GOM Regional Scientists Observe the Gulf of Mexico Slope Seafloor

During the last two weeks of August, five GOM Regional scientists participated in a research cruise aboard the *R/V Edwin Link* and made numerous observations of the seafloor on the Gulf of Mexico slope using the *Johnson Sea Link 1* research submersible. Participating in the cruise were Mary Boatman and Greg Boland (LE), Jesse Hunt and Bill Shedd (RE), and Mike Smith (FO).

For the last two years, Jesse Hunt and Bill Shedd have participated in a special project in RE to map the seafloor reflector on all deepwater 3-D seismic surveys. To date, the seafloor reflector on 110 3-D seismic surveys has been mapped, covering about 80,000 square miles of the deepwater Gulf of Mexico from the shelf break to the abyssal plain. Early in the study, it was discovered that the amplitude (strength) of the reflection from the seafloor, which gives an indication of hardness, showed a very interesting pattern where large, deep faults cut the seafloor. By researching known gas hydrate locations, core locations, and the occurrence of chemosynthetic communities from previous research, it was determined that there appeared to be a very good correlation with such unique seafloor features and the high amplitudes observed on the 3-D seismic amplitude maps.

Dr. Harry Roberts, of the Coastal Studies Institute at LSU, had an on-going research program through the Studies Program in LE to look at the interesting features that he has determined are associated with hydrocarbon seeps on the slope. Through consultation with Jesse Hunt, Bill Shedd, Mary Boatman, Mike Smith, and Greg Boland, Dr. Roberts submitted a proposal to continue his research to use the *Johnson Sea Link 1* submersible to "ground truth" the amplitude maps. Dr. Roberts was the chief scientist on the cruise.

Dr. Roberts visited the GOM Regional Office, and with Jesse, Bill, and Mary, selected about 10 sites with the best looking amplitudes. Transects were planned across the sites, and using the Sun Workstations, exact Latitude and Longitude coordinates were recorded for waypoints along each transect.

The research cruise occurred in 2 legs. Jesse Hunt was the only MMS staff member to participate in the first leg, which was five days long. The first three days were used to place various instruments on "Bush Hill" (GC 185) and adjacent vent sites. Bush Hill is a very well studied chemosynthetic community where gas hydrates are exposed on the seafloor. The instruments installed are designed to measure the flow of natural gas from gas seeps around the mound, and to measure current flow in the area and temperatures within the gas seeps. The last two days of Leg 1 were used to survey transects across amplitudes mapped in GC 286/287 and GC 204/249.

Leg 2 of the cruise lasted for eight days and was used for surveying seafloor features on six other sites that were mapped on the 3-D seismic. Two dives were made at a site each day, and the vessel steamed between sites overnight.

The British Broadcasting Company (BBC) contracted for two days of sub time, which they used to film footage for a 9-part series being filmed for the Discovery Channel (to be aired in 2001) entitled "The Blue Planet." For the second leg, they mounted a high-definition digital video camera on the sub, which was used for the TV programs "Titanic" and "Recovery of the Liberty Bell." Footage shot on the cruise at a well-studied, prolific tube worm community and a brine pool surrounded by mussels will be aired in episode 8 of the series, called "The Deep". Dr. Chuck Fisher (Penn State) was on board for leg 2 as the BBC expert. Dr. Fisher is a leading expert on the ecology and physiology of the tube worms, mussels, and clams that occur in the chemosynthetic communities in the Gulf of Mexico. Dr. Fisher and the BBC, who had accompanied him before, were impressed that the MMS maps were so accurate. They stated that previously, it took them 3 to 5 days to find the features they were looking for, and we found them on each dive using the MMS maps.

Scientifically, the cruise was a tremendous success. After the first few sites, the amplitude maps proved so accurate that the scientific crew began predicting what the sub crew would see and when they would see it. The next couple of sites brought everyone back to reality. Despite high amplitudes on the maps, the seafloor proved to be mostly soft, burrowed deep sea mud. The plausible explanation is that the venting in those areas had been dormant for a long time, and the carbonate hardgrounds or hydrates that were present were covered by a thin drape of soft deep sea muds.

During future cruises, piston cores in anomalous areas where mud drape covers shallow carbonate or hydrate will provide additional ground truth for deepwater geohazards evaluation.

On a dive in GC 286, Jesse Hunt became the first MMS employee to ever create gas hydrates at the seafloor. He and the sub pilot, Dan Boggess, decided to take a bottom sample on the inside rim of a dormant expulsion crater in 2800 feet of water. When the sample was removed from the crater wall, hundreds of drops of oil were released, and a steady stream of gas began bubbling from the seafloor. They inverted a clear sampling tube over the bubble stream, and as the sample tube filled, gas hydrates froze in the top of the tube.

Another notable discovery was made in GB 460. This site has two pinnacles (mud volcanoes) approximately 300 feet high. A bottom sample was taken at the top of each, and consisted of medium to fine grain sand. Some of the quartz grains were very well rounded, and others were highly angular. The suite of minerals observed in the samples indicate a metamorphic (formed from heat and pressure in a mountainous area) source for the sands. The only logical explanation for the occurrence of such sand at this deepwater site is that they were very old sands that were deeply buried, then fluidized, and were brought up to the seafloor from depth along with oil, gas, or brine along a major fault. This is one of very few instances where it can be shown that sands can be deposited on the top of topographic highs!

One of the questions that was considered on this cruise was whether 3-D exploration seismic data are sufficient by themselves for pre-drill shallow geohazards evaluation. This issue, along with identification and the hazard potential of gas hydrates, will be addressed in the MMS Notice to Lessees and Operators on shallow geohazards in the Gulf of Mexico, which is currently undergoing extensive revision. It appears that seafloor areas with hemipelagic (deepwater) mud can be easily identified and separated from anomalous areas with carbonate hardground and gas-charged sediment associated with gas vents. Another principle objective of this project is the ground truthing of the association of chemosynthetic communities with geophysical characteristics represented in surficial amplitude anomalies. Although there is no certainty that chemosynthetic communities are in fact present at these anomalous features, their association with these features has

been strongly supported. These anomalies are avoided at drilling and anchor sites.

Excellent weather and good luck contributed to a very successful cruise. Every site showed indications of the venting of hydrocarbons, mud, or brine, and many had carbonate rocks, tube worms, extensive clam or mussel beds, and mud flows. As the data collected are analyzed, a much better understanding of the dynamic seafloor processes of the Gulf of Mexico slope will be obtained, and the ability to identify them from remotely sensed data will be enhanced.