Geophysical Imaging of Shallow Gas Hydrates Using Electromagnetic Techniques: A Pilot Study in the Gulf Ocean

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What were the primary questions you were trying to address with this research? (Or, if more appropriate, was there a hypothesis or theory that you were trying to prove or disprove?)

The goal of this project was to conduct a pilot-study, to see whether an electromagnetic (EM) survey system would see a discernable signature of gas hydrates within seafloor mounds and their surroundings.

What have you discovered or learned that you didn't know before you started this work?

We ran a series of survey lines across 2 mounds in the Gulf of Mexico. Our data showed clear differences in conditions between the seafloor beneath the mounds and that away from the mounds. However, the response was the opposite to that expected. We believe that the EM system is showing elevated temperatures and/or increased pore-water salinities beneath the mounds, consistent with the flow of warm, saline waters from deep to the seafloor in these settings.

What is the significance of your findings for others working in this field of inquiry and for the broader scientific community?

There is great interest in the scientific and, to some extent, the petroleum industry, in seafloor gas hydrates. We do not have a good idea of how common they are, especially around seep sites. Surveying hydrate mounds is difficult, and providing good maps of physical properties is even harder. Our experiment shows that EM tools can provide a powerful addition to the suite of geophysical tools used to understand the internal structure of hydrate bearing mounds.

What is the significance of this research for society?

Hydrates are a reservoir of methane which is important as a greenhouse gas and possibly as an energy resource, yet we have little idea of how they are distributed on the seafloor. To get a better handle on hydrate abundance we need better geophysical surveying tools that can map out the sub-seafloor in key areas. Even though the survey did not find hydrate per-se, it has identified areas where conditions are ripe for their formation, and these locations include areas away from the obvious mounds. Our survey shows that EM methods are potentially an important addition to the suite of existing tools, but one that has not been widely used for this purpose.

What were the most unusual or unexpected results and opportunities in this investigation?

Our survey did not show a direct signal of hydrates (at least not one that is obvious) but did show large responses to the thermal and salinity structures of the mounds.

What were the greatest challenges and difficulties?

Towing a 40m long system on the seafloor in 1300m of water.

When and where was this investigation conducted? (For instance, did you conduct new field research, or was this a new analysis of existing data?)

We ran a cruise on board the R/V Pelican in the Gulf of Mexico in June 2004.

What were the key tools or instruments you used to conduct this research?

Towed EM System

The towed EM system we will use was built at WHOI but is based on a design developed by colleagues at the Geological Survey of Canada. We have made some design changes to the original system, particularly to facilitate its operation in water depths from 10-2500m. The system is dragged along the seafloor at speeds of 1-2 knots and makes measurements of seafloor resistivity approximately every 10m along track. The system is a frequency domain magnetic dipole-dipole array. The system has a CTD sensor mounted in the transmitter and so provides continuous measurements of bottom water salinity and temperature, important as the system traverses regions of fluid expulsion.

A photograph of the towed EM system on deck. The system consists of a transmitter (large cylinder at right) connected to the ship by a 0.680 conducting cable. Three receivers (smaller

cylinders) to behind the transmitter at se separations of 4m, 13m and 40m and provide information to depths of about 20m subsurface.

Is this research part of a larger project or program?

This is a pilot study.

What are your next steps?

Hopefully, we can use the data collected to convince other agencies to support more complete and thorough data collection in this and other similar areas.

Have you published findings or web pages related to this research? Please provide a citation, reprint, and web link (when available).

Please suggest or provide photographs, illustrations, tables/charts, and web links that can help illustrate your research.

Please provide some biographical information, such as place of birth, degrees earned, significant awards or honors, research interests, reasons why you became a scientist or why you are interested in this line of research, and any personal interests, hobbies, or details that you are willing to share. You can find a few good examples here:

http://oceanusmag.whoi.edu/v41n2/evans.html