Lander Development at MMRI

The marine technology division of the Mississippi Mineral Resources Institute (MMRI) has fabricated seafloor equipment for over 20 years. In recent years, the need for in situ monitoring of the seafloor has necessitated the use of benthic landers by scientists wanting to capture biological, geological, or chemical characteristics at seafloor areas of interest. Landers are typically composed of a durable, lightweight frame, such as aluminum, to withstand seawater for months or years at a time if needed and have sensors, scientific instruments, and floats. An expendable anchor weight held by a release mechanism is commonly used and allows the lander to be heavy enough to stay on the seafloor during operations, but also be retrieved since the lander will float to the surface without the extra weight. MMRI collaborates with scientists to develop marine systems specialized to their project needs.

Hydrocarbon Investigation Landers

Ecosystem Impacts of Oil and Gas Inputs to the Gulf (ECOGIG) is a research consortia funded by the Gulf of Mexico Research Initiative (GoMRI) which was formed after the Macondo well blowout. The goal of this consortia was to understand the environmental impacts of hydrocarbons on deep sea ecosystems. Not only was human-caused pollution studied, but also naturally occurring hydrocarbons in the Gulf of Mexico. In order to do that, a platform for in situ hydrocarbon experiments had to be developed.

In the early stages of lander development, a large frame of aluminum welded pipe and plate were used as the platform for instruments (Figure 1). Pore fluid samplers and chimney samplers were mounted onto the lander so that when the lander is deployed near a site of natural hydrocarbon emissions, a remotely operated vehicle (ROV) can

Figure 1: Early ECOGIG lander design

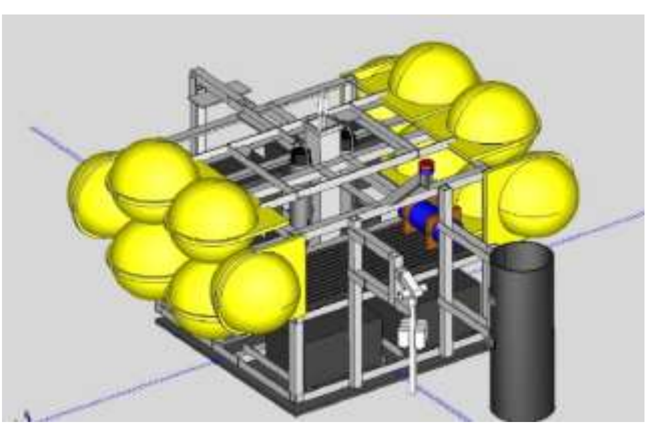

Figure 2: CAD design for more compact ECOGIG lander

Figure 3: Compact lander design

grasp the samplers and place directly onto/into the seafloor. By having the live video feed from the ROV and a manipulator arm, the experiments could be precisely placed at specific hydrocarbon features, such as bacterial concentrations and seeps. A downfall of this design was that an ROV was also needed to retrieve the equipment.

Revisions to the second phase of the ECOGIG project necessitated cost saving measures that were supported with a new lander design. The need to position sensors after deployment and repack them prior to recovery was replaced with a more autonomous approach. A smaller, more compact lander was designed to alleviate the need of an ROV to place the samples onto the seafloor (Figures 2 and 3). Chimney samplers and probes were automatically actuated onto/into the seafloor. This design maintained the same number of glass floats, acoustic release, and mooring weight. Like the first design, this lander was also deployed by use of the ISPIDER, an in-house, tethered reconnaissance platform, which has cameras and navigation in order to accurately position a lander near hydrocarbon areas of interest. Figure 4 shows the ISPIDER mounted above a lander.

Figure 4: ISPIDER atop an early-style ECOGIG lander

Microbiome Recruitment Experiment Array and Recovery Landers

The goal of this study funded by Defense Advanced Research Projects Agency's (DARPA) Biological Technology Office was to determine if human-made steel structures on the seafloor (shipwrecks, oil platforms) exude a distinct signature that can be quantified through analysis of DNA to determine the duration on the seafloor and origin of the structure. MMRI worked with Dr. Leila Hamdan's Lab in the School of Ocean Science and Engineering at the University of Southern Mississippi to produce a lander capable of bringing microbial experiments back from the seafloor after up to four months deployment.

Figure 5: Microbial experiment array on cradle and prepped for deployment

An experiment array (Figure 5) that attracted microbes within set distances from a structure needed to be deployed with the lander. The lander and array would be strategically placed on the seafloor by a remotely operated vehicle (ROV), necessitating a compact, lightweight design.

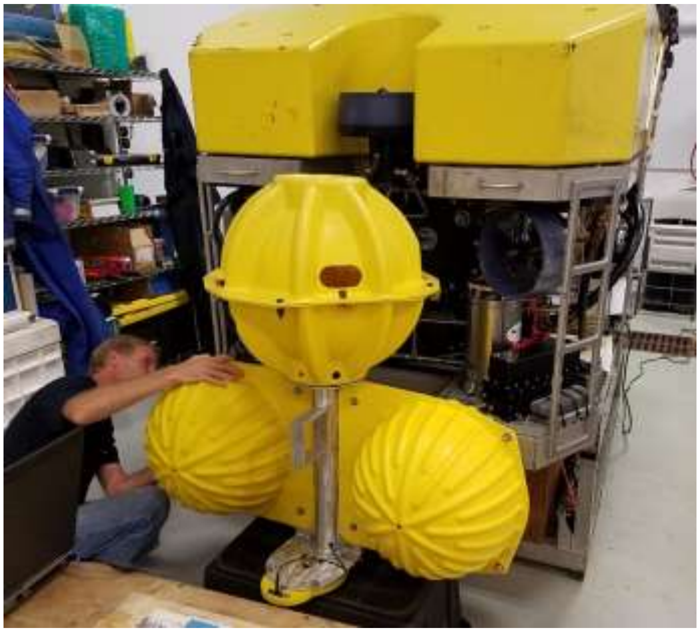

Figure 6: Lander prototype being test mounted on the ROV

Figure 7: Equipment array cradle being mounted to the ROV

The backbone of the lander was constructed from aluminum with welded support brackets. Three glass flotation spheres were mounted on the top and sides of the lander (Figure 6). One of these spheres contained the battery and electronics for an acoustically-triggered release system featuring a segment of wire that is electrochemically dissolved upon receiving the release command when the scientists return to collect their experiments.

After the lander was placed by the ROV at a known distance from a structure, the experiment array with its high tensile strength line unfurled from a cradle on the ROV (Figure 7) as it maneuvered away from the lander. The lander acted as a weighted starting point for the array since it was moored to the seafloor by a 200-pound sacrificial weight. A burn wire attached to the base of the lander allowed the entire setup to detach from the weight and float to the surface. The lander was recovered first and the tethered array was carefully winched on board with the microbial experiments.

Oyster Sensor Platforms

With oyster production off the coast of Mississippi declining in recent years, the need to understand the ocean conditions affecting oysters has given rise to the opportunity to create oyster sensor platforms. Oysters were used as biosensors for monitoring their health during changing ocean conditions. Sensors for measuring temperature and light, conductivity, and dissolved oxygen were also housed within the platform (Figure 8).

Figure 8: Oyster landers ready for deployment

This type of lander was made with low cost in mind since 11 of these platforms were made for monitoring a large area. Equipment theft is also an issue within the Mississippi Sound. Each platform was composed of an aluminum exterior to protect the sensors with a milk


Figure 9: Assembling the oyster sensor platforms

crate interior to house layers of oysters, all mounted atop a round rubber base to keep the platform above the fine-grained sediment when deployed (Figure 9). In order to retrieve the platform after a weeklong deployment, a galvanic timed release was used in conjunction with a pop-up buoy.

Additional lander designs have incorporated a variety of equipment. Water column sensors such as a mass spectrometer, oxygen, pH, turbidity, and CTD (conductivity, temperature, and depth) sensors have been used. Current meters and sonar equipment to image hydrocarbon bubble streams from the seafloor have been installed. Power and communication systems for equipment arrays were incorporated into another design. MMRI has been adaptable to the changing scientific needs with lander design.

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