**CENTER FOR MARINE RESOURCES AND ENVIRONMENTAL TECHNOLOGY**
ACTIVITIES REPORT FOR THE CRUISE GOM2-05-MC118 ABOARD THE *R/V PELICAN*

MISSISSIPPI CANYON FEDERAL LEASE BLOCK 118
NORTHERN GULF OF MEXICO

MAY 15-19, 2005

# OPERATIONS REPORT OF CRUISE GOM2-05-MC118 DEPLOYMENT OF THE INITIAL COMPONENTS OF THE SEA FLOOR MONITORING STATION - THE PORE-FLUID ARRAY AND THE GEOPHYSICAL LINE ARRAY - VIA THE SEA FLOOR PROBE SYSTEM AND COLLECTION OF CORE SAMPLES, MISSISSIPPI CANYON 118

By

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## INTRODUCTION

In 1999 the Center for marine Resources and Environmental Technology (CMRET) took the lead role in establishing the Gulf of Mexico Hydrates Research Consortium. The Consortium has, as its primary objective, the emplacement of a permanent seafloor station designed to monitor the activities of gas hydrates on the seafloor and in the shallow subseafloor on a more or less continuous basis. Research efforts of the Consortium are supported, jointly, by Minerals Management Service (MMS), the Department of Energy's National Energy and Technology Laboratory (DOE/NETL), and NOAA's National Institute for Undersea Science and Technology, Seabed Science and Research Center (NIUST/STRC).

A scientific research cruise was conducted to Mississippi Canyon Block 118, from May 16 through 19, 2005, onboard the R/V Pelican (MMS). The purposes of this cruise were 1) to select sites appropriate to the design and functions of the first permanently deployed components of the monitoring station/seafloor observatory (MS/SFO) - the Pore-Fluid Array (PFA)(DOE) and the prototype thermistors Geophysical Line Array (GLA)(DOE) – and 2) to deploy the arrays. In support of these tasks, and in order to establish a suitable deployment location, core samples were recovered, examined visually, onboard, for evidence of hydrates and gas, and subsampled for further laboratory analyses (MMS, NIUST/STRC**)**. Twelve sites were cored with either MMRI's 10m or the ship's 3m core barrels. Positive indications for hydrate were observed in cores from the area corresponding to the northwestern periphery of the mound as determined by recently acquired AUV Multibeam, sidescan, and chirp data (MMS). Two cores were recovered, capped and stored for purposes of electric logging and further sampling.

## BACKGROUND

This cruise was designed as the lead in a series of cruises to deploy the MS/SFO. The site, MC118, was selected by consensus of the Consortium in October, 2004. However, there was very little data available specific to the site other than that provided by Sassen and Roberts in their 2004 report to DOE. Their visit to the site on two dives aboard the Johnson SeaLink in the summer of 2002 revealed hydrates exposed at the seafloor, vents and seeps centered about a mound approximately 1km$^2$ in the south-central portion of the block. The CMRET, through the MMS in New Orleans, obtained access to bathymetric and 2-D seismic data from the area that supported the findings of Sassen and Roberts. The services of C&C were then retained for the purpose of surveying the block with the Hugin3000 autonomous underwater vehicle. This survey was completed May 2, 2005. The images were used to select the locations from which cores were recovered for site assessment prior to the deployments of the PFA and the GLA by means of the Sea Floor Probe (SFP).

## OBJECTIVES

Objectives of the first deployment cruise were:

- To sample the shallow subseafloor to determine suitability for probe deployment
- To deploy the Pore-Fluid Array (PFA)
- To deploy the Geophysical Array (GLA)
- To recover sediment samples for microbial, geochemical, and geological analyses

All objectives were met.

## PARTICIPANTS

University of Mississippi: Mississippi Mineral Resources Institute and the Center for Marine Resources and Environmental Technology (MMRI/CMRET); Seabed Technology Research Center (NIUST/STRC).

Project Management Team: Bob Woolsey, Carol Lutken and Ken Sleeper.
Technical Team: Brian Noakes, Andy Gossett and Matt Lowe.
Task 1: Design and construction of gravity-driven Sea Floor Probes for emplacement of the PFA and prototype GLA,
Task 2: Design, construction and operations of 10m gravity coring device.

Specialty Devices, Inc. Plano TX

Technical Team: Paul Higley, Scott Sharpe and Jim Gambony.
Task 1: Design and construction of recoverable instrument/data logger/power supply assemblies,
Task 2: Assist in the installation of the PFA and prototype GLA and their final position triangulation.

Florida State University and University of North Carolina, Chapel Hill
Scientific Team: Jeff Chanton (FSU), Laura Lapham (UNC) and Sam Perkins (UNC)

Task 1: Design and assembly of PFA osmosamplers,
Task 2: Collection of core samples for geochemical analyses.

Droycon Bioconcepts, Inc., Saskatchewan, CAN,

Technical Team: Derek Ross
Task: Collection of core samples for microbial analyses.

University of Georgia and Texas A&M University

Technical Team: Randy Culp (UG)
Task : Collection of core samples for geochemical analyses.

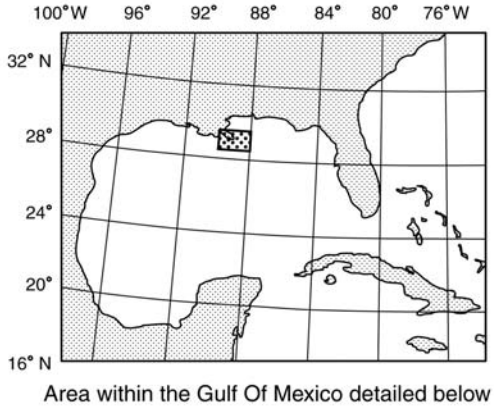
University of Southern Mississippi;

Scientific Team: Charlotte Brunner and Sondra Simpson
Task : Collection of core samples for geological and paleontological analyses

## STUDY AREA

The cruise was conducted in the northern Gulf of Mexico, Federal Lease Block Mississippi Canyon 118, (Figure 1) where gas hydrates have been documented at the sea floor by Sassen and Roberts (2004). The block comprises a portion of the continental slope with water depths ranging from 800 to 990m (2620 to 3250ft). The regional bathymetry is dominated by the Mississippi Canyon to the west; however, the block is bounded to the east by a smaller, apparently fault-controlled, canyon. The predominant seafloor feature in the block is the approximately 1km$^2$ mound in the south-central portion of the block (Figure 2).

**Figure 1. Location of Block MC118 (boxed area detailed below).**



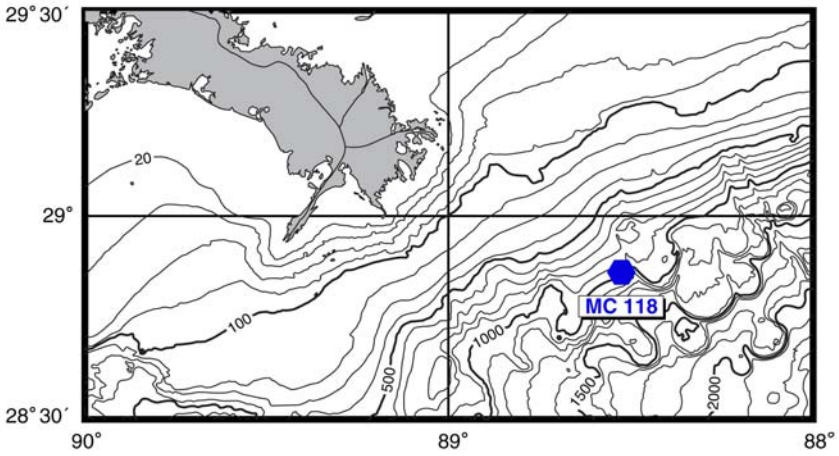
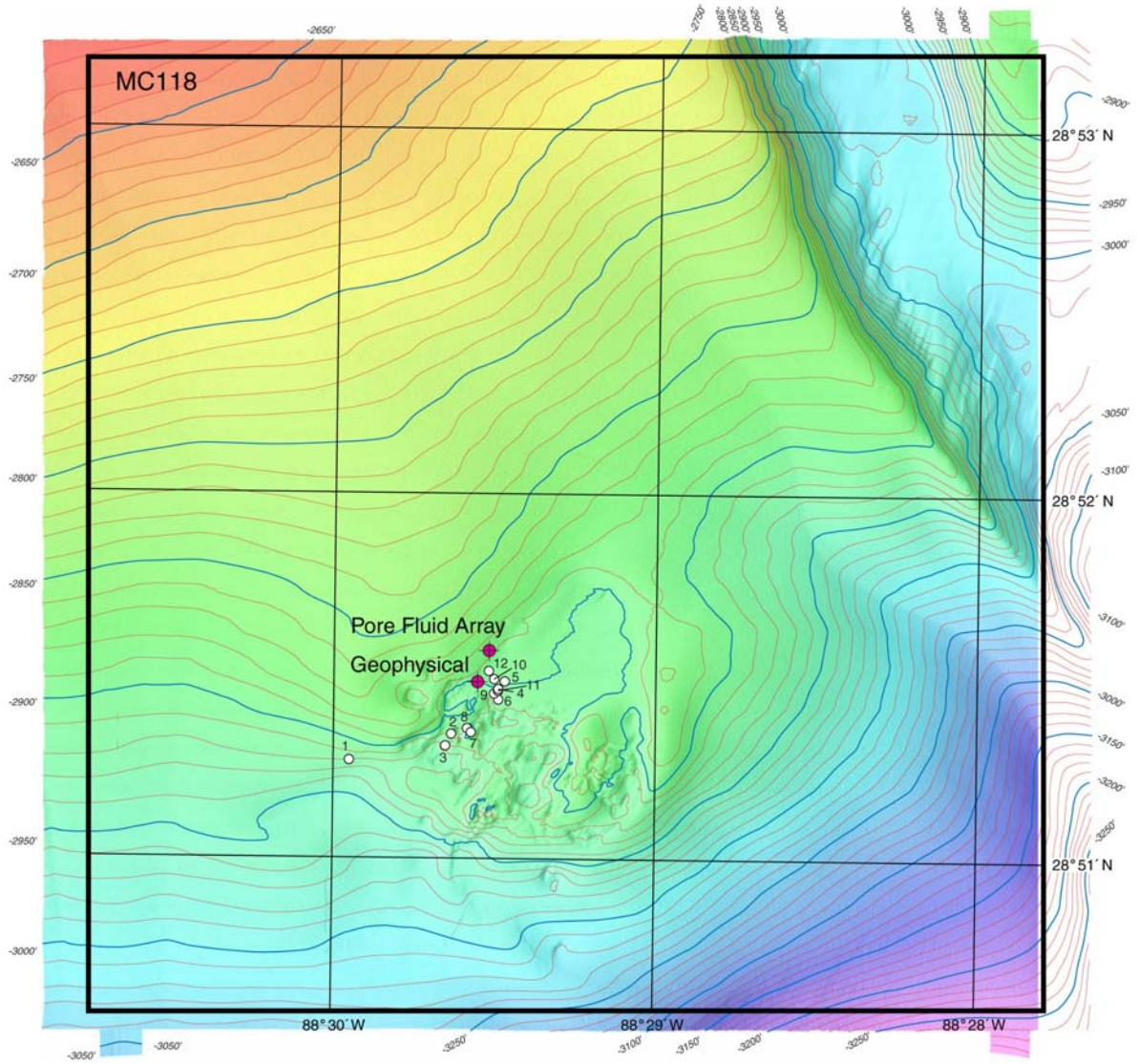



**Figure 2. Mississippi Canyon 118. Array sites are in red, core sites are in white. Bathymetry is overlain on multibeam image acquired by C&C Technologies.**




## THE PORE-FLUID SAMPLER ARRAY (DOE)

The Pore Fluid Array (PFA) is designed to provide continuous sampling of sediment interstitial fluids at several depths below the seabed. The Array collects these samples by means of an osmotic fluid pump and storage device (Figure 3) mounted on the top of the Sea Floor Probe (SFP). The pump and storage devices are mounted in such a way as to enable removal and replacement by underwater vehicle.

The PFA was installed using an MMRI-designed and constructed 10 meter, gravity-driven SFP (Figure 4). This device drives a steel box beam containing fluid

acquisition ports and associated tubing into the sea floor. An osmotic pump brings these fluids to the surface collecting device. SDI constructed an underwater vehicle compatible, eight-port, fluid coupler and a mating assembly which houses the osmotic pumps and master control shut-off valve. The fluid coupler and housing were designed to survive the installation process and to be recoverable *via* underwater vehicle. The housing and coupler are also designed to be re-installed by a small remote vehicle to extend the potential sampling duration. Recovery and reinstallation provide support for the pore-fluid sampling device designed and built by Jeff Chanton and Laura Lapham.

**TABLE 1. Osmosampler configuration.**

| Osmo Pump # | Connector | Probe Port | Depth below box* | Tubing type | Plumbed to Valve |
|---|---|---|---|---|---|
| 2 | 1 | 1 | 61cm | PEEK | Y |
| 3 | 2 | 3 | 315cm | Copper | N |
| 4 | 3 | 5 | 570 | Copper | Y |
| Open | 4 | 4 | 443 | | |
| Open | 5 | 2 | 181 | | |
| Open | 6 | 6 | 697 | | |
| Open | 7 | 7 | 824 | | |
| 1 | 8 | 8 | 1051 | PEEK | N |

*Box height = 187cm

Installation was performed May 18 by MMRI personnel and was accomplished by lowering the PFA on the SFP using the ship's trawl winch. The winch was operated at a maximum speed of approximately 90 m/minute. When the device reached the sea floor an acoustic release was activated to free the trawl cable from the SFP. A second release remained on the PFA/SFP for use in locating the sea floor position of the array. This second release was activated and recovered following triangulation and recording of the location by the SDI team (see Table 2). The PFA was deployed in ~880m water.

**Figures 3 and 4.** Recoverable osmopumps and sample storage units (left) and deployment of the Pore Fluid Array (right).

## THE GEOPHYSICAL LINE ARRAY (DOE)

The prototype geophysical line array (GLA) consists of an array of temperature sensors with inline micro-controllers and an underwater vehicle recoverable Data Acquisition and Telemetry System (DATS) data-logger and power supply (Figure 5). This deployment (Figure 6) served to test several new designs to be used in the geophysical components of the MS/SFO. These designs are intended to allow servicing by small remote vehicles, reducing the costs associated with building and maintaining the MS/SFO geophysical section and extend the operational life of its components.

This deployed instrument array is similar to the deep bore-hole array designed for installation through a 3.6" drill stem (Figure 7), planned for a later deployment. The goal of this installation was to test the design of components for the bore-hole system in addition to the continuous acquisition of high resolution near-seafloor sediment temperatures for the purpose of monitoring the thermal gradient over time. The acquisition of both acoustic data from the solid/gas phase discontinuity at the base of the hydrate stability zone (noted by a polarity reversal), and thermal gradient data over time will, hopefully, enable the monitoring of vertical migrations of the base of the hydrate stability zone and related consequences.

The prototype array consists of two, remote, in-line temperature sensors and an in-line temperature acquisition module. A unique design of the array is intended to provide long life with no required maintenance. The sensors and acquisition module are housed in anodized aluminum housings encased in neoprene bladders designed to prevent sea water contact with the pressure housings. This technique is intended to extend the useable life of the sensors and electronics to 5 to 10 years. Also included in this array installation is a new ROV-mateable design for connectors and a remote vehicle replaceable instrument housing.

## ARRAY POSITIONS

The positions of the PFA and GLA were triangulated from slant range and ship position information following deployment. A Benthos acoustic transponder release and corresponding model 210 deck box provided the slant range. HYPACK navigation software coupled to the ship GPS positioning system was used to provide the Benthos surface transducer location. Slant range and position information were entered into SDI's "Angulate" program to resolve bottom transponder position and depth. Three slant range positions are used in the calculation with additional ranges used to verify the computed location.

The resulting positions for the seabed locations for these arrays appear in Table 2 and are plotted on the location map (Figure 2). MC118 is in Zone 16, UTM grid.

**TABLE 2. Positions of arrays**

| | Latitude | Longitude | UTM X (Easterly) | UTM Y (Northerly) |
|---|---|---|---|---|
| Pore fluid array | 28° 51.470775′ | 88° 29.520042′ | 354472 | 3193151 |
| Geophysical | 28° 51.384835′ | 88° 29.555103′ | 354413 | 3192993 |


**Figures 5 and 6**. Prototype geophysical array with ROV replaceable DATS (left). Geophysical array readied for deployment (right).

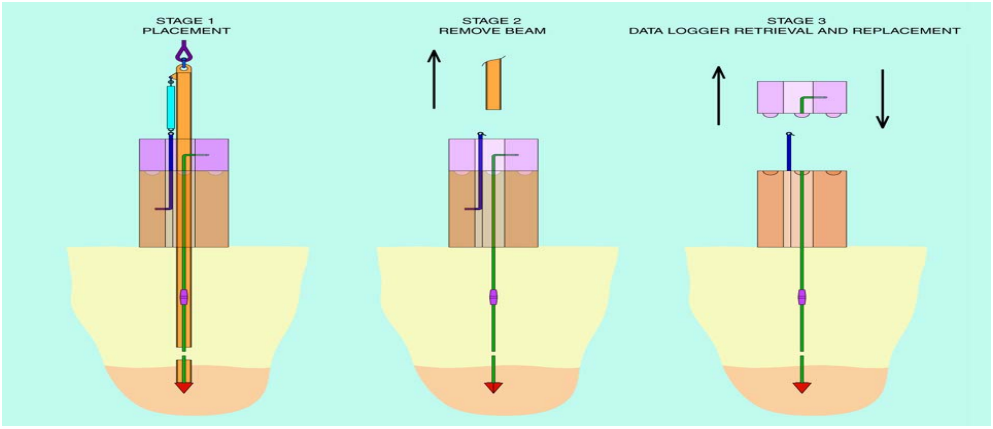



**Figure 7.** Conceptual drawing of Sea Floor Probe installation.

## CORING PROGRAM

Cores were recovered in support of a variety of efforts to expand the base of information available for MC118. Twelve cores were recovered, with two being attempts to repeat sample sites of particular interest. These two repeat cores were cut into 1.5m sections, capped and transported to John Stennis Space Center where they will be logged, electronically, and then sampled.

Coring was facilitated using either a ten foot (3-inch core barrel) or thirty foot (4-inch core barrel) corer which adapted, respectively, 2.5-inch or 3-inch (inner diameter) PVC pipe as core liner. As cores were recovered on the deck, the MMRI crew removed the core catcher and then the entire ten foot pipe from the ten foot corer. The thirty foot corer required the top to be opened first and the portion of empty pipe at the top of the corer removed. The remainder was split into ~1.5m sections, capped, then split and opened onboard by sawing down the length of the core liner (circular saw) on opposite sides and prying open the resulting halves. Sediment was, in general, very sticky; numerous hands and clean tools were required to keep the splits intact and uncontaminated.

Next, the cores were examined, visually, for signs of hydrate and/or gas expansion. If positive signs for either were observed, samples were immediately taken and canned, with Roger Sassen's canning machine, then frozen. If no signs of frozen hydrate or gas were observed, the split cores were cleaned, photographed and then sampled, according to the protocol of each group. Materials of particular interest, such as authigenic carbonate and shell material, were also bagged and refrigerated for further study. Briefly, the sampling programs were as follows:

The University of North Carolina at Chapel Hill

Cores were sampled at intervals designed to characterize the geochemistry of the site in terms of methane and sulfate concentrations, chlorinity, and porosity as a function of depth. Subsamples collected: 6 mL mud aliquots taken for methane concentration and 6 mL aliquots taken for sulfate and chloride concentrations. Four of the cores were also sampled for Pb-210 analysis by subsampling the upper 20 cm in 1-2 cm intervals.

The University of Southern Mississippi

Samples were recovered from the tops and core-catchers of all cores and at 1m intervals, placed in zip-lock bags, labeled and refrigerated. The samples were collected in support of the MMS-funded project to define the stratigraphy and depositional history of MC118. Dr. Charlotte Brunner, PI of the project, will have cores MC118-505-11 and MC118-505-12 logged with theGEOTEK Multi-Sensor Core Logger at the Sediment Physical and Geoacoustic Properties Laboratory, Seafloor Sciences Branch (Code 7430) of the Marine Geoscience Division of the Naval Research Laboratory,Stennis Space Center. After they are logged, these two cores will be transported to CMRET facilities in Oxford for splitting, subsampling, and distribution of samples for further analyses.

Mississippi State University

Samples were collected for Dr. Rudy Rogers to continue his efforts to characterize hydrate-producing sediments. Samples were collected from the tops and bottoms of each of the cores, 1-10, and at 1m intervals within the cores, placed in zip-lock bags and refrigerated.

University of Georgia

Samples taken from cores evidencing hydrate or gas expansion were placed in alcohol-washed and seawater-rinsed 16-ounce steel cans. Once the sediment sample was placed inside the can it was argon-flushed, capped and sealed using Roger Sassen's (Texas A&M) canning apparatus. Sassen's samples had seawater added to 3/4 full prior to sealing. Identification was made on the top of the can as to core number and depth and recipient: RS for Roger Sassen and CZ for Chuanlun Zhang. Core information, depth and intervals of samples were recorded. Core position data, latitude and longitude, were added later. The cans were immediately placed into a freezer in the *R/V Pelican's* lab.

Other samples were taken along with the above mentioned canned samples at most of the 10 core-sites. These samples of sediment ranged from approximately 50 to 200 grams in weight and were placed into either twist-loc or zip-lock baggies. The air was expelled and the bags sealed, marked as to core and depth interval and recipients ID and finally placed into the lab's refrigerator.

Texas A&M University

Randy Culp, University of Georgia collected samples for Dr. Roger Sassen in support of his studies of the hydrocarbon systems of MC118. Samples that showed evidence of gas expansion were collected immediately upon opening the cores, canned, and frozen onboard. These samples will be transported, frozen, to Texas A&M University where they will be analyzed for geochemical properties.

Droycon Bioconcepts Inc.

Samples from each of the 10 cores opened on deck were collected to define the microbiological flora within the hydrate mound and surrounding area. They were collected in sterile 20ml containers from a variety of intervals along the full core length, then refrigerated. The samples will be transported to Droycon Bioconcepts, Inc., Regina, Saskatchewan Canada, where they will be analyzed for bacterial analysis using the BART™ system of tests. This will have been the first analysis of the microbial structures within the hydrate mound core samples at MC-118.

Core locations, as they appear in Table 3, are taken from the Pelican's onboard navigation system.

## CONDITIONS AFFECTING OPERATIONS

Seas were calm throughout the cruise, at no time exceeding 2 feet, and weather was fair. Full penetration of the 3m and 10m coring devices was impaired in some instances, presumably, by the presence of carbonate at or near the seafloor. Vessel drift presented a problem in maintaining station both for coring and for probe deployments. For deployment of the probes, adjustments to location were made.

## SUMMARY OF ACTIVITIES

All objectives were achieved. Both Pore-Fluid and thermistor Geophysical arrays were deployed successfully on the sea floor though it will not be known for certain until the follow-up cruise with submersibles whether or not they achieved full penetration. Their locations have been determined so that the recoverable portions of the PFA and the data-logger from the GLA can be retrieved when Consortium scientists return to the site in September, 2005.

Results of the analyses of the various sample sets will be made available to Consortium workers when the analyses are complete. It may be worth noting that in the area selected for probe deployments, two cores were recovered. While on target following the retrieval of core #9, oil was noted on the sea surface. The occurrences were numerous and in some cases, widespread.

**TABLE 3. Core locations.**

| CORE # | LATITUDE | LONGITUDE | TOTAL LENGTH | Water depth |
|---|---|---|---|---|
| MC118-505-1 | 28° 51.264′ | 88° 29.952′ | 231cm | 903m |
| MC118-505-2 | 28° 51.337′ | 88° 29.635′ | 175.5cm | 895m (wire) |
| MC118-505-3 | 28° 51.305′ | 88° 29.653′ | 337cm | 908m |
| MC118-505-4 | 28° 51.461′ | 88° 29.490′ | 186cm | 897.6m |
| MC118-505-5 | 28° 51.482′ | 88° 29.470′ | 211cm | 887m |
| MC118-505-6 | 28° 51.432′ | 88° 29.490′ | 156cm | 892.6m |
| MC118-505-7 | 28° 51.342′ | 88° 29.574′ | 228cm | 895.3m |
| MC118-505-8 | 28° 51.353′ | 88° 29.586′ | 142cm | 894m |
| MC118-505-9 | 28° 51.448′ | 88° 29.503′ | 724.5cm | 877m |
| MC118-505-10 | 28° 51.488′ | 88° 29.503′ | 371cm | 894m |
| MC118-505-11 | 28° 51.456′ | 88° 29.491′ | ~ 200cm | 880m (wire) |
| MC118-505-12 | 28° 51.510′ | 88° 29.520′ | ~400cm | 890m |

NOTES:
Water depth was taken from the Pelican's fathometer, unless noted otherwise.
Lengths of cores 11 and 12 will not be known, accurately, until after they are logged and split.