

Rice Reinforces Gas Hydrate Strategy

EurekAlert

Their critics weren't convinced the first time, but Rice University researchers didn't give up on the "ice that burns."

A paper by a Rice team expands upon previous research to locate and quantify the amount of methane hydrates -- a potentially vast source of energy -- that may be trapped under the seabed by analyzing shallow core samples. The paper published this week by the *Journal of Geophysical Research- Solid Earth* should silence the skeptics, the researchers said.

Chemical engineers George Hirasaki and Walter Chapman and oceanographer Gerald Dickens headed the team.

In 2007, Hirasaki and former graduate student Gaurav Bhatnagar theorized that gas hydrates -- methane that freezes at low temperatures and high pressures -- could be detected via transition zones 10 to 30 meters below the seafloor near continental shores; at that level, sulfate (a primary component of seawater) and methane react and consume each other.

As sulfate migrates deeper into the sediment below the seafloor, it decreases in concentration, as evidenced by measurements of pore water (water trapped between sediment particles) from core samples. The depth at which the sulfate in pore water gets completely consumed upon contact with methane rising from below is the sulfate-methane transition (SMT) zone.

In the 2007 paper, Bhatnagar argued the depth of this transition zone serves as a proxy for quantifying the amount of gas hydrates that lie beneath; the shallower the SMT, the more likely methane will be found in the form of hydrates in abundance at greater depth.

Though hydrates may be as deep as 500 meters below the seafloor, locating deposits through shallow coring using such proxies should aid selection of deep, expensive exploratory drilling sites, the researchers said.

The controversy that followed the publication of the original paper focused on sulfate consumption processes in shallow sediment and whether methane or organic carbon was responsible. Skeptics felt the basis of Bhatnagar's model, which assumes methane is a dominant consumer of pore-water sulfate, was not typical at most sites.

"They believed that particulate organic carbon (primarily from ocean-borne dead matter) was responsible for reducing sulfate," said Sayantan Chatterjee, lead author of the new paper. "According to their assumption, the depth of the SMT, upward methane flux and hydrate occurrence cannot be related. That would nullify all that

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we have done."

So Chatterjee, a fifth-year graduate student in Hirasaki's lab, set out to prove the theory by bringing more chemical hitchhikers into the mix.

"In addition to methane and sulfate profiles, I added bicarbonate, calcium and carbon isotope profiles of bicarbonate and methane to the model," Chatterjee said. "Those four additional components gave us a far more complete story."

By including a host of additional reactions in their calculations on core samples from the coastline of Oregon and the Gulf of Mexico, "we can give a much stronger argument to say that methane flux from below is responsible for the SMT," said Hirasaki, Rice's A.J. Hartsook Professor of Chemical and Biomolecular Engineering. "The big picture gives more evidence of what's happening, and it weighs toward the methane/sulfate reaction and not the particulate organic carbon."

The work is important not only for a natural gas industry eyeing an energy resource estimated to outweigh the world's oil, gas and coal reserves -- as much as 20 trillion tons -- but also for environmental scientists who see methane as the mother of all greenhouse gases, Hirasaki said.

"There's a hypothesis by Dickens that says if the ocean temperature starts changing, the stability of the hydrate changes. And instability of the hydrates can release methane, a more severe greenhouse gas than carbon dioxide.

"That can create more warming, which then feeds back on itself," Hirasaki said. "It can have a cascade effect, which is an implication for global climate change."

Chatterjee had the chance to discuss his results with his peers in July at the seventh International Conference on Gas Hydrates in Edinburgh, Scotland, where he presented a related paper that focused on the accumulation of hydrates in heterogeneous submarine sediment.

Chatterjee said a number of eminent experts commended him after his talk. "I got a chance to show my recent findings on our 2-D model. This will simplify the search and locate isolated pockets where hydrates have accumulated in deep ocean sediments," he said.

Chatterjee's conference paper was awarded a first prize at the prestigious Society of Petroleum Engineers' Young Professionals meeting and second at the Gulf Coast Regional student paper competition.

Co-authors include Chapman, the William W. Akers Professor of Chemical Engineering; Brandon Dugan, an assistant professor of Earth science; Glen Snyder, a research scientist in Earth science; Dickens, a professor of Earth science, and Bhatnagar, all of Rice.

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