The Discovery of Hydrothermal Vents

25th Anniversary CD-ROM

Exploring the Ocean's Young Volcanoes

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by

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Exploring the Ocean's Young Volcanoes

By David Perlman
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Aboard the R/V Knorr,
Over the Galapagos Rift

Submarine explorers on the ocean bottom here are probing a unique volcanic phenomenon that is depositing minerals on the flanks of an undersea rift where the earth's crust is being pushed apart by fresh lava flowing from the earth's deep interior.

Edging cautiously along the sea floor inside the three-man submersible named Alvin, the scientists have closely examined for the first time a range of low hills, spectacularly shaped and colored, encrusted with manganese and iron, and topped with fragile spires, domes and ridges.

With an electronic temperature sensor they have measured the heat only 25 inches beneath the brittle crust of one of the hills, and have found it an unexpectedly warm 60 degrees — compared with the near freezing bottom water temperature of less than 36 degrees just outside the hill.

And when they used their heat probe as a tool to poke a hole in the crust, they produced an instant plume of warm water — generated by the intense heat of new lava far below.

The diving scientists are members of an expedition whose seagoing laboratories are a flotilla of ships from the Woods Hole Oceanographic Institution in Massachusetts.

They include the tiny Alvin, only 22 feet long; its twin-hulled submarine tender Lulu, and the Research Vessel Knorr, 245 feet long and crammed from keel to crow's nest with computers, transponders, underwater cameras, heat flow sensors, core samplers, analytic instruments and hydrographic winches with 12 miles of towing cable.

Their two-month mission is to explore in detail a 400-square-mile segment of the Galapagos spreading center — a spectacular mid-ocean region nearly 1000 miles long where molten rock welling up from beneath the earth's crust pushes great plates of that crust apart and reshapes the seas and continents over millions upon millions of years.

The exploration target here lies less than 50 miles north of the equator, 650 miles southwest of Panama, and 400 miles west of Ecuador in the Pacific.

The central axis of the Galapagos rift zone is a trench nearly 9000 feet deep, running east and west and lined with a chain of small young volcanoes that have extruded fresh lava into the sea floor in recent years. The lava lies black and shiny, pocked with fissures and vents that spew out miniature geysers of hot water.

The tallest of these volcanoes, as surveyed by scientists in the Alvin and aboard the Knorr is only 864 feet high. The expedition has named it Mount Nemo — after the captain of the submarine Nautilus in Jules Verne's 1869 novel "20,000 Leagues Under the Sea."

Among the volcanoes, the Alvin has already discovered an extraordinary variety of sea creatures living in sharply differentiated colonies around each warm water vent.

The scientists have found blue-eyed fish up to four feet long, brilliant yellow crabs, orange starfish, pink shrimp, clams with shells a foot wide, huge mussels, sea anemones, sea lillies, sea cucumbers, and clusters of tube worms an inch thick and a foot and a half long. A few specimens have been collected, some frozen in the lab aboard ship and some preserved in formalin.

This is an expedition of geologists, geophysicists and geochemists, and even though the area has been dredged and photographed by remote towed instruments before, no one had suspected that such a bewildering and abundant life — each group in its own distinct niche of warm-water environment — would exist in the darkness and cold of the rift zone's depths of nearly 9000 feet.

Already excited messages have come from Woods Hole urging the earth scientists here to use the utmost care in recording and preserving the unique biological specimens they have collected. There is no doubt that deep-sea marine biologists will be competing wildly for the privilege of examining the samples for new clues to the processes of evolution on the ocean bottom.

Some ten miles south of the fresh lava and the seabed geysers with their abundant life lies a different region, marked by long rows of curious low mounds formed from soft sediment. These hills are exciting the earth scientists , for their structure and composition make them unlike anything ever discovered before.

John B. Corliss, an Oregon State University geochemist, and David L. Williams, a geophysicist with the U.S. Geological Survey, are among the divers who have spent days among the mounds, exploring them through the portholes of the Alvin.

They have photographed the mounds, measured them, taken their temperature, grabbed samples of their surface crust with the Alvin's remote-controlled mechanical arm, and even used Alvin as an underwater battering ram to knock the crumbly top off one mound to see what's inside.

As Corlisss described his view of the mounds, they are strange indeed. Their crusts are brilliantly colored with oranges, yellows, dark green and black. Some form perfect cones, with steep but smooth slopes. On others the slopes are steeper, but some of the sediment has slumped away to form ragged steps and scarps.

Some are shaped like tents 50 feet long, with narrow vertical ridges on top, 15 feet high and barely 18 inches wide. Some have thin spires of crust above them, some have domes. The smallest are miniature, only a yard high; the tallest stand less than 50 feet.

Unlike the living colonies around the rift zone's hot water vents, the mounds are almost deserted, Corliss and Williams found. Here and there, however, a slender living stalk clings in a black rock outcrop, with a white tulip-like "flower" nodding at its top.

Elsewhere, large pale organisms with a few thin, membranous leaves 18 inches or so across stand motionless on the mounds. There are many mysteries to solve about these mud hills, Corliss feels. Their crumbly crusts are clearly oxide rich in manganese and mixed with iron clays; but what other minerals and metals they contain can only be decided by careful laboratory analysis — both aboard the ship and later ashore.

The rows of mounds are scattered, but all lie south of the center of the rift zone, and all the rows run parallel to the rift's axis. Where the center of the rift zone is fresh lava, here layers of sediment have buried the rock under 60 feet of mud, and the basement lava is estimated as 600,000 years old.

According to a model proposed by many scientists, the molten lava welling up at the rift zone's center cools and cracks as sea water quenches its fires. A web of fractures forms in the hardening rock, and the newly fractured crust spreads outward as more lava emerges from the earth's interior.

Now cold sea water moves downward through the fractures, reaches layers of hot lava beneath, and then turns upward. The water leaches minerals from the lava as it rises, and starts forming a chimney of leached material on the sea floor. Soon the chimney grows taller, and more water circulates through the system the way cool air in a room moves toward a fireplace and then rises swiftly up a flue, carrying soot and ashes with it.

These "hydrothermal" processes along many mid-ocean ridges, Corliss notes, are believed to have formed many of the world's valuable ore deposits — from Cyprus to Japan.

No one is ready to propose mining the Galapagos Rift Zone for treasures, but understanding the way the system works by watching and measuring it in action is surely a significant key to understanding the planet's resources for the future.