Woolsey Mound Cold Seep: An Oasis in the Deep Sea

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Goals

This project aims to document and describe the cold seep and benthic fauna - including chemosynthetic communities - at Woolsey Mound, a carbonate-hydrate complex on the continental shelf, in the Mississippi Canyon area of the northern Gulf of Mexico.

MC118 Communities

Mississippi Canyon 118 hosts a variety of chemosynthetic communities. Cold, deep-sea coral communities are present with two large Madrepora oculata colonies in the Southwest Crater and one in the Northwest Crater. Additional deep-sea coral communities with multiple species of gorgonians occupy the Northwest and Southwest Crater complexes. Exposed gas hydrates have been documented at three locations within the Southwest Crater complex, one with ice worms.

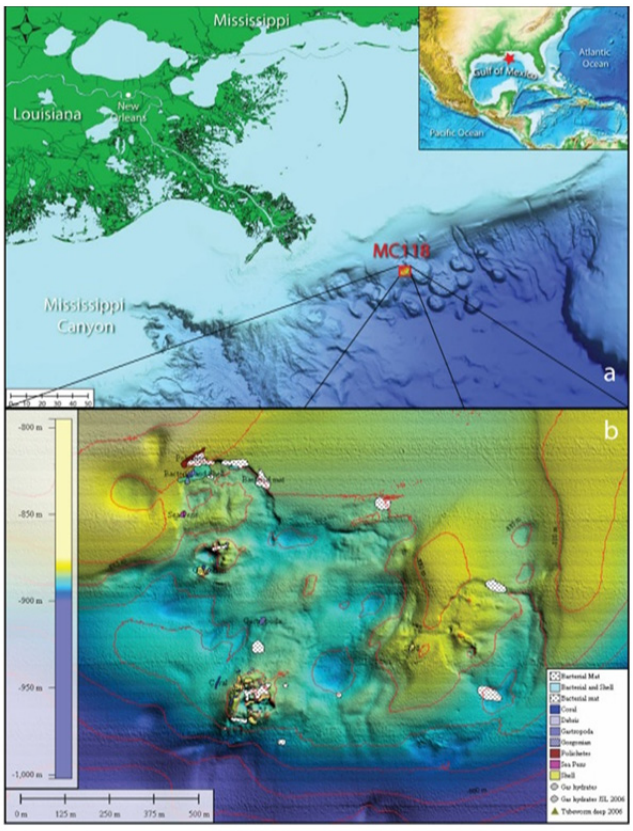

Figure 1. Mississippi Canyon 118 (upper) Location in the Gulf of Mexico and (lower) Detail of Woolsey Mound.

Deep Sea Habitat

Factors driving deep sea systems:

- High pressure (1atm/10m)
- Low temperature (average 4°C)
- Lack of sunlight, and therefore, no photosynthesis
- Lack of food; most organisms depend mainly on falling organic matter produced in the photic zone
- Low-biomass but high-diversity

Cold Seep Communities ... Oases at abyssal depths

Factors driving cold seep systems:

- High pressure
- Low temperature
- Intermittent fluid-gas expulsion
- Cold, mineral-rich water and hydrocarbon-rich fluids
- Chemosynthetic bacteria
- Presence of hard substrate (carbonate rock)
- Community dependence upon symbiotic interactions
- High-biomass but low-diversity
- Extreme environments with toxic fluids for most animals

Cold Seep Community Succession

FIRST STAGE: The community begins when chemical-rich fluids with high levels of sulfide and methane begin to seep out of the sediment and into the surrounding water. Microbes (Archaea and bacteria) are established first as PRIMARY PRODUCERS (clams have symbiotic bacteria in their gills).

MIDDLE STAGE: Declines in seepage and the uptake by secondary consumers that depend upon symbiotic bacteria, decrease the toxicity of the habitat. This results in an increase in secondary consumers, organisms living on the bacteria (such as tubeworms). Productivity near the vents remains greater than in the surrounding deep sea and results in the creation of new structure and habitat for additional organisms in and around the tubeworm colonies.

OLD STAGE: When methane and sulfide concentrations above the sediment surface are so low that they are essentially the same as the surrounding seawater, higher order consumers who cannot tolerate high levels of toxic chemicals, can become established.

END of COLD SEEP COMMUNITY: As the cold seep becomes inactive, tubeworms start to disappear and hard substrate (exposed carbonate) can be occupied by deep-sea corals. Deep-sea corals are not chemosynthetic, but form the ecological community referred to as a biocoenosis of Deep-Sea Corals.

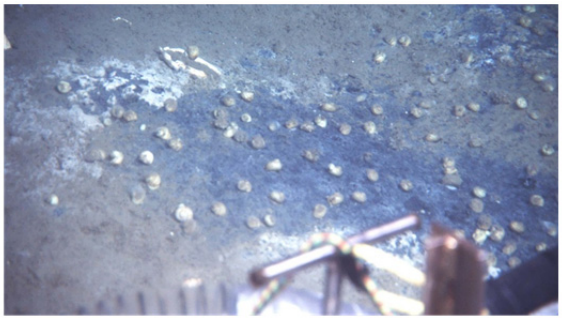

Figure 2. Example of FIRST AND MIDDLE STAGE Cold Seep Community Succession at Woolsey Mound. Bacterial mat (white) covers portions of carbonate slabs and mud in association with clams and gastropods.
Image courtesy of Chuck Fisher

Figure 3. Example of MIDDLE-TO-OLD STAGE Cold Seep Community Succession, an Isopod among secondary consumers.
Image courtesy of Chuck Fisher

BIOCENOSIS OF DEEP SEA CORALS

- Distribution: Global
- Temperature range: 4-13°C
- Salinity range: 32-38.8ppt
- Depth range: 200-2000m
- Nutrition: probably suspended organic matter and zooplankton; In the absence of sunlight, symbiotic algae are absent
- Growth rate: 4-25 mm/year

Characteristic species: Lophelia pertusa , Madrepora oculata and the solitary coral Desmophyllum sp.

Associated species: Soft corals, worms, sea urchins, bivalves, crabs, crustaceans, fishes

CORAL SIGNIFICANCE: - Reefs provide habitat, recruitment and nursery functions for a range of deep-water organisms including commercial fish species. Deep corals may provide windows into past environmental/ecological conditions. Deep corals provide historical global climate and oceanographic indicators, including temperature data. They may also have medical potential.

Example of Biocoenosis of Deep Corals in Mississippi Canyon 118. Madrepora oculata is widely distributed over Woolsey Mound. This hard coral (Order Scleractinia), also known as zigzag coral, grows in small colonies that form fan-shaped thickets about 30 to 50 cm high. Woolsey Mound also hosts soft corals: Paramuricea sp. (usually with the symbiotic the brittle star Asteroschema ophiuroidis) and Crysogorgia sp. Crabs and Urchins are commonly present in association with corals.

GAS HYDRATES COMMUNITY

Gas Hydrates outcrops can host ice worms, the Polychaete, Hesiocaeca methanicola. There is no evidence of chemoautotrophic symbionts, but data support the presence of abundant free living bacteria on hydrates. Ice worms graze on the hydrate bacteria. They are pink in color with a large red dorsal vessel, reduced eyes, and an eversible proboscis.

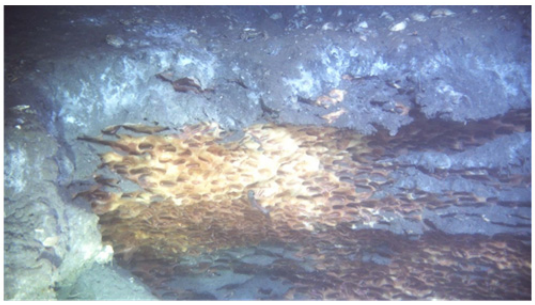

Figure 4. Gas Hydrates outcrop, Sleeping Dragon at Woolsey Mound. Gas hydrate outcroppings are light in color and are included in the carbonate slabs in association with Ice worms.
Image courtesy of Chuck Fisher

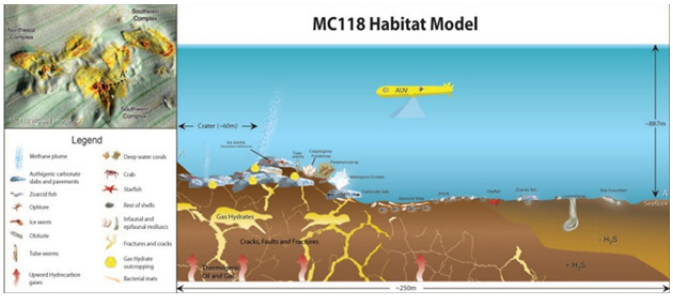

Figure 5. MC118, a mixed habitat model

Collaborators

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