



SPECIAL REPORT: SEAFLOOR SCIENCE

Oceans have captivated explorers for thousands of years. In recent decades, scientists have begun to uncover the mysteries of the ocean's most extreme environment: the seafloor. Down there, where no sunlight reaches and pressure is enormous, tectonic plates slowly shift, chimneys spew hot liquid "smoke," and exotic life forms thrive. Recently, an expedition called *VISIONS '05* visited the underwater volcanoes of the northeast Pacific. Join the cruise ...

click here to

DIVE IN

Life on the Bottom: Click here to see recent TV coverage from the *VISIONS '05* expedition about the ocean floor and its strange inhabitants.

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In the depths of the ocean, a mile or more below the surface, a fascinating mix of organisms thrives. In areas of volcanic activity, where superheated and chemically rich water emerges from the seafloor, life takes exotic and even unexpected forms.

VENT
CREATURES
EXTREMOPHILES

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Life Forms >> Vent Creatures

Hydrothermal vents occur when cracks in the seafloor allow cold water to seep beneath Earth's crust, where it is superheated and absorbs chemicals from the molten rock below. When this hot fluid meets the oxygen-rich cold seawater, chemical reactions occur, depositing metals and minerals that form chimney-like structures. The water gushes up through this 'chimney' in a kind of geyser and the precipitation of minerals makes the fluid look like a plume of smoke. Several forms of life thrive in this unusual environment. See photo gallery below.

A SPECIAL REPORT

VENT CREATURES

EXTREMOPHILES



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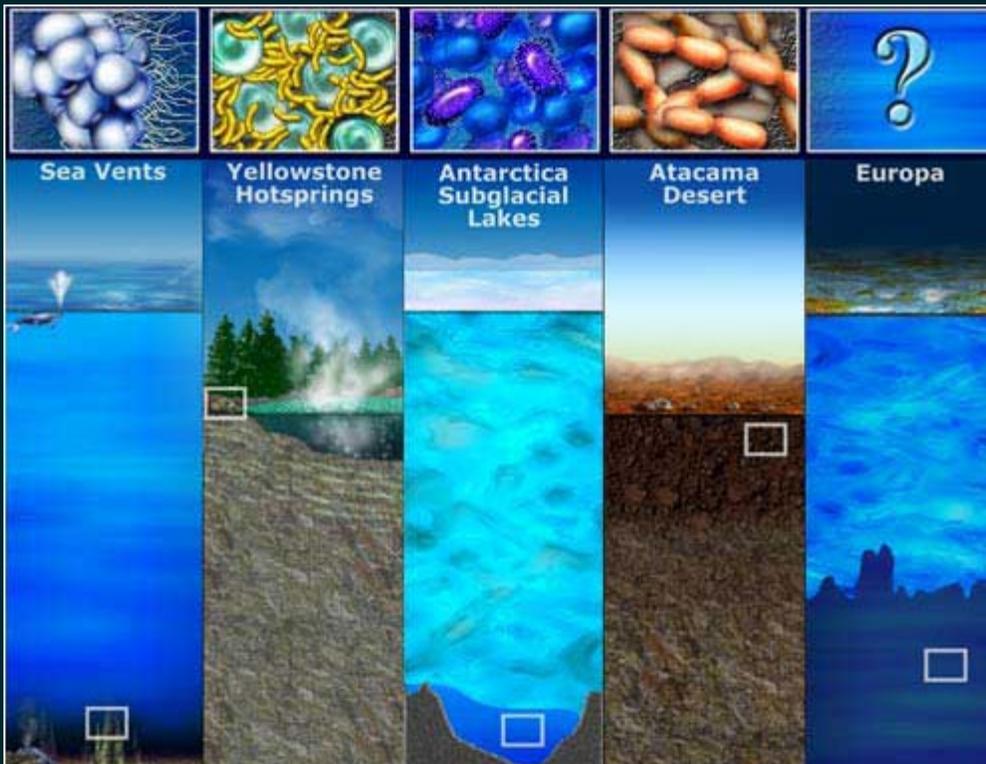
Life Forms >> Extremophiles

Life abounds in the most unexpected places—even extreme places. An organism that thrives in an extreme environment is called an extremophile. In the past decade, the search for this type of life has exploded. Discoveries about microscopic life inside seafloor vents are just one example. As we learn more about these organisms, we may learn more about the possibility of life beyond Earth.

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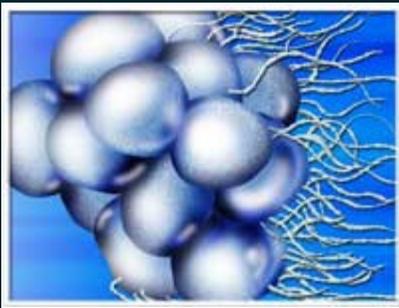
VENT CREATURES

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Credit: Nicolle Rager Fuller, NSF

Sea Vents



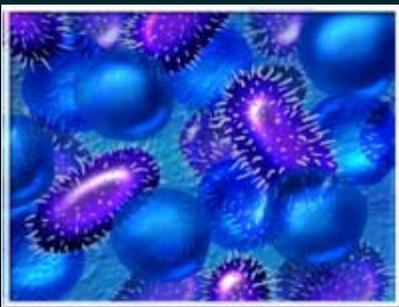
Life exists not just around [vents](#), but inside them too. Unlike the life forms that crawl or swim around the vents, those inside are invisible. These microscopic bacteria (one-celled organisms) not only survive but even thrive in the dark and hot environment of the vent. In the absence of sunlight, specially adapted bacteria and similar organisms called [Archaea](#) convert the vent chemicals to usable bioenergy, in a process analogous to plants' ability to use sunlight.

Yellowstone Hot Springs



Researchers have discovered a bizarre group of microbes that live inside rocks in the inhospitable geothermal environment at Wyoming's Yellowstone National Park. One scientist describes the life-form, found in the pores of rocks in a highly acidic environment, as "pretty weird," and resembling a lichen. Scientists believe similar kinds of geothermal environments may have once existed on Mars. The [Yellowstone discovery](#) may help steer the hunt for evidence of life on Mars.

Antarctica Subglacial Lakes



In addition to the super-hot environment of sea vents and hot springs, bacterial life may also exist in the cold, dark environment beneath the Antarctic ice sheet. Scientists aren't yet sure, but the suggestions are strong. Two separate research teams [have drilled into Lake Vostok](#), a suspected body of water below the Antarctic ice sheet. (It is still "suspected," and not proven, because scientists are reluctant to explore further until they know their actions will not contaminate a potentially unique environment.) Both teams found bacteria inside ice that is believed to be

created from lake water. DNA analysis indicates that although the bacteria have been isolated for millions of years, they are biologically similar to known organisms.

Atacama Desert



Scientists now know that life exists not only in very hot and very cold liquid environments, but in a very dry environment as well. Environmental microbiologists [have discovered evidence of microbial life](#) about a foot below the rough terrain of Chile's Atacama desert, one of the driest places on Earth. Their finding contradicts previous beliefs that the desert is too dry to support life, and may influence how scientists look for life in the similarly dry environment of Mars.

Europa



Some scientists speculate that if life does exist beyond Earth, it might be the form of vent bacteria. Because these microscopic life forms have already proven their ability to survive in the extreme environment of Earth's hydrothermal vents, they might also survive in similar environments elsewhere – for example, on Europa. Europa is one of Jupiter's moons, and is covered in ice. Scientists have recently uncovered strong evidence of liquid water beneath Europa's ice, which may be due to hydrothermal vents, which may in turn host bacteria. Alternatively,

scientists who have found evidence of bacteria living inside Antarctic ice speculate that they may also live inside Europa's ice. The questions exceed the answers, but the clues are tantalizing.

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In addition to seafloor life, researchers also study the geological structures which host that life. The VISIONS '05 expedition to the northeast Pacific in September 2005 studied the area around underwater volcanoes of the Juan de Fuca Ridge in the northeast Pacific Ocean. Here, at the boundary between two of Earth's gigantic crustal plates, scientists are examining a vent system that releases ultra-hot water rich in sulfur compounds—and thereby supports a host of extreme life-forms. Such exotic undersea environments are formed by geological and thermal forces that have been characterized only in the past 40 years, and still hold many mysteries.

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THE OCEAN
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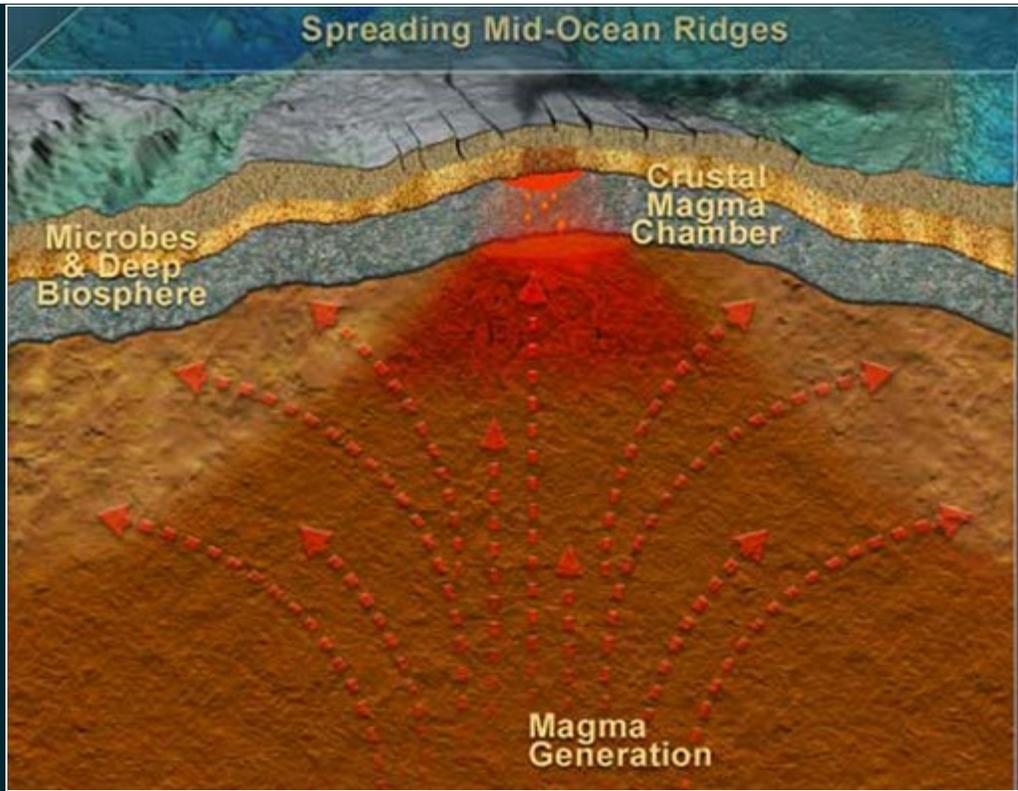
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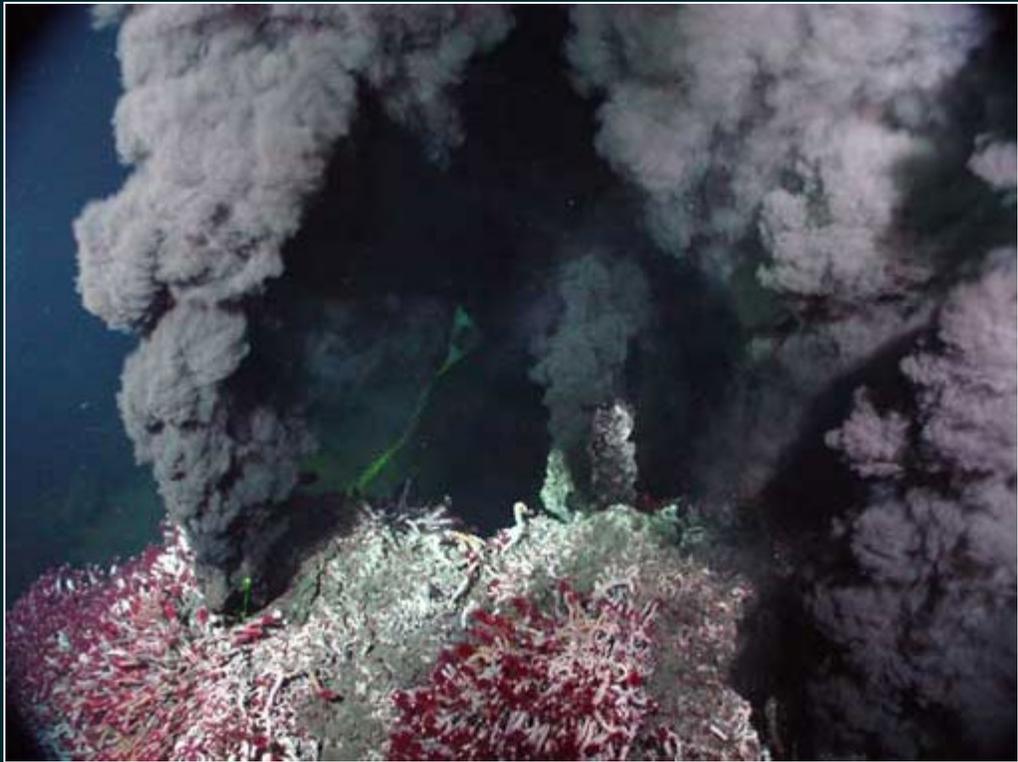
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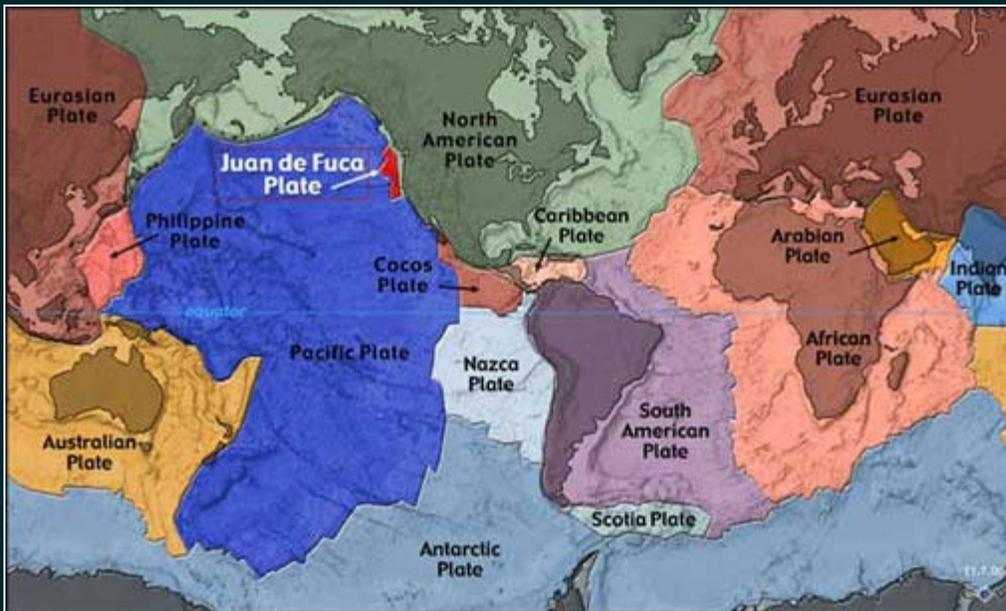
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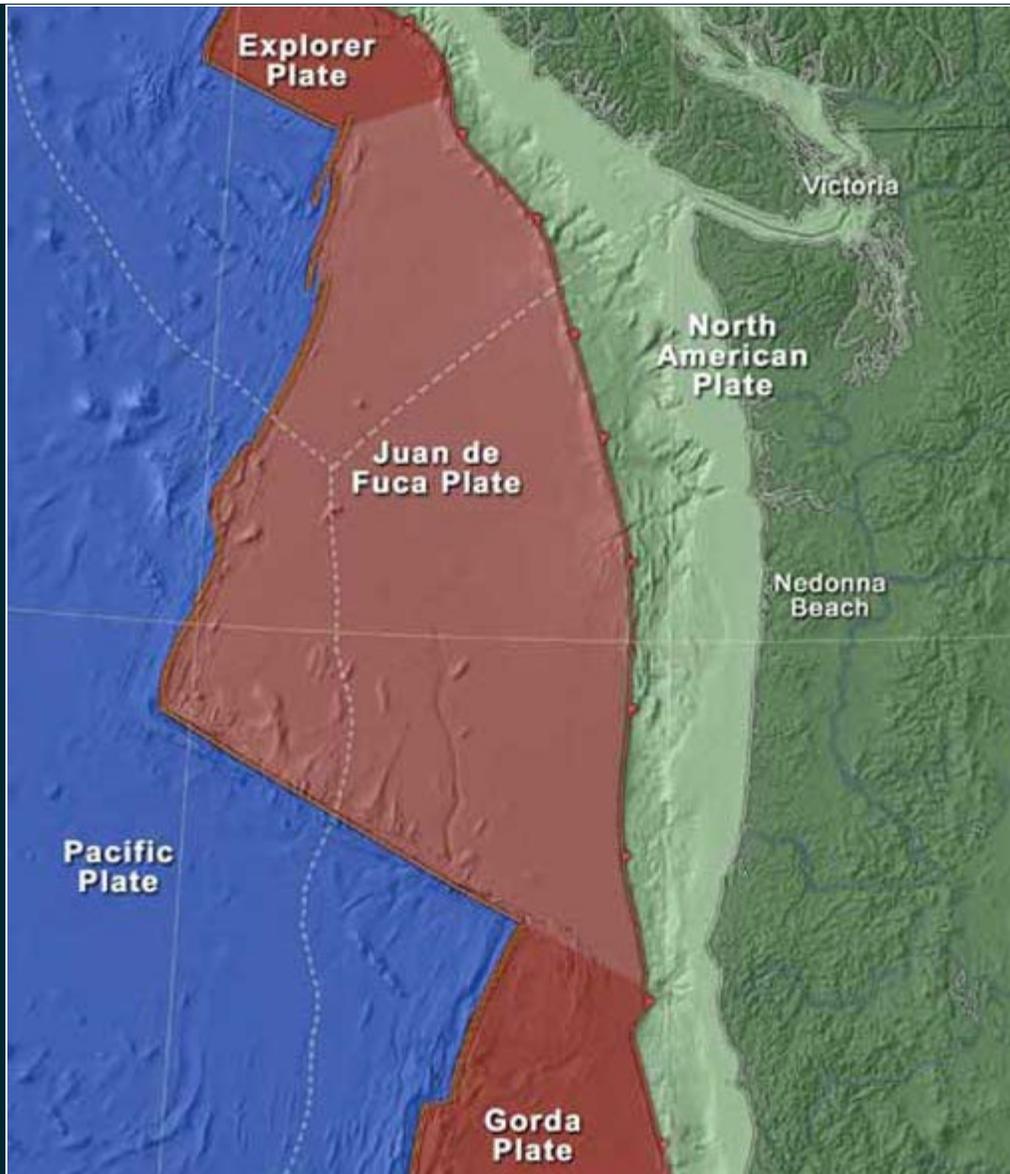
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Ocean exploration, like space exploration, requires a variety of tools—including multimillion-dollar research vessels, submersibles and various underwater helpers. Many people know about manned submersibles such as *Alvin*, which bring scientists to the ocean depths. Unmanned vehicles bring the secrets of the deep to the scientists, and are nearly as valuable to undersea exploration. AUVs (Autonomous Underwater Vehicles) such as ABE are untethered and programmed to work on their own. ROVs (Remotely Operated Vehicles) such as *Jason II* are tethered to a research vessel and controlled by a pilot. In addition to vehicles, scientists use other complex tools to explore the seafloor, such as samplers to grab and sensors to measure and analyze both fluids and gases.

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Tools of Discovery >> Research Vessels

The research vessel (R/V) is the heart of any ocean research expedition. For the participants, it serves as temporary home and office, and must carry with it all the supplies and tools needed to live and work at sea—often for several weeks at a time.

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The R/V *Thomas G. Thompson*'s operational command center is the bridge, where the crew can either steer the ship manually or via computer control by interrogation of the satellites overhead. Use the zoom indicators above to explore the bridge more closely.

Credit: Image provided courtesy of the VISIONS '05 expedition

(<http://www.VISIONS05.washington.edu>) and Véronique Robigou



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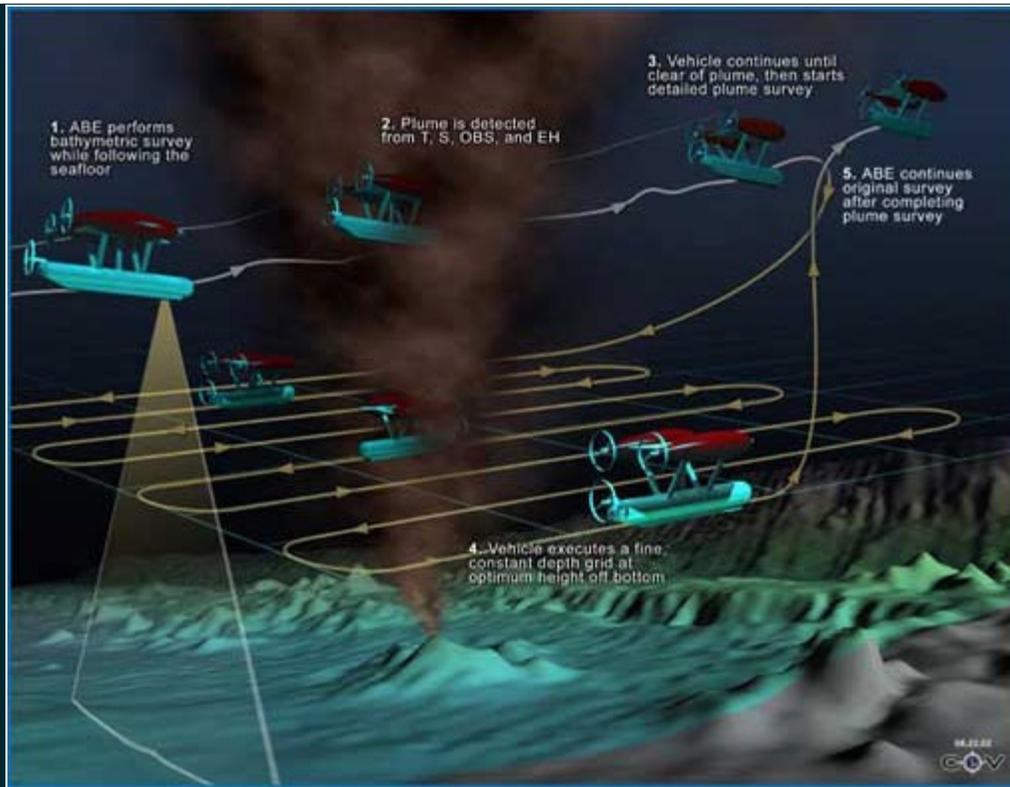
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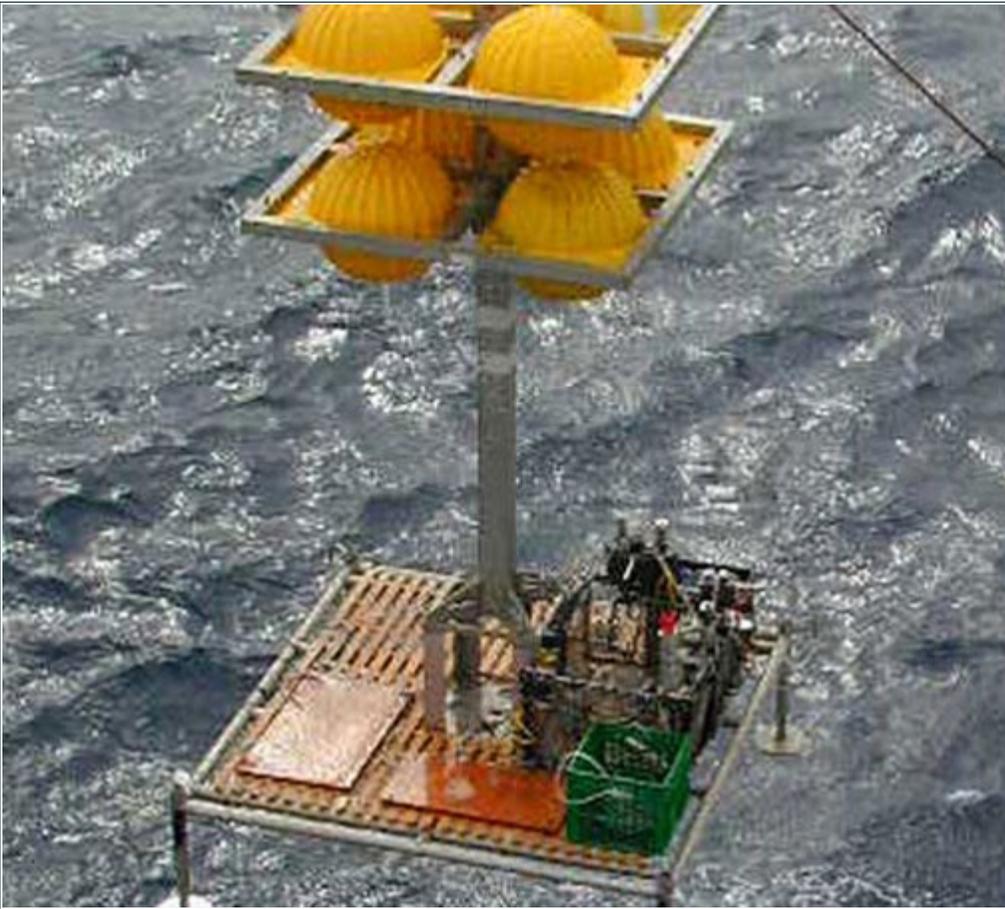
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The roadmap of humans' fascination with the ocean leads back as far as the early trade routes of 3500 BC, and forward as far as our minds can imagine. From the first modern deep-ocean scientific expedition by *HMS Challenger* in the 1870s to the VISIONS '05 expedition by the University of Washington's research vessel *Thomas G. Thompson* to the northeast Pacific in September 2005, the ocean's mysteries continue to beckon both explorers and scientists alike. Our need to look deeply into the ocean's depths shows no sign of abating soon. In fact, we are just beginning to understand the extreme world of the seafloor itself.

EXPANDING
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REVOLUTION
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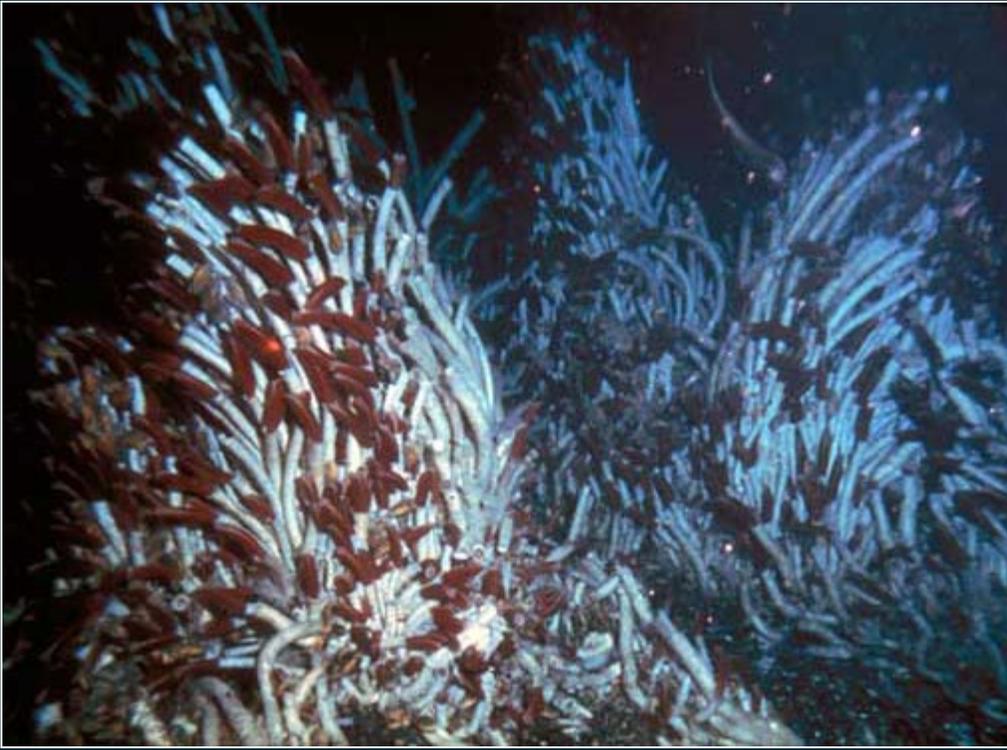
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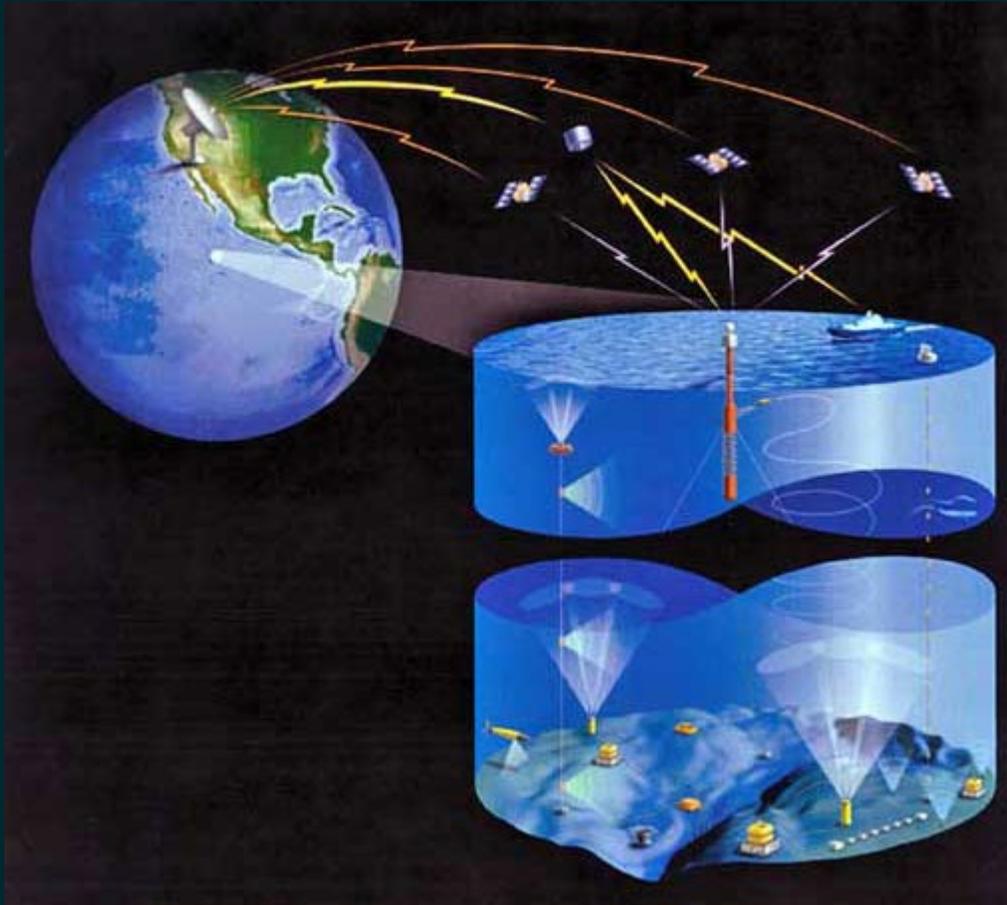
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During a seafloor expedition, all thoughts and eyes are on the ocean bottom—but the preparation and analysis occurs at the surface. Life on board a research vessel is work-intensive. A series of highly focused tasks is punctuated necessarily by sleep and occasionally by relaxation. Because a research cruise is relatively short, scientists and ship's crew alike must make the most of available time. Because it is intense, they also depend on each other a great deal and work in tight teams. Here are some shipboard scenes from ocean expeditions, including VISIONS '05, the five-week expedition to the northeast Pacific in September 2005 aboard the Research Vessel (R/V) Thomas G. Thompson.

SHIPBOARD SCENES

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