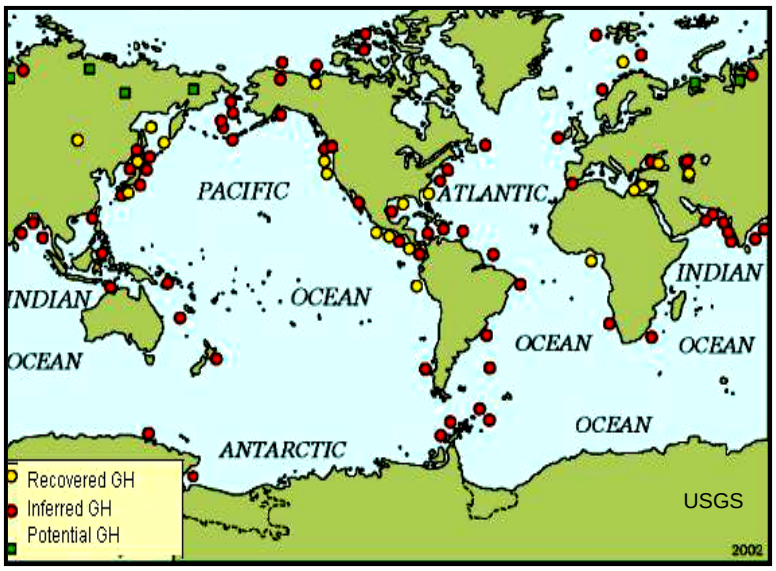
NURP Research: Investigating Gas Hydrates

Gas Hydrates: An Extraordinary Compound

Gas hydrates are crystalline solids that consist of a gas molecule, usually methane, trapped inside a lattice of frozen water molecules. They form naturally under conditions of high pressures and relatively low temperatures and commonly occur in deep sea sediments at the margins of every continent, as well as in Arctic permafrost. Hydrates have enormous implications in several areas important to society.



Energy Source The volume of energy stored in methane hydrates exceeds that of the entire world's coal, oil, and conventional natural gas *combined*. In the Gulf of Mexico alone, a 3000-km^2 area contains methane equal to thirty times the U. S. annual gas consumption, signaling that hydrates may become a major source of energy in the near future. Nations around the world are investigating processes that would permit the safe recovery of hydrates, which can be volatile if seabed sediments are exposed to changes in temperature or pressure.

Climate Change Methane is a greenhouse gas ten times more effective than carbon dioxide in causing atmospheric temperatures to increase. The amount of methane bound in sediments as hydrates amounts to approximately three thousand times the volume of methane currently in the atmosphere. Increases in ocean temperature can result in the release of methane from the seafloor into the water column and eventually, the atmosphere. This may have implications for climate change. Currently, the contribution of methane from the seafloor is not considered in the global carbon cycle.

Unique Forms of Life Communities of mussels and clams, as well as a number of newly discovered species, have been found thriving within and around the dark, methane rich environments characteristic of gas hydrates on the seafloor. These extreme ecosystems contribute to a basic understanding of life on earth, may provide a glimpse into life on other planets, and may support systems and processes applicable in pharmaceutical and other industries.

Dense mussel bed at gas hydrate site off SE US. Light blue film around edges of mussel valves contains bacteria that may derive energy from methane. Photo: NOAA

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Only since the 1990s have scientists begun to realize the extent to which methane hydrates occur beneath the sea and the enormous implications they have for energy resource issues, climate change, and marine ecosystem conservation and management. NOAA's Undersea Research Program (NURP) has been sponsoring scientists to study gas hydrates and their associated ecosystems since the late 1980's. NURP provides scientists' access to a wide variety of advanced underwater technologies necessary for studying gas hydrates, including manned submersibles, remotely operated vehicles, autonomous underwater vehicles, and seafloor observatories. Highlights of NURP-sponsored gas hydrate research include:

- Discovered exposed gas hydrate beds in northern Gulf of Mexico during research cruise in the early 1990s

- Discovered *Hesiocaeca methanicola*, a new species of worm, in northern Gulf of Mexico during cruise cosponsored by NURP and the Mineral Management Service (MMS); These "ice worms" were found living on and within mounds of methane ice on the ocean floor and were possibly grazing on microbial life that appears to thrive in this extreme environment. This discovery contributed to a greater understanding of the marine ecosystems associated with gas hydrates.

- Clarified aspects of gas hydrate geochemistry by demonstrating differences in the fluid flow and methane flux in biological communities associated with gas hydrates. This research, conducted at areas off the Oregon coast with widespread methane hydrate formation, has relevance in global carbon budgets and climate change models, since both are significantly influenced by gas hydrate geochemistry.

- In conjunction with the Department of Energy and the MMS, NURP is developing a remotely operated seafloor observatory in the northern Gulf of Mexico that will be used to study the chemical, microbial, and geologic processes associated with gas hydrates. Research results should provide improved understanding of gas hydrates and associated free gases in regard to seafloor stability and the global climate.

This exposed lobe of gas hydrate is inhabited by a newly discovered species of marine worms (*H. methanicola)*. Gulf of Mexico. Photo: I. MacDonald.

Gas hydrate mound, Gulf of Mexico. Bubbles indicate gas disassociating from mound. Photo: Jonathan Blair

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