Close Reading: Hydrothermal Vents

Hydrothermal Vents

http://www.whoi.edu/main/topic/hydrothermal-vents

What are Mid-ocean Ridges?

The mid-ocean ridge is a continuous range of undersea volcanic mountains that encircles the globe almost entirely underwater. It is a central feature of seafloor terrain that is more varied and more spectacular than almost anything found on dry land, and includes a collection of volcanic ridges, rifts, fault zones, and other geologic features.

At nearly 60,000 kilometers (37,000 miles) long, the mid-ocean is the longest mountain range on Earth. It formed and evolves as a result of spreading in Earth's lithosphere—the crust and upper mantle—at the divergent boundaries between tectonic plates. The vast majority of volcanic activity on the planet occurs along the mid-ocean ridge, and it is the place where the crust of the Earth is born. The material that erupts at spreading centers along the mid-ocean ridge is primarily basalt, the most common rock on Earth.

Because this spreading occurs on a sphere, the rate separation along the mid-ocean ridge varies around the globe. In places where spreading is fastest (more than 80 millimeters, or 3 inches, per year), the ridge has relatively gentle topography and is roughly dome-shaped in cross-section as a result of the many layers of lava that build up over time. At slow- and ultra-slow spreading centers, the ridge is much more rugged, and spreading is dominated more by tectonic processes rather than volcanism.

Scientists study the physics, chemistry, and biology of mid-ocean ridges gain insight into how Earth works in very fundamental and often surprising ways.

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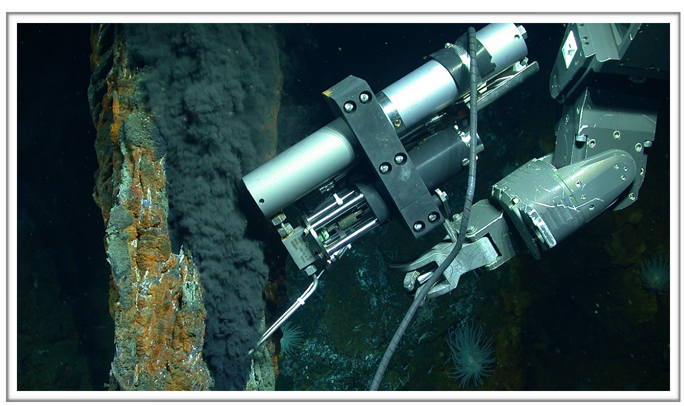

In 1977, scientists made a stunning discovery on the bottom of the Pacific Ocean: vents pouring hot, mineral-rich fluids from beneath the seafloor. They later found the vents were inhabited by previously unknown organisms that thrived in the absence of sunlight. These discoveries fundamentally changed our understanding of Earth and life on it.

Like hot springs and geysers on land, hydrothermal vents form in volcanically active areas—often on mid-ocean ridges, where Earth's tectonic plates are spreading apart and where magma wells up to the surface or close beneath the seafloor. Ocean water percolates into the crust through cracks and porous rocks and is heated by underlying magma. The heat helps drive chemical reactions that remove oxygen, magnesium, sulfates and other chemicals from the water that entered the ocean through rain, rivers, and groundwater. In the process, the fluids also become hotter and more acidic, causing them to leach metals such as iron, zinc, copper, lead, and cobalt from the surrounding rocks. The heated fluids rise back to the surface through openings in the seafloor. Hydrothermal fluid temperatures can reach 400°C (750°F) or more, but they do not boil under the extreme pressure of the deep ocean.

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As they pour out of a vent, the fluids encounter cold, oxygenated seawater, causing another, more rapid series of chemical reactions to occur. Sulfur and other materials precipitate, or come out of solution, to form metal-rich towers and deposits of minerals on the seafloor. The fluids also contain chemicals that feed microbes at the base of a unique food web that survives apart from the sun. Instead of relying on photosynthesis to convert carbon dioxide into organic carbon, the bacteria use chemicals such as hydrogen sulfide to provide the energy source that drives their metabolic processes and ultimately support a wide range of other organisms such as tubeworms, shrimp, and mussels.

Why Do They Matter?

Hydrothermal vents act as natural plumbing systems that transport heat and chemicals from the interior of the Earth and that help regulate global ocean chemistry. In the process, they accumulate vast amounts of potentially valuable minerals on the seafloor.

The mammoth copper mines of Cyprus, for example, were formed by hydrothermal activity millions of years ago before those rocks were uplifted from the seafloor to become dry land. Commercially valuable mineral deposits are believed to exist on the seafloor near hydrothermal vents, and a few companies have had plans in development for years to exploit some of these. The difficulty of mining in deep water near fragile ecosystems and the relatively small size of ocean bottom deposits compared to those on land have so far prevented seafloor mining from becoming commercially viable.

Vents also support complex ecosystems of exotic organisms that have developed unique biochemical adaptations to high temperatures and environmental conditions we would consider toxic. Learning about these organisms can teach us about the evolution of life on Earth and the possibility of life elsewhere in the solar system and the universe. Many previously unknown metabolic processes and compounds found in vent organisms could also have commercial uses one day.

Close Reading Questions

1. How do mid-ocean ridges form and evolve?

2. Where and when were the first hydrothermal vents discovered?

3. Why does the 400°C water not boil as it leaves the hydrothermal vent?

4. Why are hydrothermal vents important for the ocean's chemistry?

5. Why are hydrothermal vents important for commercial use?