Utah in Salt Lake City, said in an interview.

The Yellowstone caldera, a giant crater caused by a previous eruption, measures 40 miles by 25 miles and sits in the northwest corner of Wyoming, in Yellowstone National Park. The supervolcano erupted 2 million, 1.2 million and 640,000 years ago, fed by the movement of the North American tectonic plate. Underground, 3 to 9 miles beneath the caldera, sits a frying-pan-shaped magma chamber measuring roughly 19 miles by 55 miles.

In a previous study, Farrell and coauthors showed that the shallow magma chamber, once thought to be 1,000 cubic miles, was actually about 2.5 times that size. Farrell and colleagues set out to see whether there was a deeper chamber below that one.

Here's the basic principle: The scientists used seismometers to detect the seismic waves sent out by earthquakes, and watched to see how long it took for them to show up at various instruments. Seismic waves pass through hotter, more molten material more slowly, so the longer the delay, the more molten material the wave must have passed through.

"We have a lot of seismometers and in some places it arrives faster and in other places it arrives slower," Farrell said.

The researchers pulled data from two networks: University of Utah Seismograph Stations that were picking up shallow readings from the local quakes in Utah, Idaho, the Teton Range and Yellowstone; and the NSF-funded Earthscope array, which showed deeper readings from temblors that happened much farther away.

Together, the results allowed them to map out the dimensions of the deeper magma reservoir, 12 to 28 miles beneath the supervolcano. It's about 4.4 times larger than the shallower magma chamber, and could fill 11.2 Grand Canyons (which itself holds 1,000 cubic miles). That said, 98% of what's in there is solid rock – hot, but solid, Farrell said. Only 2% of it is actually molten rock, probably in little deposits throughout (though they can't say for sure how it's distributed).

"Think of it like a sponge: Most of it is solid material … and then there's these little pockets in there of [molten] material," Farrell said.

The findings help show how the Yellowstone supervolcano connects to the hot-spot plume in Earth's mantle, and they shed light on why Yellowstone's soil and geothermal spots seemed to be giving off more carbon dioxide than should come from the gases in the shallow magma chamber alone. The results could also shed light on how other supervolcanoes – even the hard-to-reach ones underneath the ocean – are fed.

As for whether this research will help scientists predict the next big one? Not quite, he said.

"We can use it for further modeling – and maybe that can help us estimate where this volcano is in its current state, but we're really not there yet," he added.