

Our Unmapped Ocean

If you took a flight from New York to Beijing, for 1,400 miles of it, you'd be flying over mostly unmapped ocean. We don't know exactly how deep it is. We don't know the shape of the ocean floor.

It's a mystery.

In fact, we don't understand the vast majority of the seafloor. Our maps of the moon, Mars, and even Venus are 50 times more detailed.

Near the coasts and continental shelves, where waters are shallow and boat traffic is high, we've used sonar from ships to build high-resolution seafloor maps. But these cover just 10% of the ocean.

The rest, with an average depth of 2.5 miles, is too deep for ordinary sonar, and too remote and dark for other types of visual mapping.

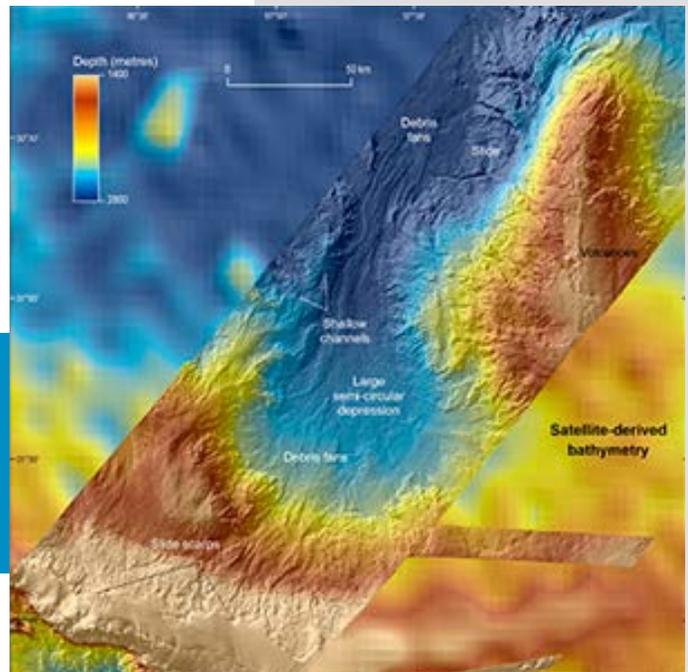
So we've resorted to measuring the ocean surface with satellites, then interpreting the seafloor from that. The best resolution we've been able to manage is a data point every 3 miles.

Exactly what's happening between these points? We have little idea.

And this is a bit of a problem. The contours of the seafloor shape the paths of tsunamis and the direction of major currents that shape our weather.

When a cargo ship or a jetliner goes missing, we struggle to locate them.

Who knows what we might discover with a better knowledge of the deep ocean. New minerals and resources. New life forms. Things so new we can't even imagine them.



Differences in resolution between multibeam and satellite-derived bathymetry data for a part of the Indian Ocean floor are striking. This detailed survey was completed during the search for Malaysian Airlines Flight 370, which disappeared March 8, 2014.

Credit: EOS, by Kim Picard, Brendan Brooke, and Millard F. Coffin



BUREAU OF
ECONOMIC
GEOLOGY

Background: Our Unmapped Ocean

Synopsis: More than 95% of Earth’s ocean floor has only been mapped from space with 5,000-m resolution. Topographic maps of the moon, Mars, and Venus have 50 times better resolution at 100 m, and the most remote land on Earth has been mapped at 100 times higher resolution—50 m.

- The ocean holds 97% of Earth’s water by volume; more than two-thirds (71%) of Earth is covered by ocean, with an average depth of nearly 2.5 miles.
- Human curiosity about Earth’s ocean floor is centuries old.
 - Humans are drawn to explore its mystery—it supplies sustenance and enables travel but is also fickle and dangerous, with unpredictable weather and strange creatures.
 - For centuries, scholars believed the deep sea to be a lifeless place, but since the late 19th century, we have discovered an amazing diversity of life in the ocean.
 - The deep sea, where less than 1% of light can penetrate, is the largest and least explored ecosystem on Earth, representing 95% of the global biosphere.
- Why do we care about the details of the shape of the seafloor?
 - Because the shape of the seafloor controls tsunami paths and important currents that stabilize and influence our weather patterns, it is essential to scientists trying to predict weather systems.
 - In January 2005, the USS *San Francisco* was travelling at 38 mph, 525 ft beneath the surface, relying on seafloor charts to navigate. The craft hit an unmapped seamount south of Guam; 100 of 137 crew members were injured and one person died. Imprecise charts were clearly one of the causes of the accident.
 - The mysterious disappearance of Malaysian Airlines Flight 370 in March of 2014 was a recent tragedy that highlighted how little we know about the ocean floor. The huge Boeing 777-200ER—with its 18.5-m height, 64-m length, and wingspan of 61 m—was just a single point on a 100-m grid.
- Recently, researchers compared mapped and unmapped regions of the ocean floor to airline flight paths and found that 60% of all flights over the oceans cross areas with unmeasured depths; one flight from New York to China crossed 1,200 nautical miles of unmapped ocean.
- How do we figure out what the ocean floor looks like?
 - Most of the ocean floor has been mapped indirectly using satellite-derived gravity data, which yield a spatial resolution of about 5,000 m = 1 point per 25 km². Radio waves from radar can’t travel through water, so satellites measure the surface of the sea, which mimics the ocean floor because of gravity, to estimate the ocean’s depth.
 - By comparison, topographic maps of even the most remote land areas on Earth resolve features approximately 50 m across, and topographic maps of the moon, Mars, and Venus resolve 100-m features.
 - While satellites can gather surface data relatively easily, researchers constantly design new instruments to gather data from below the surface of the water.
 - A new satellite mapping mission (SWOT), planned for a 2021 launch by NASA and the French space agency (CNES), could improve bathymetry resolution to 3,000 m—still 30-times-lower resolution than that of the maps provided by ship mapping.
 - Ships on the sea surface have mapped about 17% of the world’s oceans with multibeam echo sounders using sonar that bounces sound waves off the seafloor to measure depth with a resolution of about 100 m for water depths of 5,000 m—similar to our current resolution of the surface of Venus. The biggest recent global increase in sonar coverage came as a result of the search for the Malaysian airliner.

References: Our Unmapped Ocean

[Geological Insights from Malaysia Airlines Flight MH370 Search | Eos](#)
[From Flight 370 Hunt, New Insight Into Indian Ocean’s Unknown Depths | NY Times](#)
[Airline Flight Paths over the Unmapped Ocean | Eos](#)
[Search for MH370 Revealed Secrets of the Deep Ocean | The Atlantic](#)

Contributors: David Sandwell (UCSD), Juli Hennings, Harry Lynch



Background: Our Unmapped Ocean

- If we want to see things in more detail on the seafloor, like the wreckage of a missing plane, the sonar system needs to be towed much closer to the seabed to improve the resolution. Ship-based surveys in the Indian Ocean have been used to plan more-detailed surveys. Only about 26,000 sq miles of the world's ocean floor—a little larger than the state of West Virginia—have been mapped like this.
- The most detailed mapping can be accomplished by visual observations using manned or unmanned submarines, as used during the 2004 exploration of the *Titanic*.

References: Our Unmapped Ocean

[Geological Insights from Malaysia Airlines Flight MH370 Search | Eos](#)
[From Flight 370 Hunt, New Insight Into Indian Ocean's Unknown Depths | NY Times](#)
[Airline Flight Paths over the Unmapped Ocean | Eos](#)
[Search for MH370 Revealed Secrets of the Deep Ocean | The Atlantic](#)
Contributors: David Sandwell (UCSD), Juli Hennings, Harry Lynch

