Investigation of the Near Sea Floor Hydrocarbon System Within the Hydrate Stability Zone of the Northern Gulf of Mexico

Cruise Report of R/V Seward Johnson and Johnson Sea-Link
May 28 - June 5, 2002
Sponsored by
The U. S. Department of Energy
Facilitated by
The Center for Marine Resources and Environmental Technology
The University of Mississippi

During the period from May 28 through June 5, 2002, a submersible cruise, sponsored by the U.S. Department of Energy (DOE) was conducted in the northern Gulf of Mexico (GOM) onboard the R/V Seward Johnson utilizing the Sea-Link submersible. The cruise was dedicated to the study of the near sea floor hydrocarbon system within the hydrate stability zone of the northern GOM. Areas of investigation included (from West to East) the Green Canyon, Mississippi Canyon, and Desoto Canyon blocks. The primary research team included members from Florida State University, Louisiana State University, Texas A&M University, The University of North Carolina, and The University of Mississippi (see attached list of participants) representing the GOM Hydrates Research Consortium (HRC) mission, receiving support from the DOE via The Center for Marine Resources and Environmental Technology (CMRET)/The University of Mississippi. Additional research, complimentary to the overall mission was conducted by guest participants including graduate students from the associated universities as well as researchers from other institutions and industry (see attached list). The cruise enjoyed favorable weather and sea conditions, permitting two dives per day for the seven day working period scheduled from 5/29/02 through 6/4/02; a total of 14 dives. All dives were successful, having completed their assigned tasks.

Overall responsibility for the DOE leg of the cruise was that of the CMRET, represented by J.R.Woolsey and T.McGee. Dive planning, including selection of locations for study and sub traverse layout was based on information from approved proprietary data provided by the Minerals Management Service (MMS), represented by J.Hunt. This data, primarily derived from regional and site specific, shallow seismic and sonar investigations, was supplemented by the HRC site selection team of H.Roberts and R.Sassen, based on years of experience working in the study area.

Project areas of responsibility were divided into: 1) geophysical, hydro-geochemical, and biochemical observations and sampling, led by Roberts and Sassen; 2) pore water sampling, J.Chanton; 3) sediments (mineral and micro faunal constituents), B.Kohl and D.Fillon; 4) sediments (engineering properties), M.Brausse and D.McConnell. It was the responsibility of the leadership of each team to insure that the task of each dive was properly conducted, including the taking of sediment core and grab; water column; pore water; biologic (benthic macro and microbial) samples as required, according to prescribed procedures and protocol. It was also

their responsibility to see that sample splits were properly divided among the various research teams according to research needs.

Woolsey , McGee, and Hunt functioned as facilitators in the day-to-day dive activities, insuring that video tapes and camera film were available and loaded for each dive, as well as core tubes properly assembled and installed, together with sample containers, etc. McGee was further in charge of editing all dive video tapes and the making of an official master copy representative of the 14 dives undertaken.

Particular attention was given by the CMRET team to the various tools and sensors directly employed by or deployed from the submersible in the various sampling operations. Positive and negative features were noted relative to design and operation, focusing on improvements in sample/data collection with regard to efficiency and functionality, i.e. simplicity of design operation and maintenance. An example of a well conceived system was one designed for sampling sediment pore fluids at a controlled rate. At the completion of the sampling interval, valves are closed and individual sections of tubing representative of desired time intervals can be selectively sampled. This particular technology has applications for probe monitoring systems. Capillary tube lengths can be designed for continuous sampling for at least six months and possibly as much as a year or more. Further, it is conceivable that the system could be modified to include the Raman spectrometer mounted on the sea floor with intake tubes extending to selected depths on the probe sensor string within the sedimentary column.

A system with need for improvement is the high pressure cylinder used for containment of hydrate samples after collection, for transport to the surface and transfer to a ship board liquid nitrogen container. Besides being non-user friendly, the cylinder is loaded from the top which allows buoyant hydrate samples, broken from sea floor outcrops and placed in the container, to float up and out of the cylinder while attempting to secure the pressure cover. Over all, the systems observed worked well, contributing to the considerable success of the project.

Narrative Log of the DOE Sponsored Leg of the Johnson Sea-Link Cruise
May 29 - June 5, 2002

Wednesday and Thursday, May 29-30, were spent sampling hydrates, cores, grab samples, and pore water at Green Canyon 232. A large plume was observed at this site on the ship's fathometer, and the ship was in an oil slick at the surface. Droplets of oil could be seen arriving at the surface and emitting a circular sheen. Sampling included a *Beggiatoa* bacterial mat, push cores adjacent to exposed hydrates, hydrates, tube worms, clams, mussels, escaping gas, and carbonate rocks.

The afternoon of May 30 was spent sampling at Green Canyon 234. Samples included gas, tube worms, push cores, grab samples, hydrates, ice worms, sponges, and bacterial mats. A pore water sampler was also deployed adjacent to exposed hydrates. More samples were taken at this site on the morning and afternoon of May 31.

After an overnight steam, Monday, June 1, was spent surveying MC 885, which was missed due to weather on the first leg. Punch cores and grab samples were taken. During the afternoon dive at this site, a thermistor deployed three years ago by Dr. Roberts was retrieved. Samples of gorgonians, carbonate rocks, and dead mussel shells were obtained. Punch cores and grab samples were also taken.

Steamed overnight, and dove twice at Vioska Knoll 826 on Sunday, June 2. This site turned out to be a long term, slow flux rate feature. The top of the structure was entirely covered by thick authigenic carbonate rocks along with occasional tube worm colonies, clams, mussels, and gorgonians. Some deep water coral was also observed. Punch cores, grab samples, coral, shells, and carbonate rocks were collected.

Monday, June 3, was spent surveying and sampling MC 709. This was the site of a large sea floor seep. Thick, ropy oil was observed on the sea surface. A large plume was observed on the ship fathometer, but the submersible was unable to find it. The sub observed numerous extinct mud volcanoes, bacterial mats, tube worms, and other pock marks. Push cores, grab samples, and shells were collected. On the second dive, several brine seeps were observed in the rim of an old mud volcano. The walls of the volcano were about 60 feet high, and were covered with authigenic carbonates. The pore water sampler was deployed at this site. Push cores and carbonate rock samples were collected here.

The final site visited was MC 118. On the seismic amplitude map, this feature was one of the least impressive. A good seismic amplitude was observed, but there was no topography or subsurface wipe out zones associated with this site. A large vent was observed, and exposed hydrates were observed here for the first time. The hydrate mound was about 10m across and 5m high, with a smooth surface. After an hour and a half of attempts, one small sample of hydrates was collected. Gas samples were taken at the vent site, and grab and push core samples were taken. The grab sample adjacent to the vent had mid-Pleistocene microfossils. A lot of oil was also observed venting into the water column.

After an overnight steam, the R/V Seward Johnson arrived in Gulfport to unload on Wednesday morning. In all, the cruise turned out to be a great success. The great amount of geochemical, geotechnical, geological, and biological observations and data collected should yield some dramatic results in the coming months when the data is assimilated and presented.

Proposed Cruise of R/V Pelican
June 17-23, 2002

A cruise designed to deploy and test the prototype acoustic vertical line array (VLA) is scheduled for the period from June 17 through June 23, 2002, to be conducted in Mississippi Canyon, Block 798. The test site was selected on the basis of a number of high resolution seismic profiles in the area, recorded by the CMRET and U.S. Geological Survey over a period of several years, beginning in 1998. A heat flow survey performed by TDI Brooks on behalf of the CMRET has

provided additional information enabling an approximate delineation of the hydrate stability zone lower boundary in the area of interest. Also, gas vents, brine seeps, and hydrates have been reported in and around the test site. Further, the fact that the block is not currently under lease has facilitated access over the period of study.

As reported earlier, a network of five VLA's will compose the heart of the deep GOM observatory, the purpose of which being to conduct a more-or-less continuous monitoring study over an extended period of time, of the near sea floor hydrocarbon system within the hydrate stability zone of the northern GOM. The objective of this study is to thoroughly investigate and collect pertinent data on gas hydrates and related phenomena as potential geohazards, significant energy resource, extremophile biotechnology resource, and significant contributor to atmospheric greenhouse gases.

The VLA's, while primarily acoustic, are multi-sensor by design, including CTD's and current meters in addition to 16 hydrophones. The prototype array is the first of its kind, designed particularly for high resolution investigations of the upper 1000m of bottom sediments which comprises the greater part of the HSZ. Tests will involve the running of track lines, 10km long, centered over the VLA, laid out on a set of cardinal and 45 degree headings. The set will be run with a dedicated sound source (80cu in, water gun) and with ship noise (engine and propeller) only. The purpose for this exercise is to compare the seismic records with the intent to eventually utilize ship noise only as a "source of opportunity", relying on the heavy ship traffic of the area as a ubiquitous sound source for the VLA net of the observatory.

At the conclusion of the test, the seismic data will be processed, evaluated, and used to modify hydrophone frequencies, sensitivities and spacing as required to optimize the acquisition of high resolution data. Based on test results, the VLA design will be finalized and plans readied for the construction of two additional VLA's in the next funding cycle. With the three arrays complete, the initial installation of the station can be established in the fall of 2003.

Additional work planned for this summer includes the installation and testing of the prototype sea floor probe (SFP) at a selected shallow water site in Mississippi Sound. The results of the VLA test and the planned SFP test will be the subject of the next progress report.