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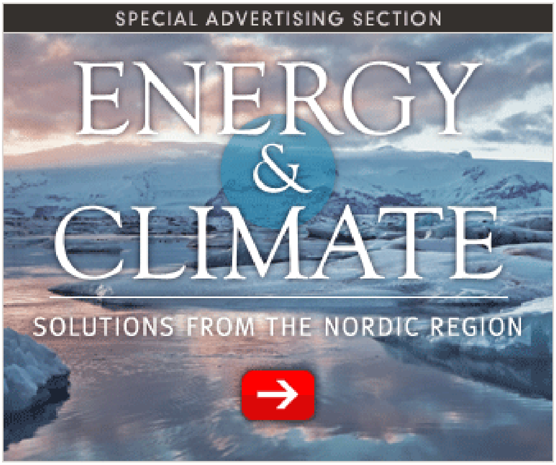
Why is lava shaped like that?

By Kathryn Eident



Editor's Note: Journalist and crew member Kathryn Eident is traveling on board the RV Atlantis *on a monthlong voyage to explore undersea volcanism in the eastern tropical Pacific Ocean, among other research projects. This is the third blog post detailing this voyage of discovery for* ScientificAmerican.com

For geologist Tracy Gregg, exploring submarine volcanoes is a lot like being a CSI detective, just without the bodies. While a CSI team gathers evidence to find the killer, Gregg explores the aftermath of a volcanic eruption so she can understand what's happening beneath the Earth's surface.

"I have the lava flow and I'm going to use that to figure out the hidden inner workings of a volcano," she said. "How fast did that lava come out? How long did it take to build that volcano I'm looking at? What can that tell me about the things I can't see?"

Gregg, a geologist from the University of Buffalo, has joined Chief Scientist John Sinton (University of Hawaii) aboard the RV Atlantis on a month-long journey to the Galapagos Spreading Center (GSC). An expert at deciphering lava morphology (the shape of lava flows after they've cooled) she's hoping to discover if the lava eruptions at this mid-ocean ridge are related, and if the eruptions are affected by a hotspot a few hundred miles to the east.

"Part of the reason we're here is [the GSC] hasn't been really well studied," she said. "[The ridge] shares some characteristics of the Mid-Atlantic Ridge, and some characteristics of the East Pacific Rise, so we weren't really sure of what we were going to find."

At her home lab at the University of Buffalo, Gregg uses computer modeling and laboratory simulations to understand how lava flows through the mantle and onto the seafloor.

Since lava itself is too hot to use in the lab, Gregg uses a wax made out of polyethyleneglycol 600 (PEG 600), the "600" referring to its molecular weight. Some may know PEG as "carbowax"; other versions of the wax are used in a variety of commercial forms ranging from antifreeze to salad dressing. PEG 600 mimics the viscosity of lava, but melts at about 68 degrees F, making it a perfect stand-in for molten rock. Using PEG 600 in big tanks, Gregg creates controlled volcanic eruptions, measuring differences in temperature, flow rates and slope.

"I'm enthralled by the idea of solid rock getting hot enough to melt and flow," she said.

Her lab experience is especially useful when she explores actual volcanic eruptions in the submarine, Alvin.

"I have this visual dictionary that I take in the sub with me, so that if I see these flow sites...I can go through my dictionary and go, 'Okay, that means it came out pretty slow' or 'that means it came out pretty fast,'" she said. "So when I'm in the sub, I'm seeing frozen solid lava out my window, but in my head I'm seeing a movie of what it looked like to get there."

So far, Gregg's seen a lot of pillow and lobate lavas on her Alvin dives. The presence of pillow lavas usually means the molten rock erupted slowly. Previous studies of the GSC have found higher levels of magnesium in this basaltic rock, leading scientists like Gregg to believe the lava flowed at high temperatures and had a lower viscosity. This combination of slow-moving, runny lava is unusual when compared to other mid-ocean ridges like the Mid-Atlantic Ridge (MAR) and the East Pacific Rise (EPR).

"We didn't know what we'd find, so everything's a surprise," she said. "Lots of magnesium means it came out hot and runny...but it was barely oozing out. It's very interesting."

Scientists discovered that lava flows on the MAR typically consist of thicker, crystal-laden lava that flowing at a slow rate, forming seamounts. At the EPR, they saw lava flows that appeared to have thinner, runnier lava flowing at a faster rate, forming sheet flows, she said.

The chemical content of the rocks present at these mid-ocean ridges factors into how it melts. Most lava flows consist of basalt, which is a silicate. Silicates contain a silica atom coupled with 2 oxygen atoms. Silica molecules can hook together, forming a three-dimensional compound called a silica-tetrahedra.

Silica-tetrahedra also hook together into chains, forming crystals like quartz. Unmelted crystals can make lava thicker and slow it down, much the way chunky peanut butter can be harder to spread than smooth peanut butter, Gregg said.

When silica molecules are heated, they act much like water molecules do when we boil water—they move fast and bounce around, making it harder for the each silica-tetrahedra to stick together and form chains. The result is a thinner, runnier lava.

Minerals like magnesium, which Gregg calls "party crashers," also inhibit the silica-tetrahedra, lowering the melted rock's viscosity and crystal content, which might explain the lava flows found at the GSC.

Some of the samples Alvin has retrieved also appear to lack crystals, adding evidence to the hypothesis that the lava flows on this portion of the GSC are made of thinner lava.

The science party aboard the RV Atlantis has yet to discover if these eruptions are fed by one big pool of lava or by many smaller pockets of molten rock. Lab tests, visual observations and eventual chemical analysis will help scientists like Gregg get a glimpse at the inner workings of the eruptions at the GSC.

Soon, the group will travel east toward a hotspot near the Galapagos Islands to explore whether the lava produced there affects the GSC. They'll continue mapping the seafloor with the autonomous benthic explorer, Sentry, and exploring eruptive events with Alvin.

Image: Deep submersible Alvin grabs a rock sample with its manipulator arm. (Photo courtesy of John Sinton)

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