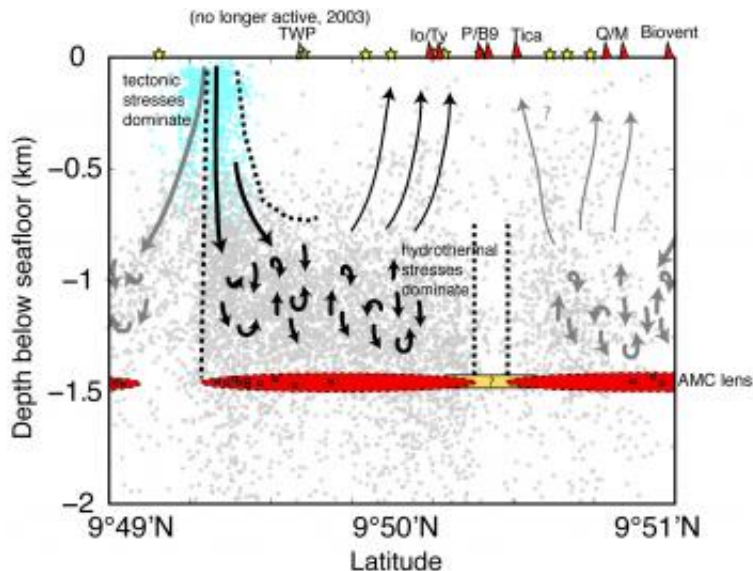


Quakes under Pacific floor reveal unexpected circulatory system

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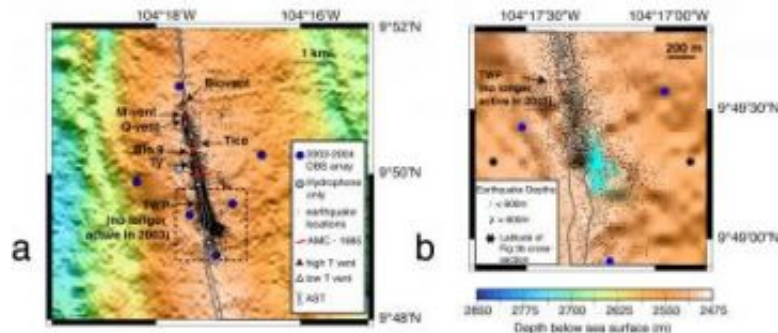


Cold water is believed to descend through chimney-like structure (left) and circulate through rocks under the ridge. It emerges, superheated, further down, fueling "black smoker" vents. Credit: Courtesy Lamont-Doherty Earth Observatory

Zigzagging some 60,000 kilometers across ocean floors, earth's system of mid-ocean ridges plays a pivotal role in many workings of the planet, from its plate-tectonic movements to heat flow from the interior, and the chemistry of rock, water and air.

It was not until the late 1970s that scientists discovered the existence of

vast plumbing systems under the ridges, which pull in cold water, superheat it, then spit it back out from seafloor vents—a process that brings up not only hot water, but dissolved substances taken from rocks below.



Dots represent earthquakes. Dense cluster to the bottom is the presumed downflow pipe. Nearer top are biovents, where hot water flows out. Credit: Courtesy Lamont-Doherty Earth Observatory

Unique life forms feed off the vents' stew, and valuable minerals including gold may pile up. Now, a team of seismologists working under 2,500 meters of water on the East Pacific Rise, some 565 miles southwest of Acapulco, Mexico, has created the first images of one of these systems—and it does not look the way most scientists had assumed. The resulting study appears in the Jan. 10 issue of the journal *Nature*.

The hypothetical image of a hydrothermal-vent system shows water forced down by overlying pressure through large faults along ridge flanks. The water is heated by shallow volcanism, then rises toward the ridges' middles, where vents (often called “black smokers,” for the cloud of chemicals they exude) tend to cluster. The new images, from a

4-kilometer-square area show a very different arrangement.

The water appears to descend instead through a sort of buried 200-meter-wide chimney atop the ridge, run below the ridge along its axis through a tunnel-like zone just above a magma chamber, and then bubble back up through a series of vents further along the ridge. “If you google on images of hydrothermal vents, you come up with cartoons that don’t at all match what we see,” said lead author Maya Tolstoy, a marine seismologist at Lamont-Doherty Earth Observatory, part of Columbia University’s Earth Institute.

The images were created using seismometers planted around the ridge to record tiny, shallow earthquakes—in this study, 7,000 of them, over 7 months in 2003 and 2004. Using new techniques developed by Lamont seismologist Felix Waldhauser, the quakes were located with great precision. They cluster neatly, outlining the cold water’s apparent entrance.

It dives straight down through the ridge about 700 meters, then fans out into a horizontal band about 200 meters wide before bottoming out at about 1.5 kilometers, just above the magma. Heated water rises back up through a dozen vents about 2 kilometers north along the ridge. The researchers interpret the quakes as the result of cold water passing through hot rocks and picking up their heat—a process that shrinks the rocks, and cracks them, creating the small quakes.

The downflow zone is thought to have been formed initially by a kink in the ridge, which stresses the rock enough to crack it mechanically. Seawater, forced down into the resulting space, eventually gets heated by the magma, then rises back to the seafloor—much the same process seen in a pot of boiling water. Tolstoy and her coauthors believe the water travels not through large faults—the model previously favored by some scientists—but through systems of tiny cracks.

Furthermore, their calculations suggest that the water moves a lot faster than previously thought—perhaps a billion gallons per year through this particular system. Their chart of the water’s route is reinforced by biologists’ observations from submersible dives that the area around the downflow chimney is more or less lifeless, while the surging vents are a riot of bacterial mats, mussels, tubeworms, and other weird creatures that thrive off the heat and chemicals.

“It’s an exciting and substantial contribution. It begins to look at some really big questions,” said Dan Fornari, a marine geologist at Woods Hole Oceanographic Institution who was not involved in the study. Among other things, it is a mystery where vent organisms came from--some evolutionary biologists believe they originated life on earth—and how or whether they now make their way from one isolated vent system to another.

The findings could add to an understanding of seafloor currents along which they may move, and of the nutrient flows that feed them. The work also has large-scale implications for how heat and chemicals are cycled to the seafloor and overlying waters, said Tolstoy. On a practical level, many large ore bodies now on land are thought to have been formed by such systems.

The work is part of a larger long-term interdisciplinary look at the East Pacific Rise, funded by the U.S. National Science Foundation. Scientists from Lamont and other institutions are still retrieving and analyzing data from earlier cruises. In 2006, a volcanic eruption buried some of their instruments; most of the instruments were lost, but those that survived provided new information about how the eruptions work. This summer, researchers hope to return aboard the new Lamont-operated vessel *Marcus G. Langseth* to generate unprecedented 3D images of the ridge’s interior.

Source: The Earth Institute at Columbia University

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