Voyage to the bottom of the Arctic Ocean

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Robotics make exploration possible

By Colin Nickerson, Globe Staff | June 22, 2007

FALMOUTH -- An international team of scientists is embarking on a search for life on the floor of the ocean at the roof of the world.

Led by researchers from the Woods Hole Oceanographic Institution -- and equipped with unique robotic vehicles designed to explore mountain ranges miles beneath the polar ice cap -- 30 geophysicists, biologists, engineers, chemists, and other deep-sea specialists will depart July 1 from a remote Norwegian archipelago, Svalbard, aboard a powerful icebreaker that will smash a path to exploration sites near the geographic North Pole.

The Arctic, its mysteries concealed beneath thick ice, is the smallest but least known of the world's oceans.

"This is about exploring a portion of the earth that has been largely inaccessible to science," said Robert Reves-Sohn, a geophysicist from the institution who will be chief scientist on the 40-day voyage.

"We're looking for underseas habitats and creatures never seen before," he said during a news conference yesterday.

The major aim of the Arctic Gakkel Vents Expedition is to seek out exotic life forms believed to thrive near deep-lying hydrothermal vents. Known as "black smokers" because they exhale dark minerals as well as superheated water, such volcanic vents have been discovered in the Pacific and Atlantic -- succoring bizarre 10-foot-long tubeworms and a strange species of swarming shrimp at depths and pressures that should by all logic be frigid and lifeless.

Until 2001, when a scientific vessel detected minerals in Arctic waters suggestive of such vents, it was thought that geological conditions under the ocean weren't right either for the boiling jets or the strange creatures surviving on their fringes.

The $5.5 million expedition marks the first search for life in the depths of the high Arctic.

"This is one of the key areas of the world where we might make big leaps in understanding biodiversity," said Timothy Shank, a hydrothermal vent biologist on the oceanographic institute's Arctic team. "We're quite sure the vents are there. And wherever we've found vents, we've found new forms of life. So we're expecting to find new life on the Arctic floor."

A big chunk of the research money comes from NASA, which hopes that vehicles tough enough to withstand Arctic conditions might serve in a future hunt for life on one of Jupiter's moons, Europa, which also features volcanic activity beneath an icy surface.

The Arctic venture will focus on the Gakkel Ridge, the northernmost extension of a chain of undersea volcanic mountains crosshatching the globe. The ridge, which stretches 1,100 miles, lies 1.8 to 3 miles beneath the ice cap.

It separates the North American tectonic plate from the Eurasian plate and is slowly widening, creating deep fissures over the course of millennia. From these cracks, or vents, water heated to more than 600 degrees bursts from the earth's mantle into icy saltwaters, creating an ecosystem of stunning temperature extremes.

The Arctic Ocean, 5.4 million square miles in area, is ringed by Canada, the United States, Siberia, Scandinavia, Greenland, and a scattering of islands. Drifting continents and other massive geological changes choked off deep-water connections between the Arctic and other oceans starting about 65 million years ago. For that reason, hopes are high among scientists that the expedition will discover undersea creatures that have evolved in isolation from life in the Atlantic or the Pacific -- much as Australia produced peculiar marsupials, such as kangaroos and koala s, that emerged nowhere else.

"Any biological habitats at hydrothermal vent fields along the Gakkel Ridge have likely evolved in isolation for tens of millions of years," said Reves-Sohn. "We may have the opportunity to lay eyes on completely new life forms in the abyss beneath the Arctic ice pack."

The progress of the expedition, which includes scientists and engineers from the United States, Sweden, Japan, and Germany, can be followed online at polardiscovery.whoi.edu or www.divediscover.whoi.edu.

The quest will depend heavily on a pair of robotic underwater vehicles, the Puma and Jaguar, designed to prowl the treacherous currents in search of volcanic vents. Additionally, the icebreaker Oden will carry a third tethered vehicle, the Camper, operated by cable and equipped to collect samples from the sea floor.

The Arctic is considered too dangerous to deploy manned midget submarines, such as the famous Alvin, often used in deep-sea exploration.

Each robotic vehicle consists of two attached torpedo-sized structures outfitted with highly-sensitive detecting gear that transmits information back to the mother ship. The vehicles can be programmed to reemerge 10 to 20 hours later at another hole and can work at depths of 3 miles. Each serves a different purpose.

Puma is a bloodhound, designed to course thousands of feet beneath the ice layer, "sniffing" for chemical and temperature signals that might mark an hydrothermal vent. Once a black smoker is found, Jaguar goes to work, able to hover above the vent, using strobe lights, high-speed cameras, and sonar to map every inch of terrain.

Once the vents are located and mapped, Camper will be maneuvered into position. The box-like craft, as clunky as Jaguar and Puma are sleek, will employ a mechanical claw for grabbing hard samples, such as rocks and shellfish, as well as a vacuum "slurp gun" that can suck in fluids or shrimp-like creatures for scientific scrutiny.

"In this environment, there's a high risk of losing one or all of the vehicles," said Hanumant Singh , the ocean engineer who designed the three undersea craft and will oversee their operation on the expedition. "We're going into the most rugged terrain on the planet. Steep rocky cliffs and peaks, enormous pressures, and vent fluids hot enough to melt the very thermometers meant to detect them. But the best science is usually high risk."

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