

New map offers deepest detail of ocean depths

By [Deborah Sullivan Brennan \(/staff/deborah-brennan/\)](#) 11:45 a.m. Nov. 23, 2014



New seafloor maps have been released by Scripps researcher David Sandwell, left. He and colleagues like Melville Captain Chris Curl, at right, both on the bridge of the Melville, used computer techniques to map out vast areas of the ocean floor that hadn't been surveyed yet.

Miles beneath the sea is a landscape of seamounts, hills and ridges, much of it unexplored or hidden under layers of muck.

A team of scientists from the Scripps Institution of Oceanography in La Jolla and other research centers have released a new map that reveals those deep-water structures with twice the level of detail as previous images.

The updated maps, described last month in the journal *Science*, will inform energy exploration and earthquake research. It also will pinpoint areas for future marine research on the underwater frontier, said David Sandwell, lead scientist on the *Science* paper and a geophysics professor at Scripps.

"The real story is, we know almost nothing about the oceans," Sandwell said.

The disappearance of Malaysia Airlines Flight MH370 this year exposed those gaps in knowledge of the ocean's depths, said Dietmar Muller, a professor of geophysics at the University of Sydney in Australia and a co-author of the new paper.

"When someone disappears on land, we have topographic maps that provide a framework for a search," Muller said. "In the oceans, our maps are so poor in most places that any search is seriously impaired."

The new map fills part of that void.

The study of the seafloor's underwater contours is called bathymetry. It's akin to topography of the terrestrial Earth, but instead represents the depths and shapes of the world's biggest bath.

Submerged in the ocean depths are mountains rising a kilometer or more from the ocean floor, chasms of pitch darkness and endless plains of "abyssal hills," small mounds that blanket much of the ocean's floor and are the most common land form on the planet.

Scientists map those features on charts marked with contour lines similar to those seen on topographic maps. To create the marine maps, they use one of two methods.

The earlier and most accurate technique relies on ships equipped with sonar that cruise over portions of the ocean. The vessels emit soundings that bounce off underwater land features, producing a sonic map of the seafloor. They can detect underwater features about the size of a football field.

Sandwell visited the RV Melville, a former Scripps research vessel, on the day before its retirement and recalled the hours spent charting seamounts and other ocean land forms with Captain Chris Curl.

Research ships such as the Melville have logged about 30 million nautical miles — the equivalent of 1,200 trips around the Earth — sonically grazing the ocean through what Sandwell calls "lawn-mowing." They're equipped with multi-beam sonar that makes swaths of measurements across the ocean floor to create high-resolution maps. They've produced images of features including small volcanoes, landslides and the corrugated rows of abyssal hills.

Those maps, however, plot just about 10 percent of the ocean's surface, Sandwell said. So the areas covered by sonar maps are less a blanket of the ocean floor than a patchwork of ship crossings.

A complete survey of the deep ocean would take \$2 billion to \$3 billion dollars and 200 ship-years — that's about 20 ships operating full time for a decade, Muller said.

The alternative is satellite technology.

Satellites measure the subtle gravitational effects of underwater land forms on the water's surface. Scientists use that data to plot the hills and mountains below.

"These spacecraft can infer the shape of the ocean bottom from the shape of the water surface above, which is measured using a radar beam," Muller said. "Because water follows gravity, it is pulled into highs above the mass of tall seamounts and slumps into depressions over deep trenches."

The drawback of satellites is that they're a high-level view of the ocean floor, offering wider coverage but lower detail than the shipside images.

According to Newton's Law, the resolution of the images is equal to the depth of the water, Sandwell said. In three-mile deep seas, the satellite can measure three-mile wide features. Anything closer together would blur into a single image.

While recent satellite measurements are still limited to that scale, they produce images with twice the accuracy of earlier versions. Over four years, researchers took repeated measurements of the same areas to fine-tune the data and filter out surface distortion.

"If we go over it more than once, we can average and then control for waves and currents," Sandwell said.

The new images shows features with greater clarity and reveal landscapes obscured by millions of years' worth of muck.

"They reveal the buried tectonic fabric of the ocean basins, submerged fault systems, fracture zones, ridges and troughs," Muller said. "Ocean basins are created by motions of the tectonic plates over tens of millions of years. When continents break apart, the story of their separation is recorded in the ocean floor that forms between them."

In the Gulf of Mexico, for instance, the satellite measurements identified seafloor spreading ridges — places where the continental plates split, pushed apart by magma that welled up through fractures in Earth's crust.

Those features, active 150 million years ago, lie buried under a mile-thick layer of sediment. The latest satellite techniques have allowed scientists to pierce that covering to expose the ancient topography below.

The new satellite data uncovered seamounts around a mile high that hadn't been mapped before, Sandwell said, and produced new images of fracture zones throughout the mid-Atlantic.

"We can see where the continents rifted apart between Africa and South America," he added.

The resulting map covers all the ocean floors on Earth, with the exception of a small hole at the North Pole, where satellite coverage doesn't penetrate. Researchers are layering those images with ship measurements to create a new map for Google Earth.

"It had all been done before, but this was done at a higher level of accuracy," Sandwell said.

The new images may be used for studying marine ecosystems; learning about tsunamis, ocean circulation and tides; improving military navigation; and aiding industrial exploration.

"Accurate bathymetry and identifying the location of seamounts are important to safe navigation for the U.S. Navy," Joan Cleveland, deputy director for the Office of Naval Research Ocean Sensing and Systems Division, said in a statement released by Scripps.

Also significant: Advancements in this field can help point the way to the next big scientific discoveries.

"We can look at the predicted depth and say, 'Oh, there's a big volcano there. Let's go out on a ship and map it,'" Sandwell said. "So it's a reconnaissance mission."

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