N.M. Geologist Surveys Ocean Floor Near Japan

BY JOHN FLECK
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Most geologists work on land.

But most of the Earth is ocean floor. And most dry land is really a relic of something that happened once at sea.

That is why Socorro geologist Harold Tobin boarded a research ship in May to drill holes in the ocean floor.

Off the coast of southern Japan, Tobin and his colleagues parked the JOIDES Resolution over a deep ocean trench and drilled into what amounts to the crumpled bumper of a tectonic collision.

There, a huge chunk of Earth's crust, called the Philippine Plate, is slamming into Asia in a slow-motion crash that is literally building Japan.

The two plates meet in the Nankai Trough, a stretch of deep ocean floor buried in sediments.

It is there that the building of a continent begins.

Raising the ocean floor

The 469-foot JOIDES Resolution is part floating drill rig and part ocean-going scientific lab.

For eight weeks this spring and summer, the ship's roughnecks drilled deep into the crust beneath the ocean floor off Japan, dragging up cores of mud and rock for the scientists.

They dropped pipe through three miles of water, then started drilling.

The ship used four computer-controlled thruster engines to hold it in position while the roughnecks would drill 30 feet, pull up a

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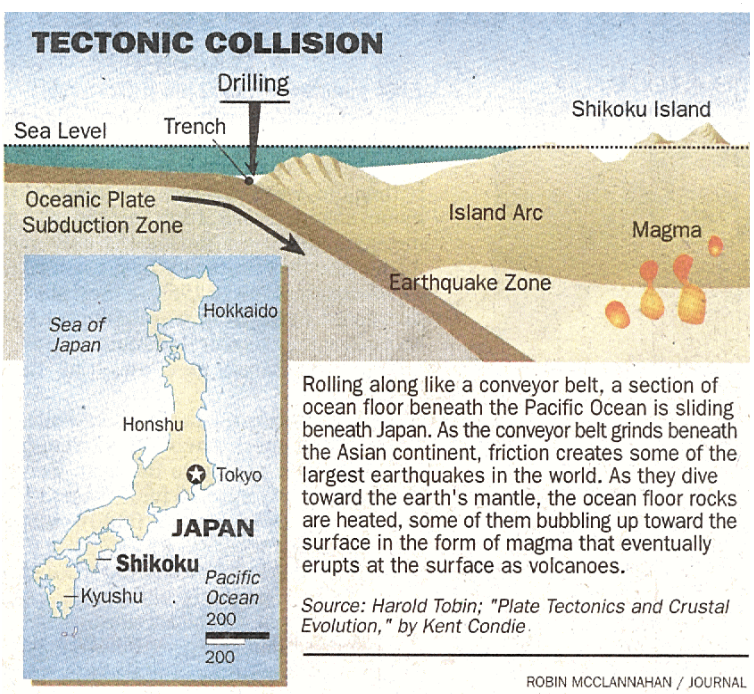

Rolling along like a conveyor belt, a section of ocean floor beneath the Pacific Ocean is sliding beneath Japan. As the conveyor belt grinds beneath the Asian continent, friction creates some of the largest earthquakes in the world. As they dive toward the earth's mantle, the ocean floor rocks are heated, some of them bubbling up toward the surface in the form of magma that eventually erupts at the surface as volcanoes.

Source: Harold Tobin; "Plate Tectonics and Crustal Evolution," by Kent Condie

ROBIN MCCLANNAHAN / JOURNAL

COURTESY HAROLD TOBIN

PUTTING THE PIECES TOGETHER: New Mexico Tech geologist Harold Tobin, left, pores over sea floor rock cores aboard the research ship JOIDES Resolution soon after the drilling ship brings them to the surface. He works with an international team, including, from right to left, Toshio Hisamitsu of the University of Tokyo, Mario Sanchez-Gomez of the Universidad de Jaen in Spain and Alex Maltman from the University of Wales.

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core of rock, drill 30 more feet, pull up another core, 24 hours a day.

Within minutes of the rocks' arrival on the surface, the scientists would begin a battery of tests on the cores. They looked for tiny fossils, measuring and sampling the type of rock in a two-shift, 24-hour-a-day research blitz.

"It's very real-time science," Tobin said. "You're all there. You've got nothing else to do."

Tobin was lured into marine geophysics in the early 1990s by the chance to go where no one had gone before.

In the tiny deep-sea research submarine Alvin, he made four dives off the Oregon coast to study sea floor geology.

For a land-based geologist, it is almost impossible to find a patch of ground to study that hasn't already been mapped and its rocks sampled.

For Tobin, the ocean floor offered a frontier.

"We could go somewhere that no one had ever been, and look at something that no one had ever seen before," he recalled.

They would spend an hour descending to the ocean floor, then look out the submarine's portholes to map the rock types, much as a geologist would do on the surface.

"We're literally doing field geology in a submarine," Tobin said.

But while the submarine just offered a look at the surface of the ocean floor, the drilling rig about the JOIDES Resolution took the scientists into the layers of rock beneath — where the action is.

Laid end-to-end, the cores provided a detailed look at the layers of rock beneath the Nankai Trough, pieces of the continents in collision.

Moving the ocean floor

Since the 1960s, scientists have known that the arrangement of continents on our planet's surface is not permanent, but like a bunch of loose-fitting puzzle pieces on the move.

It is called "plate tectonics," a theory that explains how continents ride around the globe like a floating armada, bobbing and crashing in slow-motion collisions.

When people think about tectonic plates, they tend to think about continents, Tobin said in a recent interview in his office at the New Mexico Institute of Mining and Technology.

But that's a view biased by the fact that we live on land.

The crust beneath the ocean floor is very different.

Great volcanic ridges run down the centers of the Earth's oceans. Called "spreading centers," they constantly create new ocean floor, pushing the older floor out to either side like a slow-moving conveyor belt.

That is why ocean-floor crust is young.

Continents, on the other hand, are made of older rocks that have been piled up and left behind over the years by the bulldozers of plate tectonics.

"The continents are like the accumulated flotsam and jetsam," Tobin said.

Where that conveyor belt hits land, all hell breaks loose.

In southern Japan, one edge of the conveyor belt called the Phillippine Plate hits the Asian continent, sliding beneath the land.

The plate dives under Japan, sliding down toward Earth's mantle. As it slips under the land, the friction creates an earthquake zone that makes anything on the North American continent seem timid.

In fact, all the largest earthquakes in the world happen where one plate is sliding beneath another, Tobin said.

"The history of earthquakes there is mind-boggling," Tobin said. "It makes California look like small potatoes."

As the young oceanic crust is squeezed beneath the continent, the rock is squeezed and heated, creating bubbles of lava that rise through the older crust above it to create the volcanoes that define the Japanese archipelago.

It is called an island arc, and it is one of the primary ways new continental crust is made. Over time, Japan will be shoved into Asia by the relentless conveyor belt.

You don't need to go far to see an example of what can eventually result. Much of New Mexico sits atop crust that formed as an island arc more than a billion years ago, according to University of New Mexico geologist Karl Karlstrom.

"This is how continents get built," Karlstrom said.

"North America has been built up by the same processes," Tobin said.

Life on the edge of an ongoing continental collision makes Japan a very different kind of place geologically than New Mexico.

Here, little has changed geologically in the last two million years — the Sandia Mountains look much the same as they did then, as does the Rio Grande valley, Tobin noted.

But in Japan, things are happening fast because it is on the edge of an ongoing tectonic collision.

That is why the geologists traveled there this summer to sink their drill bits beneath the ocean into the Nankai Trough.

"We can look at plate tectonics where it's happening now," Tobin said.