AAPG HEDBERG CONFERENCE
"Near-Surface Hydrocarbon Migration: Mechanisms and Seepage Rates"
SEPTEMBER 16-19, 2001, VANCOUVER, BC, CANADA

Geologic and Biologic Responses to Varying Rates of Fluid and Gas Expulsion: Northern Gulf of Mexico

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Rate measurements of fluid and gas expulsion on the northern Gulf of Mexico continental slope have not been made in enough settings to quantify the spectrum of expulsion events typical of this deep water setting. The complex geologic framework of the slope provides numerous faulted pathways for subsurface fluids and gases to be transported to the modern seafloor. These migration pathways are generally concentrated around the flanks of intraslope basins where subsurface salt masses dome the modern seafloor and focus migration. Seafloor responses to expulsion of gases and hydrocarbon-rich fluids are highly variable and qualitatively dependent on rate and duration of delivery as well as fluid and gas composition.

Rapid expulsion of fluids (including fluidized sediment) and gases generally result in formation of mud volcanoes that vary from a few meters to several kilometers in diameter and/or sheet-like flows that may extend tens of kilometers downslope. Episodic expulsion of sheets of fluidized sediment saturated with hydrocarbons provides a limited trophic resource for chemosynthetic organisms. After expulsion events, mudflows may be colonized by bacterial mats and lucinid-vesycomyid clams. The limited hydrocarbon charge in fluidized sediment flows is insufficient to sustain a complex chemosynthetic community.

Slow seepage promotes lithification of the seafloor through precipitation of a variety of mineral species. Microbial utilization of hydrocarbons promotes the precipitation of ^{13}C-depleted Ca-Mg carbonates as by-products. The ^{13}C-depleted carbonates form mounds and hardgrounds that occur over the full depth range of the slope. Mounds have relief of up to 30 m, but mounds of 5-10 m relief are most common at sites thus far investigated. Carbonates comprising the mounds are mixed mineral phases of aragonite, Mg-calcite, and dolomite with Mg-calcite being the most common. Other products like barite are precipitated from mineral-rich fluids that arrive at the seafloor in low-to-moderate seep rate settings. Biologic response to slow flux settings is minimal. Bacterial mats (*Beggiatoa*) are common, but other chemosynthetic organisms are rare.

Intermediate flux environments appear to have the unique set of conditions necessary to support and sustain densely populated communities of chemosynthetic organisms. At these sites, surficial or shallow subsurface gas hydrate deposits fill fractures and veins associated with faulting. These gas hydrates are composed of a complex mixture of biogenic-thermogenic methane and other thermogenic gases. In situ experiments have shown that slight variations in near-bottom water temperature cause gas hydrate dissociation and out-gassing resulting in the degradation-to-disappearance of surficial gas hydrate mounds. Repeated observations over a decade of submersible research suggest that an abundant supply of gas from the subsurface causes surficial gas hydrate to quickly reform after a decomposition and out-gassing event.