# Drilling Exposes Ocean's Underside

It ranks as one of the most expensive fishing trips of all time, but this recent international expedition didn't hook any deep-sea delicacies. Instead, crew members hauled up broken pieces of drilling equipment, and in doing so, they rescued a 12-year effort to bore deep beneath the seafloor, opening a window into Earth's internal workings.

The machinery had been clogging the deepest hole ever cut in the ocean floor and had threatened to end all drilling at this hole, known as 504B and located near the Galápagos Islands. But hours before they had planned to abandon 504B for another site, members of the Ocean Drilling Program (ODP) freed the offending pieces. They then went on to deepen the prized hole, eventually reaching a depth of 2 kilometers below the ocean floor.

"This is a landmark," says marine geologist Henry Dick of the Woods Hole (Mass.) Oceanographic Institution, who served as co-chief scientist on the cruise, which ended last week. "We went out there and demonstrated that deep crustal drilling in the oceans is possible."

Ocean crust covers roughly two-thirds of Earth's surface; but because it lies hidden beneath the waves, often at great depths, it has resisted the kinds of detailed investigations possible on land. It was not until the 1960s that oceanographers discovered how ocean crust originates through the process of seafloor spreading. Hole 504B will help illuminate this process by giving scientists their first real look at the interior of normal ocean crust, Dick says.

Seafloor spreading occurs at the junction of two lithospheric plates — large sections of the Earth's broken outer shell. As the plates pull apart, molten magma escapes from deeply buried chambers and squirts up to the surface, where it flows out and hardens. Over millions of years, these episodes create new crust as older crust moves away from the plate junction.

The spreading process builds a layered crust that resembles a complex cake. The "icing" on top consists of sediments and hardened lava. The middle layer is made of sheeted dikes — thin, vertical structures that form when magma solidifies in the crack between the plates. Shaped like giant sheets of paper, individual dikes often measure only 1 meter thick, yet they may stretch 1,500 meters vertically and 5,000 meters horizontally. Hole 504B is the only drillhole to reach into the sheeted dikes. Beneath the dikes lies a third layer consisting of huge deposits of gabbro rock — the fossilized remains of ancient magma chambers.

The ODP and its predecessor program have drilled at 504B on and off since 1979. But as the hole deepened, conditions grew more difficult, sparking a string of technical frustrations, caused in part by temperatures that topped 150°C at the bottom of the hole. With scores of other potential drill sites around the world, scientists debated whether to risk spending more time on this valuable but problematic hole.

In September, the ODP drillship headed back to 504B for one last try. Crew members spent nine days trying to fish broken drill pieces out of the bottom of the hole, which lay 4.5 kilometers below the deck of the ship. Success came with less than one day remaining before cruise leaders had planned to abandon the hole. Using improved techniques, they then proceeded to deepen the hole by 378 meters.

Although the recent drilling effort fell short of its goal — the gabbro deposits — several signs indicate that this long-sought layer may lie within a few hundred meters of the bottom of the hole, says Dick. The density and grain size of the rock pulled up in the drillcore has increased as expected, he notes, and the mineral chemistry suggests that the ancient magma chambers are near.

Because of previously scheduled cruises, the drillship cannot return to 504B before mid-1994. But given last month's success, ODP will place a high priority on resuming drilling there as soon as possible, says James Austin of the University of Texas at Austin, who chairs the ODP planning committee.

Recent studies on land have highlighted the importance of drilling at such sites. In the past, scientists have used ophiolites — slivers of ancient seafloor that have been pushed up onto the continents — as an accessible analog for studying ocean crust formation. But in the Nov. 14 NATURE, Don Elthon of the University of Houston suggests that ophiolites differ from most ocean crust. "We can learn a lot of general things about ocean crust by studying ophiolites," he told SCIENCE NEWS. "But for the details, the particulars, we really need to go out and drill in the ocean."

*— R. Monastersky*

## Emergency repair for the ozone hole?

The year is 2007. The ozone hole over Antarctica has expanded each year and has now become a severe global threat. Sometime in July, several hundred large airplanes head out on a dangerous mission over the sunless Antarctic continent. Their goal: to spray 50,000 tons of ethane into the stratosphere in an attempt to stop the ozone hole from forming as the austral spring approaches.

Though it may sound like the plot for a new Arnold Schwarzenegger movie, this idea has been raised by a team of atmospheric scientists who use computer models to explore methods of stemming the annual ozone depletion over Antarctica.

Ralph J. Cicerone of the University of California, Irvine, who helped originate the idea, calls it "a concept, not a proposal." While he and his colleagues want scientists to consider the approach, they do not expect anyone to actually try it, he says. "We understand as much as anybody that there could be very unexpected problems arising if you introduce yet another chemical into the system."

Their modeling results, reported in the Nov. 22 SCIENCE, suggest that a sufficient amount of ethane or propane added to the Antarctic stratosphere each year could chemically halt much of the ozone destruction caused by chlorine pollution there. In theory, hydrocarbons could limit ozone loss by binding with free chlorine molecules, preventing these molecules from attacking ozone. But the researchers warn that scientists still don't know enough about the atmosphere to determine whether that strategy could work.

Although most nations have agreed to end production of many ozone-destroying chemicals, scientists have warned that the Antarctic ozone hole could recur annually for the next 100 years as the atmosphere slowly cleans itself of existing chlorine pollution. Some projections suggest that the Antarctic situation could worsen before it improves. That concerns scientists because the severe depletions over Antarctica each spring may contribute to the ongoing erosion of the global ozone layer.

Daniel Lashof of the Natural Resources Defense Council in Washington, D.C., says the threat of even greater Antarctic ozone loss in the future makes it worthwhile to explore ideas such as those raised by Cicerone's team. "The situation is so critical that if things really continue to get worse, you may want to have these kinds of emergency measures available," Lashof says.

*— R. Monastersky*