

STUDY TITLE: Deepwater Program: Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico (Chemo III)

REPORT TITLE: Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico, Interim Report 2

CONTRACT NUMBER: 1435-01-05-39187 (M05PC00018)

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Central

FISCAL YEARS OF PROJECT FUNDING: 2005; 2006; 2007; 2008, 2009

COMPLETION DATE OF REPORT: August 2009

COSTS: FY 2005 - \$842,977; FY2006 - \$798,028

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KEY WORDS: Gulf of Mexico, chemosynthetic communities, habitat, AUV, ROV, submersible, biology, photography, tubeworms, mussels, bacterial mats, education, population dynamics, food web, life histories, biodiversity and biogeography

BACKGROUND: The largest oil reserves in the continental United States are found in the Gulf of Mexico (GOM). The Mineral Management Service (MMS) is responsible for overseeing the responsible extraction of these natural resources. By the early 1980s, energy companies had developed the technology to explore and extract oil and gas in waters up to 1,000 m deep and have continued to develop the technology to extract oil and gas from deeper water and now have the capability to drill oil wells in all water depths in the GOM Outer Continental Slope (OCS).

During the mid to late 1980s, MMS contracted with the Geochemical and Environmental Research Group (GERG) at Texas A&M University (TAMU) to collect animals from areas of the deep sea floor associated with active oil and gas seeps. Bush Hill, a site that became one of the best studied seep sites in the world, was populated with giant

tubeworms and mussels, which had only recently been discovered at deep-sea hydrothermal vents in the Pacific Ocean. Since that time similar (but different) cold-seep and hydrothermal-vent communities have been discovered in many different geological settings in the world's oceans.

Over the last 20 years these animals and communities have been studied at moderate depths in the GOM, along with the geology, geochemistry, and microbiology that allows them to flourish. The hydrocarbon seep communities in less than 1,000 m on the upper Louisiana slope of the GOM are the most intensively studied and most understood of any deep-sea cold-seep communities in the world. The basic biology of the dominant animals, their life histories, and the biodiversity and biogeography of the seep and coral communities on the upper Louisiana slope is now understood. The successional processes that lead to the eventual development of coral communities on carbonates created during periods of active hydrocarbon seepage is understood. Also discovered are new communities, such as the ice worms that inhabit methane ice and the mussels that ring the Brine Pool NR-1.

Although several GOM hydrocarbon seep sites at depths greater than 1,000 m have been visited by scientists, only a single site has been the focus of more than a few exploratory dives. This site, at 2,200 m in Alaminos Canyon, has lush communities of tubeworms and mussels that are reminiscent of the shallower sites that are well known. However, the underlying geology and almost all of the species present are different. Preliminary studies indicate that the structure of the communities associated with the tubeworms and mussels is also quite different. The normal "background" fauna are different at this depth, and different patterns of interaction between these animals and the seep specific animals are expected.

OBJECTIVES: The primary purpose of this research is to discover and characterize the sea floor communities that live in association with hydrocarbon seepage and on hard ground in the deep GOM. The sites studied are in areas energy companies will soon drill for oil and gas. Advances in understanding and knowledge of the ecology of this deep community and the types of communities that exist at depths between 1,000 and 2,200 m are the goals of this contract.

DESCRIPTION: Preparation for this program began in the fall of 2005, when Harry Roberts began to study a variety of types of information that would help discover new hydrocarbon seep and hard-ground communities in the deep GOM. Information was gathered from thousands of cores collected by the TDI-Brooks International, Inc. group, satellite images of persistent oil slicks on the surface of the Gulf, and extensive collections of geophysical data and maps of the sea floor that were made available for this project by the MMS. Fourteen sites were identified with a high potential to host lush chemosynthetic and/or deep-water coral communities.

The Reconnaissance Cruise (RC) was conducted on the TDI-Brooks research vessel R/V GYRE from March 11-25, 2006 and was the initial cruise conducted for this contract. The cruise was completed in two week-long legs with an interim port call in

Venice, LA. Leg I (March 11-18, 2006) was dedicated to drift camera work to survey the sea-bed at selected sites. Leg II (March 19-25, 2006) involved both drift camera and trawling/box core work efforts. Thousands of pictures of the sea floor were taken at locations identified by Roberts and his team. Some sites revealed little except a muddy sea floor. At most of the sites there was strong evidence of seepage, and at least scattered occurrence of the types of animals expected at seep sites. In one case there were abundant soft corals, and at a few, there were large communities of seep animals.

Based on the reconnaissance cruise report, the images of the sea floor, previous knowledge of the geophysics and geochemistry of the sites, and a desire to explore over a wide depth and geographic range, the cruise and dives on the Deep Chemosynthetic Community Characterization (DCCC) expedition were planned and completed in May 2006. The DCCC cruise was conducted on the Wood's Hole Oceanographic Institute (WHOI) research vessel R/V *ATLANTIS* and the *ALVIN* Deep Submergence Vehicle (DSV) from 7 May – 2 June 2006.

From June 4 - July 6, 2007, TDI-Brooks' project team conducted a month long ROV cruise at deep-water seep and hardground sites in the lower continental slope of the GOM. The project utilized the NOAA ship the R/V *RON BROWN* and the *JASON-II* ROV from Woods Hole Oceanographic Institute (WHOI). Data were collected by the geologists, geochemists, microbiologists, physiologists, and ecologists in the scientific party.

SIGNIFICANT CONCLUSIONS:

- The number of survey photos captured with the bottom in view (BIV) was 10,922.
- Site characterization and evaluation was completed on 24 sites.
- Multiple dives were made at four sites and the geology, geochemistry, microbiology and biology of the sites thoroughly characterized.
- Longer-term studies were established at these sites to determine growth rates of some of the animals, monitor for visitation by mobile deep-sea fauna such as larger fishes and crabs, and follow the fine scale changes in seepage patterns and community composition (Figure 1).
- A camera dedicated to taking down-looking pictures was used to construct mosaics of any new animal communities discovered.
- Push cores were collected for geological, geochemical, and microbial analyses and for the study of some of the tiny animals that may live between the sand grains at the deep seep sites.
- A chemical analyzer was used to characterize new habitats.
- Collections for study of the larger animals that live at the sites was begun.
- Communities with full mosaics were revisited and chemical analyzers used to characterize the chemistry in and around individual animals identified in the images.
- Quantitative collections of other tubeworm communities, mussel beds, and clam beds were made using specialized collection tools built specifically for this task.
- Ten nighttime trawls were completed.

- Traps and cameras were used to capture and identify the visitors to the seep and coral communities being studied to aid in characterizing the more mobile fauna around the sites.
- A rotary camera, left on the bottom for up to a year, is housed in a special glass tube and periodically “wakes up” to take 12 consecutive pictures as it rotates on a turntable.
- More than 14,000 down-camera and 400 macro images were recorded.
- Acoustic Doppler Current Profilers (ADCP) were operated on station and with the ship underway to obtain an integrated picture of current direction and velocity in the upper 1,000 m of the water column.

Autonomous Underwater Vehicle (AUV)

Sites AT340, GC852, WR269, and AC601 were mapped in great detail using the C&C Technologies Autonomous Underwater Vehicle (AUV) in February 2007. The AUV is equipped with instrumentation for collecting high-resolution multibeam bathymetry, chirp sonar subbottom profiles, and side-scan sonar swaths. These data are well constrained with excellent navigation and the data sets are acquired as the AUV travels at a constant height, 40 m, above the seabed. The data sets were used during the 2007 cruise.

STUDY PRODUCTS: TDI-Brooks International Inc. 2009. Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico. An interim report 2 for the U.S. Dept of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. OCS Study MMS 2009-046. 367 pp.

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Erik E. Cordes, Susan L. Carney, Stephane Hourdez, Robert S. Carney, James M. Brooks, Charles R. Fisher. 2007. Cold seeps of the deep Gulf of Mexico: Community structure and biogeographic comparisons to Atlantic equatorial belt seep communities. *Deep-Sea Research I* 54 (2007) 637–653.

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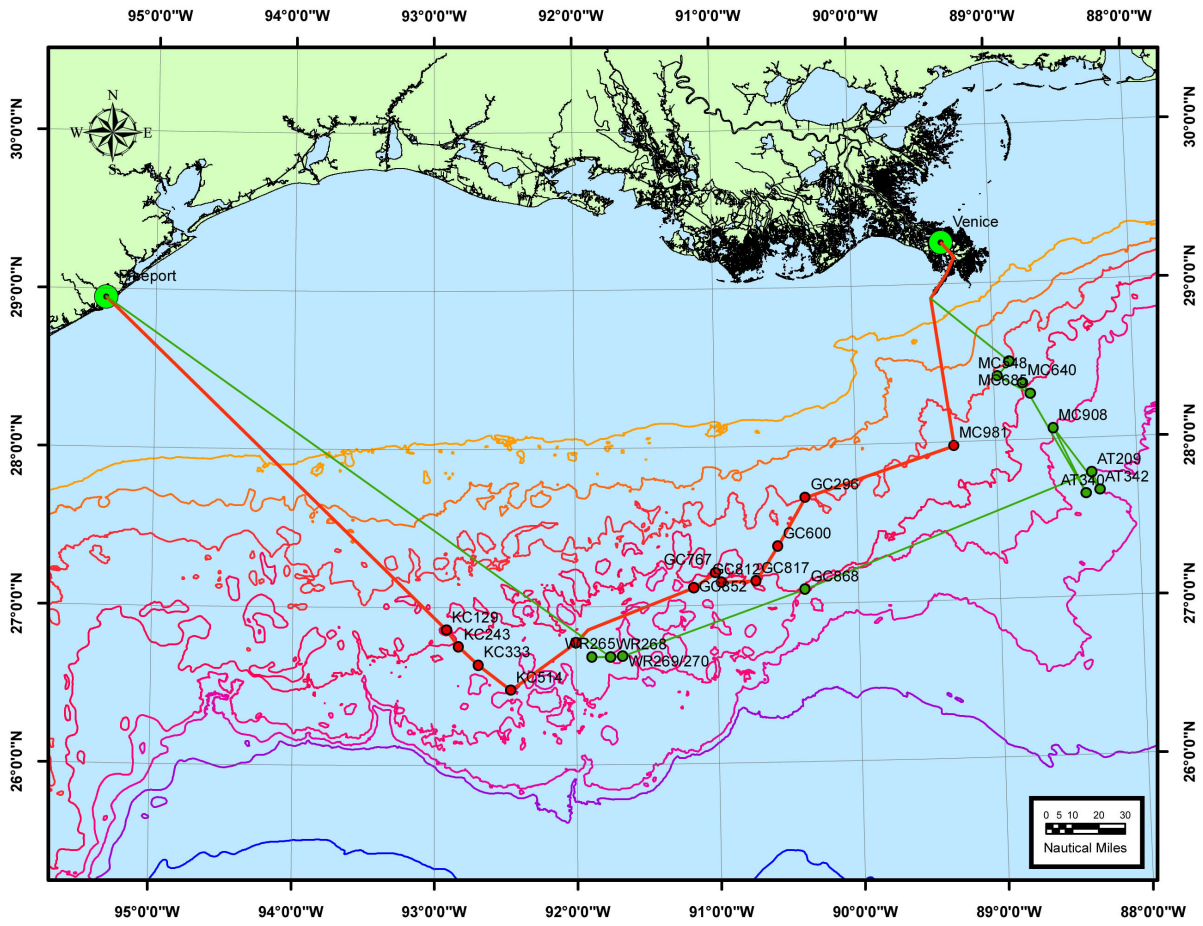
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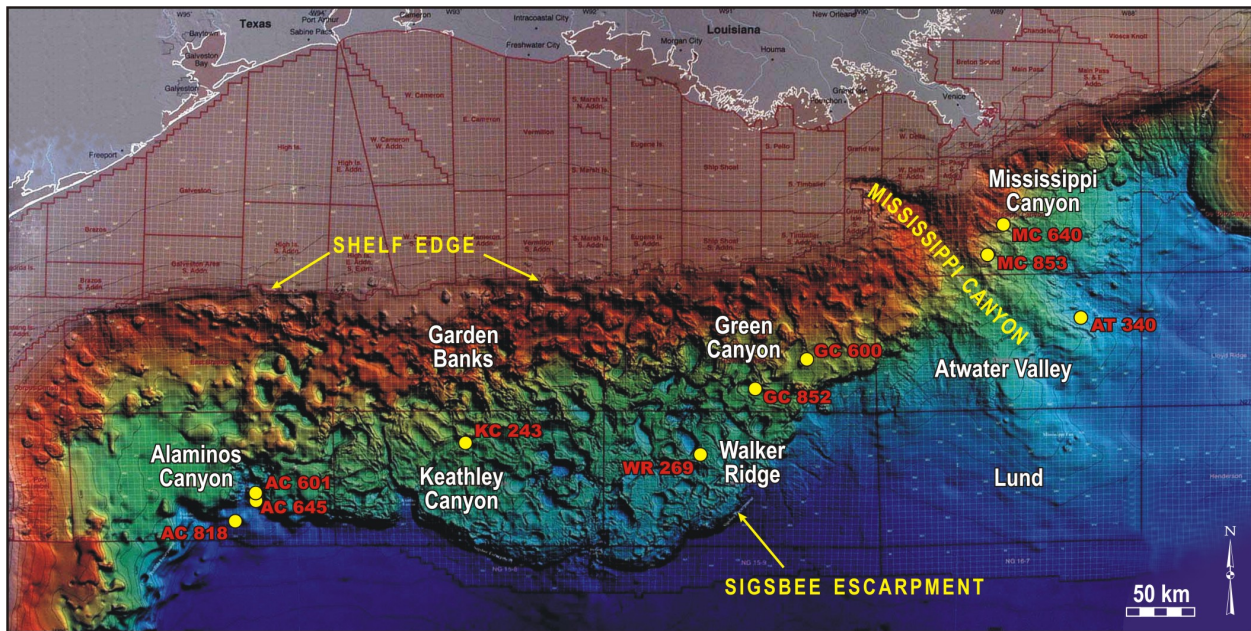
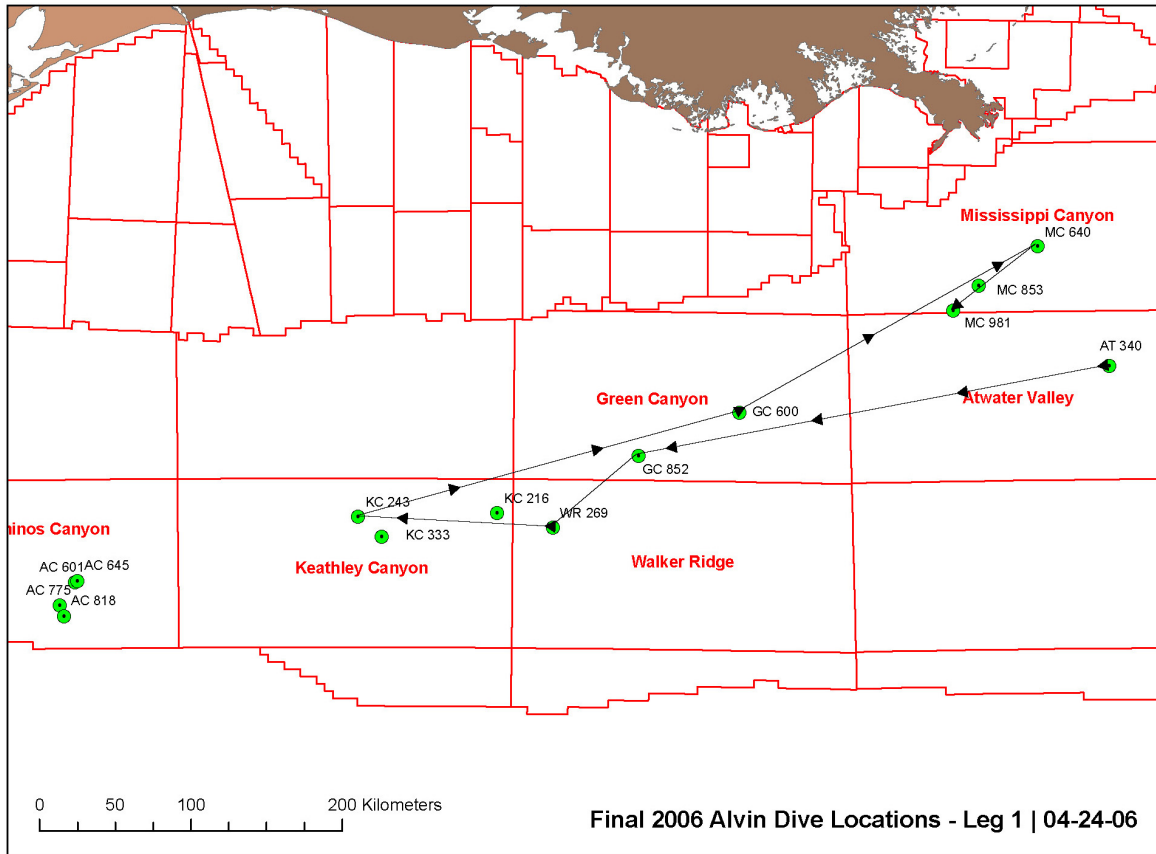
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Chemosynthetic Sites visited 2006



Site locations of JASON dives