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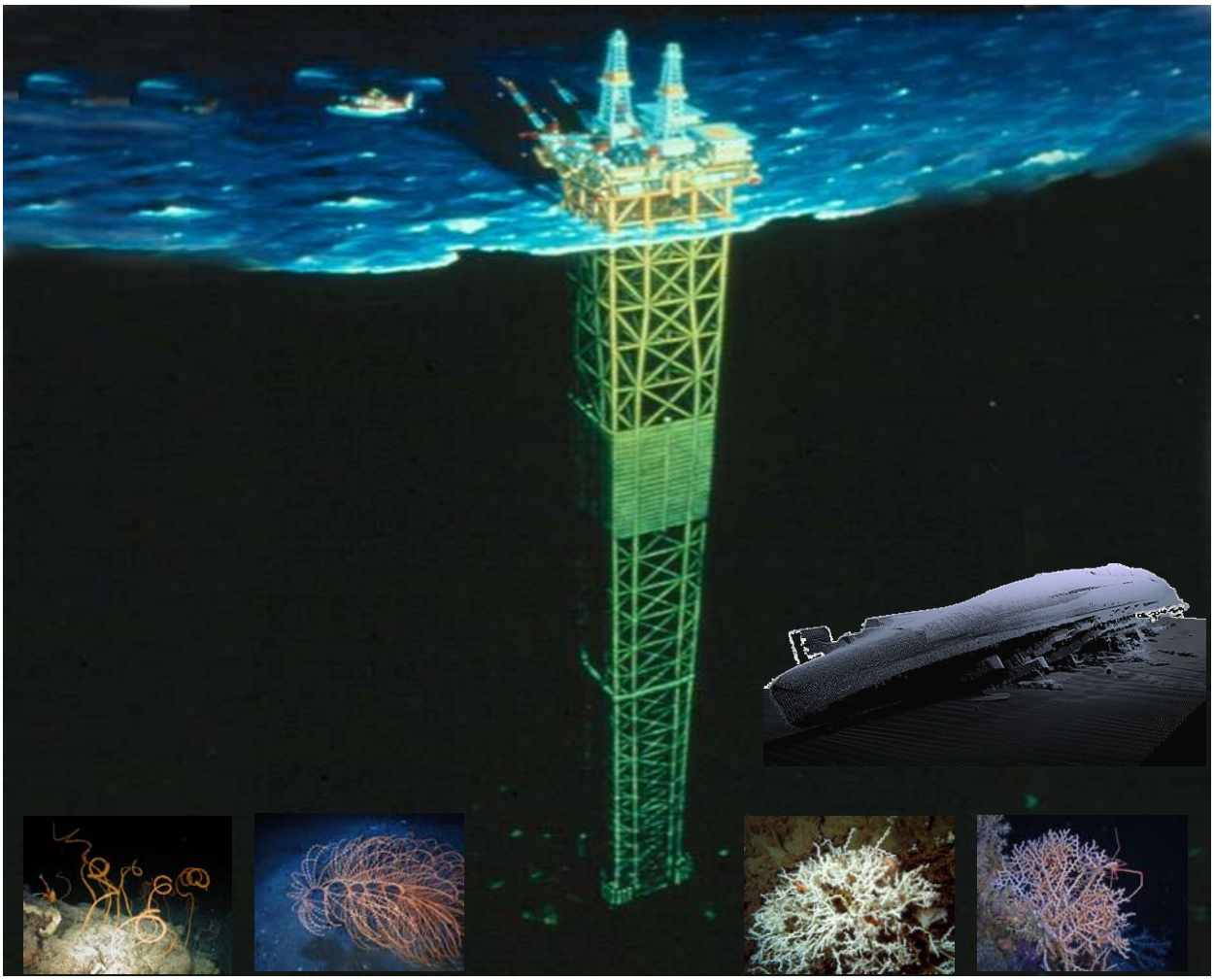
Deepwater Program: Exploration and Research of Northern Gulf of Mexico Deepwater Natural and Artificial Hard Bottom Habitats with Emphasis on Coral Communities: Reef, Rigs and Wrecks "Lophelia II"

Cruise 2 Report - Sentry AUV
17 June – 1 July 2009



October 2009

CRUISE 2 REPORT
17 June – 1 July 2009

for

Deepwater Program: Exploration and Research of Northern Gulf of Mexico Deepwater Natural and Artificial Hard Bottom Habitats with Emphasis on Coral Communities: Reef, Rigs and Wrecks

by

TDI-BROOKS INTERNATIONAL, INC.
Technical Report No. – 09-2284

October 2009

TDI-Brooks International Inc.
1902 Pinon, College Station, TX 77845, USA.
Phone: 979-696-3634

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INTRODUCTION

Overview

This document represents the TDI-Brooks International, Inc. Lophelia II Post-Cruise Report for contract number: **M08PC20038**, issued by the U.S.Department of the Interior, Minerals Management Service "*Deepwater Program: Exploration and Research of Northern Gulf of Mexico Deepwater Natural and Artificial Hard Bottom Habitats with Emphasis on Coral Communities: Reef, Rigs and Wrecks*. The Lophelia II Cruise was conducted on the TDI-BI Ship **RV BROOKS MCCALL** from **17 June – 1 July**, 2009 and was the second cruise conducted for this contract. The cruise mobilized and embarked from Freeport, Texas and demobilized in Gulfport, Mississippi. This report provides detailed information regarding operational procedures, stations occupied, and sampling activity. Results reported were obtained by analysis of the sampling information and data during the cruise and immediately afterward. Results will possibly be revised . This report is a preliminary product of the contract.

Background

Over the last half century, offshore exploration for hydrocarbons in the northern Gulf of Mexico has advanced from the bay and inner shelf to the continental slope-to-continental rise transition. Geophysical and geotechnical data collected in support of both exploration and production has been largely responsible for the foundation of our present understanding of slope geology. This database emphasizes the extremely complex geological framework of the northern Gulf's continental slope and the surprisingly important role that the expulsion of subsurface fluids and gases has on shaping surficial geology and biology of the modern seafloor. Regional topography of the slope consists of basins, knolls, ridges, and mounds derived from the dynamic adjustments of salt to the introduction of large volumes of sediment over long time scales. Superimposed on this underlying topography is a smaller class of mounds, flows, and hard grounds that are the products of the transport of fluidized sediment, mineral-rich formation fluids, and hydrocarbons to the present sediment-water interface. The geologic response to the expulsion process is related both to the products being transported and the rate at which they arrive at the seafloor. Mud volcanoes and mudflows are typical or rapid flux settings where fluidized sediment is involved. Slow flux settings are mineral-prone. Authigenic carbonate mounds, hard grounds, crusts, and nodules are common to settings where hydrocarbons are involved.

Recent manned submersible and ROV dives to the middle and lower continental slope confirm the existence of these hard substrates to the deepest parts of the slope. Direct observation and sampling of expulsion sites started in the mid-1980s on the upper slope. We now know from analysis of 3D-seismic data and submersible-ROV dives that numerous expulsion sites with hard substrates provide habitat for deep water corals exist over the slope's full depth range.

In the context of this study, deep hardground communities of the Gulf of Mexico comprise all of the biological communities inhabiting natural or artificial hard substrates, excluding the chemosynthetic seep communities. These communities consist of foundation species, those species that form large complex habitats at these sites, and their associated fauna ranging in size from large mobile fishes to microscopic meiofauna. The most prominent foundation species in these communities are the deep-water ("cold-water") corals. The terms "deep-water corals" or

"cold-water corals" include relatives of the tropical reef-forming scleractinian corals, but also refer to a variety of other cnidarian taxa including antipatharians (black corals), gorgonians (including bamboo corals), alcyonaceans (soft corals), and stylasterine hydrocorals. Other taxa, including anemones and sponges are also significant contributors to the biogenic framework of these deep-water reef systems.

In the Gulf of Mexico, deep-water corals are commonly found on seep-related authigenic carbonates, but have also been observed on anthropogenic structures, ship wrecks and oil platforms in particular. The most common species of reef-forming deep-water coral in the Gulf of Mexico (GoM) is *Lophelia pertusa* (=*prolifera*). This species was first recovered in the late 1800s by the *U.S. Coast Survey Steamer Blake.*

Increasing industry activity in deepwater has resulted in the creation of numerous platforms in water depths exceeding 300 m. In areas where hard substrates are limiting, these platforms may significantly increase the potential range of corals and other hardground fauna. Growth of *Lophelia pertusa* has been noted on the Pompano platform in VK 989. In addition, the Joliet platform in GC 184 near Bush Hill and the Neptune platform near the large *L. pertusa* site in VK 826 are very likely to host coral populations. This study will focus on the exploration and characterization of these communities and examination of their potential connection to other coral populations and surrounding deep-water communities.

Objectives of the Project

A primary goal of this study is to obtain a robust predictive capability for the occurrence of rich cnidarian (primarily scleractinian coral) hard ground communities in the deep Gulf of Mexico. To achieve this long-term goal, this study will accomplish three interrelated and interdependent objectives:

1) Discover and describe new locations at greater than 300m depth in the GoM with extensive coral community development, particularly including *Lophelia pertusa*.

2) Gain a more comprehensive understanding of the fundamental processes that control the occurrence and distribution of *Lophelia* and other extensive coral communities at depths greater than 300 m in the GoM through both laboratory experiments and field data collection.

3) Document and understand the relations between coral communities on artificial and natural substrates with respect to community composition and function, phylogeographic and population genetics, and growth rates of the key cnidarian foundation fauna.

Upon meeting these three interrelated objectives we will have obtained an understanding of the biology and biogeography of Lophelia in the GoM that will result in a quantum increase on our ability to predict the occurrence of Lophelia at additional sites based on data such as bathymetry, current models, 3D seismic profiles, and known occurrence of source populations.

CRUISE OVERVIEW

Participating Organizations

- Penn State University (PSU)
- Louisiana State University (LSU)*
- Texas A&M University (TAMUCC)
- Temple University (TEMPLE)
- Woods Hole Oceanographic Institution (WHOI)
- US Geological Survey (USGS)*
- TDI BROOKS INTERNATIONAL (TDI-BROOKS)
- Minerals Management Service (MMS)
- NOAA Ocean Exploration Program (NOAA OE)* (* Consulting on cruise planning and program execution. No cruise personnel participating)

Personnel (Chief Scientist and participants)

	NAME	AFFIL.	SEX	NAT.	POSITION
1	Ian MacDonald	TAMUCC	M	USA	Chief Sci
2	Doug Weaver	TAMUCC	M	USA	student
3	Jay Lunden	Temple	M	USA	student
4	Jeff Turner	Temple	M	USA	student
5	Leslie Wickes	Temple	F	USA	student
6	Michele Grinar	Temple	F	USA	student
7	Al Duester	WHOI	M	USA	Sentry
8	Andy Billings	WHOI	M	USA	Sentry
9	Dana Yoerger	WHOI	M	USA	Sentry
10	James Kinsey	WHOI	M	USA	Sentry
11	Jordan Stanway	WHOI	M	USA	Sentry
12	Rod Catanach	WHOI	M	USA	Sentry
13	Bill Shedd	MMS	M	USA	Company Rep
14	Bernie Bernard	TDI	M	USA	Scientist
15	Deck manager	TDI	M	USA	Tech
16	ET Navigation	TDI	M	USA	Tech
17	Lara Miles	TDI	F	USA	Tech

Affiliation Addresses

TAMUCC	Physical and Life Sciences Dept., Corpus Christi, TX 78412-5774
TEMPLE	Biology Department, Temple University, 1900 N 12th St, Philadelphia PA 19122
WHOI	National Deep Submergence Facility, Woods Hole Oceanographic Institution, Woods Hole, MA 02543-1050
USGS	US Geological Survey, Florida Integrated Science Center, St. Petersburg, FL 33701
TDI-Brooks International	1902 Pinon Dr., College Station, TX 77845
MMS	Gulf of Mexico OCS Region and Atlantic Activities, New Orleans, LA 70123-2394

Administrative:

Points of Contact

Ian MacDonald FSU Oceanography Bldg 117 N Woodward Dr. POB 3064320 Tallahassee FL 32306-4320 phone 850-644-5498	
Erik E Cordes Biology Department Temple University BL315, 1900 N 12th St Philadelphia PA 19122 phone: 215-204-8876 fax: 215-204-6646	Charles Fisher Professor of Biology 208 Mueller Laboratory The Pennsylvania State University University Park, PA 16802 cfisher@psu.edu phone - 814-865-3365 fax -865-9131

FACILITIES

1. XBT/CTD for speed of sound calibration
2. Differential GPS navigation and serial data output
3. Heading and water depth instruments
4. Deck machinery for science gear deployment and recovery.
5. A-frame for launching *Sentry*
6. Power to the winch and vans
7. Dynamic positioning system for vessel station-keeping
8. Sailor 250 FleetBroadband system for voice and data (email)
9. Networked computer printers and plotter
10. Use of walk in cold room and freezer for live coral maintenance and sample storage
11. Use of –80°C Freezer, and use of –20 chest freezer.
12. Use of compressed air in staging bay
13. Use of CTD and Niskin water sampling rosette
14. Three air tuggers
15. Laboratory and storage space
16. PC based SCS workstations
17. Zodiac, or equivalent, and motor for elevator recovery, AUV contingencies, and video and still photo acquisition
18. Crane support for all equipment during mobilization and demobilization.
19. Access to and use of the moon pool and transducer
20. Access to clean sea water and fresh water on aft deck or in wet lab.

Additionally sufficient consumables, backup units, and on-site spares and technical support were in place to assure that operational interruptions were minimal. All measurement instruments had current calibrations, and all pertinent calibration information was in the data package. The ship provided technical expertise and assistance if unexpected problems arose.

Equipment and capabilities provided by science party

The scientific party provided the following items and was responsible for their maintenance:

1. All biological and chemical sampling equipment and supplies.
2. All software associated with photo mosaic
3. Remote camera systems
4. CTD with DO and pH probes for use with AUV
5. Deployment/recovery elevators
6. *Sentry* AUV and associated equipment
7. Navigational transponders associated w/ AUV operations
8. Dynacom winch system
9. Control van, tool van, rigging, vehicle, and shipping vans
10. Effer crane

Data Collections

The primary data collected includes multibeam swath bathymetry, digital video and still photographic imagery, and CTD with DO and pH sensors. Other data streams from the AUV, such as vehicle attitude, acoustic data, and sonar imagery were recorded by networked computers in the control van. Navigational data for both the ship and AUV systems were recorded. While in transit to and from the site, and during times when the AUV was not deployed, photographic data were collected with the camera sled.

Staging plan

All of the equipment for this expedition (listed below) was loaded and installed onboard the RV BROOKS McCALL in Freeport TX 14-16 June. The science party was encouraged to arrive in Freeport 15 June and no later than the morning of 16 June.

Mobilization

The cruise mobilized in Freeport TX and departed at 10:00 17 June. The Freeport dock facility required TWIC cards for access. Escorts were made available.

R/V Brooks McCall
Freeport Launch Service
1201 E. Brazos St.
Freeport, TX 77541
(979) 233-8044

Map - http://www.tdi-bi.com/about_us/Destinations/Freeport_TX.htm

Demobilization

The RV Brooks McCall demobilized in Gulfport MS on 1 July 2009 at 0600. The Gulfport dock facility required TWIC cards for access.

R/V Brooks McCall
Mississippi State Port Authority
East Terminal

Route 90
Gulfport, Mississippi
phone#: (288) 865-4315 (main operations)
Map - http://www.tdi-bi.com/about_us/Destinations/Gulfport.htm

Contact Information for Staging:

Ian MacDonald
FSU Oceanography Bldg
117 N Woodward Dr.
POB 3064320
Tallahassee FL 32306-4320
phone 850-644-5498

Large Equipment

Description	Wt. (lbs)	Destination	Power
1 x 20 ft Control Van*	13, 500	Forward of Sentry on the port side, main deck beside the staging bay	Needs two 480V, 3 phase circuits, 60A and 100A service
1 x 20 ft Vehicle Van	17,500		
Dynacon winch & Wire	23,600		
Traction winch, level wind, & power pack	18,700		

STATION LOCATIONS

The following (**Table 1**) is a list of sites that were occupied during Cruise 2. The cruise track and site locations are shown in **Figure 1**.

Table 1. Sites occupied during Cruise 2.

Dive	Site	Lat	Lon	Depth m	Photographs	Comments
017	test					Self-terminate above bottom
018	test				49	Strobe not synched with camera shallow test West Flower Gardens
019	GB837	27.11967	93.89694	865.6		Weight fell off on 3rd line
020	GB837	27.11967	93.89694	865.6		Camera did not work
021	GB535	27.43115	93.59861	585.0	691	Phins(INS) inoperable compass substituted
022	GC600	27.36639	90.56417	1,248.8		Self-terminate above bottom 450m
023	GC600	27.36639	90.56417	1,248.8	163	Camera stopped after 10 min.
024	GC246	27.71133	90.67600	755.0	570	Camera took ~800 pics then quit weight fell at start of multibeam
025	MC885	28.08250	89.71850		3800	Photo-survey complete showing gorgonians and small Lophelia colonies. Unprogrammed weight drop before multibeam started
026	MC657	28.34364	87.93010	~2,000	5160	Completed dense mosaic of shipwreck site with multibeam data. Ship was clearly and completely imaged.
027	MC339	28.63251	88.44917	1,398.5	~4000	Completed multibeam and photo survey of mound slopes. No problems or delays with vehicle. No coral or sea fans noted.
028	VK826	29.14200	88.03783	610.0	>5000	Completed multibeam and photo survey of most of knoll area. All systems functional to end of dive. Anticipate good coverage.

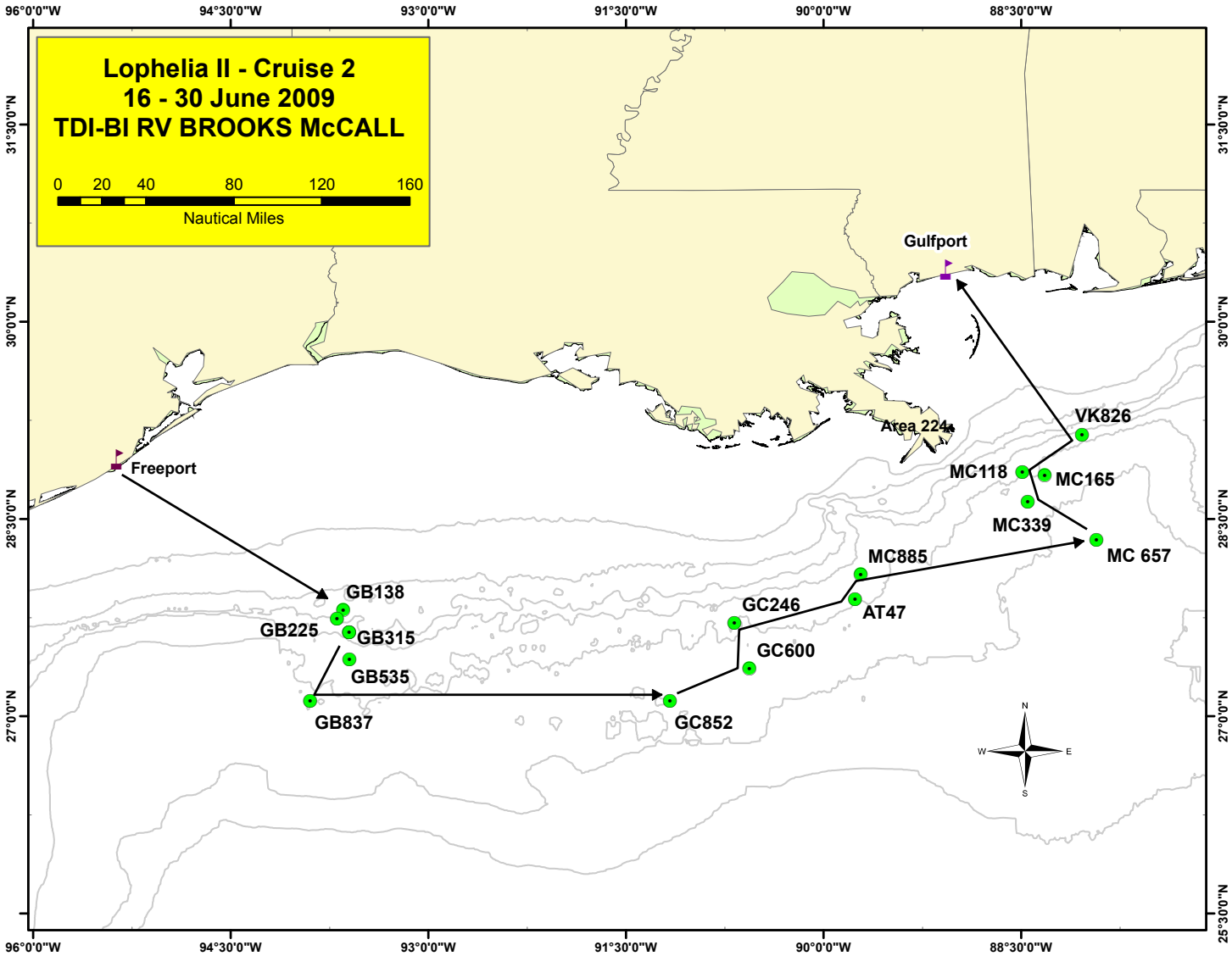

Figure 1. Sites visited – Cruise 2.

INTERIM CRUISE OVERVIEW – 26 JUNE 2009

The cruise team has been at sea for 10 days on board the RV Brooks McCall. The ship transited from Freeport, TX to the Garden Banks Lease Area south of the Flower Garden Banks and most recently to the Green Canyon lease area. Weather has been favorable, but a series of equipment and software malfunctions have limited the results until now. The primary objective has been to conduct exploratory surveys of suspected deep-sea coral communities with the Sentry AUV. To date, Sentry has conducted eight free-swimming dives. One of the dives was a test operation at 80 m, three were self-terminated due to various malfunctions, and four were completed for missions of 10 to 13 hours. Reson multibeam data was collected during all of the successful dives and appears to be providing useful bathymetry and backscatter. Photographic surveys have been planned during three of the completed dives, but a series of malfunctions have limited the number of usable photographs. As of this writing, Sentry is in operation at GC246. The secondary objective of the cruise was to complement the AUV surveys with drift camera surveys of less prominent sites. The drift camera system was deployed with a USBL transponder and obtained a small number of usable photographs until a minor leak caused the camera to stop. The camera was repaired from spares. However the winch with conducting cable needed for this operation suffered a terminal failure during the first test in shallow water and no additional drift camera operations have been possible. The following narrative describes the operations in greater detail, summarizes the results obtained at each site and outlines the problems faced and steps taken to solve them.

Operations

Sentry has been deployed from the port side of the ship, using the crane to deploy and recover the vehicle. **Figure 2** shows the recovery of Sentry following a completed dive. Prior to each dive, the chief scientist (MacDonald) and the AUV mission programmer (Yoerger) develop a survey plan for the upcoming dive. The surveys include transect lines for multibeam at altitudes of about 50 m and transit lines for photographic survey at altitudes of about 5 m. MMS contract officer (Shedd) is consulted on survey design. Survey targeting has generally selected steep escarpments and hard bottom areas.

Navigation has relied principally on USBL ranging from the ship to a Kongsberg transponder attached to Sentry. The USBL system is recalibrated prior to each mission. A long baseline array was deployed at GB837 to compare performance between the two systems. When a good calibration has been completed, results suggest that USBL provides adequate navigation to Deployment and recovery of the LBL array consumes several hours of ship time and has been avoided where possible.

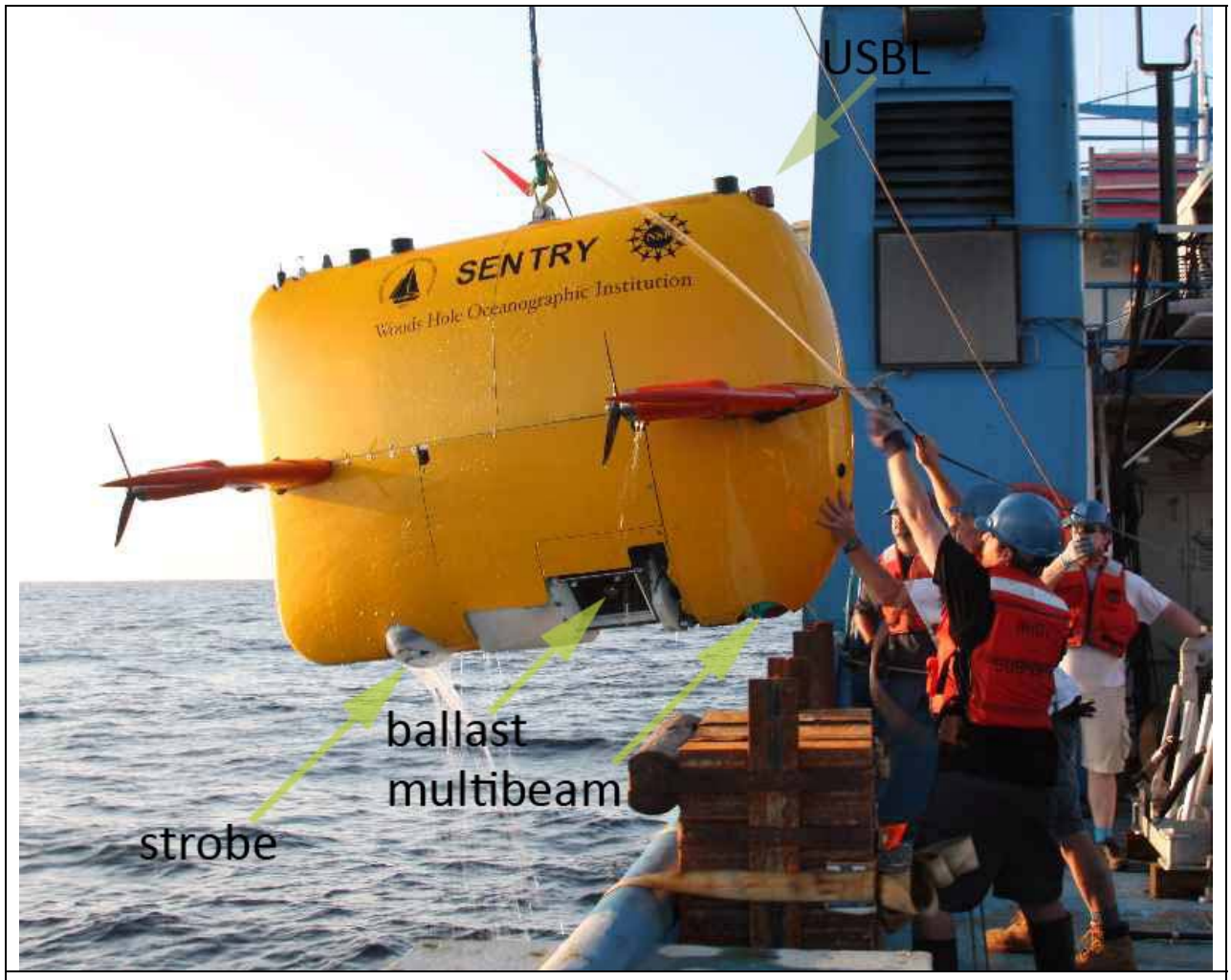

Figure 2. AUV Sentry being recovered onto the RV Brooks McCall following a successful dive. Arrows and labels indicate locations of system components described in the text.

During the survey, the progress of the AUV along the designated survey lines is continually monitored by the navigation team on the Brooks McCall. Generally the vehicle has been tracking the designated lines within offsets of a few 10s of meters or less. Dives are concluded when a) the vehicle completes all the survey lines, or b) the dive exceeds an allotted time period. At the conclusion of the dive, programmed events trigger the release of two ballast weights, allowing Sentry to rapidly ascend to the surface.

Following a dive, the AUV team reviews performance to identify problems and to log all data collections. Most of the data requires processing. For example multibeam traces have to be geo-rectified and have noise filtered by systemic treatments and by human review of individual sonar traces. Photographic images are color corrected and histogram equalized channel, by channel. Nightly meetings of the science and AUV personnel are held to assign tasks and optimize performance. The ship's crew have also organized regular briefings to advise scientists and new hands on safe operations at sea.

Results

Surveys have been completed at targeted features in the following lease blocks: GB837, GB535, and GC600. Preliminary results and example products are described below.

The surveyed area of GB837 consisted of two circular mounds and hard ground (**Figure 3**). Sentry completed a 13.6 hour survey covering 33.5 km of trackline at an average altitude of 58 m. **Figure 3** shows a partially filtered display of the bathymetry from this site. The camera system was not functional during this dive due to problems with the strobe, but a preliminary interpretation of the backscatter suggests that there were active mud flows and possibly mud volcanism at the site.

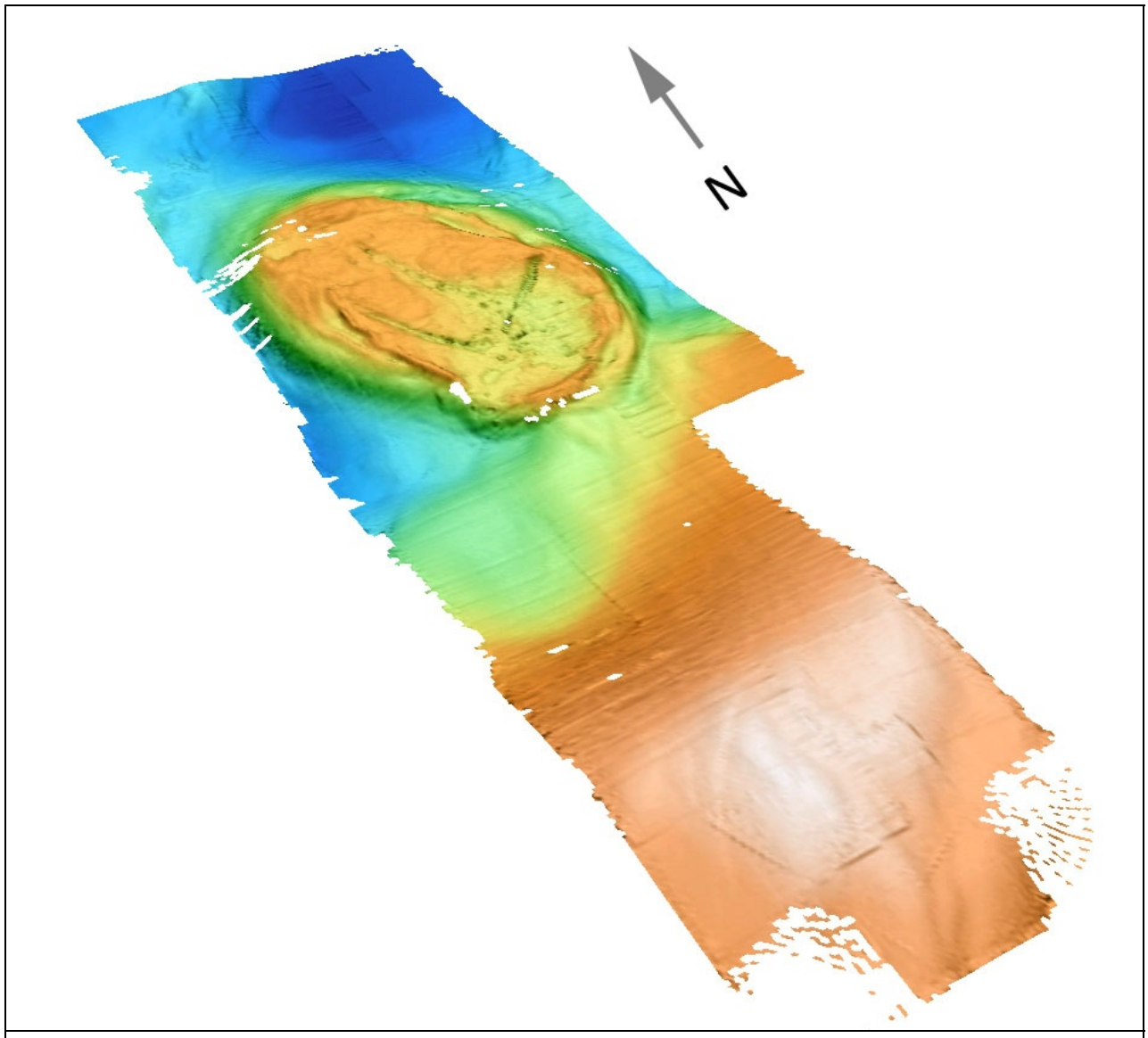

Figure 3. Multibeam bathymetry from Sentry survey of GB837. Surveyed area is approximately 2 km long by 0.5 km wide over a depth range of 630 to 820 m.

The survey at GB535 was abbreviated due to concerns about the inertial navigation system described below. Consequently, it focused on a central high ground, but avoided steep, hard-ground slopes to the south that had originally been targeted. The survey was completed in 10.0 hours and covered 28.9 km. Photographs were taken along a ~1km track along the edge and top of the mound; the photo track targeted the seismic high-amplitude areas. This feature contained numerous seep features, including bacterial mats, brine flows, and seep mussels. One image (**Figure 4**) showed possible colonies of *Lophelia.* This identification is not definitive and it is possible that the white objects were particularly dense examples of Beggiatoa.

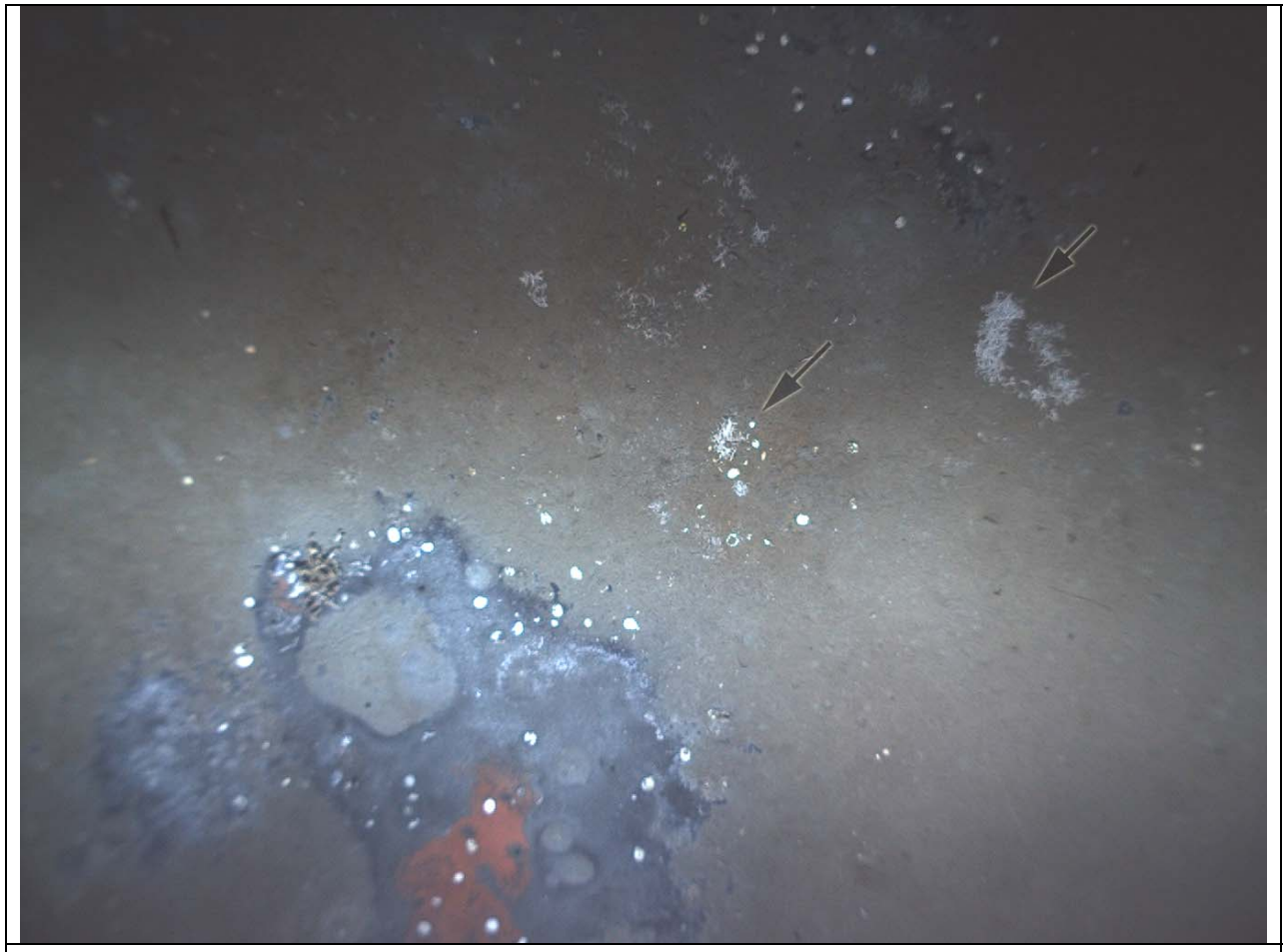

Figure 4. Seep fauna and possible Lophelia colony photographed during survey of GB535. Mussels and bacterial mats are evident in the foreground to left.

The target area at GC600 was located near a the Monarch America Drilling Platform operated by Diamond Offshore Drilling International. Before beginning our survey we hailed the Monarch America and obtained their anchor spread map and anchor locations by email. After determining that the survey area was safely clear of the anchors, we sent the operators a map of our planned survey and received their permission to proceed. The survey at GC600 targeted a series of steep escarpment faces and seismic high-amplitude areas. Although this site was near an area visited during investigations of chemosynthetic fauna, the survey area did not overlap the area visited by Alvin or Jason. This survey lasted 12.3 hours and covered 25 km. The majority of the distance

covered was flown at altitudes of 5 m for photographic coverage. Unfortunately, the camera control program malfunctioned and shut the camera off after 10 min on bottom. Only 163 bottom photographs were taken, none of which showed corals or fauna of interest.

As noted, the Sentry will complete a survey of GC 246 at approximately 10:00 on 27 June. After that, we have planned surveys of approximately 12 hours each at MC885, MC657 (wreck site, **Figure 5**), and VK826. The cruise will extend by approximately 24 hours with arrival in Gulfport planned for 08:00 on 1 July instead of 30 June. Any extra time will be used to extend the VK826 survey.

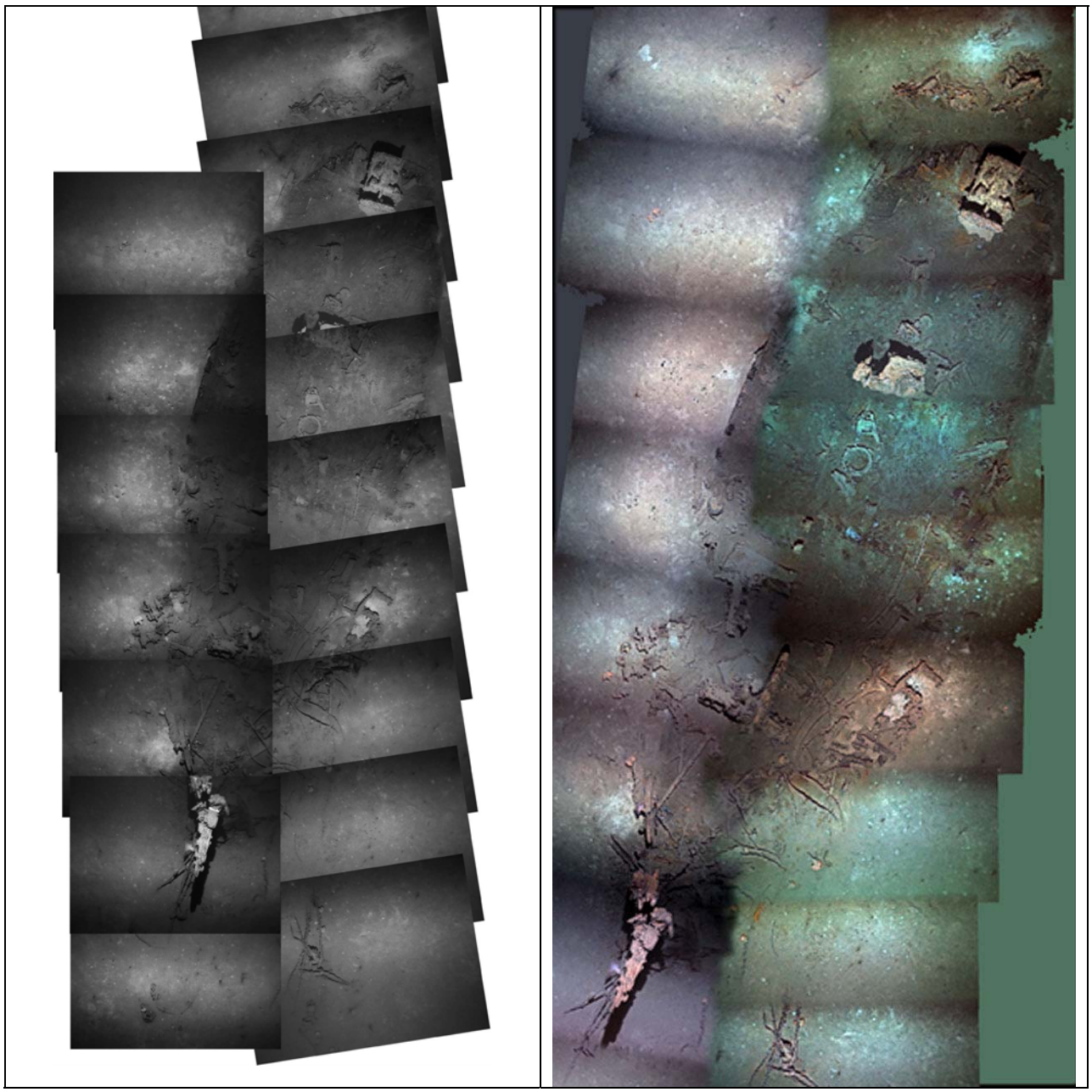

Figure 5. Stages of rendering shipwreck mosaic from MC 657

Problems encountered and solutions attempted

Sentry and the supporting navigation system has experienced a variety of problems during the cruise that have negatively impacted the science agenda. Initially, there was a recurrent problem with overheating that resulted in several delays. Faulty readings from a humidity sensor also caused delays. During the initial testing over the side, Sentry was held on its tether while tests were completed. When the vehicle was being brought back onboard, a tethered weight fouled on of the aft props. This caused a loss of control and the vehicle rammed the side of the ship. As it was being hoisted over the rail, it swung into the side of the ship again and the port, forward diving plane broke away and had to be recovered. Repairs occupied a full day.

The USBL navigation system could not be properly calibrated during the early part of the cruise. This problem was rectified by sending out an extension for the through-hull mounting plate of the USBL in-water transducer. Problems with the CTD used for sound velocity profiling cause a delay of 2 hours while the calibration file was reset.

As noted, the winch meant to operate the drift camera system was inoperable. During a trial deployment of the camera platform, the winch was unable to raise the cable from a depth of 150m and the system had to be recovered with a cable grip and line tugger.

During the first untethered test dive, Sentry dropped one of its ballast weights and returned to the surface without imaging the bottom. The problem of dropping weights recurred on two subsequent dives, resulting in significant delays. It was eventually concluded that minor voltage leaks were causing the weight release motors to creep open. The system was repaired by electronically isolating the motors.

As noted, the strobe was not synched with the camera during the first two dives and no usable pictures were taken. The problem was noise in the system which caused the system to over trigger the strobe. Electrical isolation appeared to fix the problem, but a separate camera problem caused the entire imaging system to shut down prematurely.

A potentially mission ending problem occurred when one of the fiber optic gyroscopes in the inertial navigation system failed. The Sentry team was able to calibrate the magnetic compass with sufficient precision that it substituted for the heading stream that would have come from the INS.

In general, pre-dive preparations have taken much longer than anticipated on nearly every dive. The "burn-in" process for a new system is clearly still in progress. Nearly every dive requires programming fixes for new problems. The Sentry group routinely make predictions of launch times that underestimate by several hours the actual launch time.

Despite these difficulties, the WHOI group, the TDI staff, and the science party are to be commended for never giving up, for finding creative solutions to seemingly intractable problems, and for maintaining good morale in the face of daunting obstacles. Positive results are gradually beginning to flow from the system. Weather remains very favorable and valuable data is anticipated in the remainder of the survey.

DAILY PROGRESS REPORTS

DAILY PROGRESS REPORT

Submitted 06/17/2009

current position 27°47.23'N 93°49.67'W

R/V Brooks McCall
e-mail: **brooksmccallstaff@txcyber.com**
Nav Room Iridium: 011-881-641-461-357
Nav Room GlobalStar: 254-378-3240

TDI-Brooks International, Inc
e-mail: **drjmbrooks@aol.com**
Phone: 979-696-3634 (Jim Brooks mobile)
Phone: 979-693-3446 (Main office in Texas)

Report number: 1

2009 LOPHELIA II CR2 DAILY SCIENCE REPORT

Weather clear with disorganized chop. Winds moderate. Temperatures very hot.

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments
Freeport	0930		depart			
AUV test site	2000		Prepare dunk test of SENTRY	80m		Dunk test for sonar cal.

Site name	Depth	Latitude	Longitude	Comments on site
Marble grouper mound	81	27°51'08"	93°49'26"	Shallow site in Flower Garden sanctuary
USBL calibration site	~200	?	?	Steam south from Marble grouper mound to deeper water.

Man-Hours assuming 12-hr work shifts (as of 2400 hrs this day):

Personnel	Count	Man-Hours Today
WHOI Party	6	60
Science staff	7	84
TDI-Technical	3	
MMS-representative	1	
TOTAL ON-BOARD	**14**	**168**

TDI-Brooks Party Chief (Ian MacDonald) Comments:

We left Freeport mid-morning after a delay due to a problem with the ship electric system. During the ~11h transit to the first station, science party worked on preparing respective systems, determining data-sharing protocols, and refining navigation issues.

Objectives for the coming 24 hours:

- calibrate USBL. This will happen at closest site with 200m depths
- complete test of Sentry on tether to calibrate reson sonar. This will be at Marble grouper site
- return to Marble grouper mound for full-system test. This will be an abbreviated dive in shallow water to fully test multibeam sonar and bottom photography.
- transit to GB535 for first fully operational Sentry survey This will be under USBL control.

Problems encountered and solutions worked:

- bathymetry data from MMS is in the form of images of contour lines This limits how they are used for AUV dive planning. It is also problematic because they cannot be easily reprojected into the same coordinate system being used by Sentry. Anthony Reisinger has been rubbersheeting the images into new coordinate system and this seems to be successful.
- overheating problems with Sentry. This has delayed a planned tether test until daylight 18 June.
- drift camera strobe not functioning This requires a small logic circuit. Parts are on hand to finish this.
- mounting pole for USBL transponder slipped down into moon pool by about 24" No evident damage. Pole has been better secured.

WHOI SENTRY Group Leader (Dana Yoerger) Comments:

[Occupied with dunk test. Reports that systems appear basically functional, but there is a recurrent problem with an overheating sensor that has been causing Sentry to shut down.

Projected Schedule:

Issued by:
/Ian MacDonald

_____
Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

DAILY PROGRESS REPORT

Submitted 06/18/2009

Current position N27°50.44' W93°50.53' 85m

R/V Brooks McCall
e-mail: **brooksmccall@txcyber.com**
Nav Room Iridium: 011-881-641-461-357
Nav Room GlobalStar: 254-378-3240

TDI-Brooks International, Inc
e-mail: **drjmbrooks@aol.com**
Phone: 979-696-3634 (Jim Brooks mobile)
Phone: 979-693-3446 (Main office in Texas)

Report number: 2

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		
intermittent	Chop/swell	S-SE2-4	clear	clear

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments
1	0700	1400		300		Calibration sites
2	1600	2000				AUV tether test

HSE Statistics (as of 2400 hrs this day):

Fatalities:	0	Total:	0
Occupational Illness:	0	Total:	0
Lost Time Injury:	0	Total:	0
First Aid Case:	0	Total:	0
Near Miss:	0	Total:	0
Environ. Incident:	0	Total:	0
Equipment Damage:	1	Total:	0
Safety Drill:	0	Total:	0
JSA review:	0	Total:	0
All-Hands Safety Meeting:	0	Total:	0
MOC Meeting:	0	Total:	0
Toolbox Meetings	3	Total:	0
Safety observation cards	0	Total:	0

Cruise activities (as of midnight today):

TDI-Brooks Party Chief (Ian MacDonald) Comments:

Current position N27°50.44' W93°50.53' 85m Seas 2-4' with disorganized chop. Wind is light and variable. Skies appear clear.

1. The USBL remains uncalibrated. It is recording fixes, but the accuracy deteriorates rapidly as the beacon gets any farther than more or less directly under the ship. I have suggested that they might try extending the cage farther down in the moonpool, but there may be mechanical issues that prevent this and we don't know that this will help. Absent accurate USBL navigation, drift camera work is unproductive and the AUV will have restricted operations.

2. After the second calibration attempt, repairs to the traction winch were required before the coring weight could be recovered and ~2h were lost.
3. The AUV completed a successful tether test at about 19:45. Data was collected for the sonar calibration and the systems checks were completed successfully. However, there was a mishap during the recovery. Several factors seem to have contributed. They dropped a weight as part of an emergency system test. To save the weight, they attach it to the AUV with a short line. As they approached the ship, the line became entangled in the AUV propeller. The vehicle then hit nose-first on the side of the ship. There was some confusion in line handling and one of the navigation fins was broken off while bringing the vehicle onto the ship. There were no injuries or ship's equipment damaged.

Rod Catanach reports the following damages.
1. Port aft propeller damaged and motor stopped.
2. Port forward trim stabilizer broken away, but recovered
3. Blown fuse from motor overload.

Rod estimates that repairs will take all day tomorrow, with the system ready to dive around 5pm. The SENTRY group wants to complete a 2-3 hour practice dive. This seems like a good idea because the system is still being proved out for full operations.

We are now having to consider which of the planned sites to drop. I will consult with Bill Shedd on this--have already done so. Our thinking is to drop the VK826 sites first. Next one of the intermediate depth.

My immediate plan is to do a test of the drift camera here in shallow water--the strobes are working. Evidently there have been some problems with the CTD, but this should be workable.

TDI Navigation Technician (Mike Kullman) Comments:

1. The biggest issue at the moment is that we are unable to log a sufficient number of fixes during the calibration - APOS just stops accepting fix data. There doesn't seem to be any particular pattern to when it stops logging fixes - for instance we can see that the beacon position is holding steady in Winfrog but APOS will not be logging. This seems like some sort of software issue. We have disabled any acoustic noise / dgps filters in the calibration routine so it shouldn't be rejecting any poor fix data (as I understand it). I suspect that we simply don't have something configured correctly in APOS but I haven't been able to figure out what.

I have been poking around in APOS and did notice one thing that stands out: in the transponder configuration window our two transponders (which I assume are both the same) are listed as different types: one is an HPR 400 MPT, one is an HPR 400 RPT. Not sure if this would affect anything.

Also, I just tried turning on the beacon we were using today (after it was fully charged up) and didn't get the double ping indicating the frequency is set correctly. However, we were using the other beacon at the first cal site yesterday and had the same issues.

2. There definitely seems to be an issue with noise / prop wash in the current moonpool location. You can see the beacon jumping around quite

a bit when they are backing down or otherwise going hard on the engines while trying to hold station. The single beam also gets wiped out under those conditions. I don't think this is what is causing the problem with logging fixes during the calibration though.

Ian has suggested trying to remount the transducer to get it deeper in an attempt to isolate it from prop wash, etc. However, I don't think we have anything on board that we can use for this that has a bolt pattern that would fit on the transducer and also mount to the frame that sits in the bottom of the moonpool.

WHOI SENTRY Group Leader (Dana Yoerger) Comments:

Occupied with repairs.

Projected Schedule:

Drift camera trial this evening. Shallow dive of AUV as soon as conditions permit tomorrow.

Issued by:
/Ian MacDonald

Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

Larry Lane
TDI-Brooks

DAILY PROGRESS REPORT

Submitted 06/19/2009

Current position N27°51.09' W93°49.24

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Phone: 979-693-3446 (Main office in Texas)

Report number: 3

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		
S 8-12	Swell	SSE/2-4	Clear	clear

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments
GB225	1000	1700	Drift Cam	150		Drift cam survey--aborted due to winch
FGB	1700	0000	Sentry dive	80		Sentry dive self abort

HSE Statistics (as of 2400 hrs this day):

Fatalities:	
Occupational Illness:	
Lost Time Injury:	
First Aid Case:	
Near Miss:	
Environ. Incident:	
Equipment Damage:	3
Safety Drill:	
JSA review:	
All-Hands Safety Meeting:	
MOC Meeting:	
Toolbox Meetings	3
Safety observation cards	

Cruise activities (as of midnight today):

1. Attempted drift camera survey while waiting for Sentry repairs. This was aborted when the blue winch would not rewind cable. Camera suffered small leak. Is repairable from spares.
2. Attempted check out dive with Sentry. Launch was successful, but Sentry self aborted the dive when it reach its intended starting point. Probable cause was a programming error.

TDI-Brooks Party Chief (Ian MacDonald) Comments:

Starting the drift cam survey was delayed due to issues with the CTD. Instrument was set up with altimeter on channel 1, which is correct for the TDI drift camera, but when the altimeter is used alone, the correct channel is 0. Also, the CTD was giving very inaccurate depth readings. Called SeaBird and sent them files, but have not had a reply yet.

The USBL was recording seemingly accurate fixes. Better sea conditions seemed to help this system.

Attempted a drift cam survey of GB225 relying on the altimeter to keep the camera off the bottom. However on the first attempt to bring in cable, the blue winch failed. Larry Lane shut

it down for cooling and topped of hydraulic fluids, but there was no improvement. We ended up retrieving 140m of cable with the cable grabber and the tugger winch. This winch should not be used.

The camera suffered a slight leak--about 2 tablespoons of water, but this totaled the internal camera. A number of pictures of the water and a featureless bottom were taken before the system failed. The strobes were not affected although the platform clearly banged against the bottom. There is a spare and the system could be rebuilt, but without a working winch, it is not possible to conduct drift camera operations.

We launched Sentry at its shallow test site in ~80 m water depth south of the Flower Gardens. The launch was successful, but when Sentry reached its start point for the survey, it was unable to find the trackline file in the computer system. It then self-aborted the dive and returned to the surface. Having few options, the ship went on stand by until operations would resume next morning.

Projected Schedule:

As of late evening on 6/19, Rod Catanach thought it would be possible to launch Sentry on its check-out dive around breakfast time. This would allow start of transit to the deep GB837 site where we can navigate with LBL. This would enable a possible late evening launch of sentry on 6/20 or early morning on 6/21.

Issued by:
/Ian MacDonald

_____

Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

DAILY PROGRESS REPORT

Submitted 06/21/2009

Current Position: N27°07.62' W93°54.68'

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Phone: 979-693-3446 (Main office in Texas)

Report number: 4

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		
215/5	swell			

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments
FGB	0000	2000	Checkout dive	80m		Completed check out dive
GB837	2330	current	LBL deploy	800-600m		Completed LBL deployment

HSE Statistics (as of 2400 hrs this day):

Fatalities:	0
Occupational Illness:	0
Lost Time Injury:	0
First Aid Case:	0
Near Miss:	0
Environ. Incident:	0
Equipment Damage:	0
Safety Drill:	0
JSA review:	0
All-Hands Safety Meeting:	0
MOC Meeting:	0
Toolbox Meetings	3
Safety observation cards	1

Cruise activities (current time):

1. Preparation of Sentry for check-out dive.
2. Sentry Check-out dive at Flower Garden Banks 80m site.
3. Transit to GB837
4. Deploy LBL array (four transponders)
5. Calibrate USBL in ~500m depth
6. Prepare Sentry for launch
7. Launch Sentry for 16 h survey of GB837 anomalies and steep slopes.

TDI-Brooks Party Chief (Ian MacDonald) Comments:

Sentry completed its check-out dive. Systems were generally fully functional. One problem was the digital camera, which was not synched with the strobe so that the image were taken

with available light. BMCC transited to GB837, which is a site with depths from 600-825m. Deployed 4 LBL transponders and navigated an LBL array.

While the Sentry group was preparing the AUV for launch, the TDI navigation and moved slightly north of the GB837 launch site to make another attempt at calibrating the USBL transponder. A program setting was changed and fixed the problem of the system not logging fixes. The calibration was completed. USBL still is compromised by hull noise, but is working better than before.

Sentry was launched on a 16 h mission at GB837. Recovery should occur at 0700 22 June.

WHOI SENTRY Group Leader (Dana Yoerger) Comments:

```
Sentry018 Summary
Launch:          2009/06/20 20:25:55z
Survey start:    2009/06/20 20:30:04
Survey end:      2009/06/21 00:01:01
Ascent begins:   2009/06/21 00:01:34
On the surface: 2009/06/21 00:02:07
On deck:         2009/06/21 00:19:21
descent rate:        6.1 m/min
ascent rate:         45.3 m/min
survey time:         3.5 hours
deck-to-deck time    3.9 hours
Mean survey depth:   38m
Mean survey height: 45m
distance travelled: 8.87km
average speed;       0.85m/s
total vertical during survey: 554m
```

Projected Schedule:

We need to be advised regarding plans to send a USBL extender out to us here. We need to decide whether to conduct another survey in this region or transit to the Green Canyon area for operations there.

Issued by:

IRM

Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

DAILY PROGRESS REPORT

Submitted 06/22/2009

Current Position: N27°25.89' W93°35.49'

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Phone: 979-693-3446 (Main office in Texas)

Report number: 5

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		
200/5	chop	<1ft	Clear	Clear

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments
GB837	0000	1400	Sentry survey	600-800m		Successful survey
GB535	2200		Prepare for survey	800		

HSE Statistics (as of 2400 hrs this day):

Fatalities:	0
Occupational Illness:	0
Lost Time Injury:	0
First Aid Case:	0
Near Miss:	0
Environ. Incident:	0
Equipment Damage:	0
Safety Drill:	0
JSA review:	0
All-Hands Safety Meeting:	1
MOC Meeting:	0
Toolbox Meetings	3
Safety observation cards	4

Cruise activities (as of midnight today):

TDI-Brooks Party Chief (Ian MacDonald) Comments:

Sentry completed a successful survey of GB837. The survey lines covered the areas of interest identified from the MMS geophysical data. Preliminary processing of multibeam data from the shallow test site is extremely promising. Photographic images were not available from this survey due to a programming error.

Continued issues with pH sensor on the TAMUCC CTD. We went through the test steps recommended by Sea Bird, but the sensor continues to return the same erroneous numbers. It probably needs to be returned to the factory for service.

USBL navigation is functional. With delivery of the extension pole and recalibration, the intention is to rely on USBL to save the time of LBL deployment.

WHOI SENTRY Group Leader (Dana Yoerger) Dive summary:

Sentry020 Summary
Launch: 2009/06/22 05:26:49
Survey start: 2009/06/22 05:50:53
Survey end: 2009/06/22 19:28:45
Ascent begins: 2009/06/22 19:28:45
On the surface: 2009/06/22 19:49:46
On deck: 2009/06/22 19:59:07
descent rate: 34.5 m/min
ascent rate: 25.6 m/min
survey time: 13.6 hours
deck-to-deck time 14.5 hours
Mean survey depth: 689m
Mean survey height: 58m
distance travelled: 33.45km
average speed; 0.74m/s
total vertical during survey: 4945m

Projected Schedule:

We will be accepting the transponder extensions tomorrow morning. We will complete the survey at GB535 and then transit to GC852 to survey the region to the south of the Jason and Alvin sites.

Issued by:
/Ian MacDonald

_____

Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

DAILY PROGRESS REPORT

Submitted 06/24/2009

Current Position: N27°22.76' W91°52.77' (in transit)

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Report number: 6

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		
5 S	calm	1-2	clear	clear

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments
GB535	0000	1330	Sentry survey	500		Completed Sentry survey
transit	1400		transit			ETA 0400 6/25

HSE Statistics (as of 2400 hrs this day):

Fatalities:		0
Occupational Illness:		0
Lost Time Injury:		0
First Aid Case:		0
Near Miss:		0
Environ. Incident:		0
Equipment Damage:		0
Safety Drill:	Oilspill response	1
JSA review:		
All-Hands Safety Meeting:		1
MOC Meeting:		0
Toolbox Meetings		5
Safety observation cards		0

Cruise activities (since last report):

1. Modify moon pool transducer mounting.
2. Recalibrate USBL
3. Fix navigation problem with Sentry.
4. Completed SENTRY survey of GB535. All Sentry systems including camera appear to be working.
5. Begin transit to GC600.

TDI-Brooks Party Chief (Ian MacDonald) Comments:

The SENTRY inertial navigation system developed a fatal fault sometime on 6/23. This was a potential show-stopping system failure, but the SENTRY team was able to develop a work-around by carefully calibrating the magnetic compass. The AUV was launched at 0300 and completed its slightly abbreviated survey at about 1300. The vehicle was able to follow the

designated track lines and completed the entire survey. The problems with the camera and strobe appear to be solved and SENTRY recorded about 750 bottom photographs.

The GB535 survey was centered on a large, flat-topped mound. This feature is a hydrocarbon seep. Mud flows, brine channels, bacteria, mussels, and gas venting were noted in the photographs. Several photographs showed small, distinct colonies of Lophelia associated with carbonate pavement. The colonies were no more that 30 cm in size. Steep slopes to the southeast of the surveyed area may also be colonized by Lophelia, but this portion of the site could not be survey due to uncertainty about SENTRY's track-following capabilities. Steep escarpments will be attempted in subsequent dives.

WHOI SENTRY Group Leader (Dana Yoerger) SENTRY performance summary:

```
Sentry021 Summary
Launch:          2009/06/24 07:53:56z
Survey start:    2009/06/24 08:13:00z
Survey end:      2009/06/24 18:13:35z
Ascent begins:   2009/06/24 18:13:35z
On the surface:  2009/06/24 18:23:33z
On deck:         2009/06/24 18:34:12z
descent rate:        29.9 m/min
ascent rate:         51.4 m/min
survey time:         10.0 hours
deck-to-deck time    10.7 hours
Mean survey depth:   526m
Mean survey height:  54m
distance travelled:  28.94km
average speed;       0.89m/s
total vertical during survey: 1131m
Battery energy at launch:     13.0 kwhr
Battery energy at survey_end: 7.3 kwhr
Battery energy on deck:       7.1 kwhr
```

Projected Schedule:

Transit site 8 GC600	16 hrs	6/24/2009 14:30	6/25/2009 6:30
Launch Sentry GC600	1 hr	6/25/2009 6:30	6/25/2009 7:30
Sentry survey site 3 GC600	12 hrs	6/25/2009 7:30	6/25/2009 19:30
Recover Sentry	1 hr	6/25/2009 19:30	6/25/2009 20:30
Transit site 8 GC246	2 hrs	6/25/2009 20:30	6/25/2009 22:30
Recharge Sentry and Crew	8 hrs	6/25/2009 22:30	6/26/2009 6:30
Launch Sentry GC246	1 hr	6/26/2009 6:30	6/26/2009 7:30
Sentry survey site 4 GC246	12 hrs	6/26/2009 7:30	6/26/2009 19:30
Recover Sentry	1 hr	6/26/2009 19:30	6/26/2009 20:30
Transit site 8 MC885	5 hrs	6/26/2009 20:30	6/27/2009 1:30
Recharge Sentry and Crew	5 hrs	6/27/2009 1:30	6/27/2009 6:30
Launch Sentry MC885	1 hr	6/27/2009 6:30	6/27/2009 7:30
Sentry survey site 5 MC885	13 hrs	6/27/2009 7:30	6/27/2009 20:30
Recover Sentry	1 hr	6/27/2009 20:30	6/27/2009 21:30
Transit site 14 MC657 shipwreck	10 hrs	6/27/2009 21:30	6/28/2009 7:30
Launch Sentry	1 hr	6/28/2009 7:30	6/28/2009 8:30
Sentry survey site 6 MC657 shipwreck	10 hrs	6/28/2009 8:30	6/28/2009 18:30
Recover Sentry	1 hr	6/28/2009 18:30	6/28/2009 19:30
Transit site 12 VK826	6 hrs	6/28/2009 19:30	6/29/2009 1:30
Recharge Sentry and Crew	3 hrs	6/29/2009 1:30	6/29/2009 4:30
Launch Sentry VK826	1 hr	6/29/2009 4:30	6/29/2009 5:30
Sentry survey site 7 VK826	12 hrs	6/29/2009 5:30	6/29/2009 17:30
Recover Sentry	1 hr	6/29/2009 17:30	6/29/2009 18:30
Transit Gulfport END	10 hrs	6/29/2009 18:30	6/30/2009 4:30

Issued by:
/Ian MacDonald
Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

DAILY PROGRESS REPORT
Submitted 06/27/2009

Current Position N28°04.66' W89°35.11'

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Report number: 7

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		
245°/10	1ft chop	No swell	Clear	Partly cloudy

Event Log

Site	Start	End	Activity	Depth	Wire depth	Comments
GC246	1700 6/26	0700 6/27	AUV survey GC246	800		Survey self-terminated camera malfunction
MC885	1400 6/27	2300 6/27	AUV survey MC885	800		Survey self-terminated, camera worked
Transit	2330 6/27	-				Transit to MC657 shipwreck

HSE Statistics (as of 2400 hrs this day):

Fatalities:	0
Occupational Illness:	0
Lost Time Injury:	0
First Aid Case:	0
Near Miss:	0
Environ. Incident:	0
Equipment Damage:	0
Safety Drill:	0
JSA review:	0
All-Hands Safety Meeting:	0
MOC Meeting:	0
Toolbox Meetings	3
Safety observation cards	0

Cruise activities:
AUV repair & maintenance, AUV survey, USBL calibration

TDI-Brooks Party Chief (Ian MacDonald) Comments:

We designed survey over the high amplitude areas of GC246. (Sentry dive 024) The survey was scheduled to last 13 hours and provide dense photographic coverage plus complete multibeam coverage of the sampled area. The AUV completed 9.5 of 10 planned photographic transects, but before ascending to complete the multibeam survey, the vehicle made an unprogrammed release of its ballast, necessitating a premature ascent. After the vehicle was recovered, it turned out that the camera had been shut down by a programming malfunction

after only 78 minutes. Some 750 image were recorded, mostly showing mud with burrows--generally indicating a non-seep site. There were several photographs showing bacteria mats and seep bivalves. No corals or carbonate hard grounds were seen. The students from Cordes and MacDonald labs have been making a thorough analysis of all the photographic data obtained, so the distribution of major fauna will be available after the cruise. So far though, we have not seen any coral. Because several hours of repair were required to make the vehicle ready to dive, I elected to transit to the next site.

We arrived at MC885 at 1400 and calibrated the USBL system. When this was completed we dived on the site. The bathymetery of the site was very similar to the previous site, i.e. low-relief mounds with seismic returns on the tops. We used a similar survey plan. Sentry was launched at 1730. (Sentry dive 025) After approximately 5.5 on bottom the vehicle again made an unprogrammed release of its ballast weights and had to be recovered. The photo transects were about 80% complete, but none of the multibeam coverage had been taken. This time, the software fix to the camera system worked and the camera had run the entire time. Over 3800 photographs were recorded. A very preliminary review of the pictures shows quite a few gorgonians and several small colonies of Lophelia. This is a site we could come back to with Jason. We should get a pretty complete picture of the biological communities at this site including the distribution of soft corals and Lophelia.

Once again, extensive repairs are required before the Sentry is ready to dive again. I have elected to proceed to MC657 the shipwreck site. The camera is working well now, so I am hopeful we will get good images from this site. The problem with the ballast weight release is more difficult. The weights determine a basic rescue function for the AUV. The release mechanism has redundant motor-driven and burn wire driven triggers. It is the motor-driven system that has been malfunctioning to cause the premature releases, but the reason and the sequence have resisted all attempts to unravel the reason for the unprogrammed drops. Prior to this dive, we discussed disabling the motors to prevent faulty releases. The WHOI group was unwilling to take this step because it compromised basic safety protocols. However, I am now insisting that this be done and they are devising ways to take the motors out of the process. Perhaps I should have insisted on this earlier, but the belief was always that the problem could be fixed. Now it seems that they will have to analyze the system under much more stringent conditions than can be done at sea.

WHOI SENTRY mission programmer (Dana Yoerger) summary of dive at GC246:

```
Sentry024 Summary
Launch:         2009/06/27 00:44:23
Survey start:   2009/06/27 01:10:43
Survey end:     2009/06/27 09:15:58
Ascent begins:  2009/06/27 09:15:58
On the surface: 2009/06/27 09:48:36
On deck:        2009/06/27 10:37:31
descent rate:       30.7 m/min
ascent rate:        24.3 m/min
survey time:        8.1 hours
deck-to-deck time   9.9 hours
Mean survey depth:  841m
Mean survey height: 5m
distance travelled: 12.16km
average speed;      0.53m/s
average speed during photo runs: 0.48 m/s over 15.43 km
average speed during multibeam runs: 0.06 m/s over 0.22 km
total vertical during survey: 1745m
Battery energy at launch:     13.9 kwhr
Battery energy at survey_end: 9.6 kwhr
```

```
Battery energy on deck:       9.0 kwhr
```

Projected Schedule:

6/28 survey ship wreck site
6/29-6/30 survey Vioska Knoll sites
7/1 Gulfport.

Issued by:
/Ian MacDonald

_____
Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

DAILY PROGRESS REPORT

Submitted 06/28/2009

Current Position: N28°20.74' W87°55.24

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Report number: 8

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments

HSE Statistics (as of 2400 hrs this day):

Fatalities:	0
Occupational Illness:	0
Lost Time Injury:	0
First Aid Case:	0
Near Miss:	0
Environ. Incident:	0
Equipment Damage:	0
Safety Drill:	0
JSA review:	0
All-Hands Safety Meeting:	
MOC Meeting:	0
Toolbox Meetings	
Safety observation cards	0

Cruise activities (as of midnight today):

Completed photosurvey of MC657 shipwreck site with Sentry dive 026.

TDI-Brooks Party Chief (Ian MacDonald) Comments:

Arrived at MC657 at 0830 and deployed an LBL array of two transponders in water depth of 2250m. We coordinated our activities with the Shell operators at Na Kika and contacted Mr. Mike Volz by phone and radio. There is a subsea completion approximately 1.4 nmi NNW from the shipwreck site.

Sentry was launched at 1350. Pre-dive preparations were smooth and uneventful. The weight-dropping motors have been disabled to prevent premature ballast releases. Sentry flew a series of 40, 200 m photo-lines at an altitude of 5 m and spaced 5 m apart. Sentry was recovered at 2130 after a planned conclusion of the survey. The line array was successfully centered on the

location of the wreck. A total of 5160 images were taken and the Reson multibeam was tuned for low-altitude survey. There has not yet been time to process the images for viewing. A preliminary review of the multibeam data indicate areas of relief that may be portions of the wreck.

WHOI SENTRY Group Leader (Dana Yoerger) Summary of Sentry Dives 025, 026

Sentry025 Summary	Sentry026 Summary
Launch: 2009/06/27 22:36:16	Launch: 2009/06/28 18:48:33
Survey start: 2009/06/27 22:56:47	Survey start: 2009/06/28 20:02:35
Survey end: 2009/06/28 03:23:40	Survey end: 2009/06/29 01:45:52
Ascent begins: 2009/06/28 03:25:20	Ascent begins: 2009/06/29 01:45:52
On the surface: 2009/06/28 03:44:41	On the surface: 2009/06/29 02:36:45
On deck: 2009/06/28 03:57:32	On deck: 2009/06/29 02:59:03
descent rate: 30.2 m/min	descent rate: 30.3 m/min
ascent rate: 32.7 m/min	ascent rate: 44.3 m/min
survey time: 4.4 hours	survey time: 5.7 hours
deck-to-deck time 5.4 hours	deck-to-deck time 8.2 hours
Mean survey depth: 625m	Mean survey depth: 2263m
Mean survey height: 5m	Mean survey height: 5m
distance travelled: 6.61km	distance travelled: 6.11km
average speed; 0.52m/s	average speed; 0.45m/s
average speed during photo runs: 0.49 m/s over 8.35 km	average speed during photo runs: 0.41 m/s over 9.32 km
average speed during multibeam runs: 0.09 m/s over 0.17 km	average speed during multibeam runs: -0.00 m/s over -0.00 km
total vertical during survey: 605m	total vertical during survey: 509m
Battery at launch: 12.9 kwhr	Battery at launch: 16.9 kwhr
Battery at survey_end: 10.7 kwhr	Battery at survey_end: 13.7 kwhr
Battery on deck: 10.5 kwhr	Battery on deck: 13.4 kwhr

Projected Schedule:

6/29 MC339 photosurvey and multibeam
6/30 VK826 photosurvey multibeam
7/1 Gulfport demobilization

Issued by:
/Ian MacDonald

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Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

DAILY PROGRESS REPORT

Submitted 06/29/2009

Current Position: N29°09.11' W88°01.95'

R/V Brooks McCall
e-mail: **brooksmccall@txcyber.com**
Nav Room Iridium: 011-881-641-461-357
Nav Room GlobalStar: 254-378-3240

TDI-Brooks International, Inc
e-mail: **drjmbrooks@aol.com**
Phone: 979-696-3634 (Jim Brooks mobile)
Phone: 979-693-3446 (Main office in Texas)

Report number: 9

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		
300/5kt	Low chop	1-2	clear	Partly cloudy

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments
MC339	6/29 0800	2200	Photosurvey	1300		Photos only, no multibeam
VK826	6/30 0200	-	Multibeam and photosurvey	600		

HSE Statistics (as of 2400 hrs this day):

Fatalities:	0
Occupational Illness:	0
Lost Time Injury:	0
First Aid Case:	1
Near Miss:	0
Environ. Incident:	0
Equipment Damage:	0
Safety Drill:	0
JSA review:	0
All-Hands Safety Meeting:	
MOC Meeting:	0
Toolbox Meetings	3
Safety observation cards	0

Cruise activities:

Completed photosurvey of MC339 exploratory coral site with Sentry dive 027.

TDI-Brooks Party Chief (Ian MacDonald) Comments:

Arrived at MC339 at 0300 and calibrated USBL navigation system for operation in 1200-1500m. Mission planning was slow due to only having 20m contour data from MMS for this site.

Sentry was launched at 1100. Pre-dive preparations were smooth and uneventful. The weight-dropping motors have been disabled to prevent premature ballast releases. Sentry flew a series photo-transects along the steep SW of a ~5km wide mound, which it successfully completed in

approximately 7 h of bottom time. An additional collection of multibeam data had been scheduled for the remaining 5 hours of the dive, but due to the scheduled arrival in Gulfport, this portion of the dive was curtailed so we could move on to VK826. We ended the dive at 1900 and had recovered all the LBL transponders by 2200. We then transited 4 hours to VK826. Calibration of USBL system was completed by 0400.

Lara Lane sustained a minor injury to a finger while deploying the coring weight for the calibration procedure. She has it on ice and will monitor her condition over the next day.

Sentry dived at 0630, approximately 1.5 h ahead of schedule. We have planned a mission primarily focused on obtaining 0.5m multibeam coverage of the entire VK826 site. This should take about 9 hours. We have programmed a series of photosurvey lines starting in the SW of the VK826 knoll. These lines will continue until we need to recover the vehicle to make our transit to Gulfport and arrive at 0800 on 7/1/09.

WHOI SENTRY Group Leader (Dana Yoerger) Summary of Sentry Dives 025, 026

Sentry027 Summary
Launch: 2009/06/29 16:07:02
Survey start: 2009/06/29 16:59:17
Survey end: 2009/06/29 23:44:31
Ascent begins: 2009/06/29 23:44:31
On the surface: 2009/06/30 00:20:27
On deck: 2009/06/30 00:29:13
descent rate: 27.7 m/min
ascent rate: 38.1 m/min
survey time: 6.8 hours
deck-to-deck time 8.4 hours
Mean survey depth: 1383m
Mean survey height: 5m
distance travelled: 9.29km
average speed; 0.49m/s
average speed during photo runs: 0.47 m/s over 12.09 km
average speed during multibeam runs: 0.02 m/s over 0.05 km
total vertical during survey: 958m
Battery energy at launch: 17.1 kwhr
Battery energy at survey_end: 13.1 kwhr
Battery energy on deck: 12.9 kwhr

Projected Schedule:

6/30 VK826 multibeam and photosurvey (leave station at 2000)
7/1 Gulfport demobilization (arrive 0800)

Issued by:
/Ian MacDonald

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Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

DAILY PROGRESS REPORT

Submitted 07/1/2009

Current Position: N29°34' W88°22'

R/V Brooks McCall
e-mail: **brooksmccall@txcyber.com**
Nav Room Iridium: 011-881-641-461-357
Nav Room GlobalStar: 254-378-3240

TDI-Brooks International, Inc
e-mail: **drjmbrooks@aol.com**
Phone: 979-696-3634 (Jim Brooks mobile)
Phone: 979-693-3446 (Main office in Texas)

Report number: 10

2009 LOPHELIA II CR2 DAILY REPORT

Weather summary at 0700 hrs this day:

Wind	Sea	Sea	Air Visibility	Sky
(dir/kts)	(type)	(dir/ft)		
300/5kt	Low chop	1-2	clear	Partly cloudy

Event Log for today (UTC = Local)

Site	Start	End	Activity	Depth	Wire depth	Comments
VK826	0200 2000	-	Multibeam and photosurvey	600		Completed survey

HSE Statistics (as of 2400 hrs this day):

Fatalities:	0
Occupational Illness:	0
Lost Time Injury:	0
First Aid Case:	1
Near Miss:	0
Environ. Incident:	0
Equipment Damage:	0
Safety Drill:	0
JSA review:	0
All-Hands Safety Meeting:	
MOC Meeting:	0
Toolbox Meetings	3
Safety observation cards	0

Cruise activities:

Completed photosurvey of VK826 coral development site with Sentry dive 028.

TDI-Brooks Party Chief (Ian MacDonald) Comments:

Sentry dived at 0630, approximately 1.5 h ahead of schedule. We have planned a mission primarily focused on obtaining 0.5m multibeam coverage of the entire VK826 site. This should take about 9 hours. We have programmed a series of photosurvey lines starting in the SW of the VK826 knoll. The photo lines continued until 2000 when the survey was terminated after 14 hours on bottom to complete the transit to Gulfport. Review of the survey data indicates that Sentry successfully completed a multibeam survey of the entire VK826 mound and collected over 5000 bottom images over the high-density coral area.

Review of photographs from the survey at MC339 found carbonate outcrops on a steep slope, but no Lophelia or soft corals.

WHOI SENTRY Group Leader (Dana Yoerger) Summary of Sentry Dives 025, 026

```
Sentry028 Summary
Launch:          2009/06/30 11:08:18z
Survey start:    2009/06/30 11:25:55z
Survey end:      2009/07/01 00:58:56z
Ascent begins:   2009/07/01 01:00:02z
On the surface:  2009/07/01 01:14:58z
On deck:         2009/07/01 01:25:23z
descent rate:        30.7 m/min
ascent rate:         29.3 m/min
survey time:         13.6 hours
deck-to-deck time    14.3 hours
Mean survey depth:   455m
Mean survey height:  40m
distance travelled:  29.67km
average speed;       0.66m/s
average speed during photo runs: 0.40 m/s
over 5.96 km
average speed during multibeam runs: 0.72
m/s over 26.17 km
total vertical during survey: 2921m
Battery energy at launch:     14.4 kwhr
Battery energy at survey_end: 6.6 kwhr
Battery energy on deck:       6.5 kwhr
```

Projected Schedule:

7/1 Gulfport demobilization (arrive 0800)

Issued by:
/Ian MacDonald

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Ian R. MacDonald, Chief Scientist
Texas A&M University--Corpus Christi

SHIPWRECK PHOTO LOG

Picture no.	Notes		
586	fabric sheet		
618	bright red ctenophore		
622	extended feeding siphon-entopneust?		
634	Benthiodes sea cucumber		
673	slender gray cucumber		
710	trench or buried pipe		
738	long silver fish with short paddle fin		
764	long silver fish with short paddle fin		
789	large rattail		
791	long silver fish with short paddle fin		
803	long silver fish with short paddle fin		
807	Benthiodes sea cucumber		
821	flytrap anemone and buried pipeline/trench?		
823	Benthiodes sea cucumber		
835	Benthiodes sea cucumber		
892	rattail		
895	sea whip		
905	long silver fish with short paddle fin		
906	rattail		
908	Benthiodes sea cucumber		
912	2 Benthiodes		
914	eelpout? Large pectoral fins		
920	long silver fish with short paddle fin		
923	Benthiodes sea cucumber		
932	long silver fish with short paddle fin		
936	Benthiodes sea cucumber		
952	rattail		
968	slender gray cucumber		
971	slender gray cucumber		
972	Benthiodes sea cucumber		
991	Benthiodes sea cucumber		
993	slender gray cucumber		
996	slender gray cucumber		
996	Benthiodes sea cucumber		
996	long silver fish with short paddle fin		
1000	sea whip-curled and pink		
1001	rattail		
1002	eelpout? Large pectoral fins		
1004	rattail		

Picture no.	Notes		
1011	long silver fish with short paddle fin		
1014	slender gray cucumber (2)		
1018	complex ring of large burrows		
1019	trench or buried pipe		
1027	Benthiodes sea cucumber		
1046	Benthiodes sea cucumber		
1049	spiral sea whip		
1049	slender gray cucumber		
1060	sea whip		
1065	flytrap anemone		
1071	two large burrows		
1074	slender gray cucumber		
1086	Benthiodes sea cucumber		
1087	trench or buried pipe		
1090			
1091	rattail		
1092	slender gray cucumber		
1095	long silver fish with short paddle fin		
1097	rattail		
1106	slender gray cucumber		
1110	eelpout? Large pectoral fins		
1116	long silver fish with short paddle fin		
1120	white starfish with distinct central disk		
1123	brittle star		
1126	flytrap anemone		
1130	long silver fish with short paddle fin		
1137	crinoid_orange		
1151	slender gray cucumber		
1154	ring of large burrows		
1162	flytrap anemone		
1162	ring of large burrows		
1163	wood section from wreck?		
1164	feeding siphon of enteropneust?		
1172	ring of large burrows		
1180	long silver fish with short paddle fin		
1182	slender gray cucumber		
1187	sea whip		
1189	Benthiodes sea cucumber		
1193	long silver fish with short paddle fin		
1198	eelpout? Large pectoral fins		

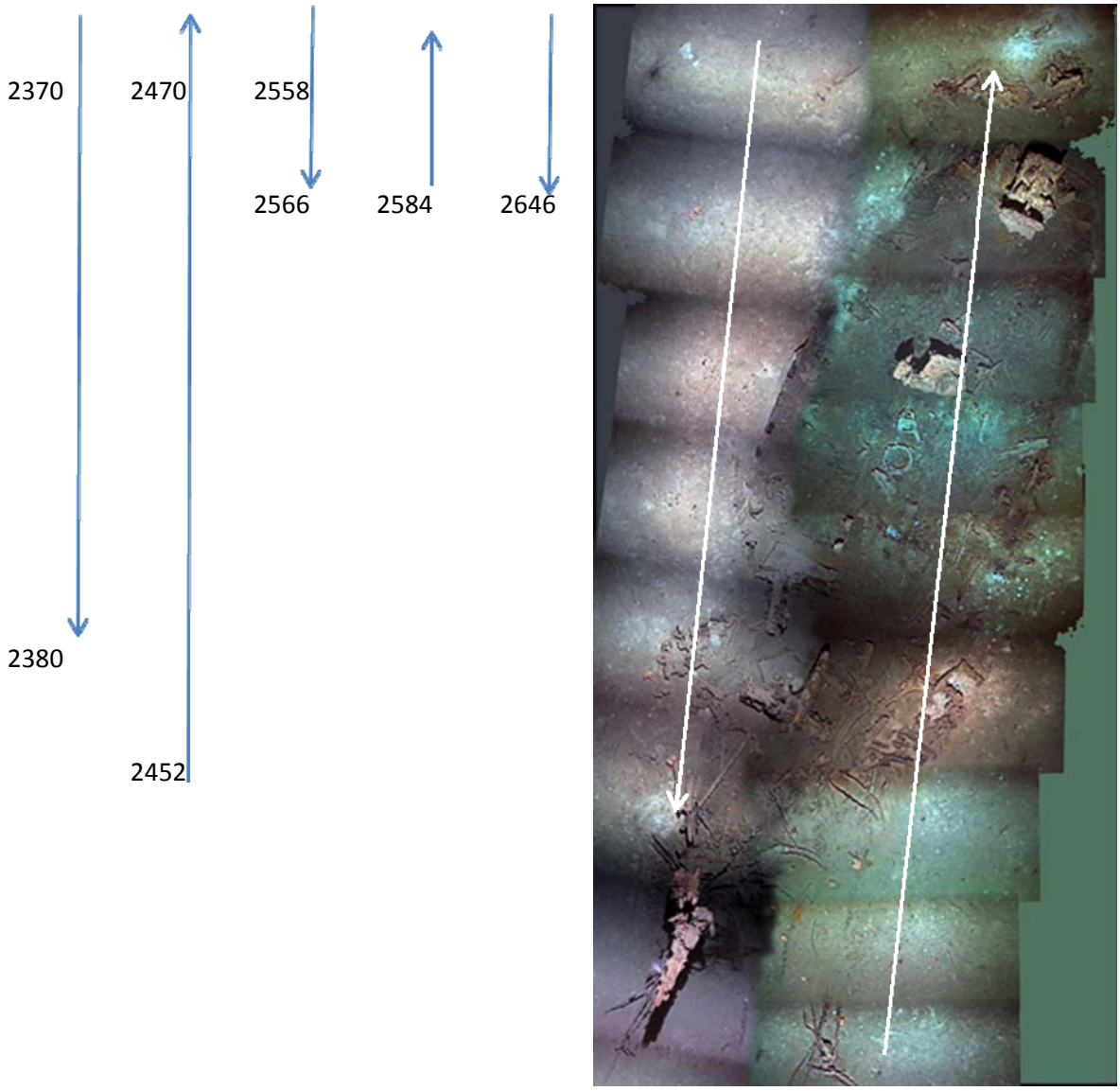
Picture no.	Notes		
1212	long silver fish with short paddle fin		
1236	slender gray cucumber		
1241	flytrap anemone		
1244	seawhip		
1245	red shrimp		
1267	slender gray cucumber		
1281	trench or buried pipe		
1284	sargassum		
1290	slender gray cucumber		
1297	ring of large burrows		
1300	slender gray cucumber		
1303	large rattail		
1306	Benthiodes sea cucumber		
1311	slender gray sea cucumber		
1314	long silver fish with short paddle fin		
1318	Benthiodes sea cucumber		
1319	sea whips_2		
1320	feeding siphon of enteropneust?		
1321	fecal mound?		
1325	ring of large burrows		
1325	long silver fish with short paddle fin		
1326	sea whip		
1327	slender gray sea cucumber		
1329	sargassum frond		
1332	slender gray sea cucumber		
1335	Benthiodes sea cucumber		
1345	wooden board of shipwreck?		
1345	feeding siphon of enteropneust?		
1346	Benthiodes sea cucumber		
1349	large central pit		
1353	Benthiodes sea cucumber		
1358	sargassum frond		
1368	ring of large burrows		
1368	Benthiodes sea cucumber		
1369	long silver fish with short paddle fin		
1375	long silver fish with short paddle fin		
1384	long silver fish with short paddle fin		
1388	flat soleus-type sea cucumber?		
1395	Benthiodes sea cucumber		
1395	large rattail		
1399	Benthiodes sea cucumber		

Picture no.	Notes		
1406	slender gray sea cucumber		
1411	slender gray sea cucumber		
1411	sea whip		
1414	slender gray sea cucumber		
1416	flat soleus-type sea cucumber?		
1430	sea whip		
	discontinued detailed analysis to look for shipwreck parts		
1571	long silver fish with short paddle fin		
2289	distinct red sea star		
2309	white tadpole fish-very distinct		
	See end of table for shipwreck photo log		
2370	2380 starboard side	2370	2470
2451	2470 port side		
2547	large fish with heterocercal tail		
2554	large white fish on bottom		
2558	boat fragments		
2559	boat fragments		
2566	metal pieces buried? Oxidized stains		
2646	Oblong pit- spindle shaped		
2653	oxidized pits and mud surface		
2659	large white fish		
2660	large white fish		
2739	piece of cable?		
2763	bright red shrimp up in water column		
2857	pelagic cucumber? Slender neck extended		
2912	bright silvery fish with extended pelvic fins	2380	
2927	deepwater skate		
3023	flytrap anemone		
3026	Benthiodes sea cucumber		2452
3027	white tadpole fish-very distinct		
3032	Benthiodes sea cucumber		
3048	slender gray sea cucumber		
3050	Benthiodes sea cucumber		
3051	flytrap anemone		
3052	slender gray sea cucumber		
3054	slender gray sea cucumber		

Picture no.	Notes		
3057	Benthiodes sea cucumber		
3070	Benthiodes sea cucumber		
3071	slender gray sea cucumber		
3099	sea whip		
3114	slender gray sea cucumber		
3115	flat soleus type cucumber		
3116	ring of large pits		
3121	red shrimp		
3122	ring of large pits		
3123	narrow trail with elongate worm?		
3138	red shrimp		
3147	small fish		
3153	ring of large pits		
3153	sargassum frond		
3154	sargassum frond		
3158	small fish		
3168	red shrimp		
3169	red soleus cucumber-2		
3174	Benthiodes sea cucumber		
3180	sea whip		
3181	slender gray sea cucumber		
3186	slender gray sea cucumber		
3192	Benthiodes sea cucumber		
3194	slender gray sea cucumber		
3212	Benthiodes sea cucumber		
3214	sargassum frond		
3217	soleus type cucumbers? 2		
3228	group of large pits		
3230	ring of large pits		
3230	sea whip-black coral		
3232	sargassum frond		
3234	slender gray sea cucumber		
3237	flytrap anemone		
3245	slender white fish with paddle tail		
3245	sea whip		
3246	bright red shrimp with large cephalic vanes		
3256	bright red shrimp		
3261	ring of large pits		
3263	slender gray sea cucumber		
3266	ring of large pits		

Picture no.	Notes		
3266	sea whip		
3268	flat soleus type cucumber		
3270	ring of large pits		
3271	flat soleus type cucumber		
3272	Benthiodes sea cucumber		
3279	rattail		
3284	sea whip		
3288	sargassum frond		
3289	flat soleus type cucumber		
3292	Benthiodes sea cucumber		
3305	red shrimp		
3306	slender gray sea cucumber	good mugshot	
3309	white lobster? Strange body shape		
3314	sargassum frond		
3325	Benthiodes sea cucumber		
3329	slender gray sea cucumber		
3330	crinoid		
3333	Benthiodes sea cucumber		
3338	sea whip		
3339	tripod ship		
3341	Benthiodes sea cucumber		
3342	flat soleus type cucumber		
3347	flat soleus type cucumber		
3360	sargassum frond		
3361	red shrimp		
3362	sea whip		
3372	begin detailed analysis here		
3377	group of large pits		
3378	bright red shrimp		
3380	sea whip		
3380	Benthiodes sea cucumber		
3384	group of large pits		
3395	soleus type cucumber?		
3396	soleus type cucumber?		
3397	slender gray sea cucumber		
3400	slender gray sea cucumber		
3403	slender gray sea cucumber		
3404	sargassum frond		
3407	Benthiodes sea cucumber		
3408	slender gray sea cucumber		
3412	distinct red sea star		

Picture no.	Notes		
3412	sea whip		
3413	sea whip		
3415	bright red shrimp		
3416	sea whip		
3421	red soleus cucumber		
3424	rag or towel		
3424	sea whip		
3424	red shrimp		
3426	small fish		
3433	slender gray sea cucumber		
3435	bright silvery fish with extended pelvic fins		
3437	Benthiodes sea cucumber		
3438	Benthiodes sea cucumber		
3440	red soleus cucumber		
3441	crinoid		
3454	red shrimp		
3460	slender gray sea cucumber		
3463	red ctenophore		
3470	red soleus cucumber		
3471	sea whip		
3476	large burrow and white mound		
3477	sea whip		
3477	Benthiodes sea cucumber		
3478	small sea whip		
3480	large pits		
3482	AUV MAKES TURN		
3493	large red shrimp		
3493	flytrap anemone		
3500	sargassum frond		
3503	slender sea cucumber		
3508	circle of large pits		
3508	red shrimp		


2370
2470
2558
2566
2584
2646
2380
2452

LOPHELIA2-2 SENTRY DIVE SUMMARIES

Lophelia2-2 Sentry Dive Summaries

Dr. Dana R. Yoerger
Dr. James Kinsey
Jordan Stanway
Rod Catanach Alan Duester
Andrew Billings

Chief Scientist: Dr. Ian MacDonald
original: July 15, 2009
Revised July 16, 2009
Revised July 23, 2009

July 24, 2009

1 Introduction

This document summarizes data from the AUV Sentry dives on the Lophelia2-2 cruise, June 17-July 1 2009. This report provides dive narratives and shows basic vehicle performance, sensor performance, and shows representative still photos and bathymetric maps.

A detailed description of the data files is provided in a separate document, Sentry_data_file_descriptions.pdf.

We visited 9 sites, obtaining multibeam data, photographic data at each site. We had difficulties with several vehicle systems that reduced our productivity substantially. These items are discussed more fully in an appendix.

Most of the improvements in this release of the report arise from improved navigation postprocessing. Updated data products in this revision of the report include:

1. Sentry018: slightly improved multibeam map due to reduced latency in depth/attitude processing, we have not corrected for refraction which is the largest error
2. Sentry019/020: improved LBL postprocessing, depth/attitude latency correction.
3. Sentry021: depth/attitude latency correction.
4. Sentry023: depth/attitude latency correction.
5. Sentry028: depth/attitude latency correction, zoomed views of bathymetry
6. all dives: conductivity, salinity, density, and soundspeed added to SCC files

2 Sentry017

This was a test dive at the Flowergardens area. The dive failed due to a mission programming software error. The plan for the dive was repeated for Sentry018.

3 Sentry018

This dive repeated the program for the failed Sentry017 dive at the Flowergarden site. The vehicle made two multibeam blocks connected by a camera line. The imaging system failed, however the vehicle followed the bottom properly at the 5-meter height. The multibeam lines were run at 60m height. The navigation from the vehicle (INS and DVL) was reprocessed using USBL fixes.

The multibeam rendering shows some artifacts between tracklines. These are most likely caused by the steep sound speed gradient at this site. We used data from a recent CTD cast to determine the soundspeed used in realtime by the beamforming, but we have not corrected the dataset for refraction. Multibeam records were hand-edited to remove interference from the vessel's echo sounder.

3.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry018_23-Jul-2009.scc
2. GMT grid file: 2009lophelia2-2/multibeam/flowergarden_sentry018_20090723.grd
3. multibeam ascii point file: 2009lophelia2-2/multibeam/flowergarden_sentry018_20090723.tllz.zip
4. PPF file: (none, no photos taken)
5. plots from this report: 2009lophelia2-2/plots
6. photos: none

3.1 Sentry018 Summary

Launch: 2009/06/20 20:25:55
Survey start: 2009/06/20 20:30:04
Survey end: 2009/06/21 00:01:01
Ascent begins: 2009/06/21 00:01:34
On the surface: 2009/06/21 00:02:07
On deck: 2009/06/21 00:19:21
Descent rate: 6.1 m/min
Ascent rate: 45.3 m/min
Survey time: 3.5 hours
Deck-to-deck time 3.9 hours
Mean survey depth: 38m
Mean survey height: 45m
Distance travelled: 8.87km
Total vertical during survey: 554m
Battery energy at launch: 12.5 kwhr
Battery energy at survey end: 10.0 kwhr
Battery energy on deck: 10.0 kwhr

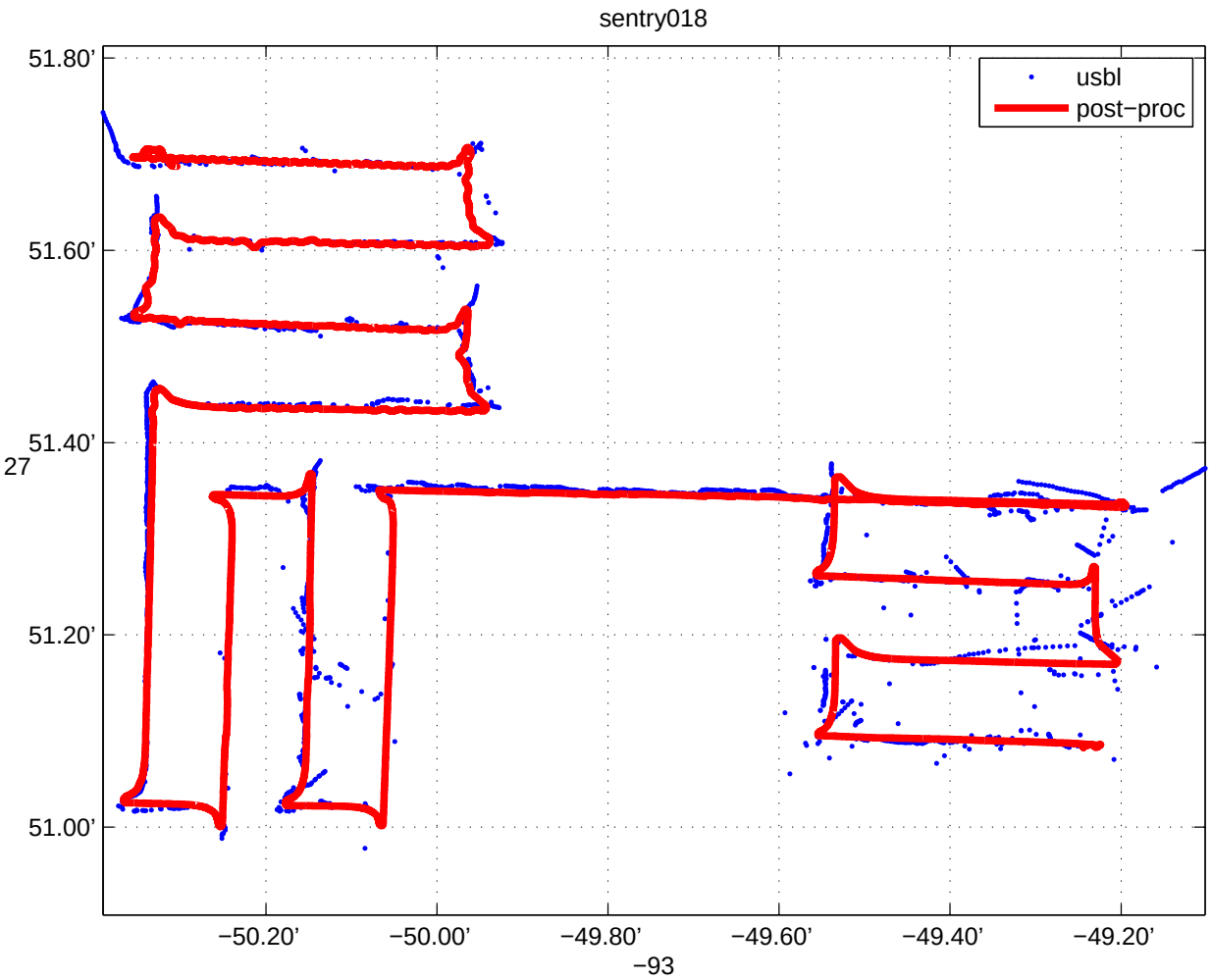


Figure 1: This plot shows the real-time USBL fixes and the post-processed dive track for Sentry018

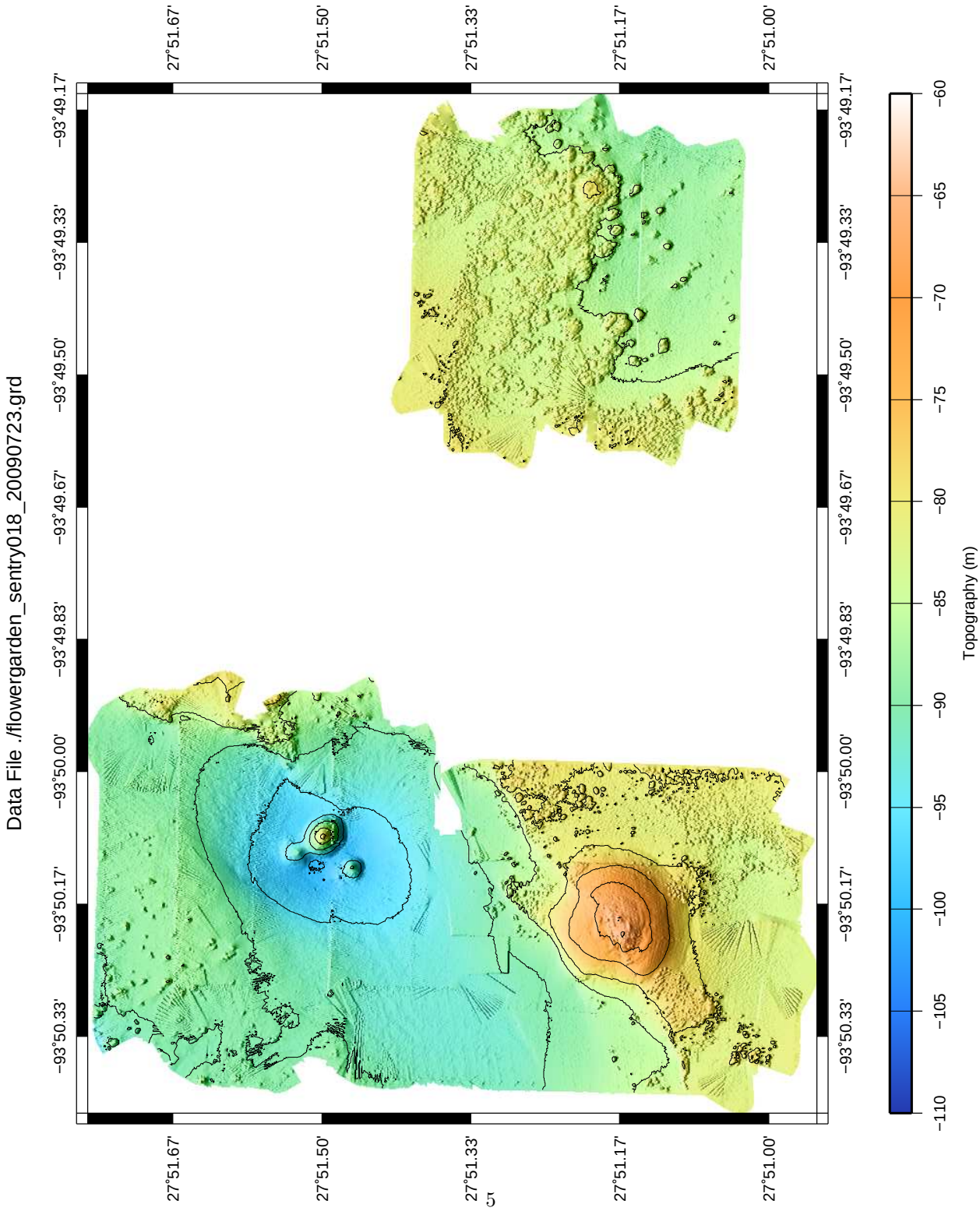


Figure 2: Processed multibeam bathymetry for Sentry018.

4 Sentry019

4.1 Sentry019 Summary

Launch: 2009/06/21 20:03:25
Survey start: 2009/06/21 20:28:19
Survey end: 2009/06/21 22:03:18
Ascent begins: 2009/06/21 22:03:52
On the surface: 2009/06/21 22:37:03
On deck: 2009/06/21 22:52:37
Descent rate: 33.5 m/min
Ascent rate: 23.2 m/min
Survey time: 1.6 hours
Deck-to-deck time 2.8 hours
Mean survey depth: 798m
Mean survey height: 60m
Distance travelled: 2.41km
Total vertical during survey: 541m
Battery energy at launch: 13.7 kwhr
Battery energy at survey end: 12.5 kwhr
Battery energy on deck: 12.1 kwhr

The plan for this dive was primarily a multibeam survey with a short camera leg at gb837. The dive ended after a short run when the port side ascent weight dropped, without an explicit command. Two tracklines were completed. The plots for this dive are combined with those from Sentry020, which continued the original dive plan.

Before the dive, we set and surveyed a four-element transponder net. Details of the transponder surveys are provided in an appendix.

4.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry019_23-Jul-2009.scc
2. GMT grid file: see Sentry019
3. multibeam ascii point file: see Sentry019
4. PPF files (none, no photos taken)
5. plots from this report: see Sentry019
6. photos: none

5 Sentry020

5.1 Sentry020 Summary

Launch: 2009/06/22 05:26:49
Survey start: 2009/06/22 05:51:05
Survey end: 2009/06/22 19:28:30
Ascent begins: 2009/06/22 19:29:03
On the surface: 2009/06/22 19:50:03
On deck: 2009/06/22 20:08:45
Descent rate: 34.0 m/min
Ascent rate: 25.7 m/min
Survey time: 13.6 hours
Deck-to-deck time 14.7 hours
Mean survey depth: 689m
Mean survey height: 58m
Distance travelled: 32.19km
Total vertical during survey: 4939m
Battery energy at launch: 13.2 kwhr
Battery energy at survey end: 5.1 kwhr
Battery energy on deck: 4.8 kwhr

This dive continued the tracklines planned originally in Sentry019 at gb837. The vehicle ran for 13.5 hours, at which point the port side ascent weight released early, terminating the dive. The camera did not run due to a mission programming error.

The dead-reckoned nav from the vehicle was combined with the LBL fixes to create the final postprocessed trackline.

The multibeam map shows some small nav misalignment, which could be remedied by more post-processing of the LBL data.

5.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry020_23-Jul-2009.scc
2. GMT grid file: 2009lophelia2-2/multibeam/gb837_sentry019020_lblpost_20090723.grd
3. multibeam ascii point file: 2009lophelia2-2/multibeam/gb837_sentry019020_lblpost_20090723.tllz.zip
4. PPF files: (none, no photos taken)
5. plots from this report: 2009lophelia2-2/plots
6. photos: none

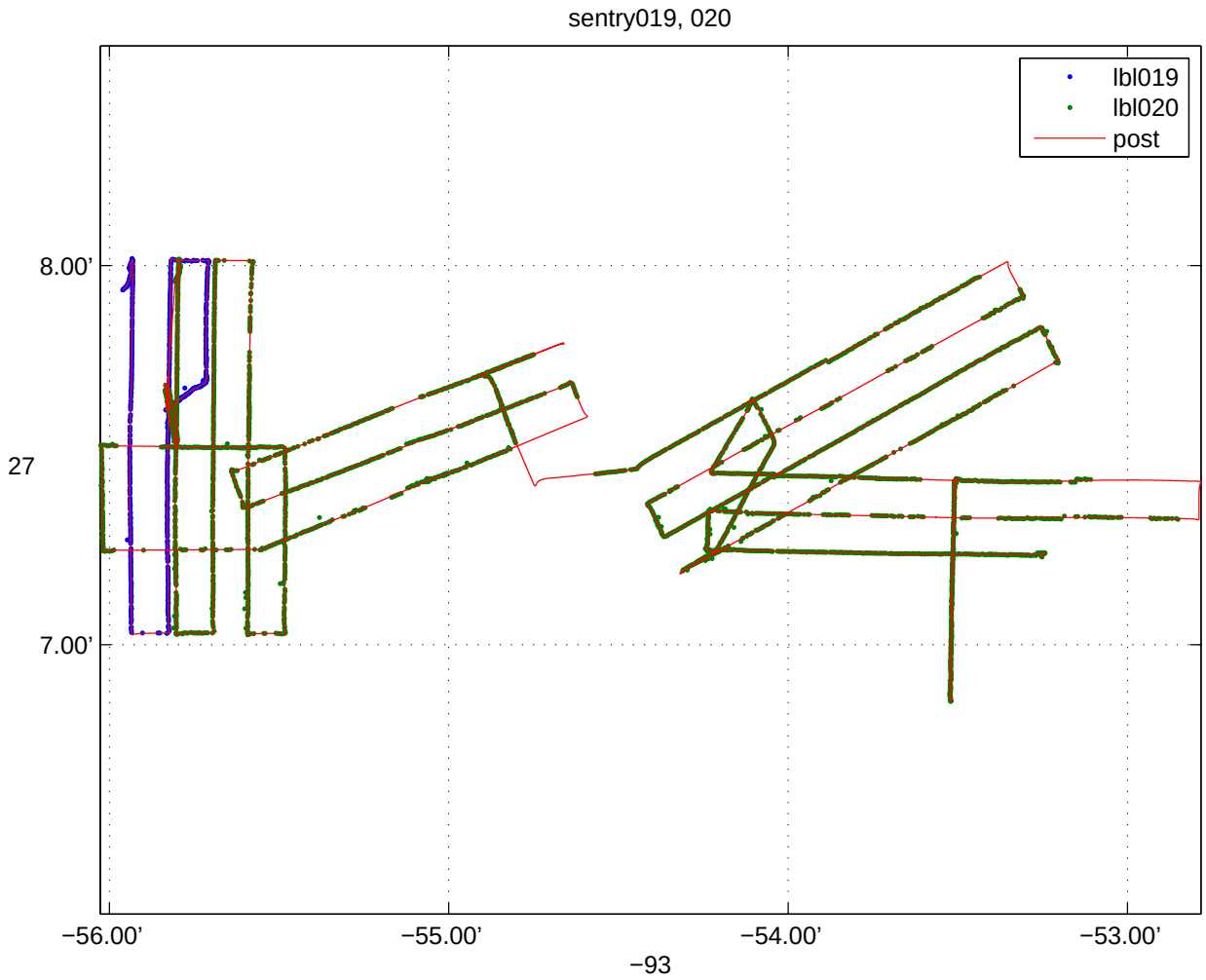


Figure 3: This plot shows the post-processed fixes and the post-processed dive track for Sentry019 and Sentry020.

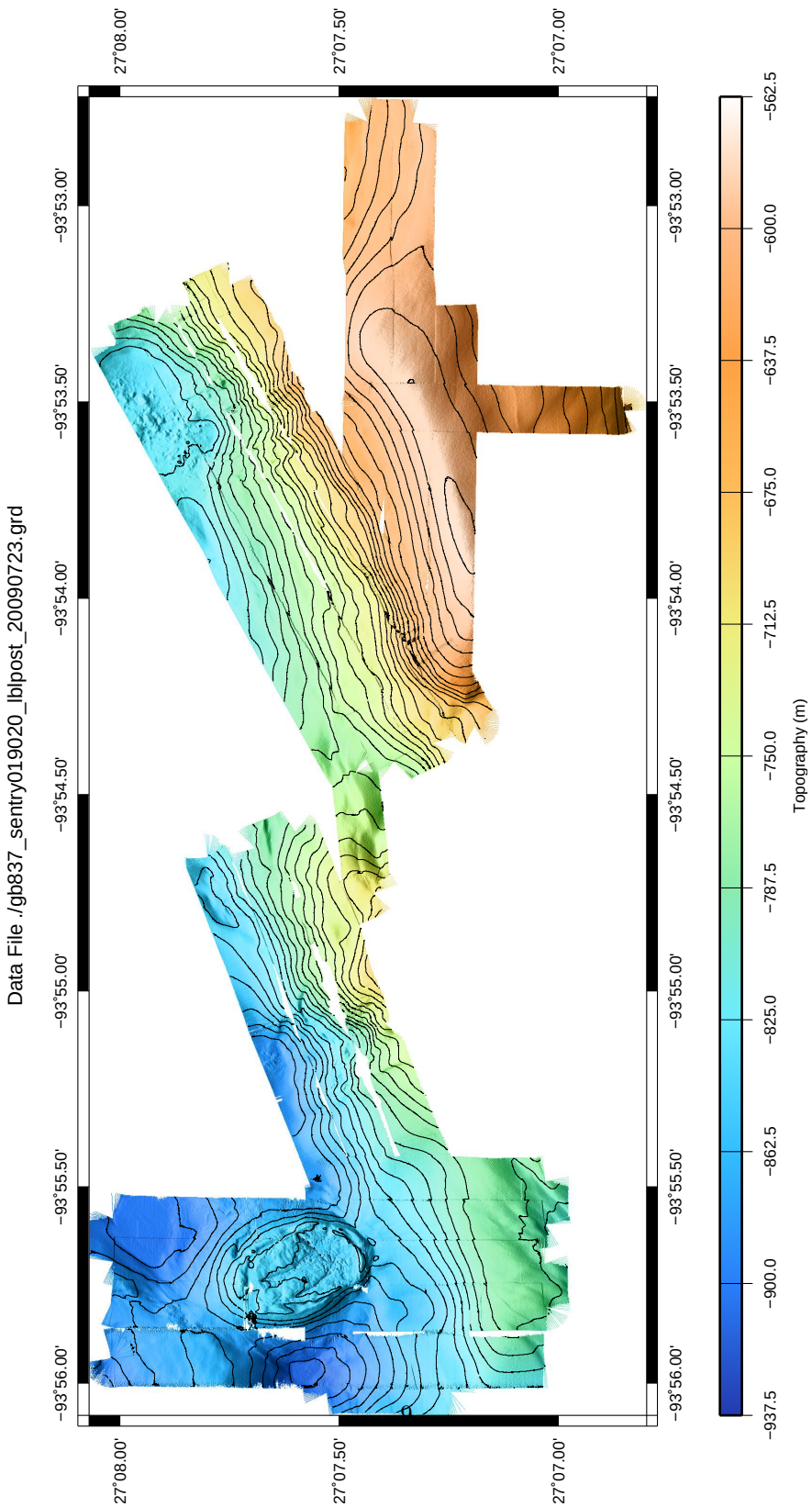


Figure 4: Processed multibeam bathymetry for Sentry019 and Sentry020, the data is gridded at 2 meters

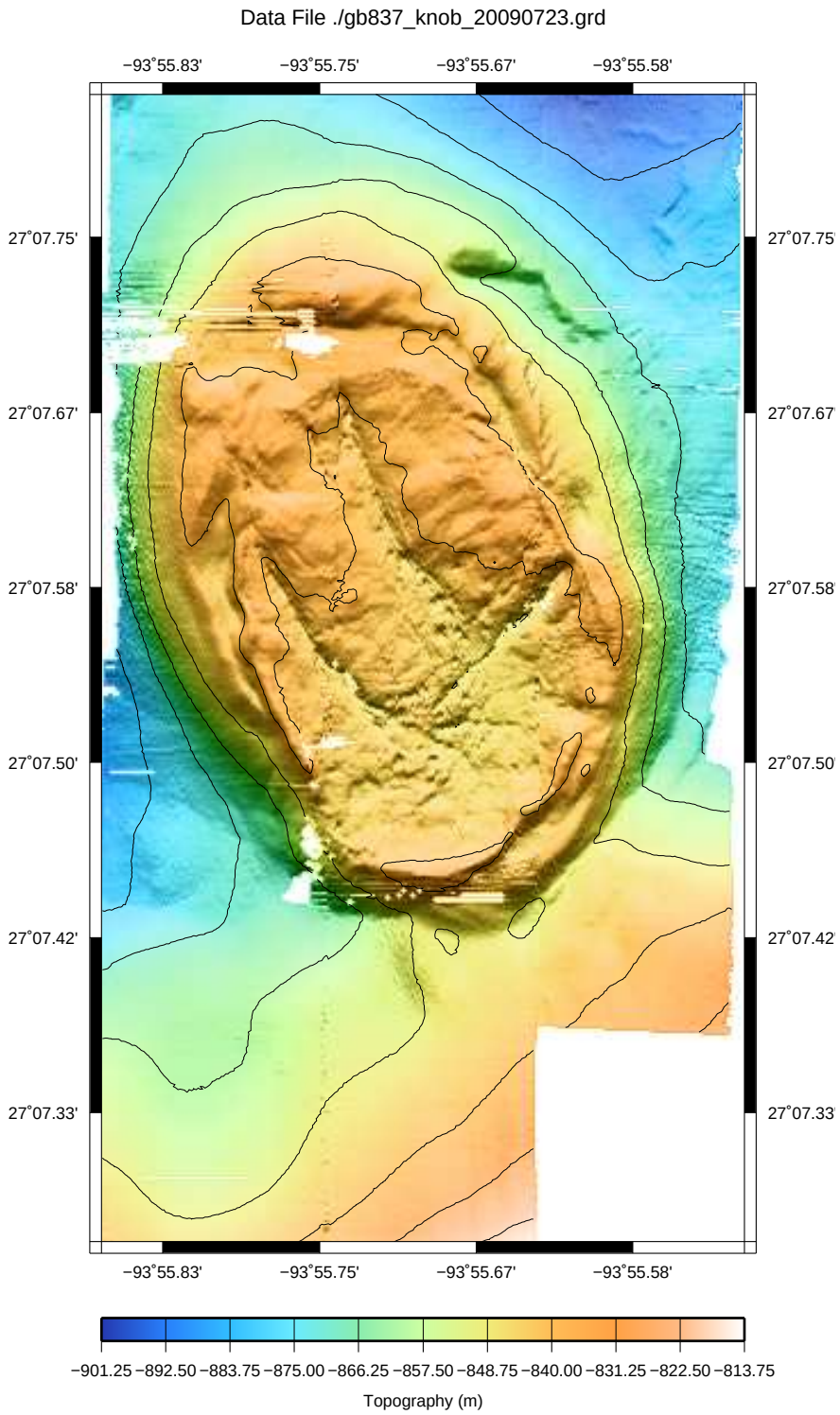


Figure 5: Processed multibeam bathymetry for the pass over the "knob" located on the west side of figure 4, gridded at 1.0 meters

6 Sentry021

6.1 Sentry021 Summary

Launch: 2009/06/24 07:53:56
Survey start: 2009/06/24 08:13:38
Survey end: 2009/06/24 18:13:35
Ascent begins: 2009/06/24 18:13:35
On the surface: 2009/06/24 18:23:33
On deck: 2009/06/24 18:37:27
Descent rate: 29.3 m/min
Ascent rate: 51.4 m/min
Survey time: 10.0 hours
Deck-to-deck time 10.7 hours
Mean survey depth: 526m
Mean survey height: 54m
Distance travelled: 28.91km
Total vertical during survey: 1124m
Battery energy at launch: 13.0 kwhr
Battery energy at survey end: 7.3 kwhr
Battery energy on deck: 7.2 kwhr

This dive at the gb535 site included a successful (700 images) photo run at 5 meters height followed by a multibeam run at 60 meters height. Our PHINS inertial navigation system (INS) failed shortly before our first planned launch. We were forced to use our magnetic compass (TCM2), which also has pitch and roll sensors. We used data from the last dive (Sentry020) where the INS was working to calibrate the magnetic compass for rotation and distortion. Even when calibrated, the use of the magnetic compass and fluid tilt sensors represents a major downgrade compared to the INS in terms of resolution and accuracy. Our estimate of the resolution and accuracy of the calibrated magnetic compass is about 0.1 degree and 1.0 degree respectively, compared to an accuracy of about 0.05 degree in heading for the PHINS. For pitch and roll, the PHINS has an accuracy of about 0.01 degrees, while the tilt sensors in the compass have a resolution of about 0.2 degree but an accuracy of about 1.0 degree. Both the compass and the tilt sensors have sluggish dynamics compared to the INS.

The navigation from the vehicle (DVL and magnetic compass) was later corrected using the USBL fixes obtained at the vessel. The USBL performance at this depth ($\tilde{5}$00m) was excellent. We used the USBL to correct the vehicle dead-reckoned (DR) track with a very sluggish (15 minute) filter.

The resulting multibeam map, gridded at 2 meters, is shown in figure 8. We can see some slight mismatches between tracklines, and each trackline swath looks a bit ''shakey" due to the performance of the roll sensor. But overall we were pleased with this result given the makeshift instrumentation we had available. Interesting textural features are visible on the top of the mound.

The photos proved useful. Lighting was adequate. Focus was good in the center of the images but was soft toward the edges. Figures 9 through 12 show some examples after automated equalization to even out the lighting and color balancing.

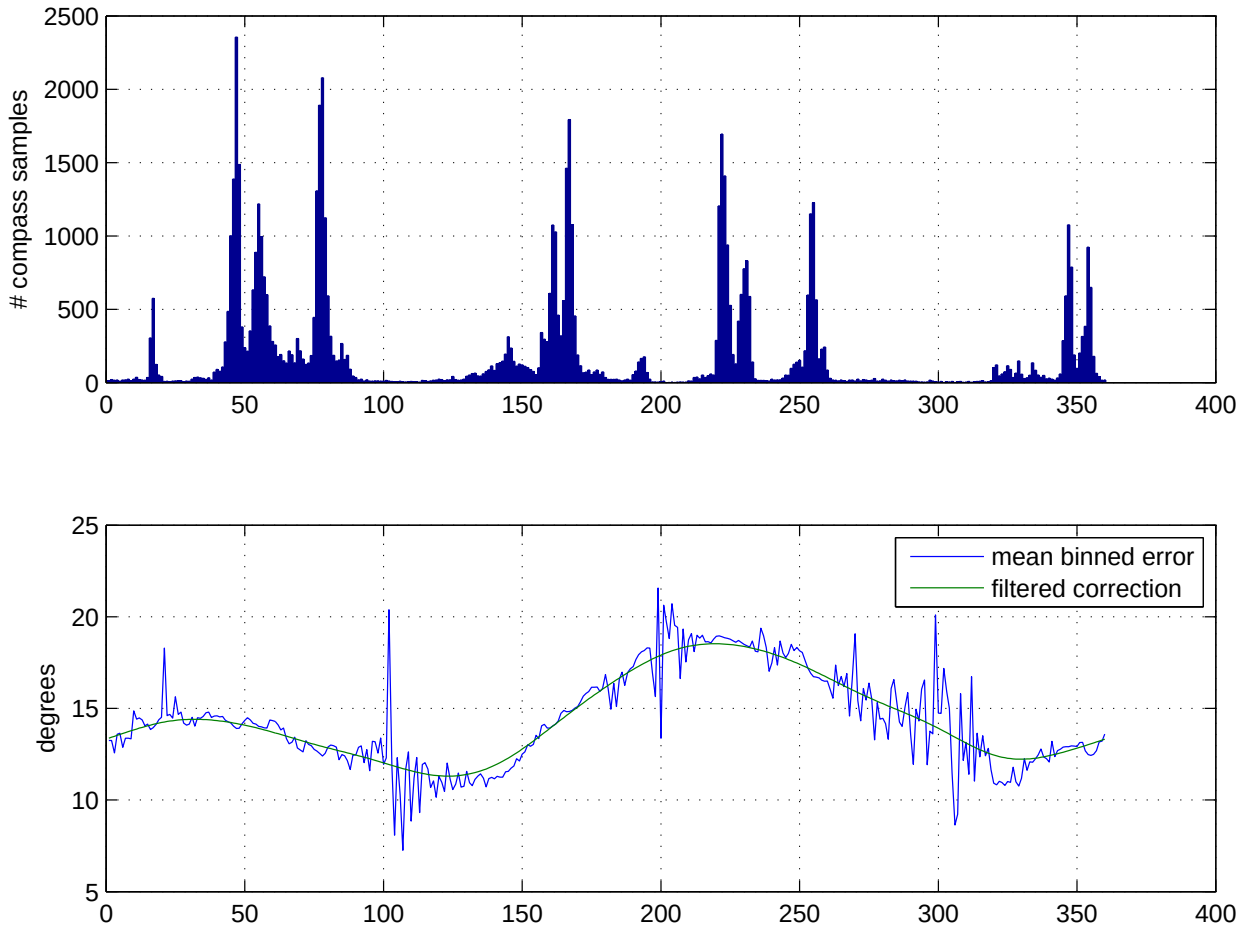


Figure 6: These plots illustrate the heading correction based on simultaneously logged data from the INS and magnetic compass from Sentry020. The upper panel shows the number of samples for 1 degree bins. The lower panel shows the correction for each 1-degree heading bin. The uneven sampling reduced the effectiveness of this approach. Our correction proved accurate for the headings with many samples (corresponding to the trackline directions from the previous dive), less accurate for the other headings were we had fewer samples and for which the vehicle was usually turning.

6.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry021_23-Jul-2009.scc
2. GMT grid file: 2009lophelia2-2/multibeam/gb535_sentry021_20090723.grd
3. multibeam ascii point file: 2009lophelia2-2/multibeam/gb535_sentry021_20090723.tllz.zip
4. PPF files: 2009lophelia2-2/ppf/sentry021_13-Jul-2009.ppf
5. plots from this report: 2009lophelia2-2/plots
6. photos: 2009lophelia2-2/photos/sentry021

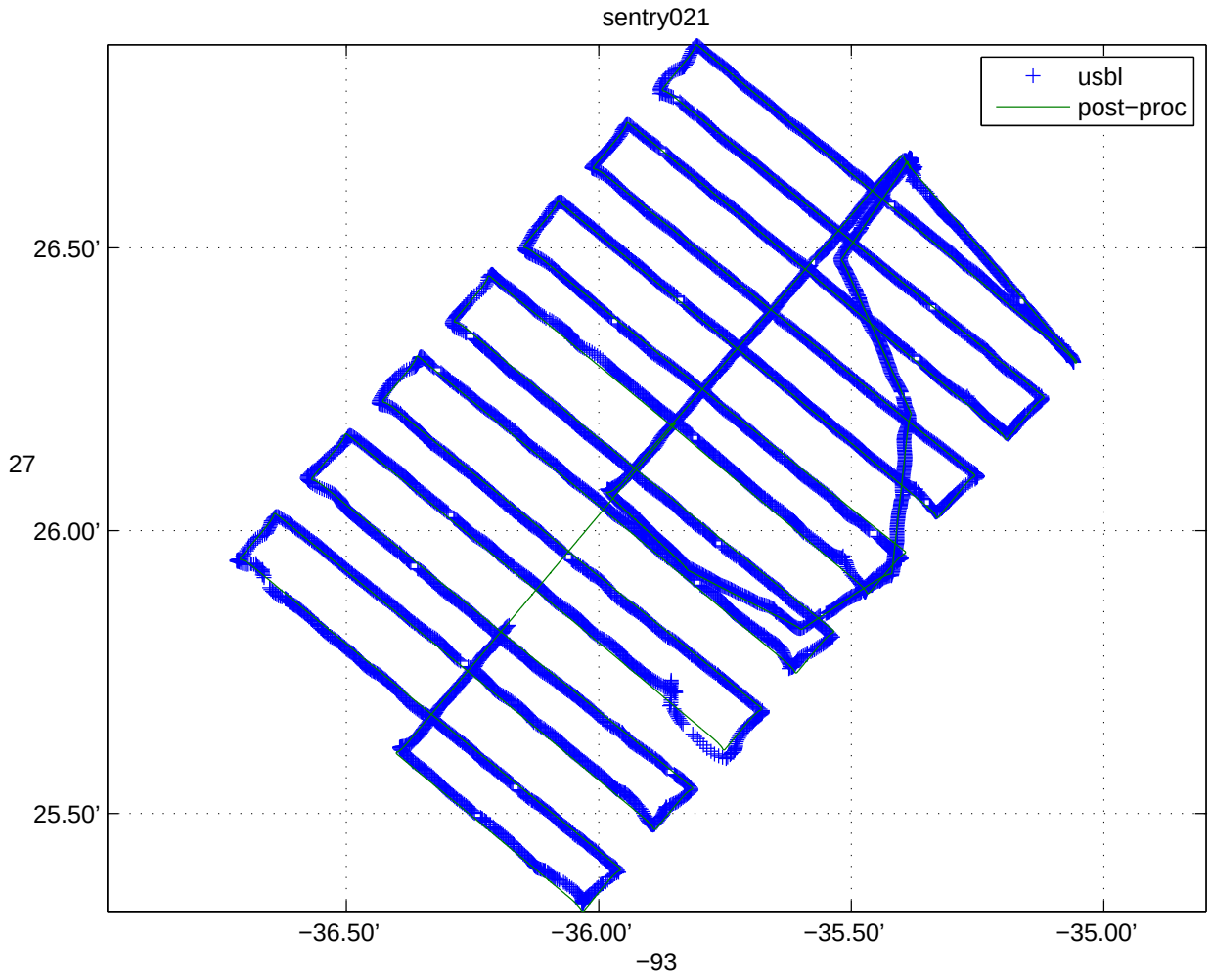


Figure 7: This plot shows the real-time USBL fixes and the post-processed dive track for Sentry021. The USBL performance at this operating depth ($\tilde{5}$00m) was excellent

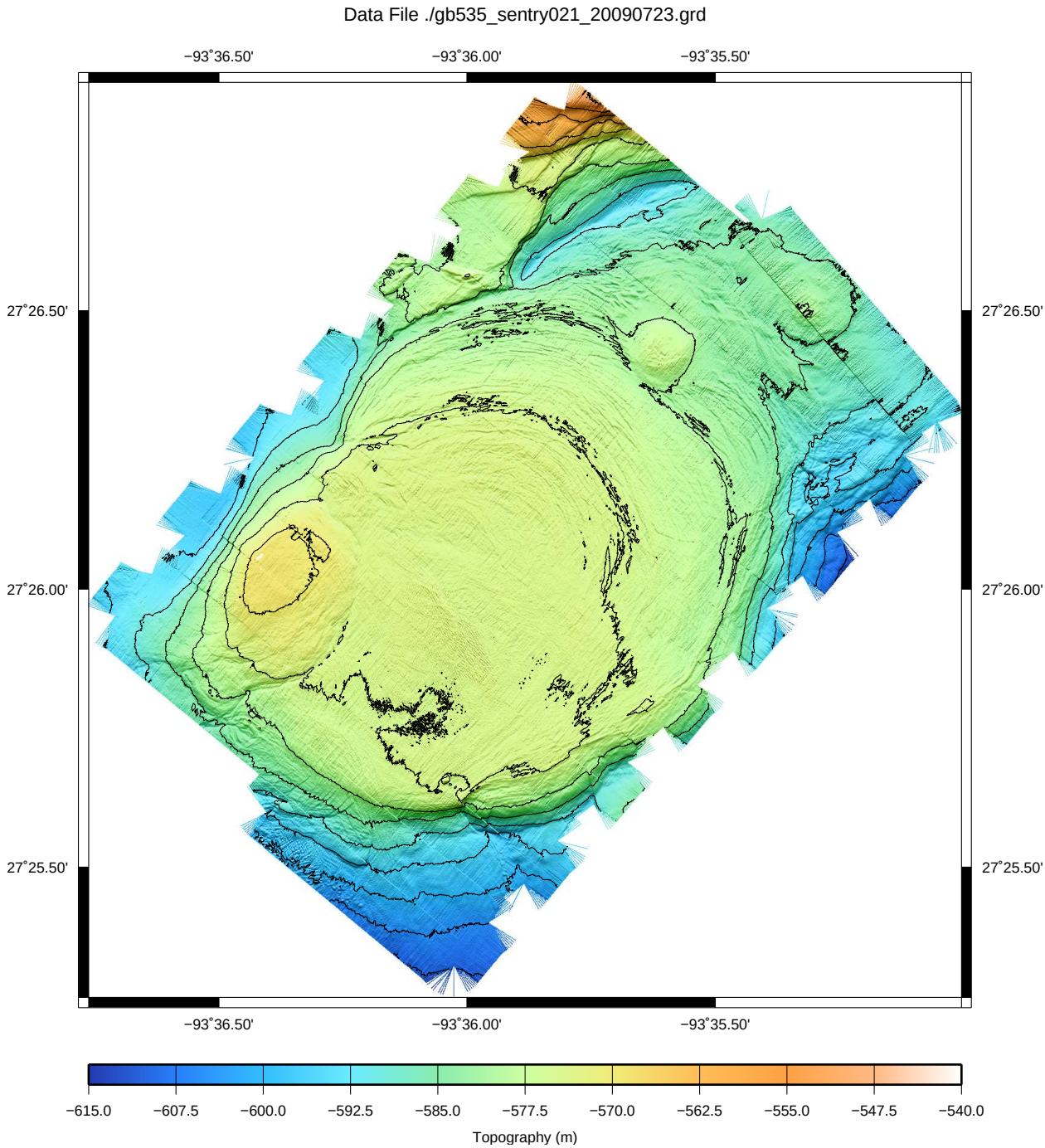


Figure 8: Processed multibeam bathymetry for Sentry021. The map shows minor mismatches between tracklines. Interesting textures can also be seen as can some jitter probably arising from the low-performace tilt sensor which replaced our INS

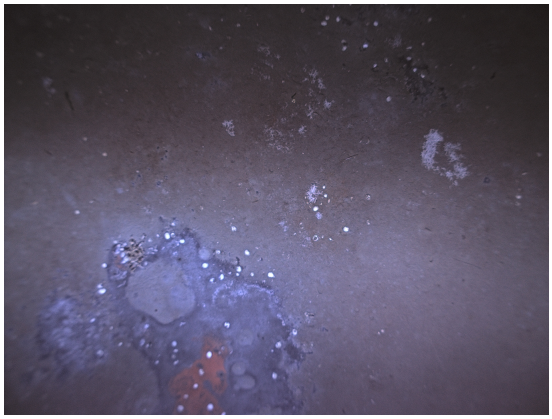


Figure 9: Possible lophelia

Figure 10: Likely chimera

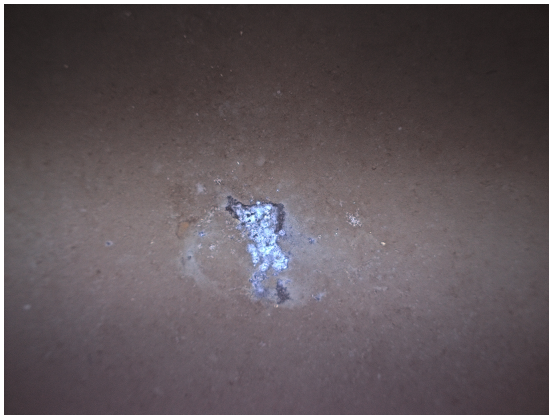


Figure 11: Possible seep

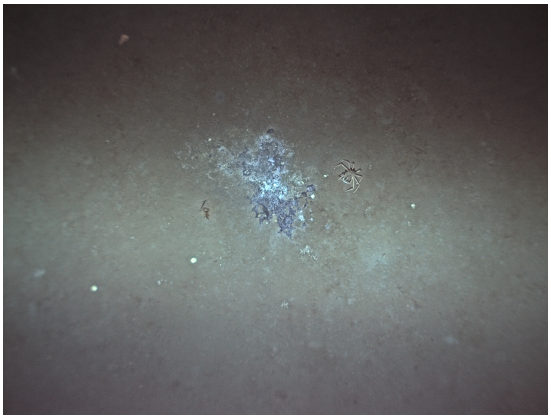


Figure 12: Possible seep with spider crab

7 Sentry022

Sentry022 ended very early. The starboard side ascent weight dropped during descent. As the vehicle was ballasted quite buoyantly, it stopped descending and we commanded an acoustic abort.

8 Sentry023

8.1 Sentry023 Summary

Launch: 2009/06/26 00:49:43
Survey start: 2009/06/26 01:24:59
Survey end: 2009/06/26 13:42:31
Ascent begins: 2009/06/26 13:41:57
On the surface: 2009/06/26 14:01:52
On deck: 2009/06/26 14:19:31
Descent rate: 31.0 m/min
Ascent rate: 54.6 m/min
Survey time: 12.3 hours
Deck-to-deck time 13.5 hours
Mean survey depth: 1155m
Mean survey height: 29m
Distance travelled: 24.96km
Total vertical during survey: 2445m
Battery energy at launch: 14.0 kwhr
Battery energy at survey end: 7.3 kwhr
Battery energy on deck: 7.2 kwhr

Sentry023 planned a photo and multibeam survey at the GC600 site. The imaging system failed after about 150 images. We later diagnosed this problem as a network service problem: the camera application was started under the secure shell program, SSH, which would terminate the session about one hour after the topside network was disconnected. We had tested the camera application for long periods, but not disconnected from the topside network. We got nearly full coverage with the multibeam until the port ascent weight fell off 12.3 hours into the run. We also processed the multibeam data from the camera run, which covers some of the area missed in the 60m multibeam survey.

We also tested a new capability: since Sentry's DR navigation was degraded after the loss on the PHINS, we used acoustic commands to make position corrections. We tested a system that allows us to offset the vehicle position by a fixed increment (50m) in any of the cardinal directions. We later added more commands for 10m increments. This capability, combined with the calibrated magnetic compass, allowed us to produce acceptable mapping results without the INS.

8.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry023_13-Jul-2009.scc
2. GMT grid file: 2009lophelia2-2/multibeam/mc600_sentry023_20090733.grd

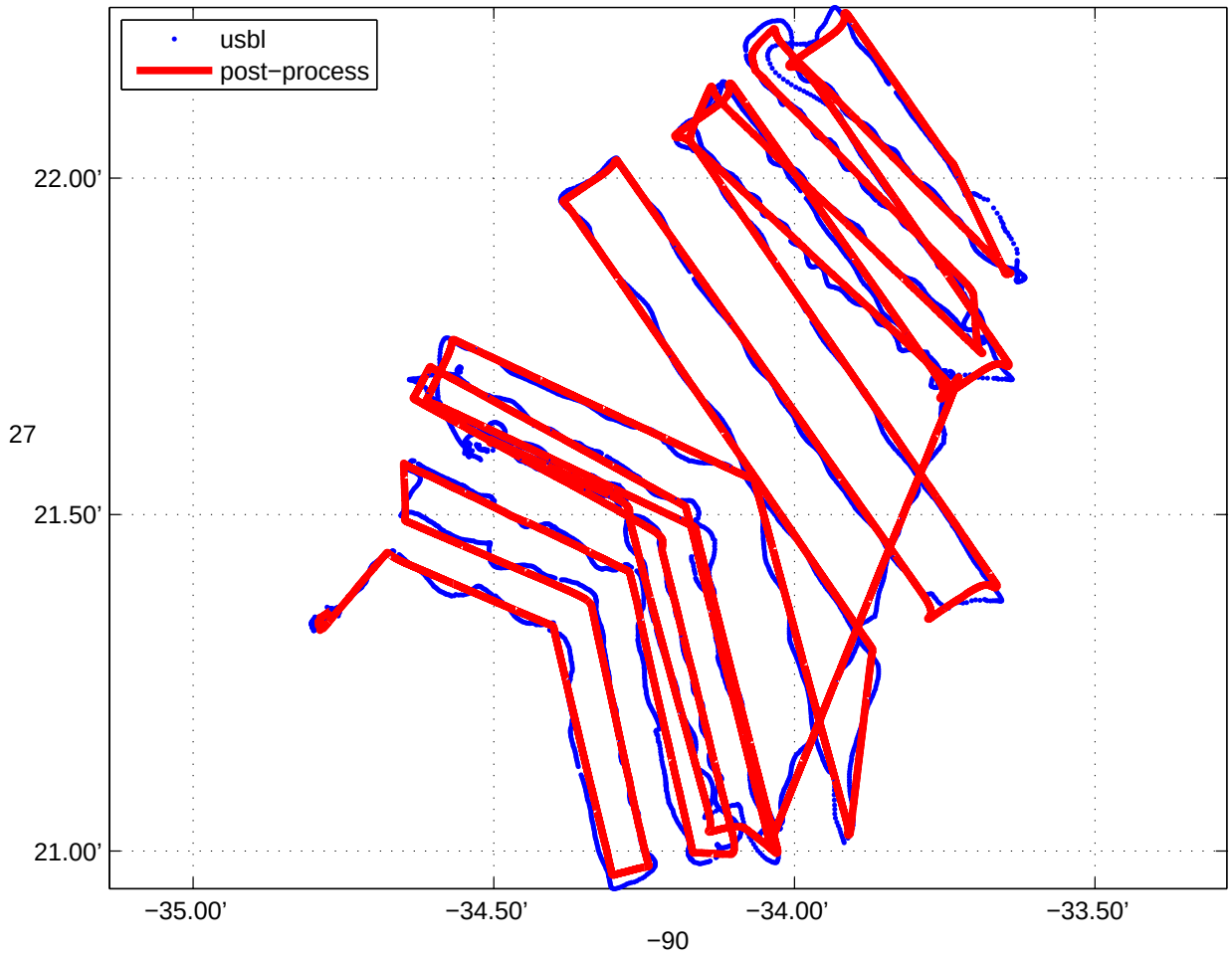


Figure 13: This plot shows the real-time USBL fixes and the post-processed dive track for Sentry023. The USBL performance at this operating depth ($\tilde{1}$100m) was degraded substantially over the previous run $\tilde{5}$00m. This could be a calibration or transducer rigidity issue, clearly the USBL is reporting motions that the vehicle is not making. The post-processed track uses a very sluggish ($\tilde{2}$0 minute) filter on the usbl.

3. multibeam ascii point file: 2009lophelia2-2/multibeam/mc600_sentry023_20090723.tllz.zip
4. PPF files: 2009lophelia2-2/ppf/sentry023_13-Jul-2009.ppf
5. plots from this report: 2009lophelia2-2/plots
6. photos: 2009lophelia2-2/photos/sentry023

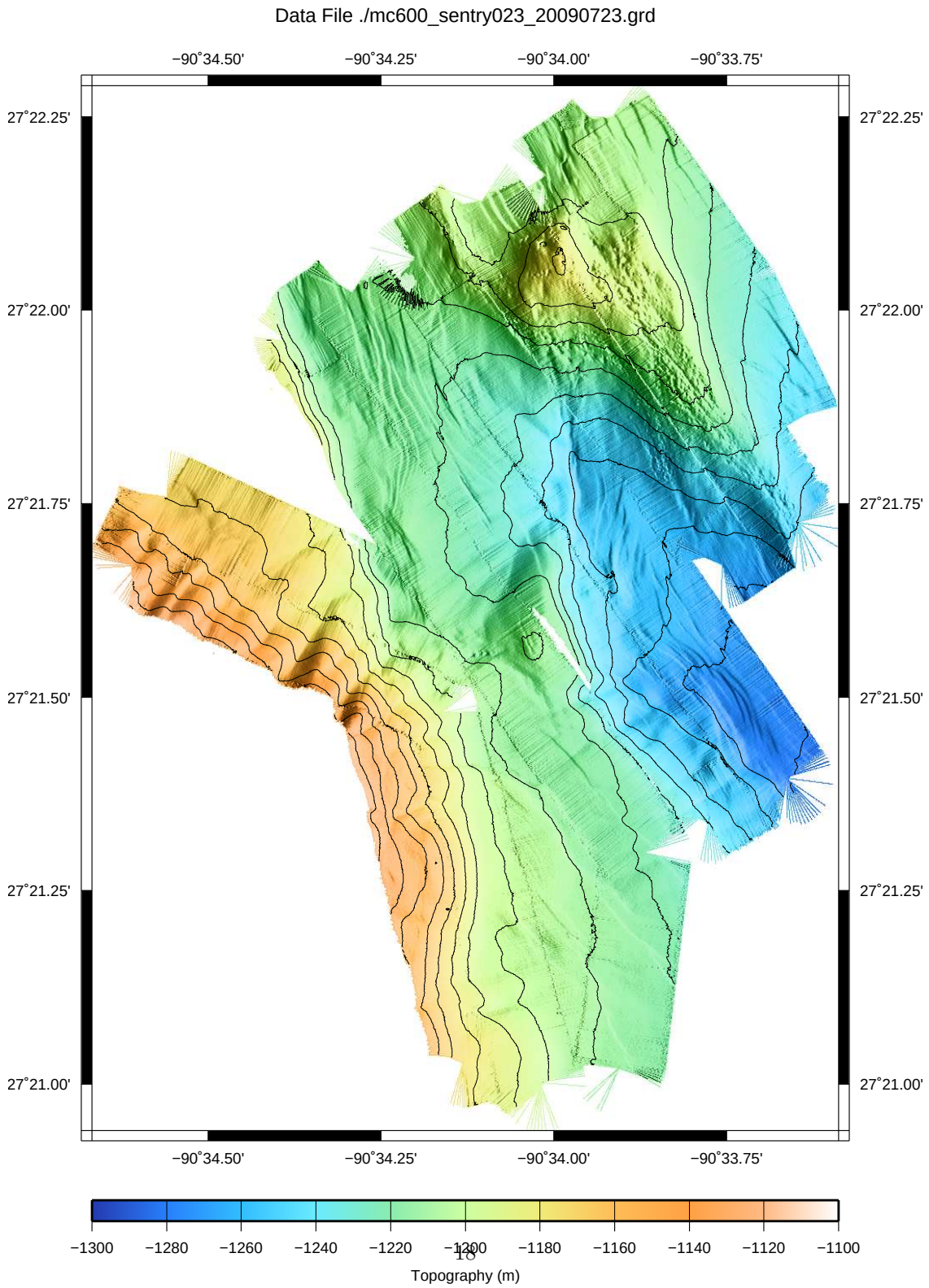


Figure 14: Processed multibeam bathymetry for Sentry023. The map shows minor mismatches between tracklines. Interesting texture can be seen on the steep slope to the north. The map also shows across-track artifacts that occur when the vehicle changes depth while climbing or descending

9 Sentry024

9.1 Sentry024 Summary

Launch: 2009/06/27 00:44:36
Survey start: 2009/06/27 01:09:04
Survey end: 2009/06/27 09:15:58
Ascent begins: 2009/06/27 09:15:58
On the surface: 2009/06/27 09:49:09
On deck: 2009/06/27 10:42:05
Descent rate: 32.5 m/min
Ascent rate: 23.9 m/min
Survey time: 8.1 hours
Deck-to-deck time 10.0 hours
Mean survey depth: 841m
Mean survey height: 5m
Distance travelled: 12.20km
Total vertical during survey: 1766m
Battery energy at launch: 13.9 kwhr
Battery energy at survey end: 9.6 kwhr
Battery energy on deck: 9.0 kwhr

Sentry024 was planned as a photo and multibeam survey at the gc246 site. The imaging system failed after about 700 images. We attempted to fix the problem seen on the previous dive. We believed that the camera application was crashing, so we engineered a solution that involved restarting the program should it terminate. But in fact the session under which the application was running had been terminated, so restarting did not address the problem. The dive ended at the start of the 60m multibeam run when the port weight came off.

We processed the multibeam data from the photo run. While this provides only a thin strip of coverage (see 16), some texture can be seen in the plot. MB-system tools (like mbgrdviz or mbeditviz) can be used to view the processed multibeam grid, zooming in on interesting areas.

9.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry024_23-Jul-2009.scc
2. GMT grid file: 2009lophelia2-2/multibeam/gc246_sentry024_20090713.grd
3. multibeam ascii point file: 2009lophelia2-2/multibeam/gc246_sentry024_20090713.tllz.zip
4. PPF files: 2009lophelia2-2/ppf/sentry024_13-Jul-2009.ppf
5. plots from this report: 2009lophelia2-2/plots
6. photos: 2009lophelia2-2/photos/sentry024

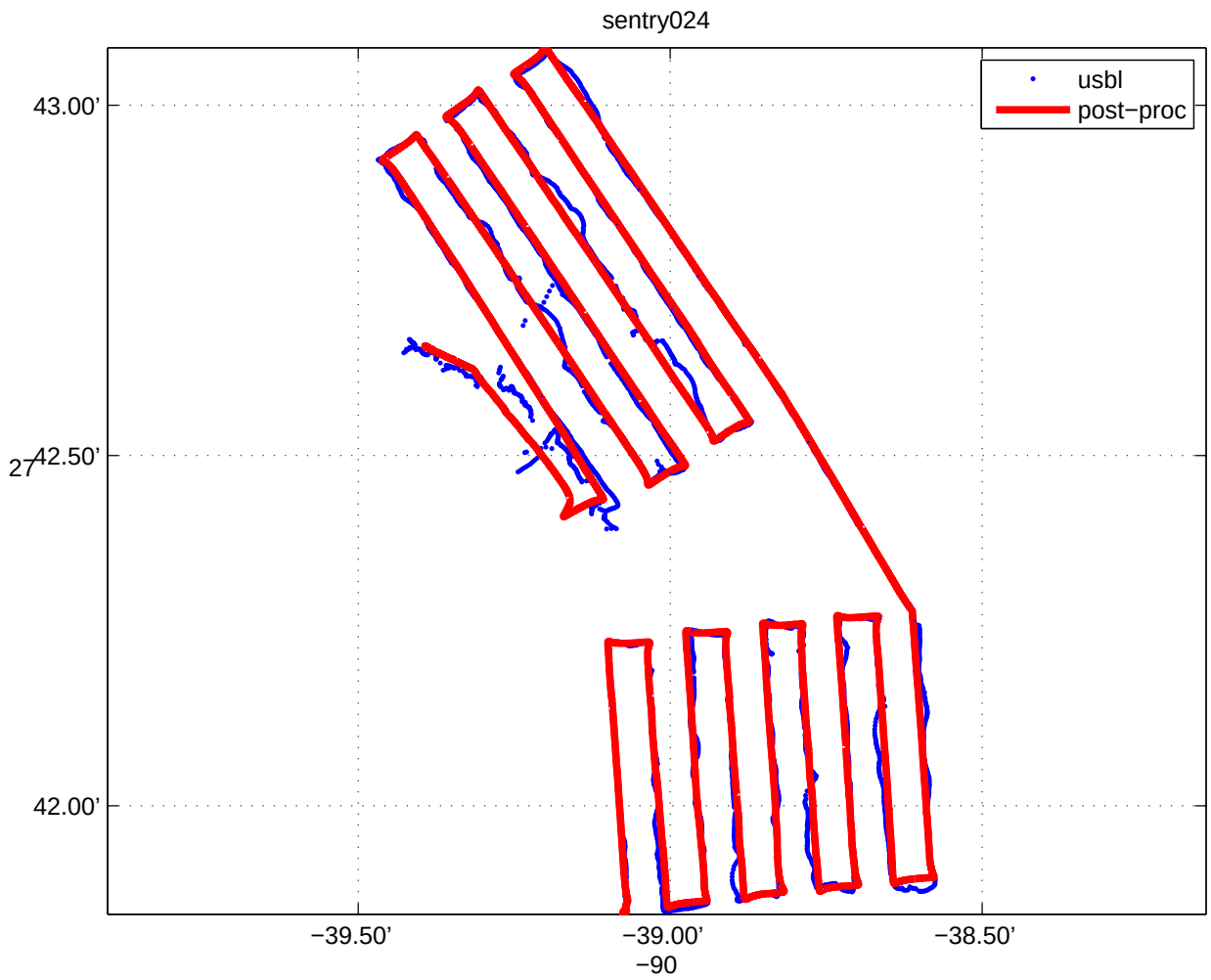


Figure 15: This plot shows the real-time USBL fixes and the post-processed dive track for Sentry024. The USBL performance at this operating depth (800m) was degraded substantially like the previous dive at 1100 m. The post-processed track uses a very sluggish filter on the usbl.

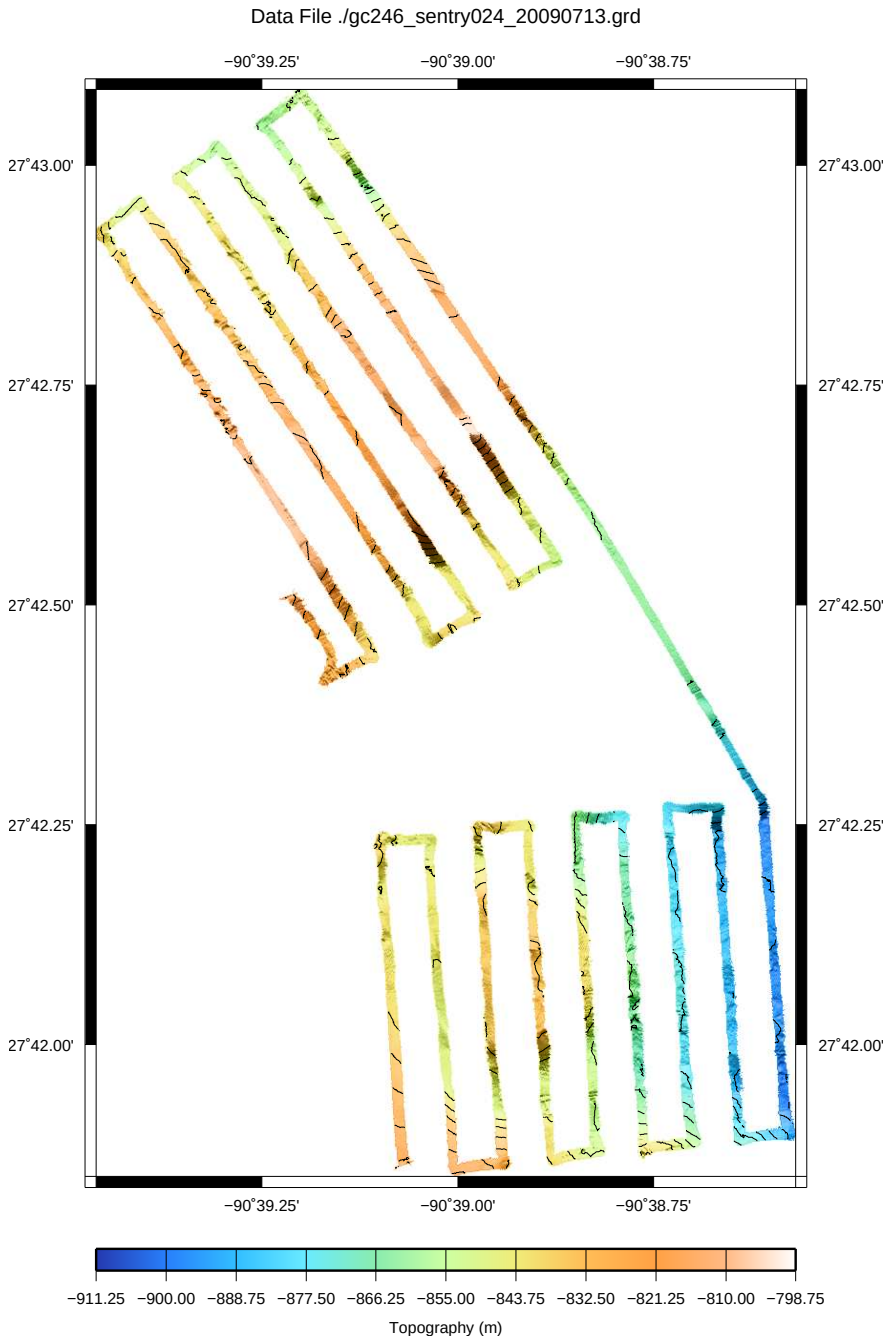


Figure 16: Processed multibeam bathymetry for Sentry024. The swath is very narrow, as the only multibeam data was taken at 5 m height. Close up views of the tracks show texture in a few spots.

10 Sentry025

10.1 Sentry025 Summary

Launch: 2009/06/27 22:36:03
Survey start: 2009/06/27 22:57:12
Survey end: 2009/06/28 03:24:13
Ascent begins: 2009/06/28 03:24:13
On the surface: 2009/06/28 03:44:41
On deck: 2009/06/28 04:01:38
Descent rate: 29.5 m/min
Ascent rate: 30.4 m/min
Survey time: 4.5 hours
Deck-to-deck time 5.4 hours
Mean survey depth: 625m
Mean survey height: 5m
Distance travelled: 6.61km
Total vertical during survey: 612m
Battery energy at launch: 12.9 kwhr
Battery energy at survey end: 10.7 kwhr
Battery energy on deck: 10.5 kwhr

Sentry025 was planned as a photo and multibeam survey at the MC885 site. The camera problem was solved, and images from the entire run were logged. Unfortunately the ascent weight problem occured again, this time after two lines in the second camera block.

10.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry025_23-Jul-2009.scc
2. GMT grid file: none
3. multibeam ascii point file: none
4. PPF files: 2009lophelia2-2/ppf/sentry025_13-Jul-2009.ppf
5. plots from this report: 2009lophelia2-2/plots
6. photos: 2009lophelia2-2/photos/sentry025

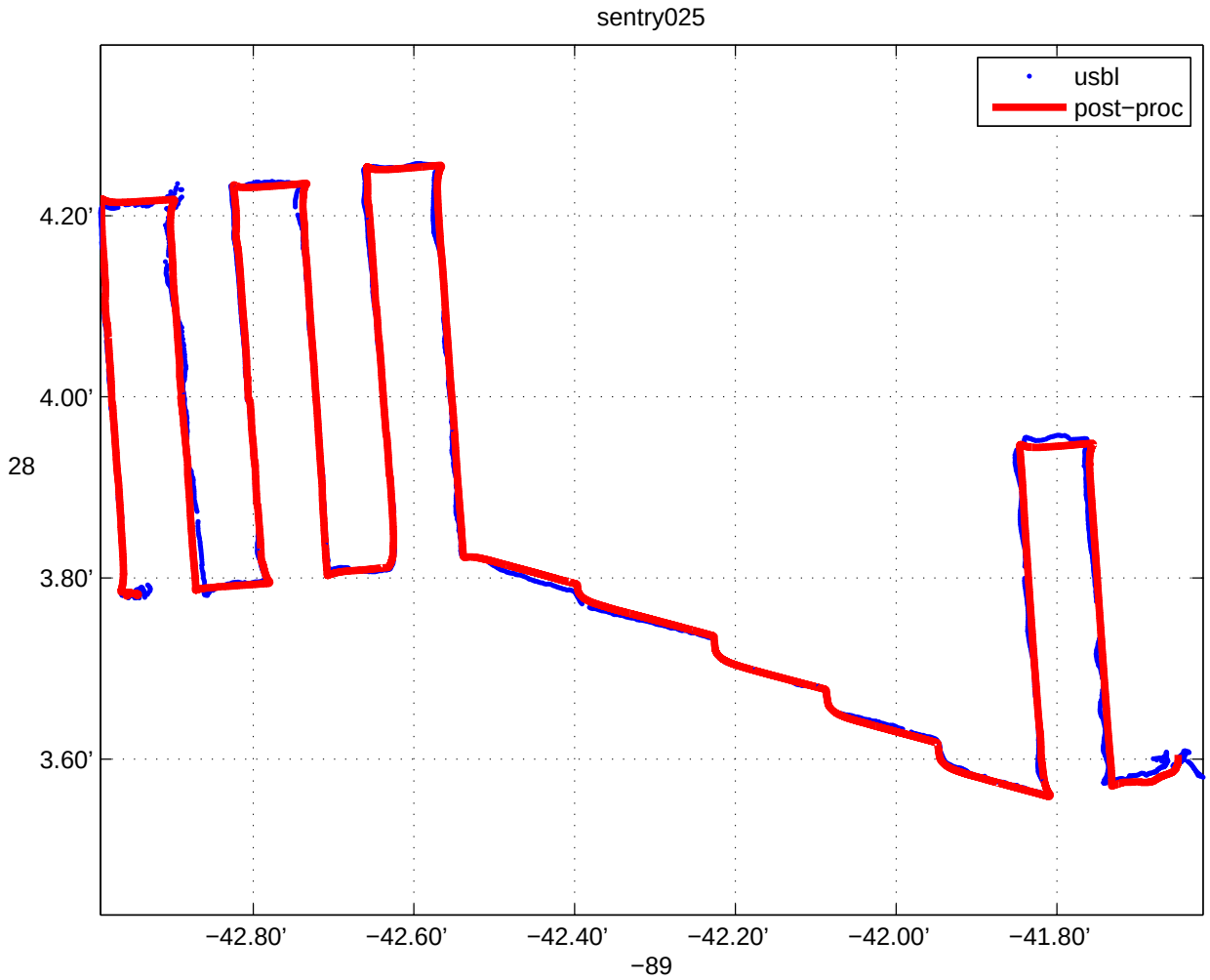


Figure 17: This plot shows the real-time USBL fixes and the post-processed dive track for Sentry025. The USBL performance at this operating depth (600m) was nearly comparable to the excellent performance obtained on the earlier shallow dives.

11 Sentry026

11.1 Sentry026 Summary

Launch: 2009/06/28 18:48:33
Survey start: 2009/06/28 20:02:35
Survey end: 2009/06/29 01:45:52
Ascent begins: 2009/06/29 01:45:52
On the surface: 2009/06/29 02:36:45
On deck: 2009/06/29 02:59:03
Descent rate: 30.3 m/min
Ascent rate: 44.3 m/min
Survey time: 5.7 hours
Deck-to-deck time 8.2 hours
Mean survey depth: 2263m
Mean survey height: 5m
Distance travelled: 6.11km
Total vertical during survey: 509m
Battery energy at launch: 16.9 kwhr
Battery energy at survey end: 13.7 kwhr
Battery energy on deck: 13.4 kwhr

Sentry026 was planned as a photo and 5m height multibeam survey at the MC657 shipwreck site. Coordinates were provided to us by C&C Technologies, these proved very accurate. The camera problem was solved, and images from the entire run were logged. We disabled Sentry's weight-release motors, relying instead on the backup burn-wire releases and the positive buoyancy of the vehicle for redundancy. This solution worked well and the vehicle ran for the full planned mission. This was our deepest dive of the cruise at 2200 meters.

We deployed and surveyed a 2-element long baseline (LBL) transponder net. The tracklines were run using DR navigation only, but were reprocessed after the dive using LBL returns. As the vehicle approached the site from the southwest, we commanded several 50 position corrections using Sentry's acoustic signalling system to account for drift during descent. No corrections were made during the 200m grid survey.

The tracklines covered a 200mx200m block with 5 meter line spacing. We chose the start point for the dive approximately 500 meters from the wreck site to be certain that the vehicle's descent weight would not be dropped near the wreck. Sentry did not contact the wreck or create any disturbance. Ascent weights were dropped over 100m from the site.

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11.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry026_23-Jul-2009.scc
2. GMT grid file: 2009lophelia2-2/multibeam/mc657_sentry026_20090714.grd
3. multibeam ascii point file: 2009lophelia2-2/multibeam/mc657_sentry026_20090714.tllz.zip
4. PPF files: 2009lophelia2-2/ppf/sentry026_14-Jul-2009.ppf
5. plots from this report: 2009lophelia2-2/plots

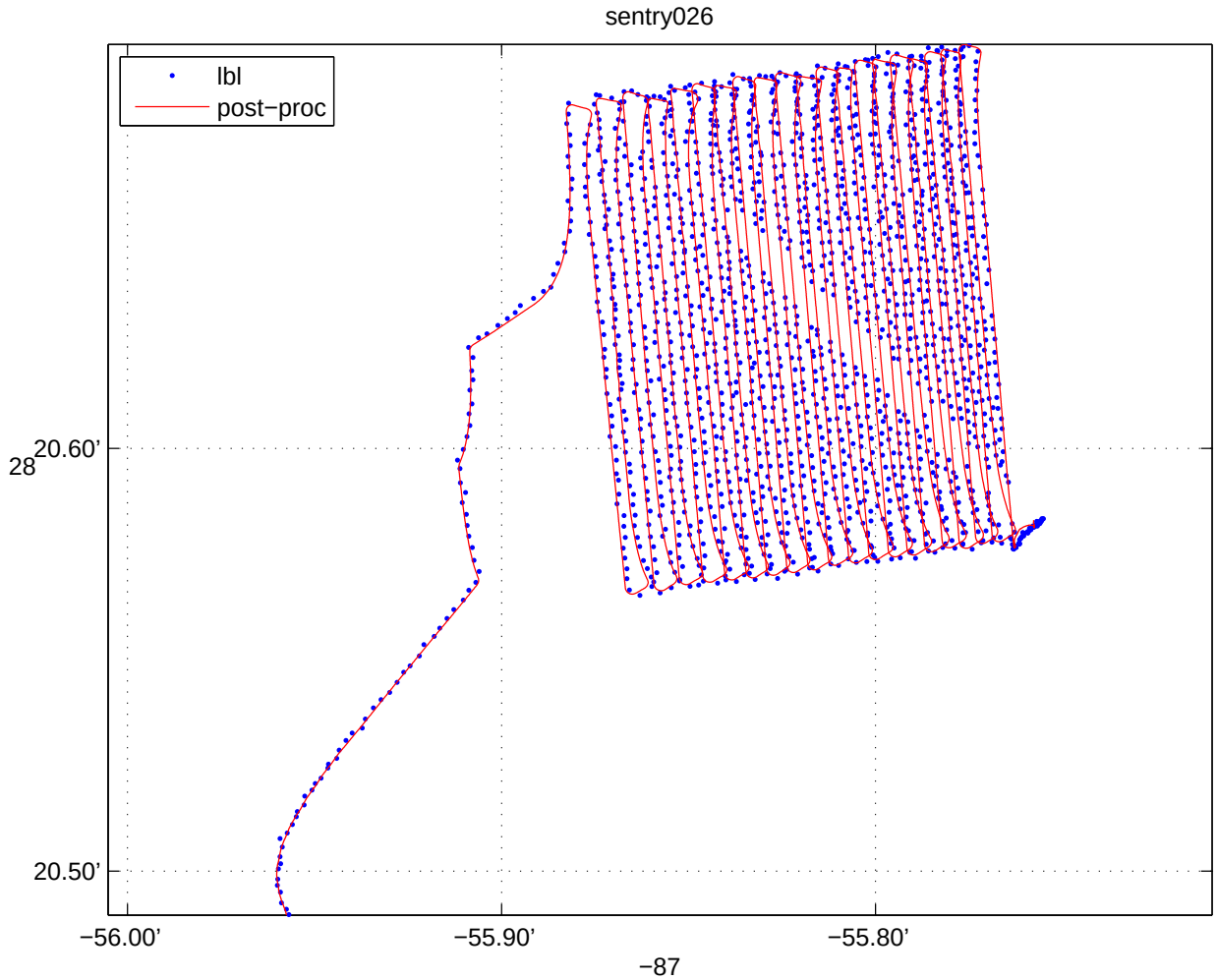

Figure 18: Post-processed dive track and LBL fixes for Sentry026. The lbl fixes were highly repeatable. The orientation of the grid reflects an error (declination?) in our calibrated magnetic compass. Fortunately this error applied nearly equally in both directions. The gap in the LBL fixes occur along a strip where the travel times would be exactly the same, which confuses the receiver.

6. photos: 2009lophelia2-2/photos/sentry026

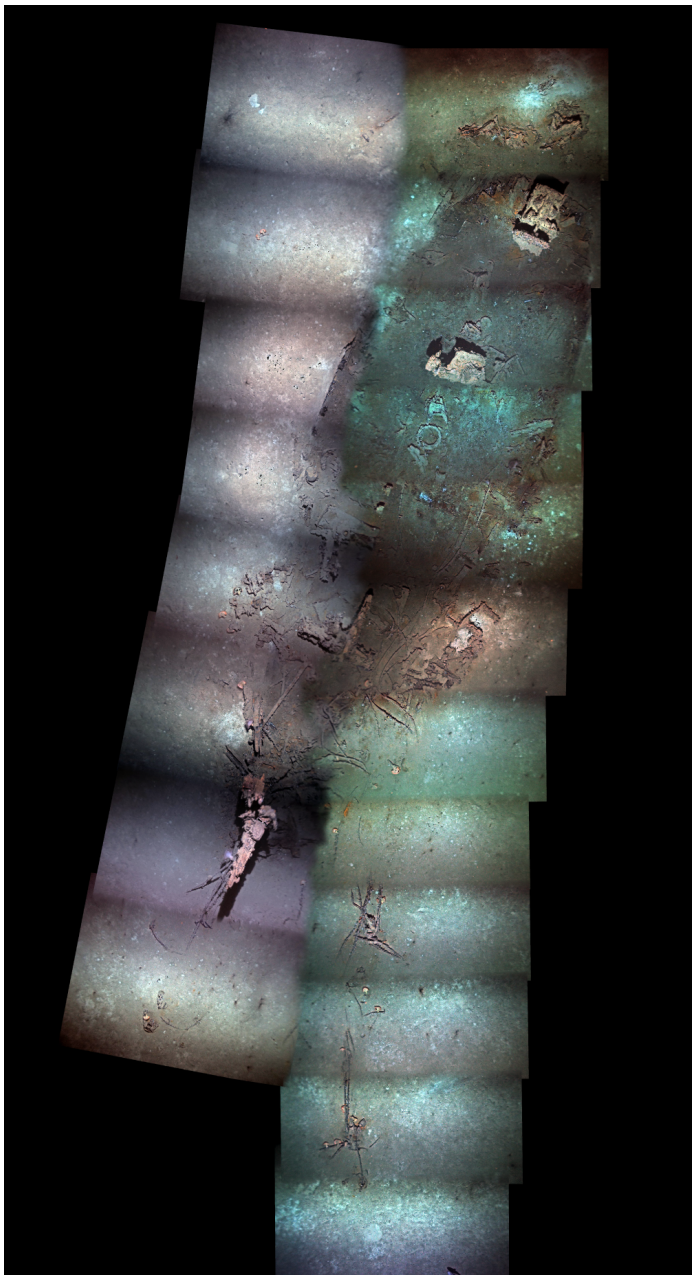

Figure 19: This image shows a photomosaic of the shipwreck assembled by Dr. Ian MacDonald and other members of the science party. The combination of 5 meter line spacing, excellent trackline following, and the field of view of the camera provided overlapping coverage

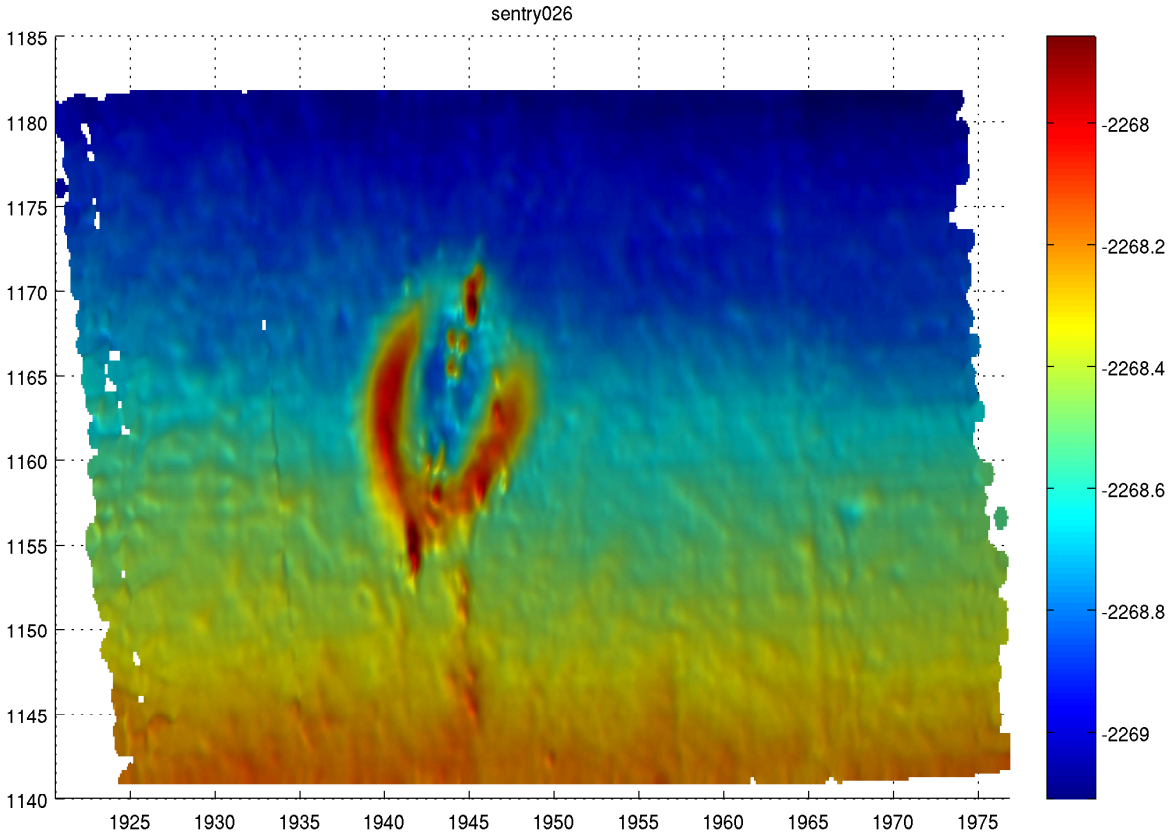

Figure 20: Gridded bathymetry for Sentry026. The data was gridded at 0.1m in the EW direction and 0.3m in the NS direction to reflect the sounding density in those respective directions. We used MB-system to produce the point cloud, but gridded the data in Matlab, which provided more flexibility. The plot above uses simple mercator (Alvin xy) coordinates with an origin at 28 20.0000 -87 -57.0000

12 Sentry027

12.1 Sentry027 Summary

Launch: 2009/06/29 16:07:02
Survey start: 2009/06/29 16:59:17
Survey end: 2009/06/29 23:44:31
Ascent begins: 2009/06/29 23:44:31
On the surface: 2009/06/30 00:20:27
On deck: 2009/06/30 00:29:13
Descent rate: 27.7 m/min
Ascent rate: 38.1 m/min
Survey time: 6.8 hours
Deck-to-deck time 8.4 hours
Mean survey depth: 1383m
Mean survey height: 5m
Distance travelled: 9.29km
Total vertical during survey: 958m
Battery energy at launch: 17.1 kwhr
Battery energy at survey end: 13.1 kwhr
Battery energy on deck: 12.9 kwhr

Sentry027 was planned as a photo and multibeam survey at the MC339 site. The camera ran well and our modified weight dropper caused no problems. The vehicle took 4900 photos. We terminated the dive at the end of the photo transects out of consideration for the schedule.

12.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry027_23-Jul-2009.scc
2. GMT grid file: none
3. multibeam ascii point file: none
4. PPF files: 2009lophelia2-2/ppf/sentry027_14-Jul-2009.ppf
5. plots from this report: 2009lophelia2-2/plots
6. photos: 2009lophelia2-2/photos/sentry027

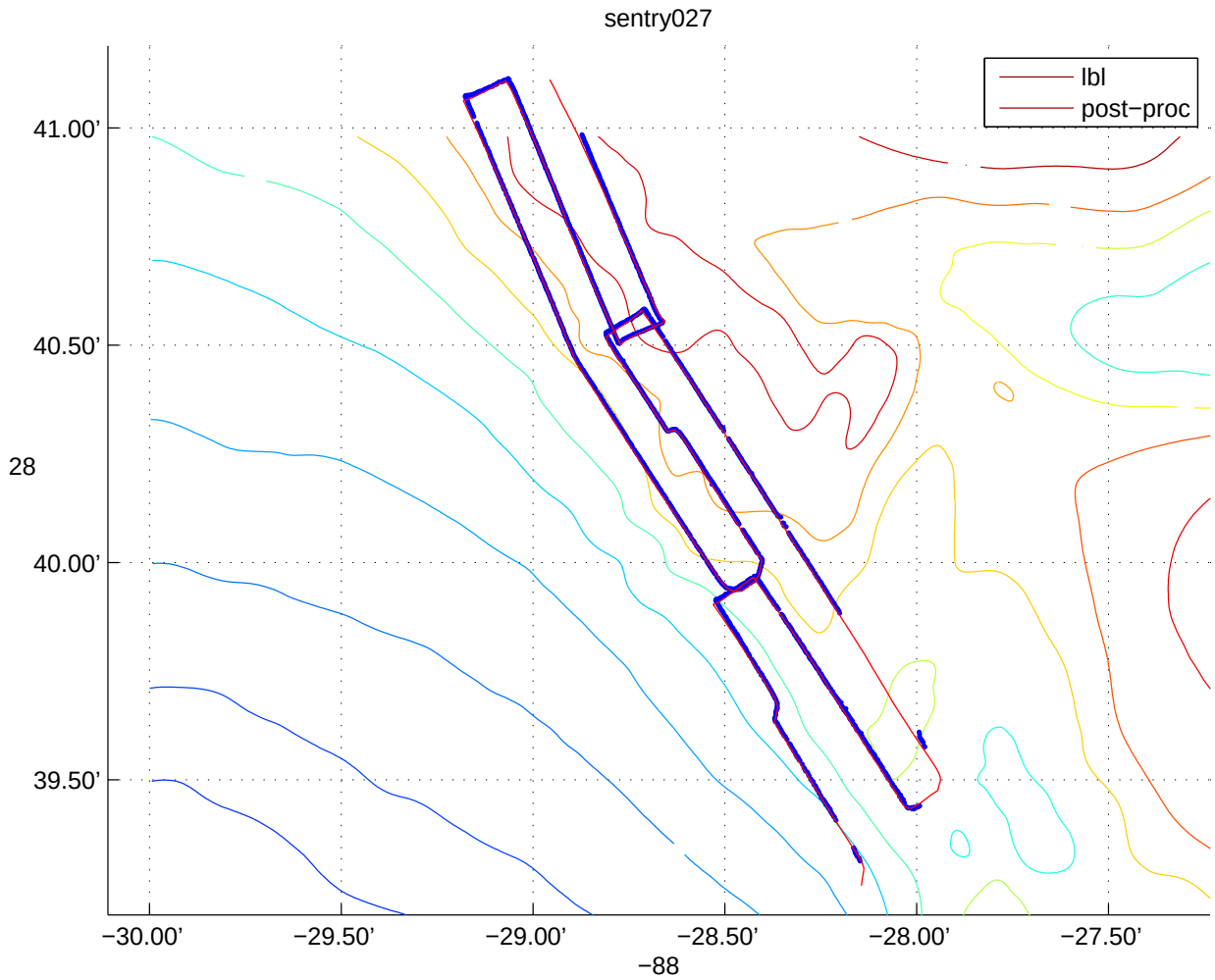

Figure 21: This plot shows the LBL fixes and the post-processed dive track for Sentry027.

13 Sentry028

13.1 Sentry028 Summary

Launch: 2009/06/30 11:08:18
Survey start: 2009/06/30 11:25:55
Survey end: 2009/07/01 00:58:56
Ascent begins: 2009/07/01 01:00:02
On the surface: 2009/07/01 01:14:58
On deck: 2009/07/01 01:25:23
Descent rate: 30.7 m/min
Ascent rate: 29.3 m/min
Survey time: 13.6 hours
Deck-to-deck time 14.3 hours
Mean survey depth: 455m
Mean survey height: 40m
Distance travelled: 29.67km
Total vertical during survey: 2921m
Battery energy at launch: 14.4 kwhr
Battery energy at survey end: 6.6 kwhr
Battery energy on deck: 6.5 kwhr

Sentry028 was planned as a photo and multibeam survey at the VK826 site. The camera ran well and our modified weight dropper caused no problems. The vehicle mapped a 2kmx2km block with the multibeam, then ran camera lines on the steep face. The dive ran until the pre-programmed deadline time.

13.2 Data files

1. SCC file: 2009lophelia2-2/scc/sentry028_23-Jul-2009.scc
2. GMT grid file: 2009lophelia2-2/multibeam/vk826_sentry028_20090720.grd
3. multibeam ascii point file: 2009lophelia2-2/multibeam/vk826_sentry028_20090720.tllz.zip
4. PPF files: 2009lophelia2-2/ppf/sentry028_09-Jul-2009.ppf
5. plots from this report: 2009lophelia2-2/plots
6. photos: 2009lophelia2-2/photos/sentry028

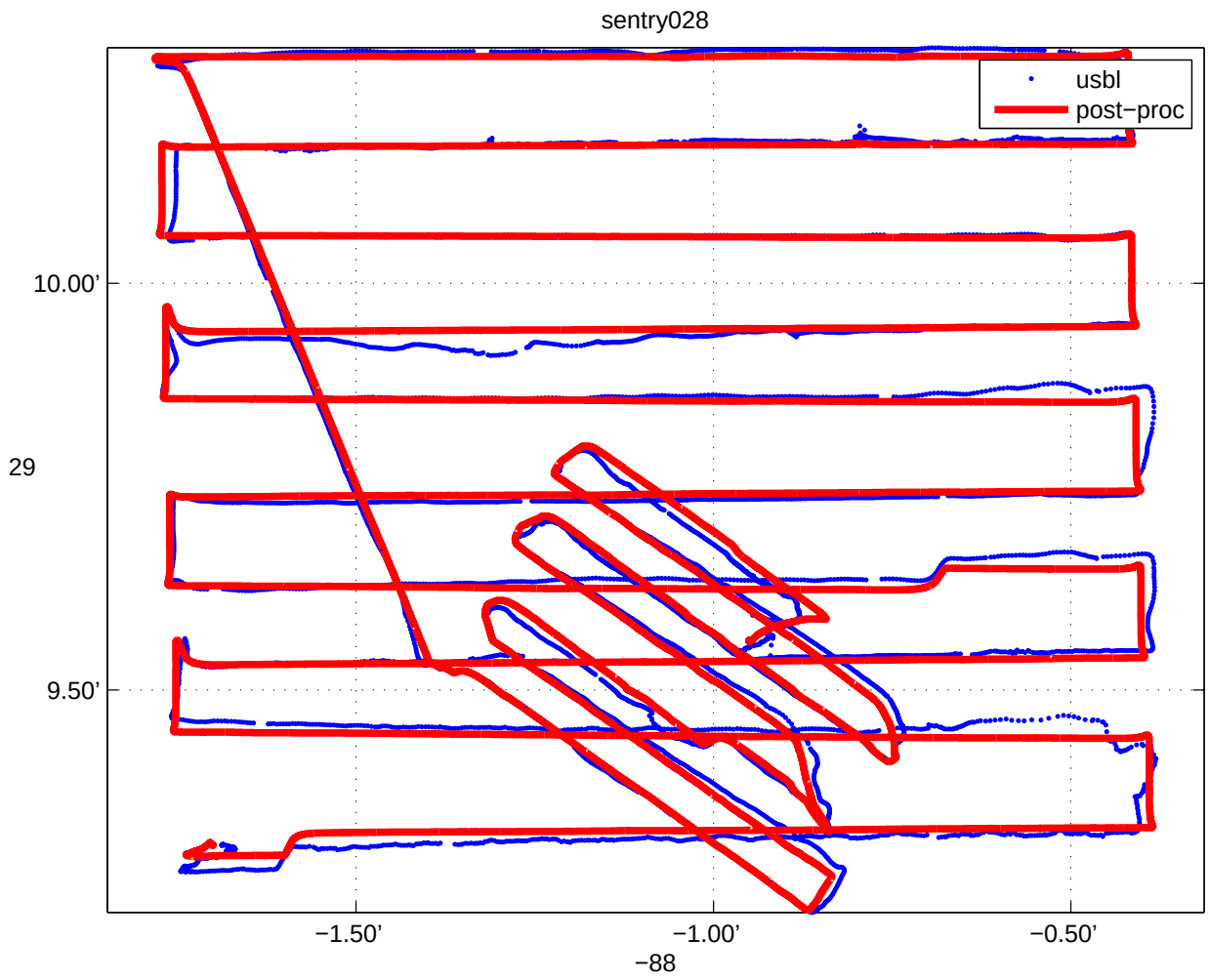

Figure 22: This plot shows the USBL fixes and the post-processed dive track for Sentry028. The USBL performance at this operating depth ($\tilde{6}$00m) was nearly comparable to the excellent performance obtained on the earlier shallow dives.

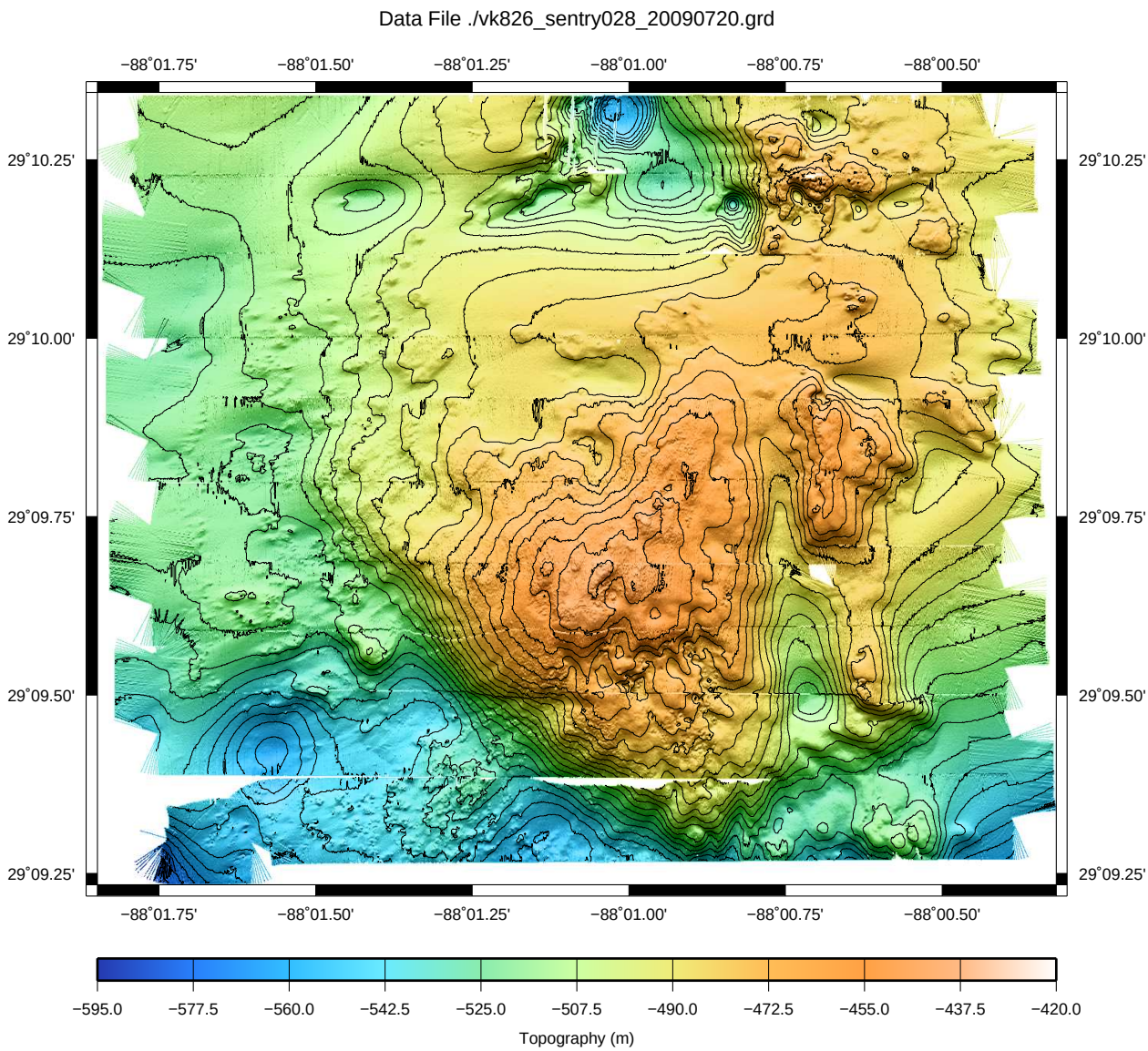

Figure 23: Gridded bathymetry for Sentry028

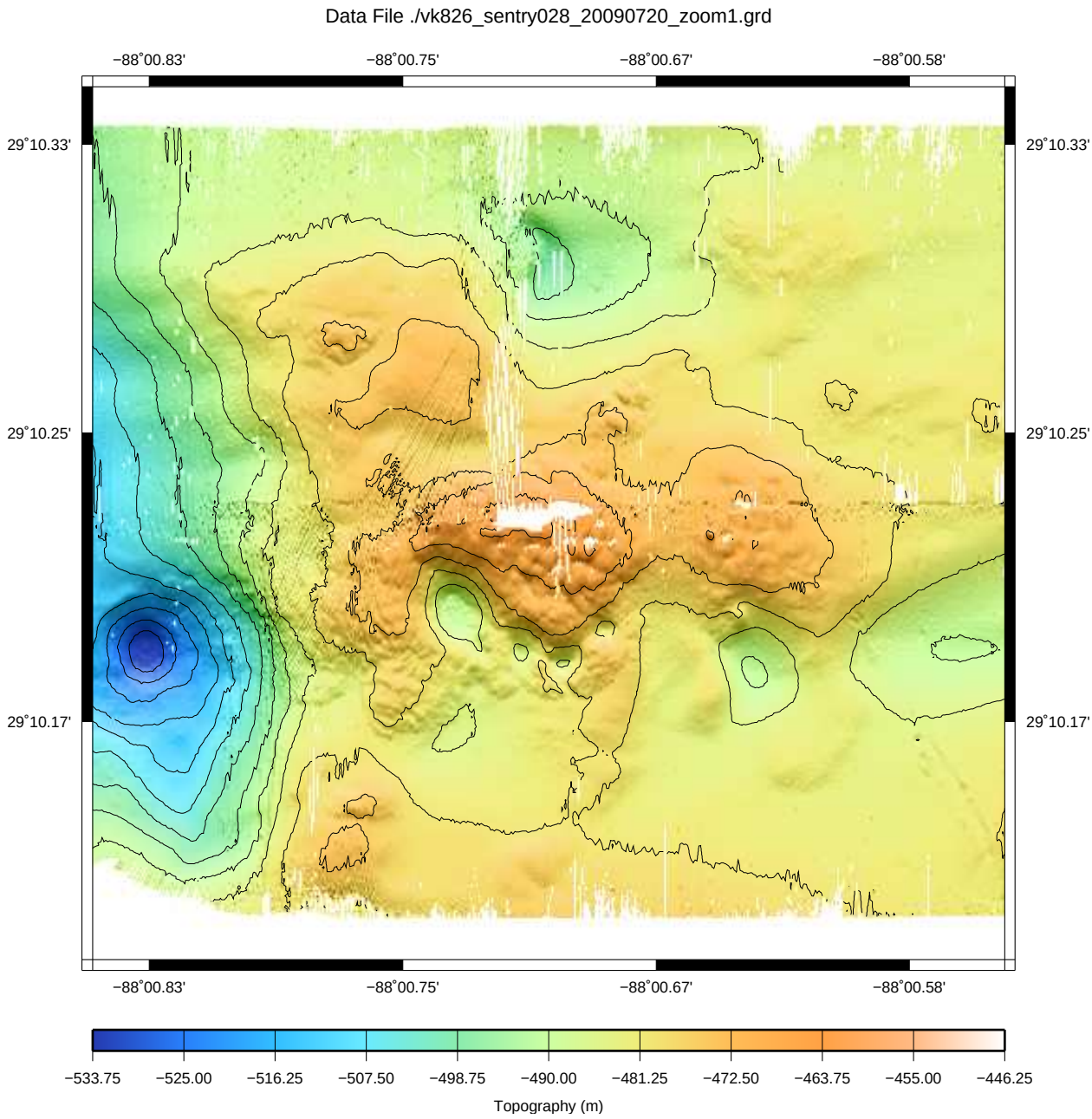

Figure 24: Gridded bathymetry for Sentry028, feature to the north

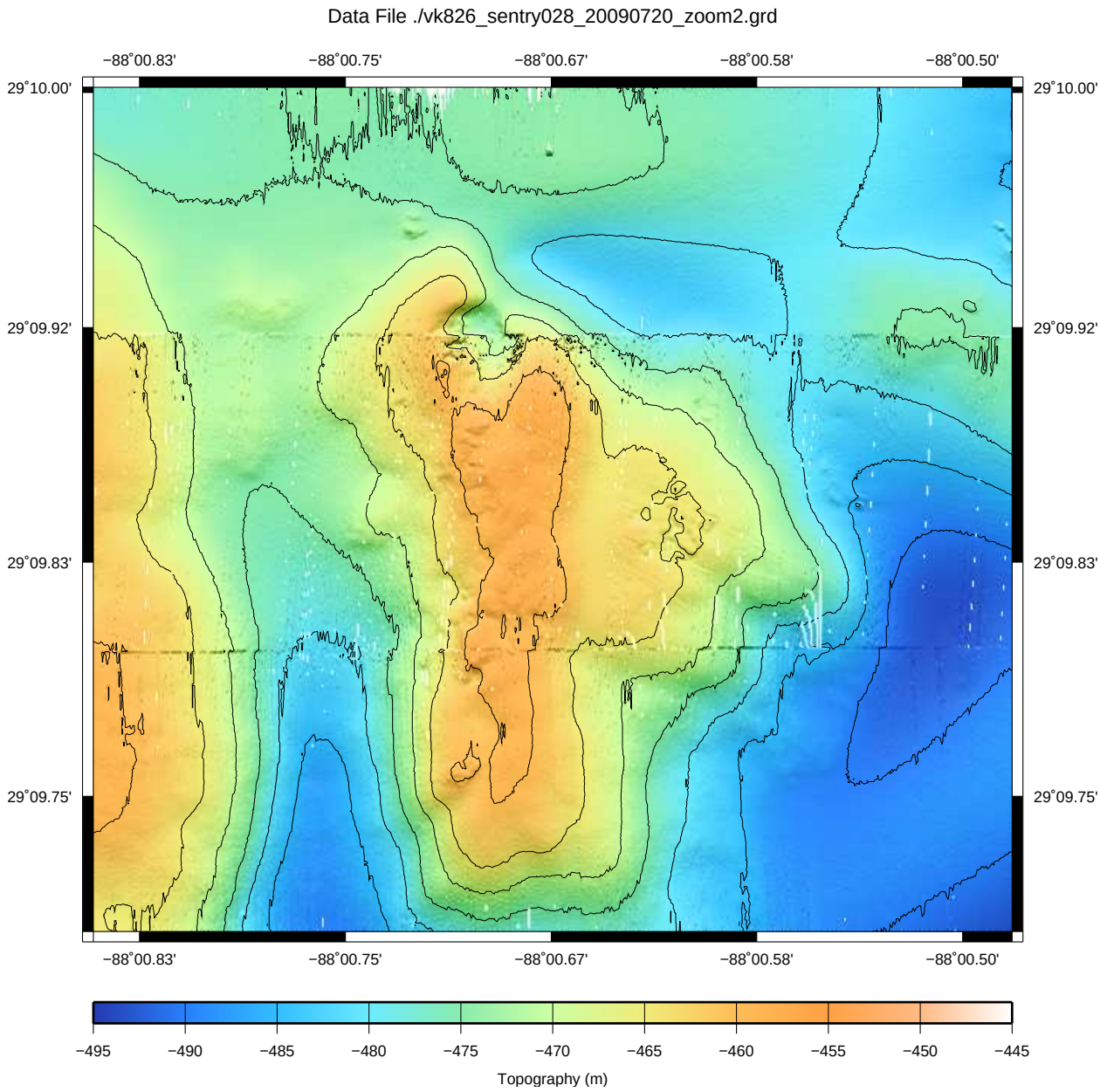

Figure 25: Gridded bathymetry for Sentry028, feature to the east

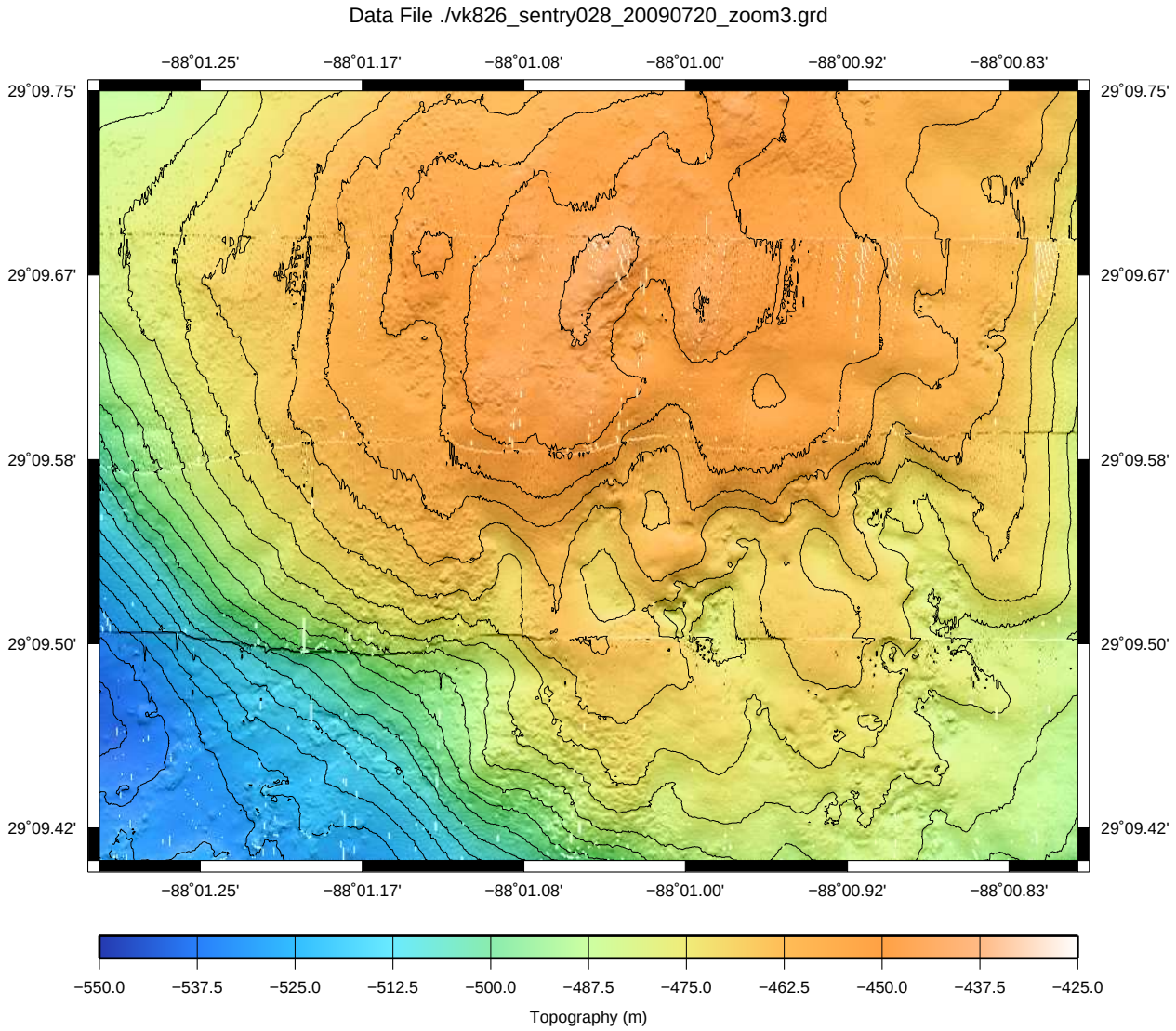

Figure 26: Gridded bathymetry for Sentry028, feature to the south

14 Appendix: Sentry system problems

1. We used a new camera system that had been tested at the Woods Hole but not in the field. We had hoped to have MacDonald's drift camera available as a backup, but the drift camera could not be used due to the failure of the winch on the Brooks McCall. Our new camera system suffered some electrical and computer system problems. A noise problem on the strobe sync line was solved fairly early in the cruise. An operating system problem, which caused the camera application to quit within a hour of launch, was more difficult to find. We had run the camera application for more than a day in the lab with no difficulties, the problem arose when running the application disconnected from the topside network.

   The camera ran for the entire scheduled portion of the last 3 dives.

   We also had a problem with poor focus at the edge of the images. The manufacturer of the housing and dome are addressing this issue currently.

2. A descent weight could drop from the vehicle at any time, ending the dive. In hindsight, this problem may have occurred once in Sentry's previous 16 dives, although at the time we had attributed the event to mechanical issues. Sentry's weight droppers are actuated by electric motors with burn-wire backups, but the burn-wires were not suspect as we often recovered the vehicle with the burn-wires intact. We were unable to solve this problem during the cruise and we were initially reluctant to disable the motor releases, which were clearly at fault, for fear of eliminating one of our redundant mechanisms for returning the vehicle to the surface. For the last 3 dives, we ran with the motor releases disabled, relying on the burn wires and positive vehicle buoyancy to ensure that the vehicle would return to the surface at the end of the dive.

   Since our return to Woods Hole, we believe the cause of this problem has been revealed. The weights never released inappropriately during extended pre or post-cruise tests in the lab and off the WHOI dock. But when we ran the electronic units that control the release motors at cold temperatures (0C), we observed that the motors could turn without any command with a frequency of once or twice per day. This was tracked to a temperature-induced timing problem in the digital electronics driving the motors, most likely an integrated circuit not meeting specifications. The offending section has been repaired and tests are ongoing.

3. Our Ixsea PHINs inertial navigation system failed as we were preparing to launch Sentry021. While diagnostics were lacking, the problem appeared to be a hard failure in one of the units fiber-optic gyros. The PHINES is not field repairable and we carried no spare. The unit costs approximately $150K and is advertised to be highly reliable. We compensated as best as we could using our magnetic compass and associated tilt sensors (TCM2). Fortunately, we had the last run (sentry020) with the working INS and the TCM2 running side-by-side, so were able to build a calibration table for the TCM2 (see the discussion in the section on Sentry021). The resulting multibeam maps are usable for our purposes, if not as clean as they would be with the INS.

15 Coordinate origins

The vehicle's control system uses simple mercator coordinates. This system uses an origin, defined in terms of latitude and longitude (WGS84), and a fixed scaling between meters displacement from the origin. We use the identical routines that have been used by the NDSF assets Alvin and Jason for decades. These simple coordinates have several advantages for realtime control of a vehicle. Unlike UTM grid coordinates, the x and y axes intersect at right angles and align with true east and north respectively at the origin. These coordinates distort quickly as one moves away from the origin, but we solve that problem by putting the origin close to the operating area. We almost always report our results in latitude/longitude, so most users need not be aware of these details

Flowergarden site: 27 49.000'N 093 53.000'W
GB837 site: 27 5.000'N 093 57.000'W
GB535 site: 27 24.000'N 093 40.000'W
GC600 site: 27 21.000'N 090 36.000'W
GC246 site: 27 41.210'N 090 40.015'W
MC885 site: 28 0.000'N 089 46.000'W
MC657 site: 28 20.000'N 087 57.000'W
MC339 site: 28 37.000'N 088 30.000'W
VK826 site: 29 8.000'N 088 4.000'W