Published online 2 May 2011 | Nature | doi:10.1038/news.2011.263

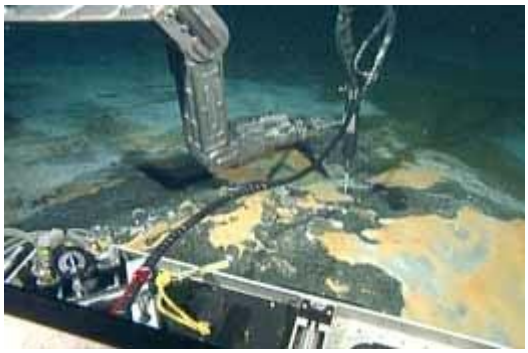
News

Seafloor probe taps methane reservoir

Greenhouse gas found in high abundance but risk of mass release uncertain.

Nicola Jones

A robotic submarine has been used to measure the amount of methane lurking in mud on the seafloor — the first time such measurements have been made *in situ*. The observations support larger estimates of how much methane is stored under the world's oceans and could be used to monitor areas where methane might be released in large bursts. Such measures are important given that some scientists have concerns about catastrophic releases of methane contributing to climate change, and others are keen on mining such deposits for fuel.



A robotic sub samples the methane content of the seafloor off the coast of southern California.

Monterey Bay Aquarium Research Institute

Researchers have known since the 1960s that there are some natural deposits of frozen ice containing methane lying on the ocean floor, where the high pressure and cold temperature keep them from melting. Oceanographers have pulled up frozen chunks of this material, called methane clathrate or hydrate, from more than 90 locations around the world and have estimated — from acoustic studies and assumptions about where hydrate might reasonably form — that there is some 10,000 gigatonnes of carbon stored in this way under the sea. That's twice as much as the carbon thought to be in conventional fossil fuels. Some have speculated that sudden melting of subsea hydrates, thanks to a warming ocean for example, released massive amounts of methane into the atmosphere and triggered rapid climate change in the past.

But current estimates of the amount of methane buried under the sea are missing a big part of the picture, says Peter Brewer, ocean chemist at the Monterey Bay Aquarium Research Institute in Moss Landing, California. In addition to the natural gas stored inside the ice, he says, there must be a lot of gas in the water saturating the mud in which that ice is buried. Otherwise, he says, the hydrate wouldn't be stable. "If you just put a block of methane hydrate on the seafloor it will dissolve really fast," he says. "The hydrates in sediments have to be in equilibrium with the water around them, which must contain huge amounts of methane. One would guess it is about the same as the amount in the clathrate itself."

To start to get a handle on this part of the picture, Brewer and colleagues — particularly PhD student Xin Zhang from the Chinese Academy of Sciences' Institute of Oceanology in Qingdao — fitted up a remotely operated vehicle with a metal probe and a Raman spectrometer. The robotic sub can stick its metal probe into the mud next to a hydrate deposit and suck up water, and then a laser beam reveals the amount of methane and other substances in that water — all without leaving the seafloor. Previous studies have tried to pull up mud to the surface for analysis, but the change in pressure means that

most of the gas escapes along the way. On-site measurements were long thought to be impossible because of interfering fluorescence problems, but Brewer's team has shown it can be done.

Lead author Zhang Xin, analyzing a mud core on board the research vessel Western Flyer.

Nancy Barr / Monterey Bay Aquarium Research Institute

The champagne of greenhouse gasses

For their paper in *Geophysical Research Letters*[1], they visited three sites — Barkley Canyon offshore British Columbia, Hydrate Ridge offshore Oregon and an area offshore Los Angeles — and found high concentrations of methane, at pressures up to three times that in a champagne bottle, corked up in the mud.

The technique, says Brewer, could be used to check up on areas where it is suspected that a large volume of gas might be set to be released. "If you see bubbles of methane coming out of the water or the seafloor, is that an isolated chimney of gas or is it a large area poised for release? There has been no way of knowing. Now you can go measure it," he says. "It's a really powerful tool."

"It's expensive, but it's useful," says Ross Chapman, a geophysicist at the University of British Columbia who studies hydrates and was not involved with Brewer's work. "It's nice to see these results," he says, even if they simply confirm what everyone suspected: there's a lot more methane down there than is apparent from cores brought up to the surface.

All this said, both Chapman and Brewer think that mass releases of seafloor methane are unlikely to cause a blip in today's climate, since released gas is more likely to get chewed up by bacteria or dissolved into the seawater rather than released to the air. "It's not a scare story," says Brewer. "It's hard to imagine this happening," agrees Chapman. "Warming happens at the surface, and that would have to work its way down to the bottom. It would have to warm up about 4 °C — that's a huge amount."

References

1. Zhang, X. *et al. Geophys. Res. Lett.* **38**, L08605 (2011).

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Nature ISSN 0028-0836 EISSN 1476-4687