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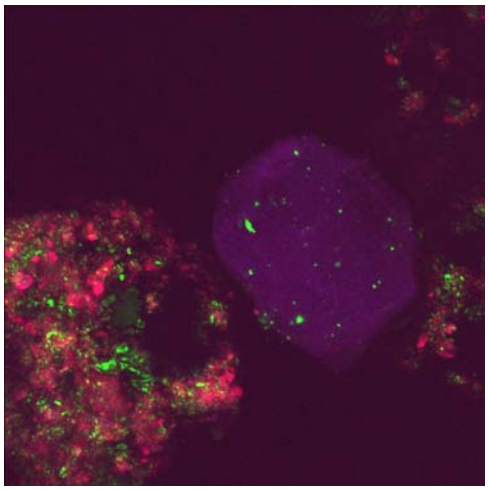
Microbiology of Methane Hydrates

The methane gas hydrates found in sediments along continental margins and beneath permafrost are a remarkable natural fuel resource. They dwarf all other fossil fuels in terms of their potential as an energy resource. These hydrates, however, may also represent an important environmental hazard: methane release could contribute to global warming. We need to understand the environmental implications of methane hydrates and their behavior and distribution in the subsurface environment. The methane in hydrates is largely a metabolic waste product, yet little is understood about the microbial communities in the sediments that produce the methane.

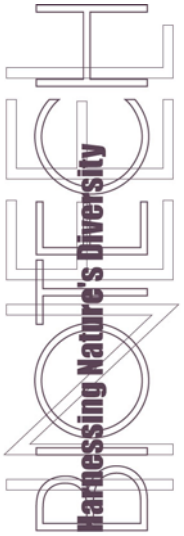
Progress

INEEL researchers are studying the basic microbial and chemical processes that form methane proximal to the hydrates. Vertical sections of the hydrate-rich sediments have been sampled, and the microbial communities have been characterized to determine the relationship between the location of the microbes and the location of the hydrate in the sediments. The INEEL team has collaborated in three international coring efforts off the coast of Japan and on the Mackenzie Delta in Canada's Northwest Territories.

A principal objective is to determine the in situ rates of methane production. This requires knowing the types of microbes, their activity, their biomass, and their distribution in the sediments. Current models for methane production contain no meaningful biological information. Modelers need realistic methane production rates to estimate the extent of the huge methane hydrate resource in the earth.



Ongoing research activities include growing microbes collected from the subsurface in bioreactors to determine methane production rates under simulated in situ conditions. Using the bioreactors, we have estimated the pressure and temperature limits of the microbes. DNA signatures of the various methanogens have been obtained from a range of geographic locations and subsurface depths.



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Selected publications/presentations

F. S. Colwell, "Constraints on the Distribution of Microorganisms in Subsurface Environments," *Subsurface Microbiology and Biogeochemistry,* J. K. Fredrickson and M. Fletcher, eds., Wiley-Liss, Inc., 2001.

F. S. Colwell, invited speaker, *International Continental Drilling Program, Mallik Gas Hydrate Research Well Workshop*, July 2001.

F. S. Colwell, invited speaker, *5th RIDGE Theoretical Institute on the Subsurface Biosphere at Mid-Ocean Ridges, Big Sky, Montana*, July 2000.

F. S. Colwell, M. E. Delwiche, D. Blackwelder, M. S. Wilson, R. M. Lehman, and T. Uchida, "Microbial Communities from Core Intervals, JAPEX/JNOC/GSC Mallik 2L-38 Gas Hydrate Research Well, Mackenzie Delta, Northwest Territories, Canada," *Geological Survey of Canada Bulletin 544*, S. R. Dallimore, T. Uchida, T. S. Collett, eds., 1999, pp. 189–195.

F. S. Colwell, invited speaker, *Annual Meeting of the American Society for Microbiology: Special Session on Microbial Ecology of the Deep Subsurface Atlanta, Georgia, May 1999.*