CRUISE REPORT

USNS *Sumner* (T-AGS 61*)*

U.S. Extended Continental Shelf Cruise to Map Sections of the Mariana Trench and the Eastern and Southern Insular Margins of Guam and the Northern Mariana Islands

CCOM-JHC CRUISE SU10-02

Leg 2: September 24 to October 21, 2010

Apra Harbor, Guam to Apra Harbor, Guam

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UNH-CCOM/JHC Technical Report 11-002

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Introduction

This report describes the second of two 2010 cruises, which are the third and fourth in a series of 30-day extended continental shelf-related bathymetry cruises to the insular margin of Guam and the Commonwealth of the Northern Mariana Islands. Cruises in 2006 (Gardner, 2006) and 2007 (Gardner, 2007) focused on the West Mariana Ridge whereas the 2010 cruises concentrated on sections of the Mariana Trench (Leg 1) (Gardner, 2010) and the southern margin of the island arc (Leg 2).

An exhaustive study of the U.S. data holdings pertinent to the formulation of U.S. potential definition of an extended continental shelf under the United Nations Convention of the Law of the Sea (UNCLOS) identified these areas as regions where new bathymetric surveys are needed (Mayer, et al., 2002). That report recommended that multibeam echo sounder (MBES) data are needed to rigorously define (1) the foot of the slope (FoS), a parameter of the two UNCLOS-stipulated formula lines, and (2) the 2500-m isobath, a parameter of one of the UNCLOS-stipulated cutoff lines. Both of these parameters, the first a precise geodetically located isobath and second a geomorphic zone, are used to define an extended continental shelf. In addition, further consideration by the U. S. ECS Task Force suggested that seamounts accreted to the inner wall of the Mariana Trench might be used as criteria for a natural prolongation of an extended shelf. The Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) at the University of New Hampshire was funded by the National Oceanic and Atmospheric Administration (NOAA) to conduct the new surveys and archive the resultant data.

NOAA entered into an agreement with the U.S. Naval Oceanographic Office (NAVOCEANO) to conduct the bathymetry cruises in 2010. NAVOCEANO made available the 329-ft, 5000-ton hydrographic ship USNS *Sumner* (T-AGS-61) (Fig. 2) with a hull-mounted Kongsberg Maritime EM122 MBES and a Kongsberg Maritime SBP120 chirp sub-bottom profiler. The schedule for the cruise called for two 30-day legs each beginning and ending in Apra Harbor, Guam, Guam and the Commonwealth of the Northern Marianas.

NAVOCEANO was responsible for system calibration, data collection and quality control, and overall cruise management whereas the UNH/NOAA representative was responsible for cruise planning before and during the cruises, bathymetry and acoustic-backscatter processing aboard ship and during post-processing ashore. NAVOCEANO personnel also processed the bathymetry aboard for their internal use and assisted the UNH/NOAA Chief Scientist with data management and on-board analysis.

The cruise began with an 8-hr transit to the east from Apra Harbor, Guam to a location on the western edge of the survey area, just west of the Mariana Trench. A CTD cast with simultaneous XBT casts was performed at this site to compare CTD and XBT profiles for sound speed corrections. As no significant system changes had occurred since Leg 1, the patch test results from Leg 1 were considered valid and employed during this subsequent survey.

The cruise mapped a total of 156,023 km^2 in 27 mapping days and collected 15,927 line km of MBES with an average speed of approximately 13.3 kn. Junctioning with Leg 1 data on the east, Leg 2 completed the full mapping of the Mariana Trench to the west and a large area of the southern and southwestern insular margin of Guam and the

Mariana Islands. A summary of the cruise is given in Table 1 and a sketch of the area completed is provided in Figure 1.

Table 1. Cruise Statistics

Leg 2

Julian dates	JD 267 to JD 294
Dates	September 24 to October 22, 2010
Weather delay	0 days
Total non-mapping days (transits)	1 day
Total mapping days	27 days
Total area mapped	156,023 km^2 (45,247 mi^2)
Total line kilometers	15,952 km (8640 nmi)
Average ship speed for survey	~13.3 kn

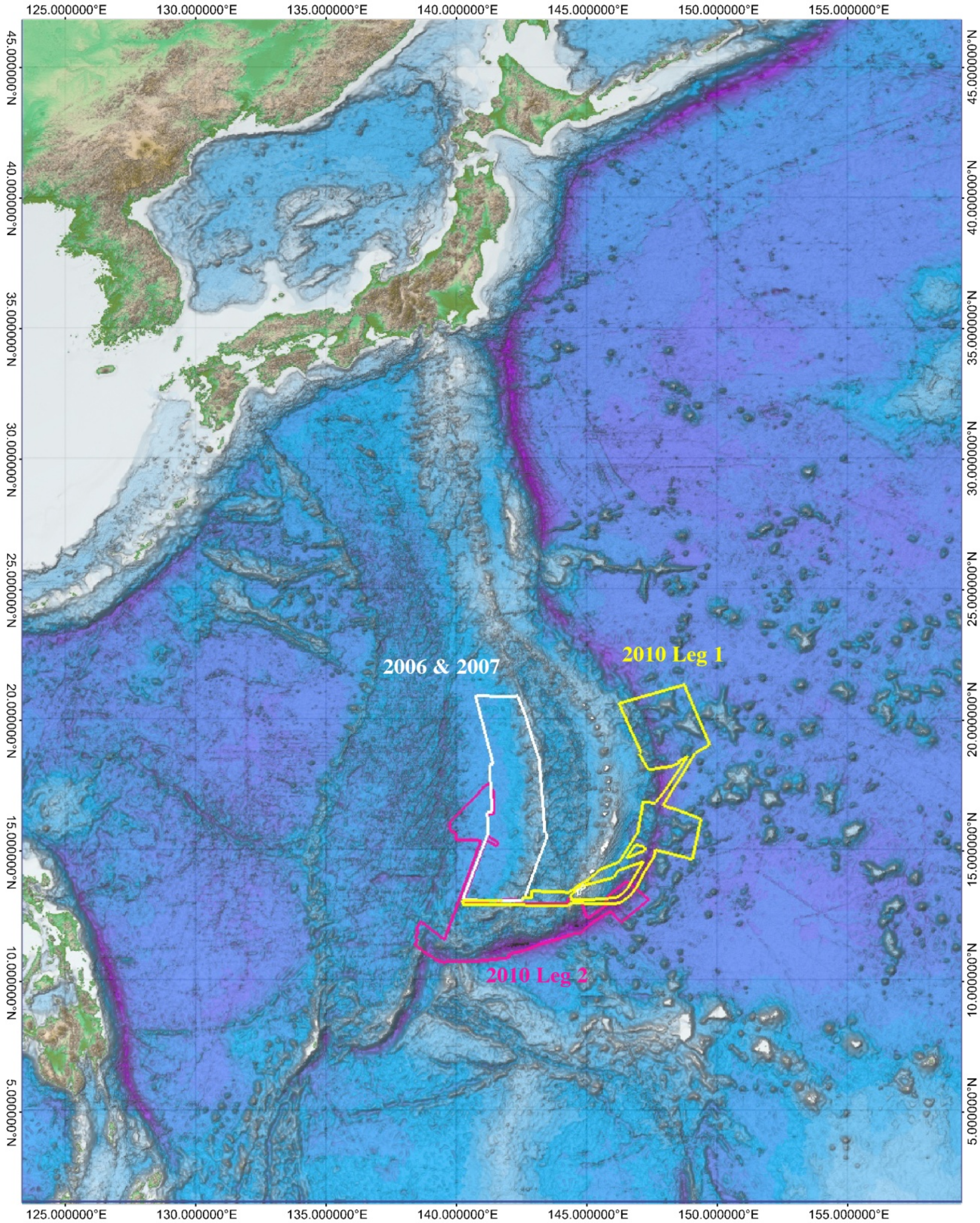


Figure 1. Overview map showing the three areas mapped in 2010 Leg 1 (yellow polygons) and the three areas mapped in 2010 Leg 2 (violet polygons). White polygon outlines the combined area mapped in 2006 and 2007.

Figure 2. *USNS Sumner* (T-AGS 61) used for the mapping.

The Multibeam Echosounder System and Associated Systems

The hull-mounted Kongsberg Maritime EM122 MBES system aboard USNS *Sumner* is a 12-kHz multibeam echo sounder that transmits a 1˚-wide (fore-aft) acoustic pulse and then generates 432 1˚ receive apertures ("beams") over a swath as large as 150˚ perpendicular to the ship's heading. The system can automatically adjust the pointing angles of the receive beams to maximize the achievable coverage or a maximum aperture can be defined by the operator. The transmit cycle can be rapidly duplicated to provide two swaths per ping, each transmitted with a small along-track offset that compensates for water depths and ship speed and that can generate a constant sounding spacing in the along-track direction. This mode can provide as many as 864 soundings per transmit cycle swath (432 soundings per swath) in the high-density dual-swath mode. With more than one sounding generated per beam in the high-density mode, the horizontal resolution is increased and is almost constant over the entire swath when run in the equidistant mode. In addition, the receive beams can be steered as much as 10° forward or aft to reduce the effects of specular reflection and/or sediment penetration of the acoustic pulse at nadir and near-nadir angles.

The EM122 uses both continuous wave (CW) and frequency modulation (FM) pulses with pulse compression on reception to increase the signal-to-noise ratio. The transmit pulse is split into several independently steered sectors to compensate for vessel yaw. The system is pitch, yaw and roll stabilized, with beam steering up to ±10˚ from vertical and roll compensation up to ±10˚, to compensate for vessel motion during transmission. Kongsberg Maritime states that, at a 10-ms pulse length used during most of these surveys (deep mode), the system is capable of depth accuracies of 0.3 to 0.5% of water depth. The Kongsberg Maritime EM122 Product Description should be consulted for the full details of the MBES system.

For the EM122, the installed software versions used on the Seafloor Information System (SIS) and the transmit-receive unit (TRU) systems are given in Table 2.

Table 2. Kongsberg Maritime EM 122 software version numbers.

System	Software Version
Seafloor Information System	3.6.4, build 174
TRU CPU	1.1.1
DDS DDS software version	3.4.9
BSV BSP software version	2.2.3
Transmit software version (RSV)	1.1.1
Transmit software vesion (TSV)	1.1.1
Datagram format version (DSV)	3.1.1

On JD 289 the ship's Kongsberg EM710 multibeam echo sounder, serial no. 105, was turned on and collected data in depths less than about 700 m. The EM710 is a high resolution, frequency-modulated echo sounder operating at frequencies from 70 to 100 kHz, with beam focusing and roll, pitch and yaw stabilization. The system on *Sumner* is configured for a 0.5° transmit and 1.0° receive beamwidth, and was operated in the high density equidistant mode. Refer to the Kongsberg system manual for more detailed information.

The Kongsberg Maritime EM122 and EM710 are capable of simultaneously collecting full time-series acoustic backscatter that is co-registered with each bathymetric sounding. The full time-series backscatter is a time series of acoustic-backscatter values across each beam footprint on the seafloor. If the received amplitudes are properly calibrated to the outgoing signal strength, receiver gains, spherical spreading, and attenuation, then the corrected backscatter should provide clues as to the composition of the surficial seafloor. However, the interpreter must be cautious because the 12-kHz acoustic signal undoubtedly penetrates the seafloor to an unknown, but significant (meters) depth, thereby generating a received signal that is a function of some unknown combination of acoustic impedance, seafloor roughness and volume reverberation.

A hull-mounted Applied Microsystems Ltd Smart SV&T (SSVT) sound-speed sensor (serial no. 4692), last calibrated on May 21, 2009, was used to measure the sound speed at the MBES transducer array for accurate beam forming. Beam forming during this cruise used the high-density equidistant mode with FM enabled and Automatic mode in deep water. For receive beams at near-normal incidence, the depth values are determined by center-of-gravity amplitude detection, but for most of the beams, the depth is determined by split-beam phase detection. The EM122 spacing of individual sounding is approximately every 50 m, regardless of survey speed. EM710 soundings, being generated at a greater pulse repetition rate in shallower depths, are significantly denser.

During data acquisition, survey operations were partially controlled by the NAVOCEANO ISS-60 data acquisition software system. This system provided line control, logged GSF data for NAVOCEANO purposes, and was the primary operator interface for the watch standers, but did not directly control the EM122. The Kongsberg SIS software was running simultaneously and controlled the sonar operation and internal logging of the "*.all" data files. Watch standers monitored SIS settings as well as ISS-60 settings during the survey.

An Applanix POS/MV model 320 version 4 (serial no. 2571) inertial motion unit (IMU) (without TrueHeave) was interfaced to two Force 5 (version 0507) global positioning (GPS) receivers and a Starfire Navcom model SF-2050R (serial no. 5098) differential global positioning (DGPS) receiver to provide position fixes with an estimated accuracy of ~±0.5 m. The IMU provides roll, pitch and yaw at accuracies of better than 0.1˚ at 1 Hz. The lack of the TrueHeave component with the installed POS/MV requires a 15-minute run-in for each line to completely eliminate residual heave at the start of each line. Whenever practicable, a 15-minute run-in was employed. The impact of shorter run-ins on depth accuracy was negligible in this survey, as the amount of residual heave is very small. All horizontal positions were georeferenced to the WGS84 ellipsoid and vertical referencing was to instantaneous sea level.

After the initial CTD cast, Sippican T-7 Deep Blue expendable bathythermographs (XBTs) were used to measure sound speed in the water column. Deep Blue XBTs have a 760-m maximum depth of measurement so the profiles were extrapolated to 12,000 m to provide a profile throughout the water column. The extrapolation software used by NAVOCEANO appeared to introduce an artifact into the extended profile, altering the sound speed gradient slightly at about 7500 meters of depth. This appears to have had negligible effect on survey results. Water column sound-speed profiles were routinely collected every 6 hrs during the cruise as well as anytime the sound speed measured at the transducers differed for a protracted period by more than 0.5 m/s from the value at the transducer depth from the XBT-derived sound speed. In many instances, however the XBT-derived transducer-depth speed and the SSVT-measured sound differed by about 0.5 m/s immediately after the XBT cast. In these cases, the XBT cast was used without significant impact. Sound-speed profiles were calculated from measurements of water temperature vs. depth and salinity value from the Navy's GDEM salinity database or the measured salinity from the CTD cast collected at the start of the survey. A Sea Bird Electronics model SBE-911+ CTD serial no. 0581 was used in this inter-comparison to adjust the XBTs for salinity. The two temperature sensors (serial no. 2667 and 2588) were last calibrated on March 30, 2009, the two conductivity sensors (serial no. 2347 and 2560) were last calibrated on April 22, 2009 and the pressure sensor (serial no. 77997) was last calibrated August 21, 2009.

A BIST test (refer to Appendix 3, BIST Test 1, from Leg 1 Cruise Report, Gardner, 2010) was run on August 7 at the beginning of Leg 1 while transiting at 7.5 knots along the west side of Guam in unknown water depths. The test shows the noise on all receivers is less than 50 dB. A full patch test was conducted on Leg 1 on Monday August 9, 2010 to ensure sensor offsets were correct. As no significant changes in the EM122 configuration had occurred during the short period between Leg 1 and leg 2, the Leg 1 BIST test and the Leg 1 Patch test were considered satisfactory for Leg 2.

Portions of the August 9 and 19, 2010 daily log from The Chief Scientist Cruise Report for Leg 1 (Gardner, 2010) relative to the patch test are quoted here:

> "The pitch and timing sections of the patch test (Lines patch13 and patch14) was begun at 0700 L and were completed at 1900 L. The results showed that both pitch and timing required no static offsets.
>
> "At 2050 L during the first of the roll-test lines, the SIS crashed and the line had to be rerun.
>
> "The day was fair with ~4 ft swells and light winds. The roll patch test (Lines patch15 and patch16) was completed during the night and no static offset was required. The heading patch test (Lines patch17 and patch19) were completed at 1245 L and no static offset was required."

Tables 3 and 4 show the sensor offsets used for the survey.

Table 3. Initial system sensor offsets

	Location Offsets			Angular Offsets		
Sensor	**Forward**	**Stbd**	**Down**	**Roll**	**Pitch**	**Heading**
POS 1	0.00	0.00	0.00	–	–	–
POS 2	0.00	0.00	0.00	–	–	–
POS 3	0.00	0.00	0.00	–	–	–
Tx tdr	18.34	-0.58	4.08	0.390	0.950	359.850
Rx tdr	13.51	0.02	4.16	0.150	0.987	359.880
Attitude 1	0.00	0.00	0.00	0.020	0.130	0.000
Attitude 2	0.00	0.00	0.00	0.000	0.000	0.000

The departure depth to transducers was 6.7 m. The change in transducer depth during the leg was negligible for this survey.

Table 4. Offset corrections determined by Patch Test

Offset	Value
roll	0
pitch	0
yaw	0
latency	0

Subbottom Profiling System

In addition to the MBES, the ship is equipped with a Kongsberg Maritime SBP120 high-resolution subbottom profiler. Despite considerable effort, the survey team was unable to obtain satisfactory data from SBP120 and the system was not operated for most of the cruise. No SBP120 data were collected.

MBES Data Processing

NAVOCEANO assigned the survop designator *610610* to the cruise whereas UNH/NOAA designated the cruise ID as SU10-02. All raw MBES files were initially labeled with a unique Kongsberg file designator but the files were renamed to MarianaTrough_line_X, (or MarianaTrench…) where X is a consecutive line number starting with 1 (see Appendix 1). The renaming was done so that lines from this leg would be consistent with those of Leg 1 and so the individual lines would be unequivocally identified with the survey area in the future. Line numbers for Leg 2 commenced with the next number in the sequence from Leg 1 (i.e., MarianaTrough_line_168).

The raw MBES bathymetry and acoustic backscatter data were examined aboard ship for coverage and quality using the IVS3D Fledermaus software suite, version 7.1. Each EM122 .all file was collected by the onboard Kongsberg SIS data-acquisition system on a server and the file was copied to an external hard drive that was then disconnected from the server and connected to the UNH computer at the end of each line. The NAVOCEANO bathymetry lead independently cleaned and processed the MBES data for NAVOCEANO purposes daily aboard ship. The data archived at NGDC are the raw data and processed data from the UNH process.

A high resolution full-coverage multibeam echo sounder survey such as this one obtains redundant data at almost every point on the seafloor, and typically also includes erroneous depths that must be removed in a data-cleaning process. The still-dense data remaining after cleaning are typically gridded for visualization and scientific analysis. The data cleaning process is described below. A series of quality assurance cross-check techniques are applied to estimate the uncertainty of the processed data. The results of that analysis are presented in Appendix 4.

For Extended Continental Shelf project purposes, all files were post-processed ashore by James V. Gardner of UNH using the University of New Brunswick's OMG/SwathEd software suite, version 2010-07-30 rev. 97. His procedures, as described in the Leg 1 report (Gardner, 2010) are quoted here: "Each .all file is composed of individual data packets of bathymetry, acoustic backscatter, navigation, parameters, sound-speed profiles, orientation and sound speed at the transducer. The first step in the processing separates each of these data packets into the individual files. The second step in the processing plots the navigation file so that any bad fixes can be flagged. Once this step is completed, the good navigation is merged with the bathymetry and acoustic backscatter files.

"The third step involves editing (flagging) individual soundings that appear to be fliers, bad points, multipaths, etc. The entire file of soundings is viewed and edited in a sequence of steps through the file. Once the bathymetry file has been edited, the valid soundings are ready to be gridded into area DTM [digital terrain model] maps and the co-registered valid acoustic backscatter full beam time series is assembled into a file and gridded into area mosaics."

Mapping Coverage

The complete area mapped in Leg 2 is shown in Figure 3. This leg completed the mapping of the connecting seafloor between the Mariana Ridge and the West Mariana Ridge and completed the mapping of the Mariana Trench to the south and west of the sections mapped in Leg 1.

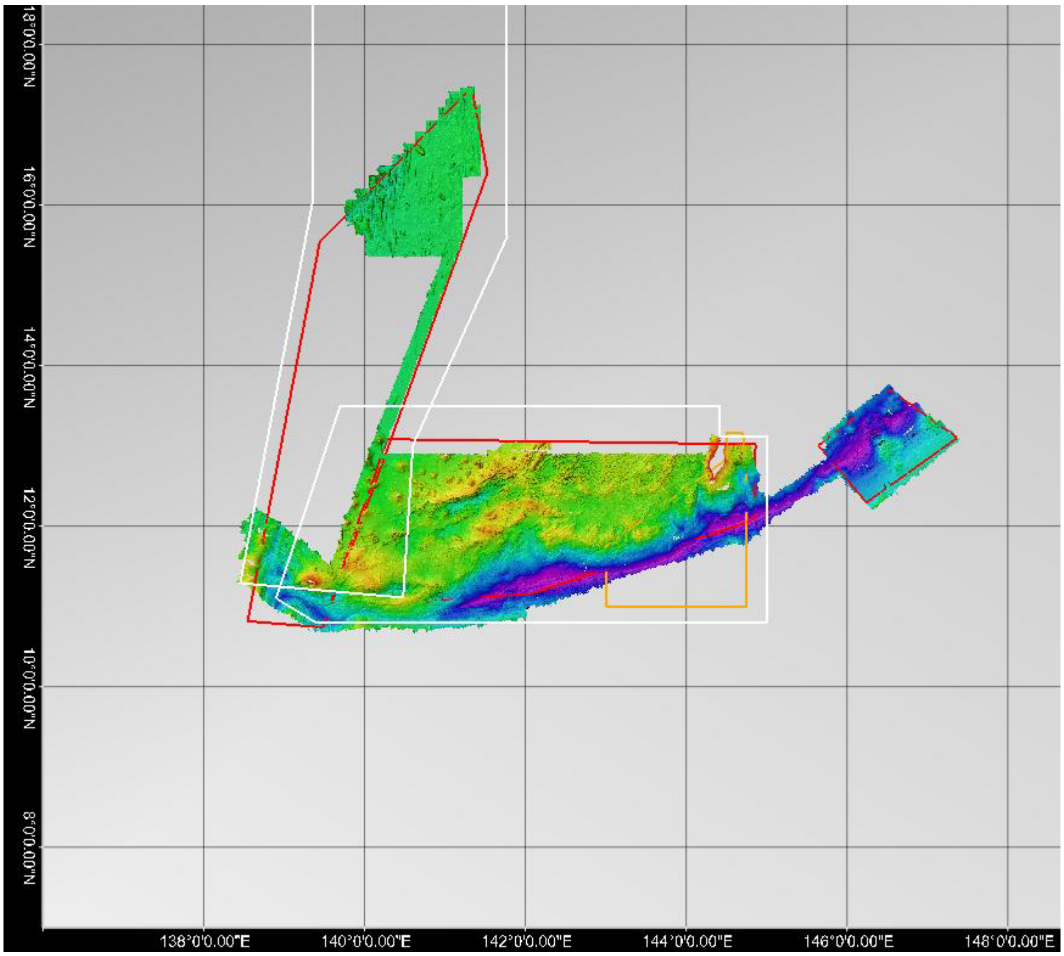


Figure 3. Plan view of Leg 2 coverage, showing NAVOCEANO OpAreas 3 (center white), 4 (left, white) and 5 (right, red) and NOAA-UNH project areas 1c (right, red), 2 (center, red) and 3 (left, red). The yellow-outlined area is a military gunnery exercise area.

The Areas Mapped

The Mariana Trench East of Guam

Gardner described the Mariana Trench east of Guam in the Leg 1 Report (Gardner 2010) and the mapping of accreted seamounts. One additional seamount accretion area to the east of Guam was added to the overall project plan based on Leg 1 bathymetry, and was mapped in the first part of this leg (Leg 2). The mapping shows that an irregularly shaped and slightly elevated bridge of accreted material crosses the trench in this area and connects to a fractured seamount on the southeastern side of the trench. This accretion area is less defined than the areas detailed in Leg 1 and rises a smaller amount from the floor of the trench. Mapping in this part of the leg continued along the southwesterly curving Mariana Trench to a point south of Guam.

The Mariana Trench South and West of Guam

South of Guam, the Mariana Trench continues its curve toward the west. The trench in this area also continues the boundary between the subducting Pacific Plate and the overriding Phillipine Plate and includes the Challenger Deep, the area containing the deepest seafloor of the world's oceans, with depths of nearly 11,000 meters. The deepest valid sounding (valid soundings are those measured depths remaining in the data set after erroneous soundings have been removed in the data cleaning process) obtained in this survey was 10,994 m at latitude 11.326344°N, longitude 142.187248° E. This measured depth has an estimated uncertainty of ±40 m. A gridded DTM, based on the mean depth of redundant soundings will, by definition, display a lesser depth in the same location. The gridded DTM depth for the deepest part of the Trench was 10,962 m. A secondary deep with a gridded depth of 10,951 m was located approximately 23.75 nautical miles to the east at latitude 11.369639° N, longitude 142.588582° E.

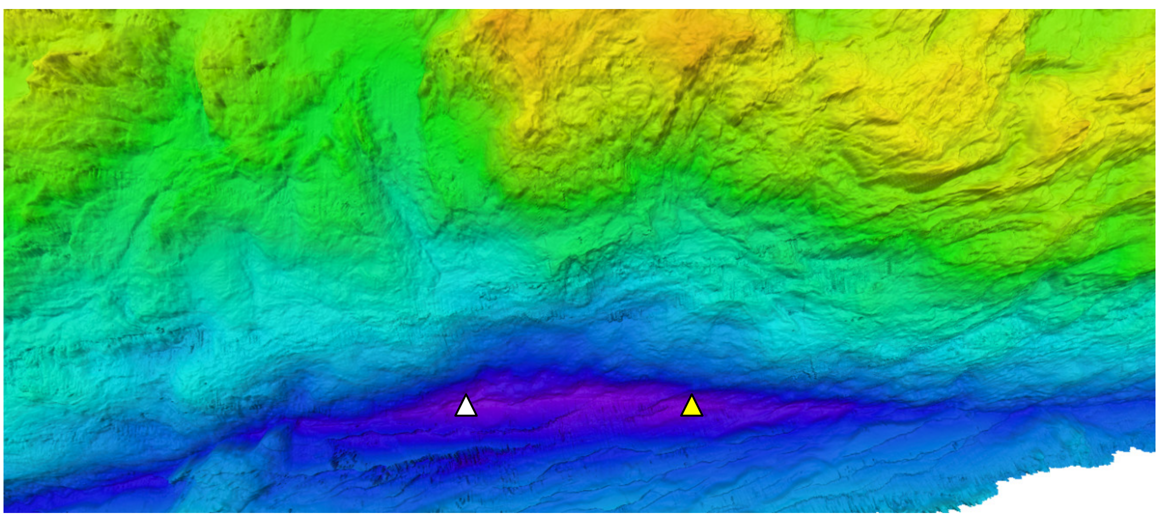


Figure 4. Deepest point in Challenger Deep (white triangle) and secondary deep (yellow triangle).

At the western end of the survey area, the east-west trending Marianas Trench intersects with the north-south trending Yap Trench. The Mariana Trench also constitutes the southern margin of the Mariana Trough.

The Southern Mariana Trough

The Mariana Trough is the region between the Mariana Ridge, upon which Guam and the Northern Mariana Islands rest, and the West Mariana Ridge, mapped by this program in 2006 and 2007 (Gardner 2006, 2007). Mapping of the Mariana Trough consumed the largest part of the cruise. The Mariana Trough is deeper than the Mariana and West Mariana Ridges, but shallower than the abyssal seafloor to the east and south of the Mariana Trench and west of the West Mariana Ridge. The seafloor is very irregular within this area with depths ranging from less than 1500 m on elevated features to over 4100 m in small basins and deeper than 5500 m in the basin at the foot of the West Mariana Ridge. Much of the seafloor in this area is characterized by a ropy texture and numerous volcanic features. At the southern limit, the seafloor falls off into the Mariana Trench. This part of the Mariana Trough is bounded on the west by the southern terminus of the West Mariana Ridge.

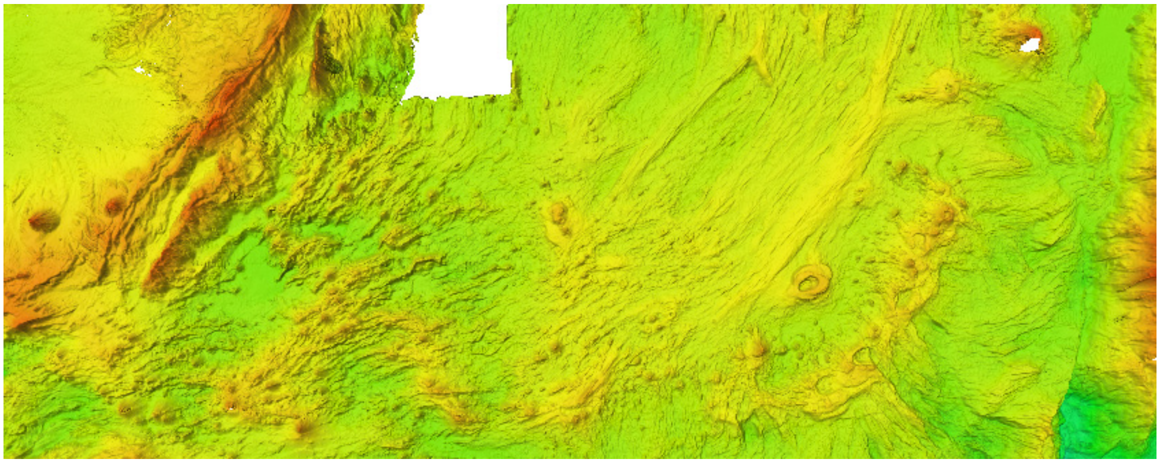


Figure 5. Textured seafloor of Mariana Trough

The Southern Terminus of the West Mariana Ridge

The western end of the survey lines crossed the southern end of the West Mariana Ridge, which curves toward the southwest in this area, roughly following the curve of the Mariana Trench. The most striking feature of the West Mariana Ridge in this area is a large rift and the associated seafloor highs on either side. The northwestern flank of the ridge is strewn with dozens of conical submarine volcanoes, many of which are arranged in lines trending northwesterly from the axis of the crest. The volcano-strewn seafloor slopes upward from the northwest to a crest at about 1500 m depth with a precipitous drop-off to a depressed basin of 5500 m depth. Portions of the drop-off have a slope in excess of 55 degrees. Across the basin and facing the western crest is a large plateau, also with a 1500 m depth.

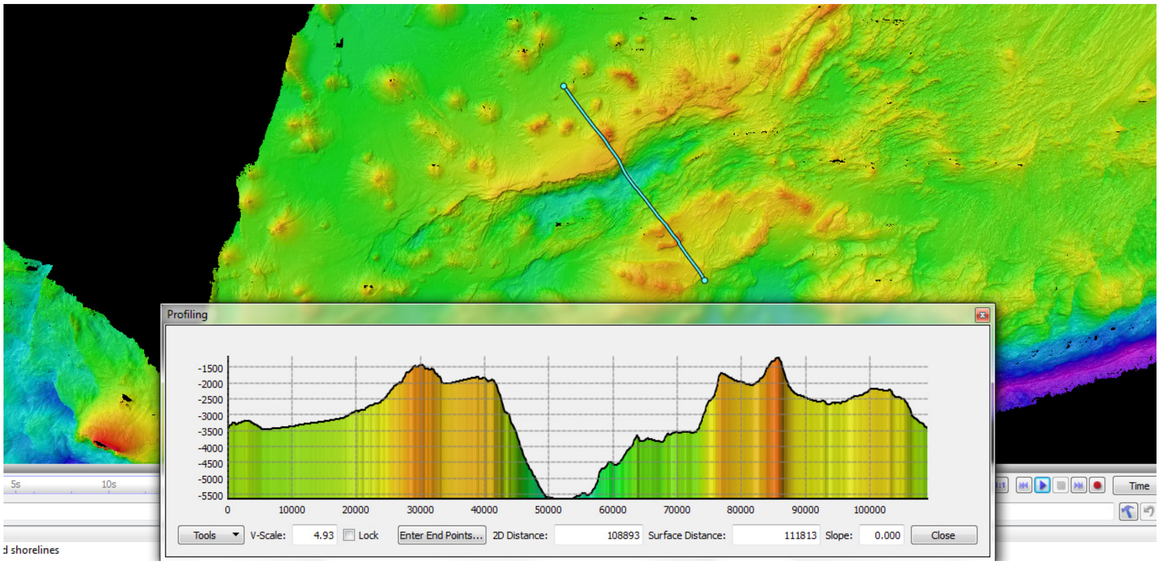


Figure 6. Large rift at southern end of West Mariana Ridge and profile across features

The Parece Vela Basin

The final portion of the cruise was devoted to additional mapping in the Parece Vela Basin, extending the seafloor coverage slightly to the west of the area mapped in 2006 and 2007 (Gardner 2006, 2007). In this area, the smooth seafloor texture resulting from sediment originating on the West Mariana Ridge merges with the irregular washboard texture of the abyssal seafloor.

Daily Log (local time = UTC + 10 hours)

Chief Scientist Log—Leg 2—Marianas 2010

Part 1—Mariana Trench east of Guam

24 September 2010—Day 267 UTC

0600Z USNS *Sumner* (T-AGS 61) got underway from Pier S1 U.S. Naval Base, Guam on 2010 Survey Leg 2 of the Mariana Islands ECS bathymetry project; NAVOCEANO designation 610610.

0645Z Cleared Apra Harbor (Figure 7) and began transit toward CTD site in NW corner of “new” Oparea. NAVO watch team begins bringing up EM122 and SBP 122. Unable to obtain meaningful SBP display. ETs are testing CTD system, which had failed during cruise between Leg 1 and Leg 2.

Figure 7. Orote Point at the entrance to Apra Harbor, Guam

0900Z Watch team was provided Jim Gardner's protocol sheets to guide data acquisition. They are still working on setting up systems and getting SBP operating.

0920Z Unable to save data to J. Gardner laptop computer; will save data to HD and RAID 2 on my laptop (Gunnel).

1315Z Entered into ConOps Area 5; watch team shifting system data set to begin acquisition of releasable data. SBP still looks useless.

1325Z Stopped at CTD site. Lat 13-00.001 N Lon 45-43.997 E

1400Z CTD in the water

1408Z Began lowering CTD

1510Z Lost data link with CTD at approximately 3300 m depth. ET opinion is that the cable termination at the CTD has failed. Retrieving CTD. We will use the down cast for sound speed correction.

1545Z Compared the Deep Blue XBTs taken before and after the CTD cast using both the CDOM database for salinity and the CTD for salinity. Both compare well to the CTD, although we are seeing a 0.5 m/s delta from the *in situ* SV. We will go ahead with the sound speed profile from the CTD for the first line. Will watch delta for any sign of constant offset.

1625Z CTD on deck. Failure point identified as deck unit. Began picking up speed on run-in to line. CTD position was on line, so no maneuvering required.

1645Z Began logging data on first line. NAVO team has laid out a 1000-m spaced set of parallel lines in ISS60. I am selecting desired line out of this set and this line is being run. This seems to be working ok for "ConOps area 5."

2000Z Silver NAVO portable HD not reading well into my laptop via Trendnet powered hub. Keep getting message that disk needs to be formatted. Tried again with NAVO blue portable HD. Getting same message or message that files need to be repaired, but after several tries it seems to be recognized and I can copy files to laptop. When time permits, I will remove the hub from my laptop and replace with the D-Link powered hub—maybe the problem is in the hub.

2300Z Began regular file actions:

- Copy _sumner.all files and .edf files from NAVO portable HD to laptop desktop.
- Copy _sumner.all files to "orig raw" directory on Lacie Rugged HD
- Rename _sumner.all to MarianaTrench_line_###.all and copy files to RAID Mariana Trench Raw daily folder and
- Move renamed MarianaTrench_line_###.all files and TD.edf files to Leg 2 Bathy daily folder on Desktop.
- Copy TD.edf files to RAID2 and Lacie Rugged Hard Drive; note these files are not the edited files that were applied as sound speed profiles—top data and bottom data are often cut off
- Bathy files are now saved in 3 places—Rugged hard drive with original name, RAID2 with UNH name, laptop desktop with UNH name; XBT files are stored in same 3 places—RAID and rugged hard drive
- Incorporate line files from Leg 2 Bathy folder into Mariana Leg 2 scene.
- At end of each day, copy daily sub-folder from Leg 2 Bathy folder on Desktop to UNH HDD "Frog."
- Create (and add to daily) spreadsheet of XBT file day/time/position in decimal degrees. Paste position and label into Notebook .txt file and import to Fledermaus scenes as points object.

25 September 2010—Day 268 UTC

0100Z Watch team reports that just acquired XBT profiles result in 0.7 m/s delta with SV. Applied profile from last night's CTD cast and reduced delta to within 0.5 m/s.

0300Z Beams going too deep along nadir recording ~11000 m in ~8700 m. Reduced maximum depth to 10,000 m. Seems to help.

0531Z Broke line at W end of area. Next eastward line is S of Trench line from Leg 1.

0520Z Fire and Abandon Ship drills

0600Z On eastward line south of Leg 1 data

0730Z Getting holidays in deepest part of trench in the area. Possibly shadow or possibly too small a grazing angle to get return.

0900Z Still getting some holidays in the deep part of the trench and also seeing nadir beams plunging below the seafloor periodically. Forcing depth to regain bottom track at nadir. Sea state has risen somewhat, and may be contributing to problem. Using minimum depth is concerning based on the EM122 SIS manual statement that no depths deeper than minimum set are accepted by the system. This is a problem because the outer part of the swath is often deeper that the max that would be desirable at nadir—will discuss with Kongsberg via Larry/Jim on NH monday.

2008Z Began next to last line in ConOps area 5 in northeastward direction. Previous line suffered from periodic center beam plunges.

26 September 2010—Day 269 UTC

0338Z Started last line in ConOps area 5, heading southwestward along southern margin of area.

0900Z When I gridded lines 174-179 (sumner lines 7-12) a large gap was present in the coverage. The gap was traced to what must have been a watch stander error in line 177 that occurred at the day change. Apparently the SIS was not logging for some period of time. The data exist in the NAVO raw.all file and the unprocessed and processed .gsf files. NAVO will provide me with an .sd file for my scene, and their raw.all, and .gsf files to carry home***.***

1335Z Completed cross line and turned toward trench line transect to next ConOps area (3).

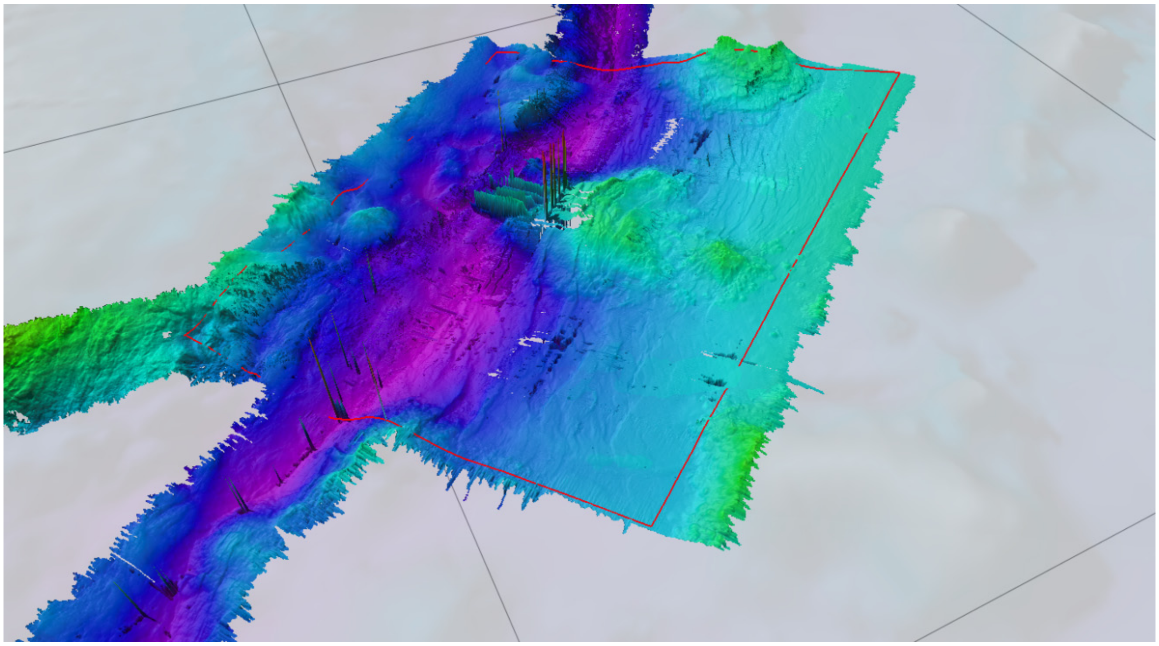


Figure 8. The accreted feature (before bathymetric data cleaning) crossing the trench in OpArea 5.

Part 2—Mariana Trench South and West of Guam, the Southern Mariana Trough, and the Southern Terminus of the West Mariana Ridge

2038Z Completed transit line along trench from ConOps 5 to ConOps 3 (main survey area). At end of trench line, there were some system problems and watch stander confusion that together led to a gap in the line along the southern edge of the area. Began "dip" line north along E edge of survey area.

27 September, 2010—Day 270 UTC

0015Z Completed dip line at N end of survey area, turning westward to begin mapping along the flanks of a shoal area. We plan to skirt the area with the ship approximately along the 1000 m contour, then start westward on the E-W lines on the west side of the shoal. The EM 710 is ready to be brought on line, but we don't expect to use it unless depths are less than expected.

0209Z ISS-60 system reporting delays in receipt of auxiliary GPS input, but POS/MV reporting satisfactory accuracies

0337Z ETs reset GPS unit; POS/MV attitude accuracy dropped to red.

0350Z POS attitude returned to green, all POS/MV values green.

0500Z Discovered that there was once again a gap in the SIS .all file at the start of the new UTC day. All the data between 0000Z and the line count increment (at 0015 today) were missing.

Logging was never turned off and the green logging button was constantly on. *Apparently SIS drops all the data between the end of the UTC day and the next line count increment. The data were in the ISS-60 .all files and the .gsf files. Watchstanders have been directed to increment the line count within seconds of the day change.*

0700Z Completed skirting shoal area (although I should have gone farther north to fill in the holiday) and turned on our first westward line of the area. The variability of depths makes it difficult to establish a line spacing that completes the coverage without also creating excessive overlap in long segments of the line.

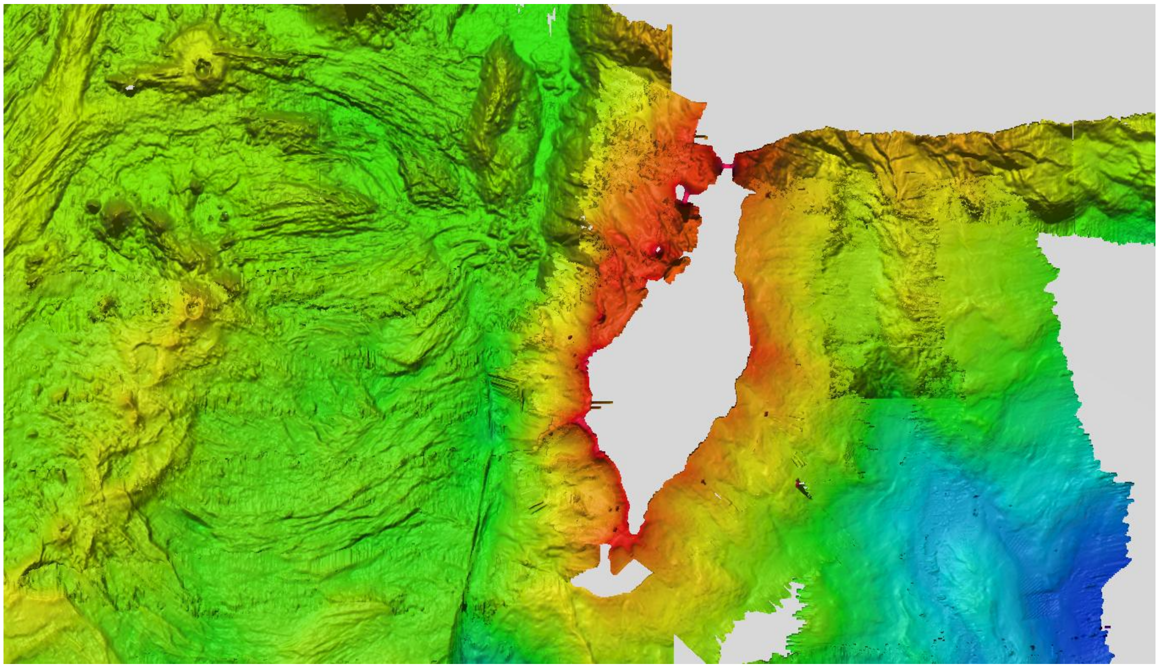


Figure 9. Coverage of Flanks of Santa Rosa Reef

1805Z Broke mainscheme line to fill in holidays between this line, and the next two lines north. Rationale—the swaths are narrowing as we approach and cross the West Mariana Ridge. Although this is perhaps not essential, complete coverage in this area may be needed to establish connection between the two main ridges. On balance, it seems better to run the main lines at spacing for most of the area and fill in the holidays across the ridge.

28 September 2010—Day 271

0000Z + 3 seconds Incremented line count in SIS. Official time of next file start was 0000 + 15 seconds. Unclear why there is a delay. No apparent gap in coverage, however.

0900Z Attempted to process .all files in FM Geocoder. Received navigation error messages and unable to create mosaics from any files. Concern that backscatter is ok; sent sample file to Larry to examine.

29 September 2010—Day 272

0456Z Broke mainscheme line and began skirting shoal area to fill in holidays missed on first pass on Day 270.

1108Z Resumed main E-W line heading west from Shoal area.

Analysis of Kongsberg .all files at CCOM/JHC revealed that there are two sources of attitude (Figure 10) being fed to the SIS, the primary from POS/MV, a secondary from the Mk39 gyro. The two inputs are in opposite sign. While only the POS input is actually being used for attitude, the presence of the Mk39 is unnecessary.

Based on inquiry to NAVO Stennis, this apparently is NAVO standard configuration, but info and approval provided to change to POS only as Jim says was the case on Leg 1. Will make the change at some period of a long turn when logging is off.

Also confirmed that max depth setting on SIS runtime parameters applies to entire swath, not just center beam bottom track. Will use “force depth” function to keep from getting center beam plunges.

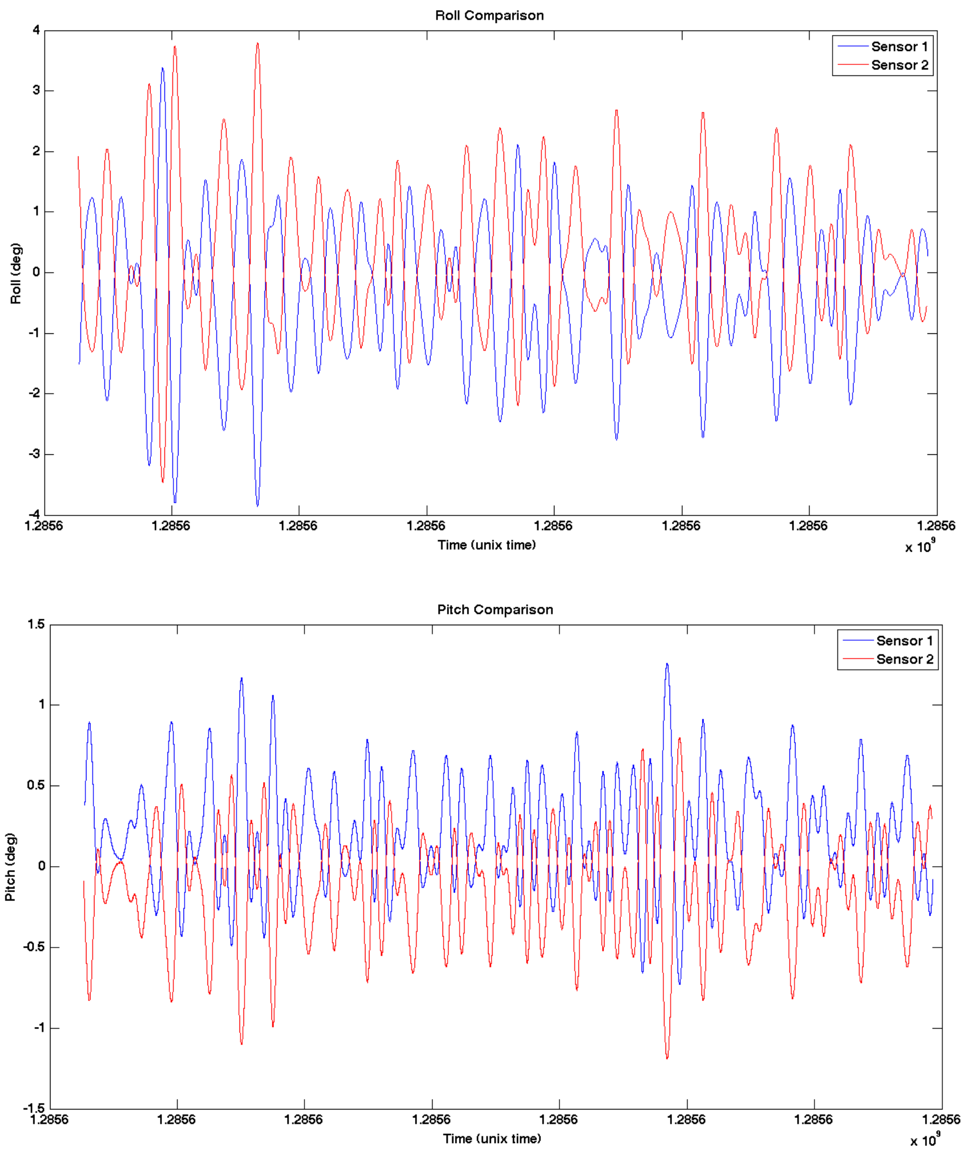


Figure 10. Graph of dual attitude sources as recorded in .all files; upper image—roll data, lower image—pitch data.

30 September 2010—Day 273

xxxxZ Broke mainscheme again to fill holidays over W. Mariana Ridge. Confirmed that Mk39 is being logged, but that POS is and has been primary source for heading and for attitude throughout the leg.

0911Z Stopped logging and broke holiday line, turned south. Began process of removing Mk39 Gyro input from datagram.

0913Z Stopped pinging to make Com port configuration changes.

0914Z Resumed pinging

0915 Resumed logging (en route to resume mainscheme line) to create file with new configuration. Sent file to NAVO and UNH for check.

1001Z Resumed main scheme line westward.

1130Z Line 210, the first line of the JD, crashes Fledermaus. Turns out first ping is corrupted with no position data and a negative sounding. Seems we still have an issue at the new day, in this case the first ping after line count was updated at +3 seconds had a previous day time and no navigation. We will try to wait about 15 seconds after 0000 to increment. Coverage exists, but data need to be edited to remove first ping. Got an sd file from watch to show coverage.

01 October 2010—JD274

0022Z Waited until +12 sec to increment line count to avoid problem found yesterday, but ended up missing a ping or two and leaving a small gap. Will try +03 sec again tomorrow.

1029Z SIPS hiccup, coincided with change in max depth as outer beams reached depths greater than setting (6000). Lost 7 pings and SV profile seemed to go missing until reapplied.

1141Z Turned NE to fill in strip between shoal-skirting line and xl. Left a holiday for later.

1509Z Running S along E edge of survey area.

1751Z System failure, broke line to loop around and restart.

1837Z Back on line. Seem to have lost part of the swath to port, but data manager tells me max depth was set to 9500 before this area.

2145Z Turned W to resume main scheme lines.

02 October 2010—Day 275

0000Z The watch stopped pinging accidentally, instead of hitting the line count button. XBT 44 failed, XBT 45 next in sequence.

1527Z Broke off to fill holidays in coverage. Irregular depths along line preclude efficient line spacing. See Figures 11 and 12.

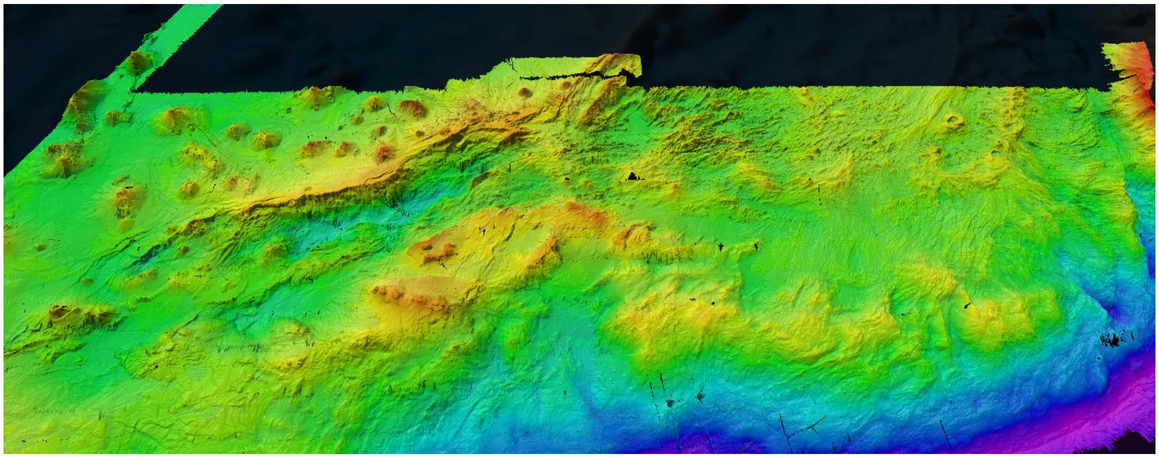


Figure 11. Irregular seafloor of the southern Mariana Trough region (3X vertical exaggeration)

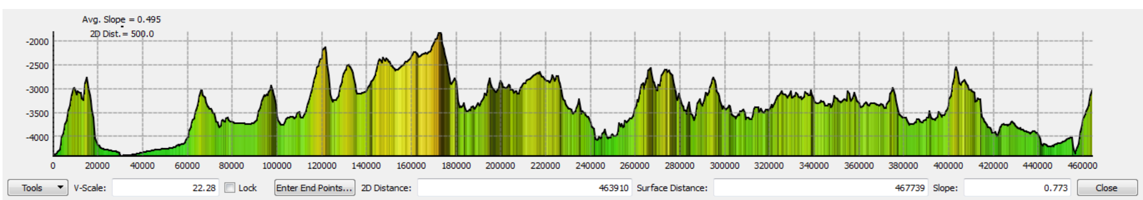


Figure 12. Typical profile across survey area in along-survey-track direction

03 October 2010—Day 276

Running E-W lines across area

04 October 2010—Day 277

0241Z Reduced speed to take one ship propulsion generator off line for maintenance. Expect about 4 hrs of reduced speed. We are in the trench area, so this may be helpful in maintaining full coverage and bottom tracking.

0439Z On line westward in the trench, increased forward beam steering to 4 degrees to see if center beam plunging is reduced.

0445Z Not much improvement with 4 degrees forward steering. Losing depths on port side (trench side), periodically, but the lost depths are from areas up the slope on the opposite side, not at the deepest part of the trench. We've returned to steering 2 degrees forward with no apparent difference. Watch stander is trying to keep max depth setting as close to deepest depth as practical.

05 October 2010—Day 278

0001Z Uneven length of splits is making this fill-in particularly inefficient.

06 October 2010—Day 279

0001Z XBT 61 was bad (increasing temp with depth), dropped XBT 62.

0650Z Decided to adjust the line pattern at the deep (E) end of the project to avoid so much overlap and make some other adjustments to get the military gunnery range (see Figure 3.) completed while there is no activity planned. Will angle toward the SE to get best coverage. Then will run SW parallel to the trench and then back NE, then fill in any gaps in the gunnery range. From then on, will run E-W from the W edge to the 5000 m contour, leaving the deep area for lines nearly parallel to contours. Hopefully this speeds up completion of the survey.

222Z Began line to SW along trench axis

07 October 2010—Day 280

0001Z Not so many center beam plunges along this line.

0805Z Reduced speed to 10 kt to improve data density over deepest part of trench.

0856Z Mapped over 10965.6 m depth (per grid on display) at coordinates of Challenger Deep. Small dropout in coverage suggests there may be a slightly deeper point shadowed by part of the seafloor. See Figures 13 and 14.

0915Z Somewhat deeper point ~10990 m. Hard to tell if these are valid depths. Will see when processed.

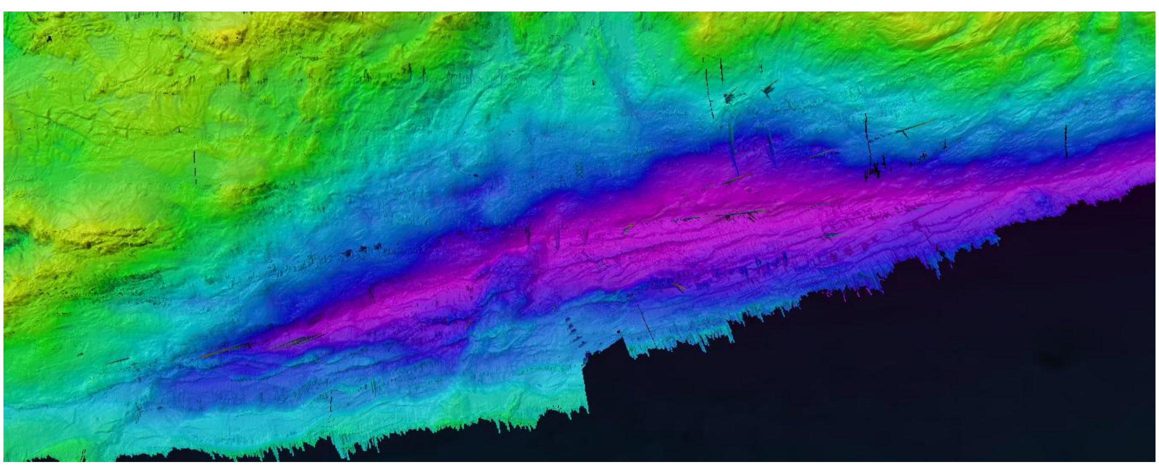


Figure 13. Challenger Deep (before data cleaning)

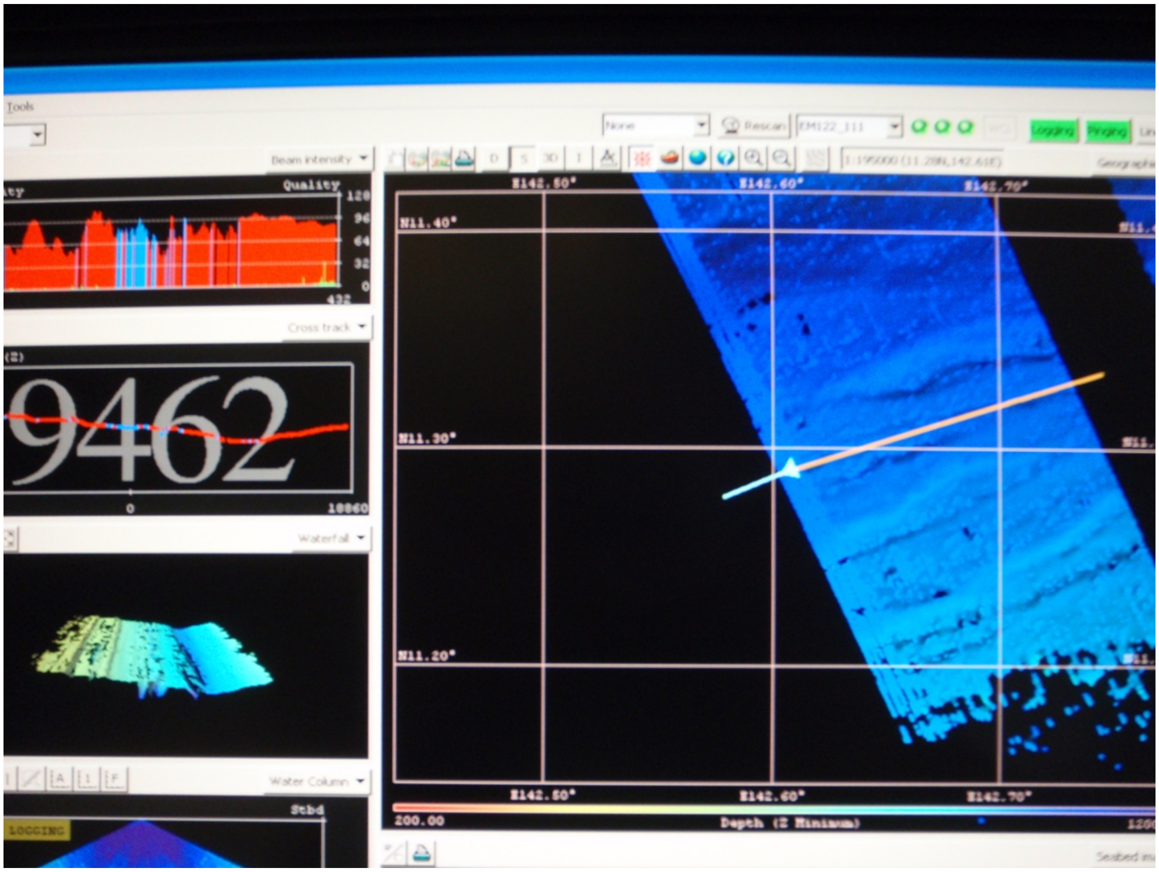


Figure 14. SIS display along trench. Note depths below seafloor at nadir in waterfall and profile displays and shadowing along faults (on port side) and in trench (on starboard side).

1100Z Difficulty getting new XBTs to match SV sound speed at transducer, and an odd downward kink in extended profile beginning at around 8,000 m, See Figure 15. My guess is that the in situ SV sensor is actually reading SV at a depth somewhat less than the transducer, that there is a near surface temperature gradient, and thus the XBT value at the transducer depth and the SV are not agreeing. Decided to use a profile where we do have agreement, and therefore small delta. The rest of the curve seems pretty much consistent.

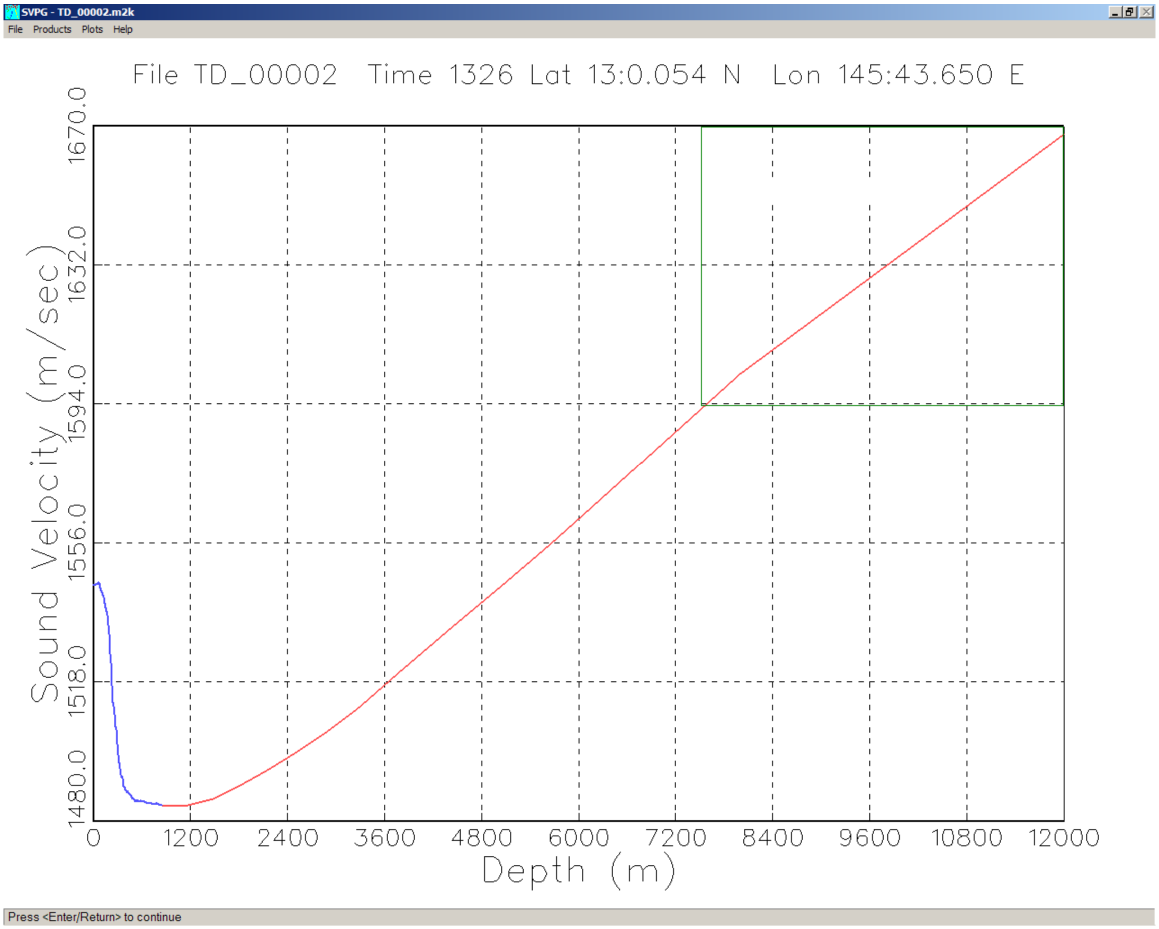


Figure 15. Sound Velocity profile showing kink at deep end of curve—*from NAVOCEANO Physical Oceanography Report 610610.*

08 October 2010—Day 281

0026Z Began a SW line approximately parallel to trench lines. Will complete coverage of gunnery range to ensure we are not excluded after 10 Oct.

09 October 2010—Day 282

E-W lines moving south

10 October 2010—Day 283

E-W lines moving south, and then cross line to south to re-beam deepest portion of trench, and then westward along trench.

11 October 2010—Day 284

Continuing along trench at southern end of Op Area. Will fill in deep part of area before completing E-W lines on shelf. Beginning E-W lines.

12 October 2010—Day 285

Continuing E-W lines

13 October 2010—Day 286

Finishing up E-W lines at west end of Area 3

1800 Z Fantail secured due to weather and seas, unable to launch XBT; will continue to use current profile, which is within acceptable limits.

2045Z Began seeing problems in EM122 system positioning input. Broke line.

2055Z Rebooted EM122 system. Reset RTG GPS input parameters and returned system to operation.

2207Z Back on line.

14 October 2010—Day 287

0001Z Tropical cyclone (turning to typhoon shortly) is north of us, in next planned operational area (Figure 16). Storm is moving to west, but we are going to stay south and clean up some data gaps in the trench area to allow storm to clear area. Fantail is accessible for XBT again.

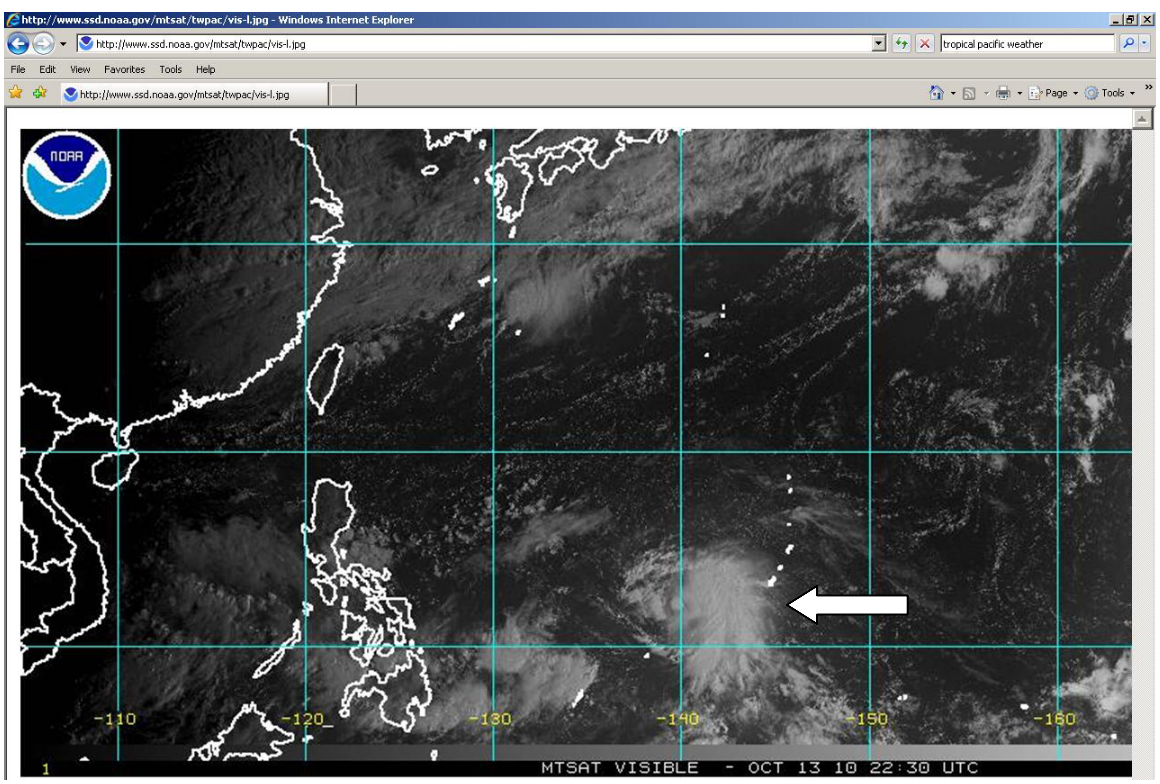


Figure 16. Tropical Pacific Satellite image on October 13, showing tropical cyclone Megi in western survey area.

0757Z Completed clean-up line along trench axis and turned south to run towards southern end of Oparea.

15 October 2010—Day 288

0154Z Turned NW from southern edge line into next operating area, running along trench axis. Weather much improved.

0640Z Enroute to next line, SE orientation parallel to previous line. Will run lines on this axis until southern terminus is defined.

16 October 2010—Day 289

0200 Z Completing SE line, will loop to begin closing coverage around charted 19.7 m – 55 m area. As suggested by charted depths and ETOPO compilation, this is a very large feature.

0453Z Started logging EM 710 data. Nadir depth agrees within 1-2 m with EM 122. Start and stop EM 710 logging in this area as depths permit. Note—an image, identical in appearance to the suspected plume artifact described in the Leg 1 report on Days 246 and 247 appeared directly at nadir on the EM 710 trace, never changing configuration while appearing, confirming the suspicion that the feature was an artifact.

0803Z No further logging of EM 710 data—too deep.

0939Z Completed all the development of this large seamount, shown in Figure 17, that we can justify for this cruise. We closed the 1000 m contour, and the shallowest depth obtained was about 85 m, but Capt is reluctant to go in closer given uncertainty of least depth. Full development would take 2 more days at the likely rate of progress.

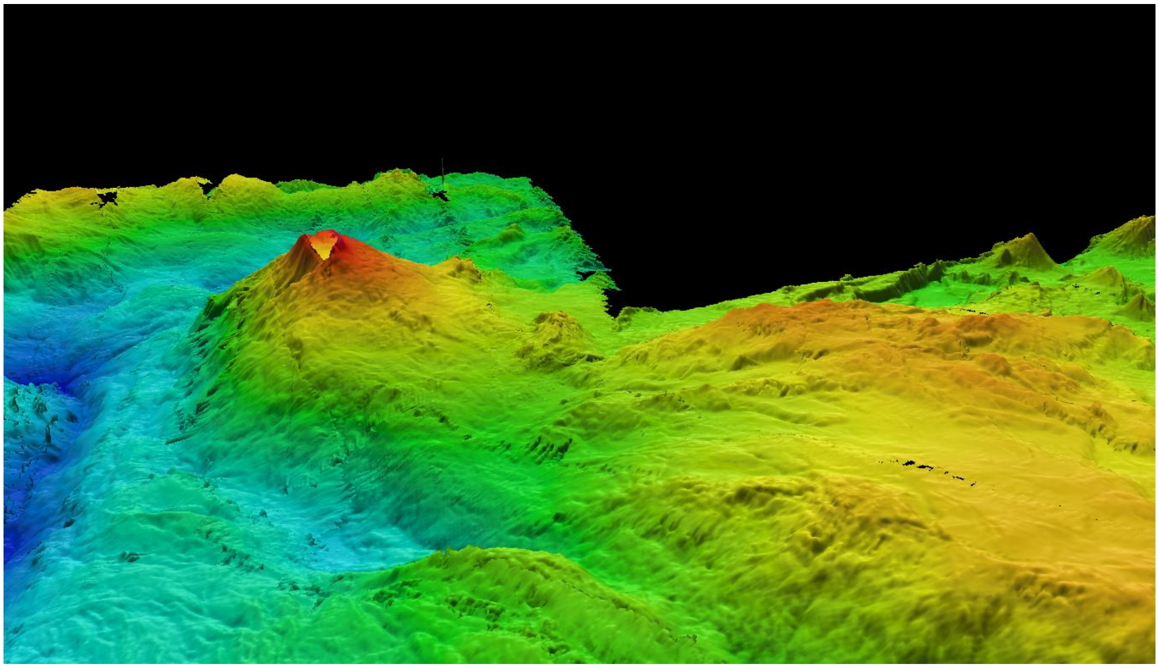


Figure 17. Large seamount bordering the western terminus of the Mariana Trench; least depth undetermined

0954Z Online to NW to fill in gaps between lines and to complete the mapping of the SW end of the trench and associated elevated bathymetry.

Part 3—Parece Vela Basin

2142Z Began line to NE, bounding the W edge of our Area 3 coverage. From there we will continue along the W boundary of 2007 mapping.

17 October 2010—Day 290

0100Z XBT 114 and 115 failed. XBT 116 next in sequence after 113.

0500Z XBT sequence number 117 was test canister, XBT 118 next in sequence after 116.

18 October 2010—Day 291

Running N on first of N-S lines to west of area of ambiguous backscatter from 2007 cruise.

19 October 2010—Day 292

Continuing N-S lines at regular spacing; area is very flat.

20 October 2010—Day 293

We completed the set of N-S lines, entering the area of washboard seafloor topography on the western end, and began E-W lines to fill in as far south as time permits, between the 2007 coverage area and the washboard seafloor as shown in Figure 17.

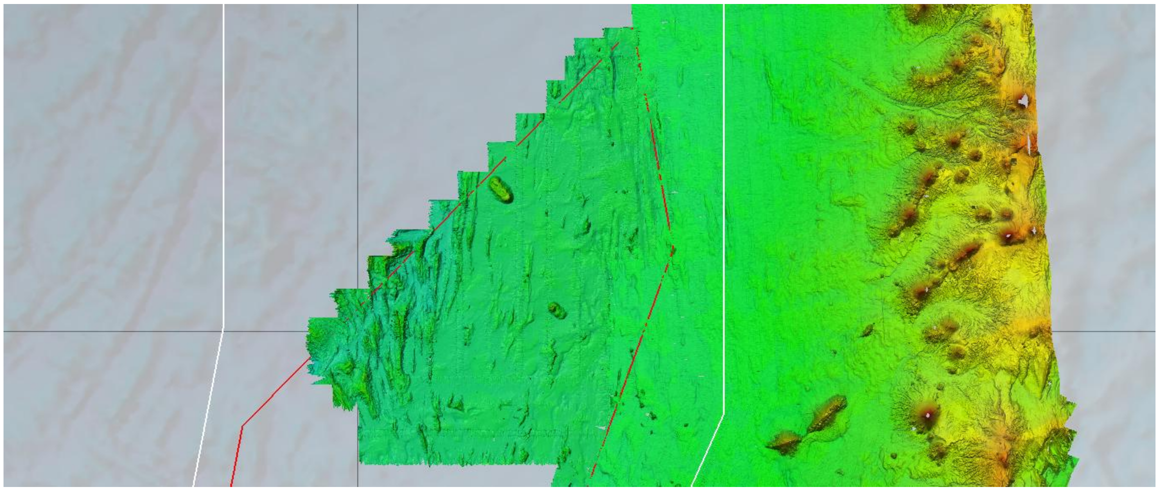


Figure 18. Area of additional mapping to determine limits of down-slope processes; washboard seafloor topography at left.

21 October 2010—Day 294

0200Z We completed the mapping mission and began our transit directly to Agana, Guam. We will log data en route although these data will not be part of the cruise data set.

2000Z Arrived at Naval Base, cruise complete.

2200Z Disembarked with data.

References Cited

Mayer, L., Jakobsson, M, and Armstrong, A, 2002, The compilation and analysis of data relevant to a U.S. Claim under United Nations Law of the Sea Article 76: A preliminary Report. Univ. of New Hampshire Technical Report, 75p.

Gardner, J.V., 2006, Law of the Sea Cruise to Map the Western Insular Margin and 2500-m Isobath of Guam and the Northern Mariana Islands. Cruise Report, University of New Hampshire (UNH), Center for Coastal and Ocean Mapping (CCOM)/Joint Hydrographic Center (JHC), Durham, NH, 45 p.

Gardner, J.V., 2007, U.S. Law of the Sea Cruise to Map the Western Insular Margin and 2500-m Isobath of Guam and the Northern Mariana Islands. Cruise Report, University of New Hampshire (UNH), Center for Coastal and Ocean Mapping (CCOM)/Joint Hydrographic Center (JHC), Durham, NH, 37 p.

Gardner, J.V., 2010, Law of the Sea Cruises to Map Sections of the Mariana Trench and the Eastern and Southern Insular Margin of Guam and the Northern Mariana Islands. Cruise Report, University of New Hampshire (UNH), Center for Coastal and Ocean Mapping (CCOM)/Joint Hydrographic Center (JHC), Durham, NH, 83 p.

Appendix 1. Conversion table of Kongsberg .all file names to UNH .all file names

JD	Data Folder	Kongsberg .all file name Line_yyyymmdd_time_Ship.all	UNH file name .all
267	**100924**	**0001_20100924_164453**	**MarianaTrench_line_168**
	100924	0002_20100924_164549	MarianaTrench_line_169
	100924	0003_20100924_180042	MarianaTrench_line_170
	100924	0004_20100924_230211	MarianaTrench_line_171
	100924	0005_20100924_230241	MarianaTrench_line_172
268	**100925**	**0006_20100925_000343**	**MarianaTrench_line_173**
	100925	0007_20100925_060027	MarianaTrench_line_174
	100925	0008_20100925_130001	MarianaTrench_line_175
	100925	0009_20100925_180029	MarianaTrench_line_176
	100925	0010_20100925_200811	MarianaTrench_line_177
269	**100926**	**0011_2010926_000814**	**MarianaTrench_line_178**
	100926	0012_20100926_033858	MarianaTrench_line_179
	100926	0013_20100926_060133	MarianaTrench_line_180
	100926	0014_20100926_103609	MarianaTrench_line_181 (dip)
	100926	0015_20100926_120030	MarianaTrench_line_182 (dip)
	100926	0016_20100926_134331	MarianaTrench_line_trench183
	100926	0017_20100926_180033	MarianaTrench_line_trench184
	100926	0018_20100926_202335	MarianaTrench_line_trench185
	100926	0019_20100926_203906	MarianaTrough_line_186 (dip)
270	**100927**	**0020_20100927_001546**	**MarianaTrough_line_187 (dip)**
	100927	0021_20100927_014743	MarianaTrough_line_188 (buffer)
	100927	0022_20100927_041801	MarianaTrough_line_189 (buffer)
	100927	0023_20100927_062439	MarianaTrough_line_190
	100927	0024_20100927_065258	MarianaTrough_line_191
	100927	0025_20100927_120259	MarianaTrough_line_192
	100927	0026_20100927_180014	MarianaTrough_line_193
	100927	0027_20100927_182253	MarianaTrough_line_194
	100927	0028_20100927_191457	MarianaTrough_line_195
	100927	0029_20100927_222644	MarianaTrough_line_196
271	**100928**	**0030_20100928_000015**	**MarianaTrough_line_197**
	100928	0031_20100928_025332	MarianaTrough_line_198
	100928	0032_20100928-060019	MarianaTrough_line_199
	100928	0033_20100928_100340	MarianaTrough_line_200
	100928	0034_20100928_120018	MarianaTrough_line_201
	100928	0035_20100928_180015	MarianaTrough_line_202
272	**100929**	**0036_20100929_000016**	**MarianaTrough_line_203**
	100929	0037_20100929_045625	MarianaTrough_line_204
	100929	0038_20100929_060009	MarianaTrough_line_205
	100929	0039_20100929_073327	MarianaTrough_line_206
	100929	0040_20100929_110841	MarianaTrough_line_207
	100929	0041_20100929_120013	MarianaTrough_line_208
	100920	0042_20100929_180020	MarianaTrough_line_209

JD	Data Folder	Kongsberg .all file name Line_yyyymmdd_time_Ship.all	UNH file name .all
273	**100930**	**0043_20100930_000010**	**MarianaTrough_line_210**
	100930	0044_20100930_004348	MarianaTrough_line_211
	100930	0045_20100930_053500	MarianaTrough_line_212
	100930	0046_20100930_060335	MarianaTrough_line_213
		Test lines after MK39 gyro input was turned off	
	100930	0047_20100930_091544	MarianaTrough_line_214
	100930	0048_20100930_093634	MarianaTrough_line_215
		Resumed normal mapping with new configuration	
273	100930	0049_20100930_100155	MarianaTrough_line_216
	100930	0050_20100930_120012	MarianaTrough_line_217
		No line 0051	
	100930	0052_2010930_160348	MarianaTrough_line_218
	100930	0053_2010930_180010	MarianaTrough_line_219
274	**101001**	**0054_20101001_000022**	**MarianaTrough_line_220**
	101001	0055_20101001_060522	MarianaTrough_line_221
	101001	0056_20101001_114138	MarianaTrough_line_222
	101001	0057_20101001_121010	MarianaTrough_line_223
	101001	0058_20101001_150916	MarianaTrough_line_224
	101001	0059_20101001_183709	MarianaTrough_line_225
	101001	0060_20101001_214530	MarianaTrough_line_226
		No line 0061	
275	**101002**	**0062_20101002_000012**	**MarianaTrough_line_227**
	101002	0063_20101002_060009	MarianaTrough_line_228
	101002	0064_20101002_120011	MarianaTrough_line_229
	101002	0065_20101002_163902	MarianaTrough_line_230
	101002	0066_20101002_180004	MarianaTrough_line_231
	101002	0067_20101002_195646	MarianaTrough_line_232
	101002	0068_20101002_234108	MarianaTrough_line_233
276	**101003**	**0069_20101003_000010**	**MarianaTrough_line_234**
	101003	0070_20101003_042425	MarianaTrough_line_235
	101003	0071_20101003_060134	MarianaTrough_line_236
	101003	0072_20101003_120425	MarianaTrough_line_237
	101003	0073_20101003_180019	MarianaTrough_line_238
277	**101004**	**0074_20101004_000026**	**MarianaTrough_line_239** ***(bad start)***
	101004	0075_20101004_043115	MarianaTrough_line_240
	101004	0076_20101004_060052	MarianaTrough_line_241
	101004	0077_20101004_120010	MarianaTrough_line_242
	101004	0078_20101004_125317	MarianaTrough_line_243
	101004	0079_20101004_180010	MarianaTrough_line_244
	101004	0080_20101004_203334	MarianaTrough_line_245
278	**101005**	**0081_20101005_005020**	**MarianaTrough_line_246**
	101005	0082_20101005_060527	MarianaTrough_line_247
	101005	0083_20101005_095715	MarianaTrough_line_248
	101005	0084_20101005_100305	MarianaTrough_line_249
	101005	0085_20101005_105544	MarianaTrough_line_250

JD	Data Folder	Kongsberg .all file name Line_yyyymmdd_time_Ship.all	UNH file name .all
	101005	0086_20101005_120641	MarianaTrough_line_251
	101005	0087_20101005_132150	MarianaTrough_line_252
	101005	0088_20101005_152739	MarianaTrough_line_253
	101005	0089_20101005_180012	MarianaTrough_line_254
	101005	0090_20101005_191855	MarianaTrough_line_255
	101005	0091_20101005_221027	MarianaTrough_line_256
279	**101006**	**0092_20101006_000031**	**MarianaTrough_line_257**
279	101006	0093_20101006_060014	MarianaTrough_line_258
	101006	0094_20101006_120327	MarianaTrough_line_259
	101006	0095_20101006_143814	MarianaTrough_line_260
	101006	0096_20101006_180010	MarianaTrough_line_261
	101006	0097_20101006_222227	MarianaTrough_line_262
280	**101007**	**0098_20101007_000036**	**MarianaTrough_line_263**
	101007	0099_20101007_060009	MarianaTrough_line_264
	101007	0100_20101007_120050	MarianaTrough_line_265
	101007	0101_20101007_122452	MarianaTrough_line_266
	101007	0102_20101007_123355	MarianaTrough_line_267
	101007	0103_20101007_134524	MarianaTrough_line_268
	101007	0104_20101007_180020	MarianaTrough_line_269
281	**101008**	**0105_20101008_002635**	**MarianaTrough_line_270**
	101008	0106_20101008_060327	MarianaTrough_line_271
	101008	0107_20101008_093139	MarianaTrough_line_272
	101008	0108_20101008_120017	MarianaTrough_line_273
	101008	0109_20101008_151542	MarianaTrough_line_274
	101008	0110_20101008_180013	MarianaTrough_line_275
	101008	0111_20101008_194800	MarianaTrough_line_276
	101008	0112_20101008_205320	MarianaTrough_line_277
282	**101009**	**0113_20101009_000036**	**MarianaTrough_line_278**
	101009	0114_20101009_023901	MarianaTrough_line_279
	101009	0115_20101009_065110	MarianaTrough_line_280
	101009	0116_20101009_090439	MarianaTrough_line_281
	101009	0117_20101009_120041	MarianaTrough_line_282
	101009	0118_20101009_162510	MarianaTrough_line_283
	101009	0119_20101009_180007	MarianaTrough_line_284
283	101010	0120_20101010_000029	MarianaTrough_line_285
	101010	0121_20101010_024830	MarianaTrough_line_286
	101010	0122_20101010_060013	MarianaTrough_line_287
	101010	0123_20101010_120516	MarianaTrough_line_288
	101010	0124_20101010_131145	MarianaTrough_line_289
	101010	0125_20101010_180004	MarianaTrough_line_290
	101010	0126_20101010_232831	MarianaTrough_line_291
284	**101011**	**0127_20101011_000031**	**MarianaTrough_line_292**
	101011	0128_20101011_030538	MarianaTrough_line_293
	101011	0129_20101011_061110	MarianaTrough_line_294
	101011	0130_20101011_073638	MarianaTrough_line_295
	101011	0131_20101011_120354	MarianaTrough_line_296

JD	Data Folder	Kongsberg .all file name Line_yyyymmdd_time_Ship.all	UNH file name .all
	101011	0132_20101011_124909	MarianaTrough_line_297
	101011	0133_20101011_133125	MarianaTrough_line_298
	101011	0134_20101011_180026	MarianaTrough_line_299
	101011	0135_20101011_194214	MarianaTrough_line_300
285	**101012**	**0136_20101012_000037**	**MarianaTrough_line_301**
	101012	0137_20101012_072745	MarianaTrough_line_302
285	101012	0138_20101012_105809	MarianaTrough_line_303
	101012	0139_20101012_120357	MarianaTrough_line_304
	101012	0140_20101012_145822	MarianaTrough_line_305
	101012	0141_20101012_180008	MarianaTrough_line_306
	101012	0142_20101012_235015	MarianaTrough_line_307
286	**101013**	**0143_20101013_000023**	**MarianaTrough_line_308 (busted)**
	101013	0144_20101013_033741	MarianaTrough_line_309
	101013	0145_20101013_060014	MarianaTrough_line_310
	101013	0146_20101013_080322	MarianaTrough_line_311
	101013	0147_20101013_121652	MarianaTrough_line_312
	101013	0148_20101013_171940	MarianaTrough_line_313
	101013	0149_20101013_180007	MarianaTrough_line_314
		No line 150	
	101013	0151_20101013_220653	MarianaTrough_line_315
287	**101014**	**0152_20101014_004037**	**MarianaTrough_line_316**
	101014	0153_20101014_030644	MarianaTrough_line_317
	101014	0154_20101014_060239	MarianaTrough_line_318
	101014	0155_20101014_080610	MarianaTrough_line_319
	101014	0156_20101014_091256	MarianaTrough_line_320
	101014	0157_20101014_120045	MarianaTrough_line_321
	101014	0158_20101014_164702	MarianaTrough_line_322
	101014	0159_20101014_180017	MarianaTrough_line_323
	101014	0160_20101014_192342	MarianaTrough_line_324
288	101015	0161_20101015_000021	MarianaTrough_line_325
	101015	0162_20101015_071852	MarianaTrough_line_326
	101015	0163_20101015_120025	MarianaTrough_line_327
	101015	0164_20101015_133120	MarianaTrough_line_328
	101015	0165_20101015_180013	MarianaTrough_line_329
	101015	0166_20101015_202530	MarianaTrough_line_330
289	101016	0167_20101016_000036	MarianaTrough_line_331
	101016	0168_20101016_031144	MarianaTrough_line_332
	101016	0169_20101016_041607	MarianaTrough_line_333
	101016	0170_20101016_062013	MarianaTrough_line_334
	101016	0171_20101016_081716	MarianaTrough_line_335
	101016	0172_20101016_095413	MarianaTrough_line_336
	101016	0173_20101016_120556	MarianaTrough_line_337
	101016	0174_20101016_133727	MarianaTrough_line_338
	101016	0175_20101016_150131	MarianaTrough_line_339
	101016	0176_20101016_180025	MarianaTrough_line_340
	101016	0177_20101016_214248	MarianaTrough_line_341

JD	Data Folder	Kongsberg .all file name Line_yyyymmdd_time_Ship.all	UNH file name .all
290	101017	0178_20101017_000032	MarianaTrough_line_342
	101017	0179_20101017_060004	MarianaTrough_line_343
	101017	0180_20101017_120240	MarianaTrough_line_344
	101017	0181_20101017_175308	MarianaTrough_line_345
290	101018	0182_20101018_000028	MarianaTrough_line_346
	101018	0183_20101018_025917	MarianaTrough_line_347
291	101018	0184_20101018_060516	MarianaTrough_line_348
		Line 185 is not used	
	101018	0186_20101018_083025	MarianaTrough_line_349
	101018	0187_20101018_122551	MarianaTrough_line_350 *(xl)*
	101018	0188_20101018_140417	MarianaTrough_line_351
	101018	0189_20101018_180013	MarianaTrough_line_352
	101018	0190_20101018_211833	MarianaTrough_line_353
292	**101019**	**0191_20101019_000031**	**MarianaTrough_line_354**
	101019	0192_20101019_042110	MarianaTrough_line_355
	101019	0193_20101019_060124	MarianaTrough_line_356
	101019	0194_20101019_102058	MarianaTrough_line_357
	101019	0195_20101019_120309	MarianaTrough_line_358
	101019	0196_20101019_154209	MarianaTrough_line_359
	101019	0197_20101019_180017	MarianaTrough_line_360
	101019	0198_20101019_201718	MarianaTrough_line_361
293	101020	0199_20101020_003913	MarianaTrough_line_362
	101020	0200_20101020_041227	MarianaTrough_line_363
	101020	0201_20101020_072808	MarianaTrough_line_364
	101020	0202_20101020_090649	MarianaTrough_line_365
	101020	0203_20101020_120027	MarianaTrough_line_366
	101020	0204_20101020_152614	MarianaTrough_line_367
	101020	0205_20101020_180007	MarianaTrough_line_368
	101020	0206_20101020_210542	MarianaTrough_line_369
294	101021	0207_20101021_000035	MarianaTrough_line_370
	101021	0208_20101021_021714	MarianaTrough_line_371 *(transit)*
		End of survey	

Appendix 2. Location of XBT casts

XBT #	Lat N	Lon E
2	13.000920	145.727458
3	12.999993	145.733268
4	13.079248	145.833805
5	13.186185	145.973453
6	13.485682	146.610270
7	13.397505	146.494987
9	13.052258	146.043913
10	12.702707	145.971305
11	13.312738	147.074317
12	12.646323	146.204573
13	12.953562	146.865967
14	13.133710	147.331250
15	12.817712	146.918897
16	12.603855	146.115707
17	12.272542	145.126042
18	12.846912	144.633300
19	12.856480	144.291407
20	12.829340	143.062223
21	12.829378	141.672982
22	12.884120	141.882537
23	12.829340	140.918717
24	12.718145	140.505762
25	12.718170	141.838525
26	12.718150	143.199252
27	12.925087	144.324283
28	12.602260	144.093278
29	12.602242	142.679703
30	12.602210	141.275700
31	12.773717	142.063297
32	12.602210	140.844058
33	12.486282	140.458105
34	12.486330	141.842090
35	12.486283	142.396957
36	12.486288	143.155730
37	12.486298	144.040170
38	12.583482	144.458285
39	12.636222	144.782390
40	12.365642	144.295980
41	12.365627	142.967903
42	12.365652	141.568538
43	12.548637	141.216700

XBT #	Lat N	Lon E
45	12.365637	140.704183
46	12.244930	140.107813
47	12.244977	140.311702
48	12.244952	141.379737
49	12.244927	141.662728
50	12.244945	142.971842
51	12.244940	144.333268
52	12.119590	144.717887
53	12.119530	143.303678
54	12.119505	142.938867
55	12.119535	141.952832
56	12.264443	142.379638
57	12.119545	141.596793
58	12.314427	140.988282
59	12.119537	140.676140
60	12.119518	140.109977
62	11.998725	140.267790
63	11.998755	141.560970
64	11.998743	142.901042
65	11.938803	144.185287
66	11.935917	144.570328
67	11.498018	143.240120
68	11.133502	142.134358
69	11.311785	141.987923
70	11.440587	142.401953
71	11.534207	142.703125
72	11.943612	143.690218
73	11.626985	142.334050
74	11.793253	142.413412
75	11.904615	142.530403
76	11.877842	142.659392
77	12.067655	141.527507
78	11.944717	141.917172
79	11.877845	140.654638
80	11.772927	140.121728
81	11.772953	141.494222
82	11.668522	141.227165
83	11.668522	139.804978
84	11.556822	140.770117
85	11.519617	142.103255
86	11.301140	142.114193
87	10.971473	140.934750
88	11.307723	141.798372
89	11.433380	141.064013

XBT #	Lat N	Lon E
90	11.445052	140.260303
91	11.445068	139.734570
92	11.501690	140.153125
93	11.348558	140.337988
94	11.209403	140.971762
95	11.206687	140.696988
96	11.283617	139.858692
97	11.155368	140.411182
98	11.067465	140.024935
99	11.059498	140.462418
100	11.114195	141.483935
101	11.157535	141.777865
102	10.888587	141.372265
103	10.958950	140.557862
104	10.801417	139.734358
105	11.325728	138.531072
106	10.961637	139.399772
107	11.557685	138.713330
108	11.491433	139.243457
109	11.184848	139.467968
110	11.385557	139.191325
111	11.281523	139.429492
112	11.660903	138.752670
113	11.759825	139.118718
116	11.887023	139.778565
118	12.885598	140.118538
119	14.083475	140.581673
120	14.219737	140.633122
121	14.355963	140.684522
122	14.476573	140.730078
123	15.567587	141.134327
124	16.969025	141.137793
125	17.506872	141.208398
126	16.783433	141.274690
127	17.177692	141.364437
128	16.321577	140.996127
129	16.359667	140.854525
130	16.995257	140.854475
131	16.960125	140.712728
132	16.525683	140.712858
133	16.178547	140.566537
134	16.081688	140.424837
135	16.470288	140.203500
136	15.817228	140.141650

XBT #	Lat N	Lon E
137	15.703958	140.070443
138	15.749947	139.999983
139	16.117778	139.999983
140	15.703473	140.552002
141	15.575378	140.547770
142	15.438017	140.670100
143	15.267152	141.456348

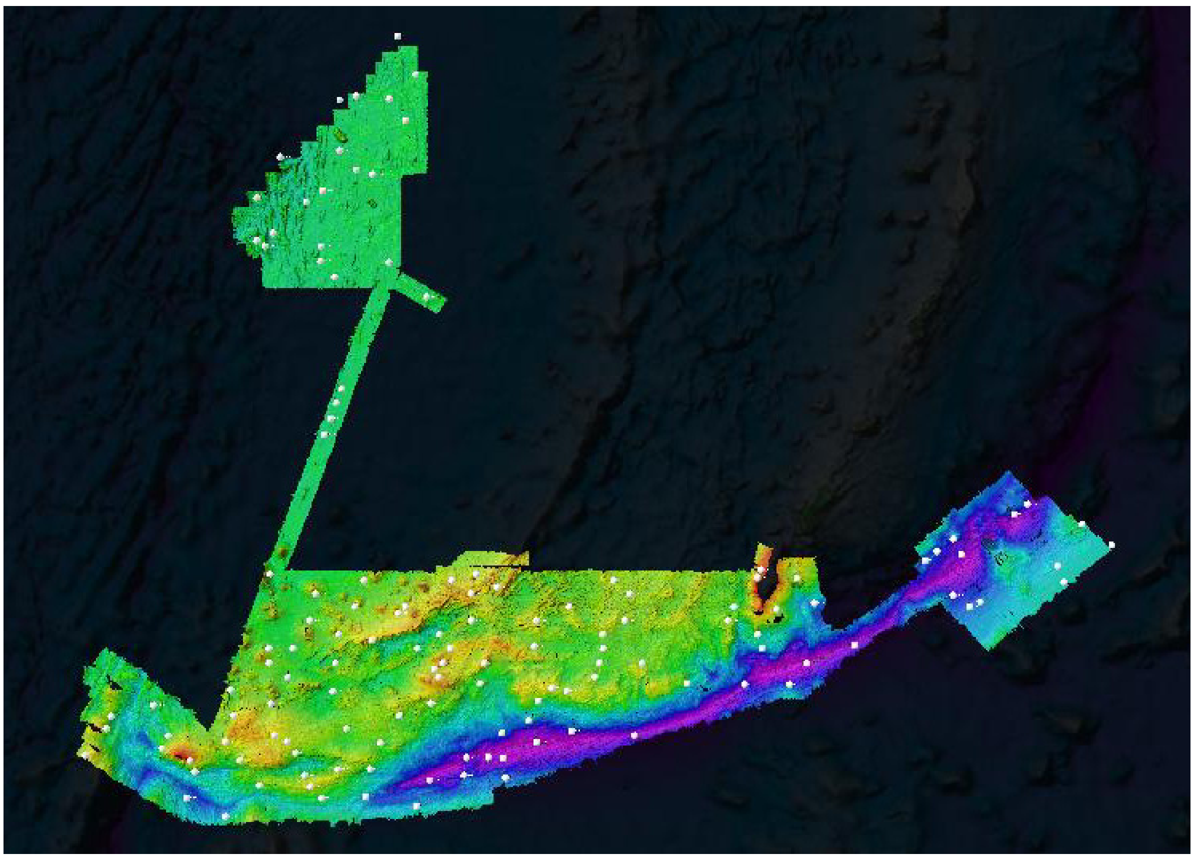


Figure 19. Location of XBT casts.

Appendix 3. Cruise calendar

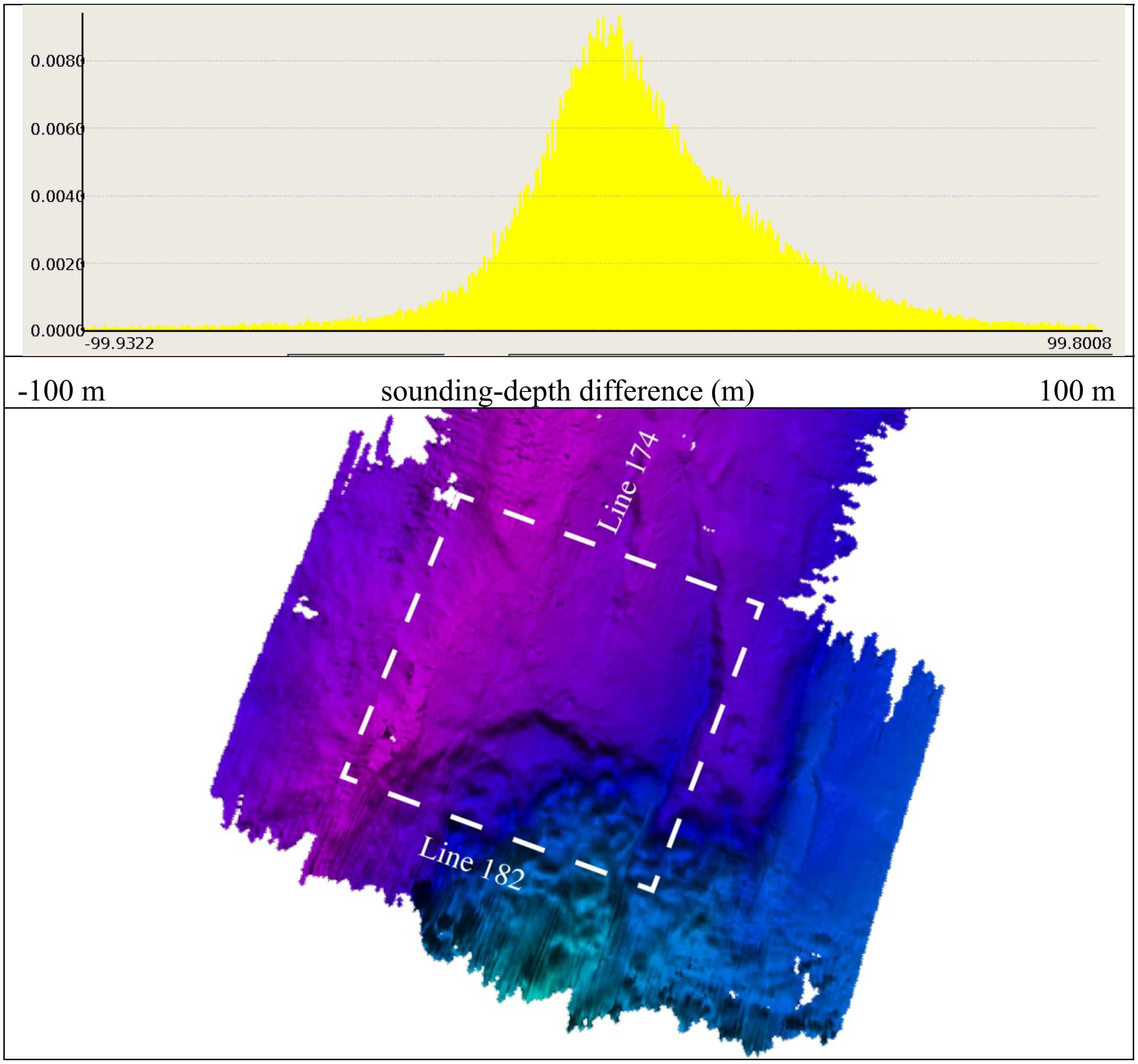
September 2010						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24 U/W from Guam, transit, CTD, began mapping Trench E of Guam	25 Mapping Trench E of Guam
26 Completed Trench area E of Guam, transit Trench to area S of Guam	27 Mapping Trough and Trench S of Guam	28 Mapping Trough and Trench S of Guam	29 Mapping Trough and Trench S of Guam	30 Mapping Trough and Trench S of Guam		

October 2010						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 Mapping Trough and Trench S of Guam	2 Mapping Trough and Trench S of Guam
3 Mapping Trough and Trench S of Guam	4 Mapping Trough and Trench S of Guam	5 Mapping Trough and Trench S of Guam	6 Mapping Trough and Trench S of Guam	7 Mapping Trench S of Guam—Deepest point	8 Mapping Trough and Trench S of Guam	**9** Mapping Trough and Trench S of Guam
10 Mapping Trough and Trench S of Guam	11 Mapping Trough and Trench S of Guam	12 Mapping Trough and Trench S of Guam	13 Mapping Trough and Trench S of Guam	14 Mapping Trough and Trench S of Guam	15 Mapping Trough and Trench S of Guam	16 Completed mapping S of Guam
17 Mapping in W	18 Mapping in W	19 Mapping in W	20 Mapping in W	21 Completed mapping, transit, arrive Guam	22	23
24	25	26	27	28	29	30
31						

Appendix 4. Cruise Personnel

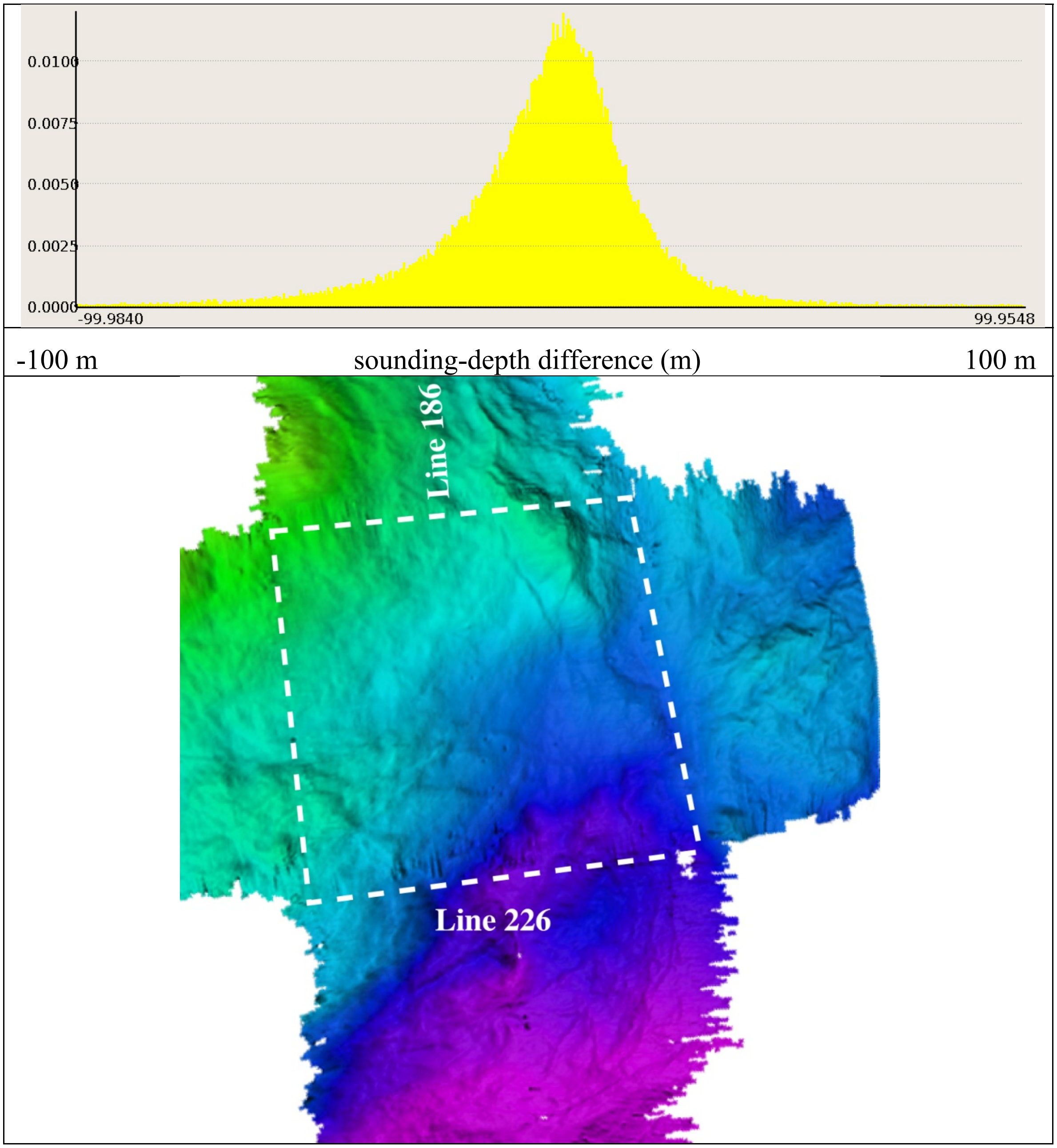
Andrew Armstrong	NOAA/UNH Representative/Chief Scientist
Gordon Marsh Senior	NAVOCEANO Representative
Melissa Odom	NAVOCEANO System Administrator
Matthew Thompson	NAVOCEANO Lead Bathymetrist
Betty Howell	NOCEANO Physical Oceanography Lead
Wesley Hillstrom	NAVOCEANO Watch stander
Matthew Kuhn	NAVOCEANO Watch stander
Paul White	NAVOCEANO Lead Electronics Technician
Julius Jackson	NAVOCEANO Electronics Technician
Capt. Kristin Mangold	Ship's Master, 3PCS Inc.

Appendix 5. Cross-check Analyses



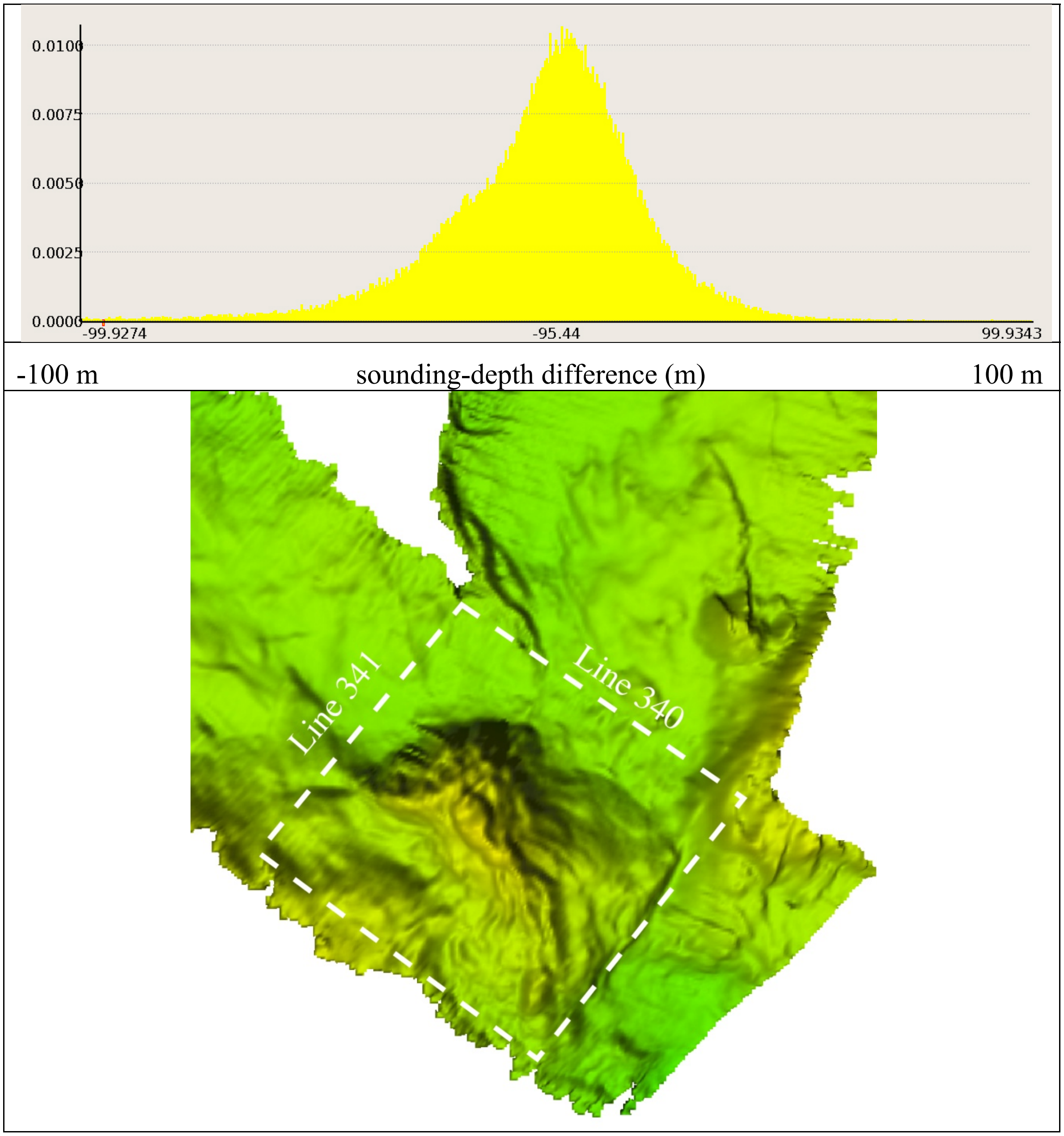
(upper) Histogram of sounding-depth differences from cross-line check of Line 182 and Line 174. (lower) DTM showing area of cross-line check (dashed polygon).

Line 182 vs line 174	Mean water depth	8857 m
	Mean Z difference	9.52 m
	Standard deviation	25.0 m
	Number of samples	73,221
	Percent of water depth	0.7% at 2σ



(upper) Histogram of sounding-depth differences from cross-line check of Line 186 and Line 226. (lower) DTM showing area of cross-line check (dashed polygon).

Line 186 vs line 226	Mean water depth	6494 m
	Mean Z difference	0.85 m
	Standard deviation	21.5 m
	Number of samples	93,229
	Percent of water depth	0.7% at 2σ



(upper) Histogram of sounding-depth differences from cross-line check of Line 340 and Line 341. (lower) DTM showing area of cross-line check (dashed polygon).

Line 340 vs line 341	Mean water depth	3095 m
	Mean Z difference	2.32 m
	Standard deviation	20.9 m
	Number of samples	104,311
	Percent of water depth	1.42% at 2σ