The Discovery of Hydrothermal Vents

25th Anniversary CD-ROM

Astounding Undersea Discoveries

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by

David Perlman, Science Editor

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Galapagos Rift Expedition

Astounding Undersea Discoveries

By David Perlman
Science Correspondent

Above the Galapagos Rift

Scientists mounting a major oceanographic expedition have discovered a wealth of wholly unexpected sea life and volcanic activity deep beneath the eastern Pacific where a new section of the earth's crust is apparently forming this very instant.

Diving nearly 9000 feet by submarine into a great crustal fracture zone, and towing complicated instruments across the bottom from a large research ship on the surface, the elated scientists have found extraordinary events taking place.

They have pinpointed geysers of hot water venting from fissures in fresh lava and sending warm plumes of brine shimmering upward into the near-freezing lower levels of the sea.

They have found rich clusters of living organisms basking in the warmth of the geysers — clams, mussels, shrimp, sponges, crabs, and even fish whose obviously functioning eyes pose a major mystery because the water at such depths is so black that vision is impossible.

They have discovered fresh lava that was poured out onto the sea bottom in ropes and wrinkles, sheet-like pavements and bulbous pillows — squeezed or erupted from the hot, semi-molten material of the deep earth's interior mantle beneath the crust.

So fresh is the lava that it is untouched by sediment; it glistens jewel-like, and near the plumes of escaping hot water the black basalt is stained by evidence of mineral deposits: bright red, orange, white and shimmering gold.

When these findings are all analyzed in detail they are bound to "revolutionize" many theories about the deep ocean floor and the volcanic and earthquake activities that mark the formation of continents and the evolution of the earth, according to Robert D. Ballard, this expedition's chief scientist.

It will also revolutionize deep-sea biology, says Tjeerd H. Van Andel, professor of geology at Stanford University, who has been one of the diving scientists.

Traveling across the lightless depths by submarine, Van Andel has explored three "hot spots" or plumes of heated brine escaping from the fresh sea-bottom lava through vents no bigger around than a coffee cup.

"What is so remarkable," Van Andel said after he completed a series of dives, "is that each vent seems to have a different colony of organisms around it, depending on the temperature of the hot water.

"We've seen scores if not hundreds of animals of at least ten different species. The molluscs and other filter-feeding organisms cling to the rocks right around the warmth; the fish lie there with blessed expressions on their faces, obviously enjoying themselves."

To Van Andel and to John B. Corliss of Oregon State University, who heads the deep-diving ventures, the wholly unexpected animal populations around each vent are sharply reminiscent of the Galapagos Islands, which the expedition has just left.

On the Galpagos, 270 miles west of this expedition's survey site, naturalists beginning with Charles Darwin found sharp variations in many species of animals on each of the archipelago's many islands. Tortoises, finches, iguanas and tiny lizards are all distinctly different, depending on the varying environment of each island — "adapted for different ends," as Darwin put it.

Now, on the bottom of the sea, this expedition has apparently found that at "hot spots" of varying temperatures differing species of organisms tend to cluster in accordance with their differing needs.

"It's as if each plume of brine were a different kind of oasis," Van Andel says, "and each oasis has its different kind of life."

"I think," said Corliss, "that what we are finding will prove to be the greatest discovery in the history of benthic biology since the discovery that life was even possible in the deep sea."

This expedition actually did not set out to explore life at all. Its major purpose is to study closely the "hydrothermal" processes by which sea water circulates through newly fractured rift zones in the earth's crust.

In that process the water leaches minerals — including many valuable metals — from the fresh basaltic rocks and the sea water chemical composition is itself altered significantly.

For example, here on the Galapagos rift zone — and presumably elsewhere around the world where vast plates of the earth's crust are grinding against each other and moving like ice floes — this expedition has found solid evidence of abundant manganese, copper, nickel, sulphur and iron leached from the lava by ocean brine.

The sea water, in turn, is extraordinarily rich in the radioactive element called radon — 60 times more radon than normal — and rich, too, in hydrogen and silicon, while significantly depleted in oxygen. It is heavy with salt.

"This is obviously something other than ordinary sea water," says Van Andel, "but what and why we don't know yet."

Thirty scientists and three vessels make up this expedition, which is sponsored by the National Science Foundation.

Headquarters ship is the research vessel Knorr, out of the Woods Hole Oceanographic Institution in Massachusetts, on which chief scientist Ballard is a geologist and diving scientist.

Accompanying the Knorr is the catamaran Lulu, on which Corliss is the scientific leader.

And riding aboard the Lulu in between its daily independent dives is the deep submersible Alvin, a submarine that has carried its crew of three into ocean troughs as deep as 12,000 feet.

Since mid-February the Alvin has made one fabulously successful dive after another into the Galapagos Rift Zone.

During those days the Alvin has photographed the bottom, measured temperatures with minute accuracy, collected water and loose lava rock for chemical analysis in the Knorr's superb laboratories, and drilled two-foot core samples from the untouched basalt.

The submarine's claw-like sampler, remote-controlled by the crew safely housed inside her titanium-alloy pressure sphere, has also grabbed a variety of sea creatures from around the hydrothermal vents.

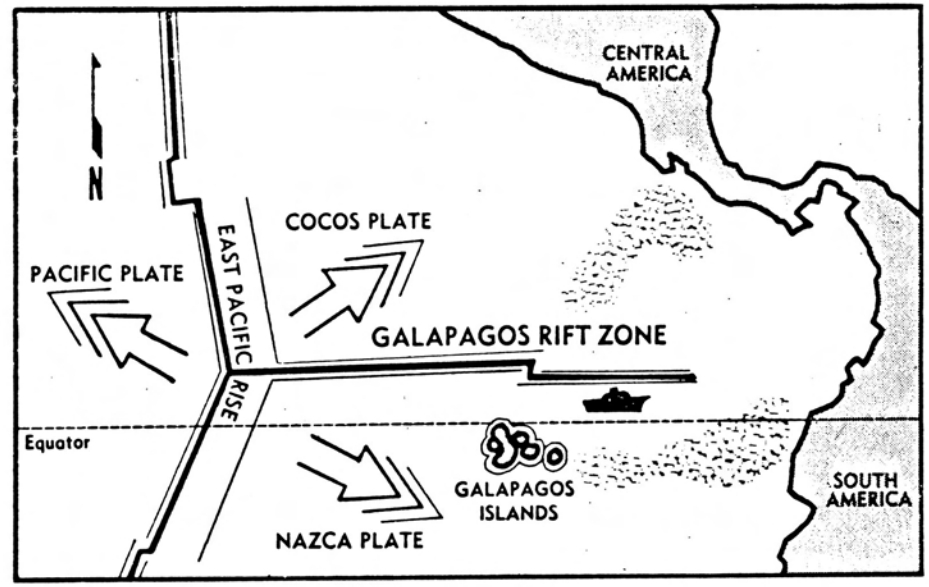
Many look just like their counterparts along shallow reefs near any shore but they may represent entirely new species adapted to an environment that until recently most scientists believed could only support the most primitive, blind life.

The Knorr, meanwhile, has been towing a huge tubular steel sledge loaded with remote cameras, samplers and devices to record ocean-bottom temperatures, salinity and pressures.

The pictures from the Knorr, too, have detected abundant life near the hot-water vents.

The target for all this activity along the region known as the Galapagos Rift Zone is a curious, broken valley running east and west for nearly 1000 miles just north of the equator. The ships are at work right now about 600 miles southwest of Panama, between two large undersea mountain ranges called the Carnegie Ridge and the Cocos Ridge.

The rift zone forms part of a huge global network of mid-ocean rifts and ridges, 40,000 miles long in all, where the earth's crust is divided into great plates that literally float above an interior mantle of semi-liquid, molten rock.



The Galapagos Rift Zone marks the boundary between the shifting earth plates

Some of these plates are far larger than the continents that ride on them, and the Galapagos Rift Zone marks the boundary between the Cocos Plate to the north and the Nazca Plate to the south.

West of here, running at right angles to the Galapagos Rift, is the East Pacific Rise, which marks another plate boundary, and west of that boundary is the great Pacific Plate, which stretches from California almost down to Antarctica.

Virtually all earth scientists now believe that these plate boundaries form dynamic "spreading centers" where the plastic material of the earth's interior mantle squeezes, or at times erupts violently upward, to form new crust and to push the plates apart.

The plates, then, grind their way across the earth; they collide with other plates, and many of them dip downward along the edges of the continents to rejoin the mantle below and to melt within it.

Thus the trenches — such as the ones along the coastlines of the Americas — are marked by violent earthquakes and volcanic eruptions.

The Galapagos Rift Zone marks a significant "spreading center," where new crust is welling upward to form the brand-new lavas that the Knorr and the Alvin are seeing. The basalts photographed and collected by this expedition are absolutely fresh, but as the ships move away from the center of the rift, they find the lava growing older.

Bare and glistening black where it emerges from its source at the very center of the rift, the lava becomes dusted with sediment as fine as talcum powder, and as the new crust spreads outward the lava becomes more and more deeply buried in the dust.

The endless rain of dead microscopic organisms, shells and carcass particles from the ocean's upper layers slowly covers the bottom at the rate of an inch or so every thousand years.

Yet less than ten miles from the central axis of the Galapagos spreading center that sediment lies more than 75 feet thick.

Here, then, along the Galapagos Rift, scientists of this expedition are seeing some of the very freshest material of the earth's crust. It was "born only yesterday," as Ballard puts it, and some of it is literally being born this very minute — to drive the earth's great oceanic crustal plates into motion, and keep the continents drifting imperceptibly across the globe.