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Overview of Observatory Development and the Site Selection Process

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Background

Gas hydrates are solid ice-like structures consisting of cages of water molecules that enclose molecules of gas. Most interesting to the energy community are hydrates that contain hydrocarbon gases. In the northern Gulf of Mexico, hydrates of this type form in water depths greater than 450m and often outcrop in mounds along faults that intersect the sea floor. Hydrates outcropping at the sea floor are in direct contact with a relatively large volume of sea water. They are stable only marginally because salt in sufficient concentration impedes hydrate formation. For this reason hydrate outcrops can be ephemeral; capable of changing greatly within rather short periods of time. In the absence of pressure fluctuations, whether the outcrops accumulate or dissociate is determined by variations in water temperature and rate of gas flow. The water temperature in the northern Gulf is influenced greatly by warm eddies shed from the Loop Current which enters the Gulf east of the Yucatan Peninsula. These eddies slowly drift westward along the continental slope and can raise bottom temperatures by several degrees Celsius.

The susceptibility to change associated with hydrates influences all aspects of attempts to study them. Since cause-and-effect is not understood well enough to allow accurate predictions, hydrate research must rely on observing variations of parameters in the hydrate environment and correlating them with physical changes observed in the hydrates themselves. As the realization grew that hydrate outcrops change significantly in relatively short intervals of time, it became obvious that occasional visits by a research vessel, no matter how well equipped, would not suffice to understand the dynamics of a hydrate mound. Such an understanding is critical to researchers. Some suspect that events which produce changes in the hydrate mounds may also trigger episodes of sea-floor instability and others are trying to determine whether or not methane from hydrates is an important green-house gas. A good understanding is perhaps most important to those trying to figure out how to exploit hydrates as and energy source.

For the purpose of advancing the level of understanding, a project to design, construct and deploy a sea-floor monitoring station near a hydrate mound was initiated in 1999 by the Gulf of Mexico Hydrates Research Consortium. The consortium is managed by the Center for Marine Research and Environmental Technology (CMRET) of the University of Mississippi. The project is funded by the Minerals Management Service (MMS) of the Department of the Interior, the National Energy Technology Laboratory (NETL) of the Department of Energy and the National Institute for Undersea Science and Technology (NIUST) of the National Oceanographic and Atmospheric Administration of the Department of Commerce.

Technical Overview of the Hydrate Monitoring Station

The monitoring station consists of three types of observing systems: geochemical, microbial and seismo-acoustic. Each system collects data more-or-less independently but all are connected to the same data recording and transmission system. Fig. 1 shows a cartoon of the station and its component systems.

Geochemical observations will be made within sea-floor sediments, at the sea floor and in the lower water column. Geochemical sensors include pore water samplers to measure salinity and concentrations of hydrocarbon gases at various depths below the sea-floor, chimney samplers to measure the composition and quantity of gas passing through the sea floor, and arrays to measure conductivity, temperature, density, and composition of dissolved gas at various levels in the lower water column. The geochemical observatory also includes a mass spectrometer to perform chemical analyses on the sea floor.

The microbial observatory will monitor various aspects of microbial activity including microbial abundance and diversity of microbial communities, temporal variability and dynamics of microbial communities, rates of methane oxidation and sulfate reduction, and relationships between microbial products and hydrate formation. Monitoring sensors will include retrievable, pressurized sea-floor test cells and bioreactors, high-surface-area sampling plates of different materials, low-light digital cameras, and devices to retrieve samples under *in-situ* conditions. Goals will be to document the stability and persistence of gas hydrate outcrops, determine whether methane oxidation and sulfate reduction occur within