OBJECTIVES AND SIGNIFICANCE: Methane hydrates in deep ocean sediments and arctic permafrost constitute an enormous energy reservoir that is estimated to exceed the energy content of all known coal, oil, and conventional natural gas resources. The primary goals of this project that has been ongoing since 2001 are 1) to support exploration of hydrate reservoirs in seafloor sediments and arctic permafrost; 2) to support the development of safe and practicable methods to destabilize hydrates to produce methane fuel; and 3) to advance our understanding of the environmental impacts of natural seeps and accidental releases of methane and other hydrocarbons in the ocean. In addition, HNEI has also investigated engineering applications of hydrates including desalination and H₂ storage, and promoted many international R&D collaborations.

BACKGROUND: Research on CO₂ hydrates at HNEI began in the early 1990’s as part of an international collaboration on CO₂ ocean sequestration. Our research scope expanded to include methane hydrates around 1999 when HNEI was asked by the Minerals Management Service (MMS) of the Department of the Interior to participate in a study on deep oil spills. Over time, we have conducted a host of laboratory investigations on a wide range of topics related to hydrates and participated in numerous oceanographic research cruises to offshore hydrate zones.

At present, our activities are focused on the following three areas: 1) chemical destabilization of hydrates; 2) biogeochemistry of seafloor methane hydrates and the biodegradation of methane in the ocean; and 3) promoting international research collaborations and information exchanges.

Methane hydrates can be destabilized by application of heat, depressurization, or contact with chemical reagents known as thermodynamic inhibitors. Destabilization results in melting of the solid hydrate, which releases liquid water and methane gas. Many conventional inhibitors are expensive and/or toxic. Our laboratory experiments evaluate the effectiveness of various inhibitors with the goal of identifying safe and inexpensive alternatives. Figure 1 shows a novel facility developed by HNEI researchers to investigate the thermochemistry of hydrates. This facility employs a fiberoptic probe coupled into a high pressure calorimetry test cell to permit Raman spectra to be sampled as hydrates form and decompose. The Raman calorimeter has provided valuable data to assess inhibitor effectiveness.

Figure 1. Photo of the Raman calorimetry facility.

PROJECT STATUS/RESULTS: This project is ongoing. Key results of recent work include: completed an analysis of seismic data of hydrate reservoirs in the Nankai Trough offshore of Japan; determined the effectiveness of alternative inhibitors such as salts that occur naturally in seawater and glycerol to dissociate hydrates; evaluated the feasibility of hydrogen storage using hydrates; and identified novel marine microbes that degrade hydrocarbons. Details of this research can be found in the publications listed on the next page.

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**ADDITIONAL PROJECT RELATED LINKS**

**PAPERS AND PROCEEDINGS:**


**LABORATORY:** OCEAN RESOURCES AND APPLICATIONS LABORATORY