CRUISE REPORT

USNS *Bowditch*

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 BD07-1

November 16, to December 17, 2007

Garapan, Saipan, to Garapan, Saipan,
Commonwealth of the Northern Mariana Islands

James V. Gardner

Center for Coastal and Ocean Mapping/Joint Hydrographic Center
University of New Hampshire
Durham, NH 03824

January 1, 2008

UNH-CCOM/JHC Technical Report 08-001

Table of Contents

Introduction

This cruise is the second of two bathymetry cruises to the western insular margin of Guam and the Commonwealth of the Northern Mariana Islands. An exhaustive study of the U.S. data holdings pertinent to the formulation of U.S. potential claims of an extended continental shelf under the United Nations Convention of the Law of the Sea (UNCLOS) identified this area as one of the regions where new bathymetric surveys are needed (Mayer, et al., 2002). The report recommended that multibeam echosounder (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 geodetic isobath and second a geomorphic zone, are used to define an extended continental shelf claim. The Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) of the University of New Hampshire was directed by the U.S. Congress, through funding to the U.S. National Oceanic and Atmospheric Administration (NOAA) to conduct the new surveys and archive the resultant data. This is the cruise report of the second U.S. Law of the Sea cruise to complete the bathymetry mapping the Guam and Northern Mariana Islands western insular margin (Figs.1 and 2). Most of the introduction, systems descriptions, data processing and area description are taken directly from the first Marianas cruise report (Gardner, 2006) because the same ship and systems were used during both cruises.

NOAA entered into an agreement with the U.S. Naval Oceanographic Office (NAVOCEANO) to conduct the second bathymetry survey to begin November 16, 2007. NAVOCEANO made available the 329-ft, 5000-ton hydrographic ship USNS *Bowditch* (Fig. 3) with a hull-mounted Kongsberg Simrad EM121A MBES and as a Knudsen 320 B/R 3.5-kHz sub-bottom profiler. The schedule for the cruise called for a single 31-day leg from Saipan to Saipan, 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 bathymetry, acoustic-backscatter and 3.5-kHz profiler processing aboard ship. The overall responsibility of cruise planning, both before and during the cruises, was the responsibilities of the UNH/NOAA representative aboard ship.

The cruise began with a 23-hr, 230-km, transit from Garapan, Saipan CNMI to an area where mapping ended in 2006 (Fig. 1). A full patch test, including a calibration of an XBT cast with a CTD and XSV casts, was performed in this area and was followed by 29 days of progressively mapping the insular margin from north to south. The cruise mapped a total of 92,151 km^2 in 28.5 survey days and collected 16,688 line km of MBES and 3.5-kHz profiler lines with an average speed of 12 kts. A summary of the cruises is given in Table 1.

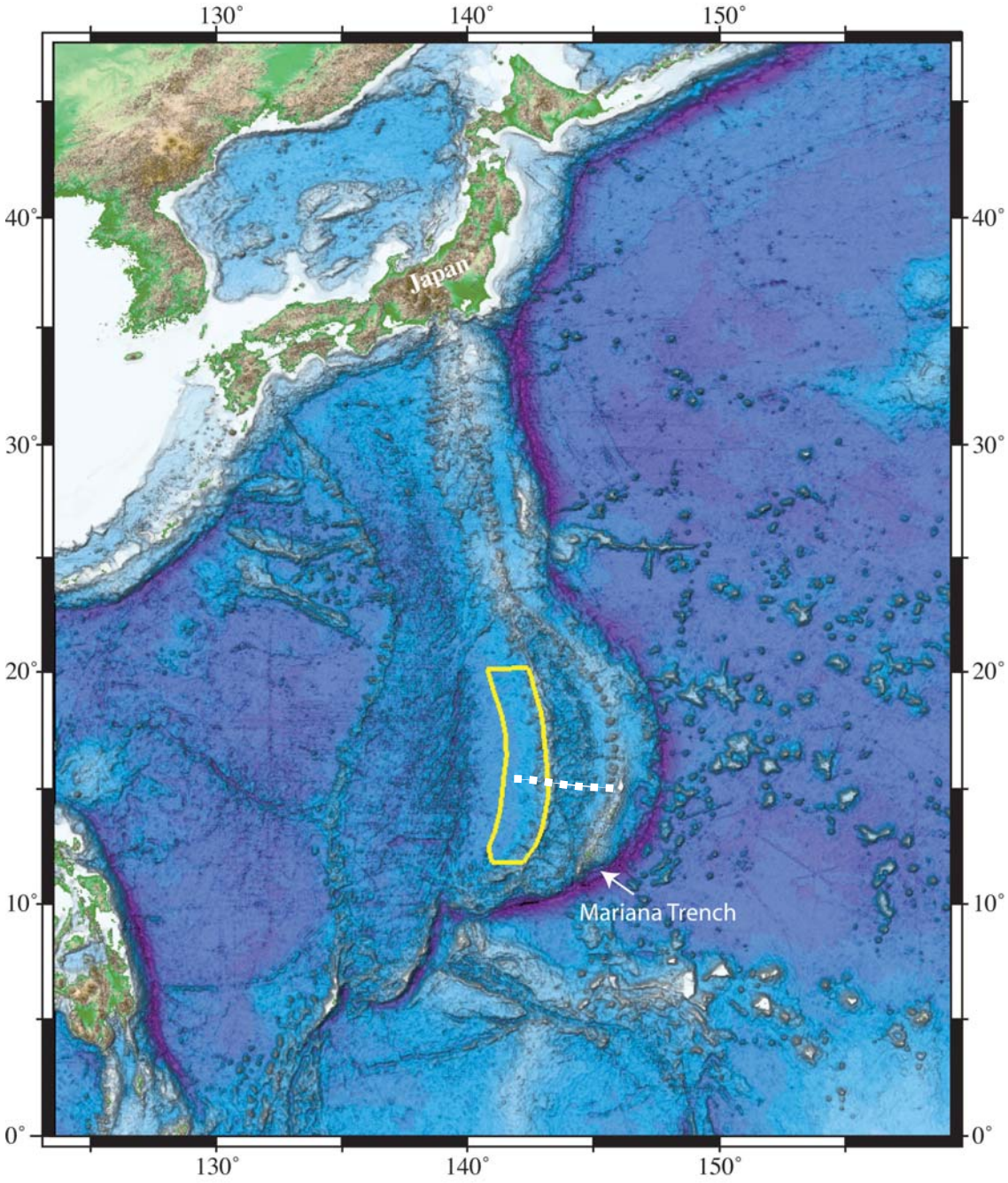


Figure 1. Transit track (white dashed line) from Saipan, CNMI to the patch test area. Yellow polygon outlines the 2006-2007survey area.

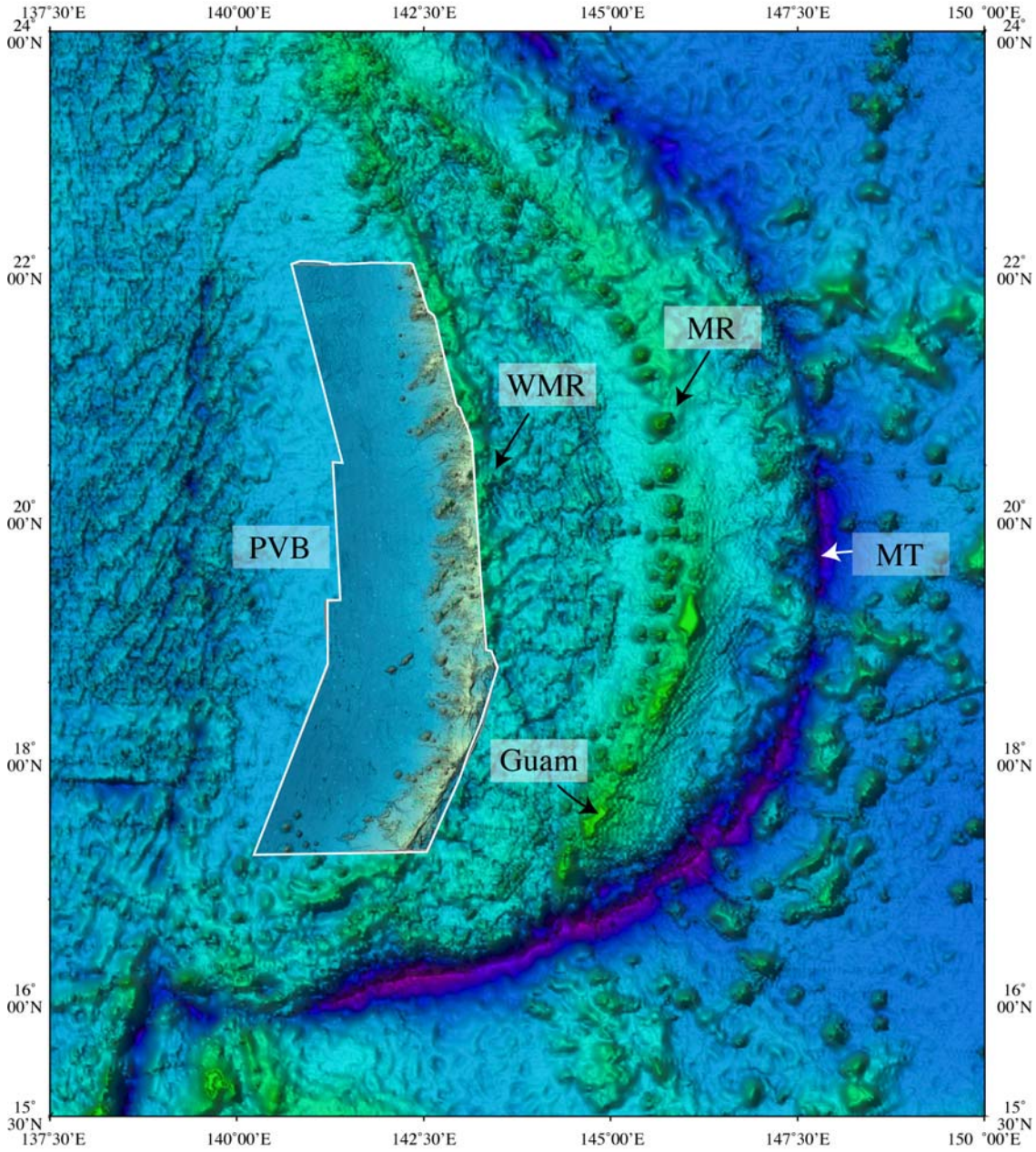


Figure 2. Map of area total mapped in 2006 and 2007 (white polygon). Background is ETOPO2 digital bathymetry. PVB is Parece Vela Basin, WMR is West Mariana Ridge, MR is Mariana Ridge and MT is Mariana Trench.

Figure 3. USNS *Bowditch* used to map the western insular margin of Guam and the Northern Mariana Islands.

The Multibeam Echosounder System and Associated Systems

A hull-mounted Kongsberg Simrad EM121A MBES system was used to map bathymetry and acoustic backscatter. The EM121A is a 12-kHz MBES system that generates 121-1˚ receive apertures over a 120˚ swath. An Applied Microsystems Ltd Smart SV&T sound-velocity sensors is used to measure the sound speed at the sonar array for accurate beamforming. Equiangular beamforming for the EM121A produces seafloor footprints of each receive beam that grow with angle away from nadir. For 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 interferometric phase detection. Individual soundings are spaced approximately every 50 m, regardless of survey speed. The manufacturer states that, at the 7-ms pulse length (deep mode), the system is capable of depth accuracies of 0.3 to 0.5% of water depth. A pulse length of 7 ms was used in depths shallower than 3000 m but the pulse length was increased to 20 ms in deeper depth to increase the signal-to-noise ratio.

The motion reference units (MRU) included a Applanix POS/MV 320 version 3 for instantaneous heave, pitch and roll and a Sperry Model Mark 39 gyro for heading. The EM121A system can incorporate transmit beam steering up to ±10˚ from vertical, roll compensation up to ±10˚ but does not compensate for yaw. The Applanix POS/MV was also interfaced with two Trimble Force 5 GRAM-S GPS receivers using Navcom Defense Electronics Starfire SF2050R Wide Area Differential-Aided GPS (DGPS) that provide position fixes with an accuracy of < ±0.5 m. All horizontal positions were georeferenced to the WGS84 ellipsoid and vertical referencing was to instantaneous sea level.

The Simrad EM121A is capable of simultaneously collecting full time-series acoustic backscatter along with the bathymetry. This represents a time series of 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 calibrated backscatter should provide clues as to the composition of the surficial seafloor.

Water-column sound-speed profiles were calculated from casts of Sippican model Deep Blue (760 m maximum depth) expendable bathythermographs (XBTs) to measure temperature as a function of depth routinely every 6 hours and between scheduled casts as required. A Sea Bird Electronics model SBE 911+ CTD and a Sippican model XSV were used to calibrate the XBTs during the patch test. Derived sound-speed profiles were compared between the systems to calibrate the XBT.

All systems are referenced to a stable reference mark co-located with the POS/MV sensors and Sperry Mark 39 gyro. The position of each system was surveyed relative to the reference mark providing a table of initial offsets (Table 1). A patch test was run immediately prior to the mapping to determine any static offset corrections (Tables 1 and 2).

Ancillary Systems

A Knudsen 320B/R 3.5-kHz high-resolution echosounder was deployed throughout the cruise. Data were recorded in SEG-Y format using 1500 m/s for the sound speed. Each 3.5-kHz line coincides with a multibeam line. The Knudsen SEG-Y data were processed aboard ship using SonarWeb (Chesapeake Technology, Inc.).

The Knudsen system was configured to operate in the low-frequency mode with a 500-m window. The automatic gain control (AGC) was disabled, the pulse length was set for a 24 ms and the time varying gain (TVG) was set at “bottom reflection”. This produced a high-quality record and allowed the system to operate in the “autophase” mode

MBES Data Processing

The raw Simrad multibeam bathymetry and acoustic backscatter data were processed aboard ship using the University of New Brunswick’s SwathEd software suite, version 200708096. Each Simrad raw.all files was collected by the onboard Simrad Merlin 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. Each raw.all file was renamed from the system-generated file name to *Mariana_Line_n_raw.all* (see Table 4) so that later each file could be easily identified to the area. The line numbers for the 2007 leg commenced with the next in the sequence (Marianas_line 103) from the end of the 2006 Marianas leg. Each raw.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.

Table 1. Initial system sensor offsets

Parameter	meters	Parameter	meters
Draft on Nov. 17, 2007	5.48	**MK39 Calibration**	
Draft on Dec. 16, 2007	5.40	Calibration Date	11/17/07
Alongship Offset	3.29	MK39 Roll Delay	0.00
Athwart Offset	0.00	MK39 Roll Offset-S	0.14
Motion Sensor Menu		MK39 Roll Offset-I	0.51
Calibration date	n/a	MK39 Roll Offset-D	0.49
Ref to IMU lever arm X	0.520	MK39 Pitch Offset-S	1.30
Ref to IMU lever arm Y	-0.180	MK39 Pitch Offset-I	1.45
Ref to IMU lever arm Z	-0.300	MK39 Pitch Offset-D	0.10
Ref to primary GPS lever arm X	-4.710	Gyro Offset	0.21
Ref to primary GPS lever arm Y	0.020		
Ref to primary GPS lever arm Z	-30.040	**Position System Menu**	
2-antenna separation	1.9990	Time Delay	0
Heading calibration threshold (deg)	0.1000	**ISS60 Vessel File**	
Baseline vector X	-1.9990	EM121A transducer Location X	0.00
Baseline vector Y	0.0120	EM121A transducer Location Y	0
Baseline vector Z	0.0120	EM121A transducer Location Z	0.00

Table 2. Offset corrections determined by Patch Test

Offset	Value
roll	0
pitch	0
yaw	0
latency	0

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 maps and the co-registered valid acoustic backscatter full beam time series is assembled into a file and gridded into area mosaics.

The entire region to be mapped was subdivided into 41 area maps and mosaics (Fig. 4). Each area map and mosaic was designed to maximize the spatial resolution allowed by the mapped water depths within the area. The region was also subdivided into larger North, Central and South regional maps and mosaics with 100 m/pixel spatial resolution (Figs. 5, xx and XX). Bathymetry and the full-beam time-series acoustic backscatter were gridded into the appropriate area maps and mosaics and the appropriate area maps and mosaics were gridded into the various regional maps.

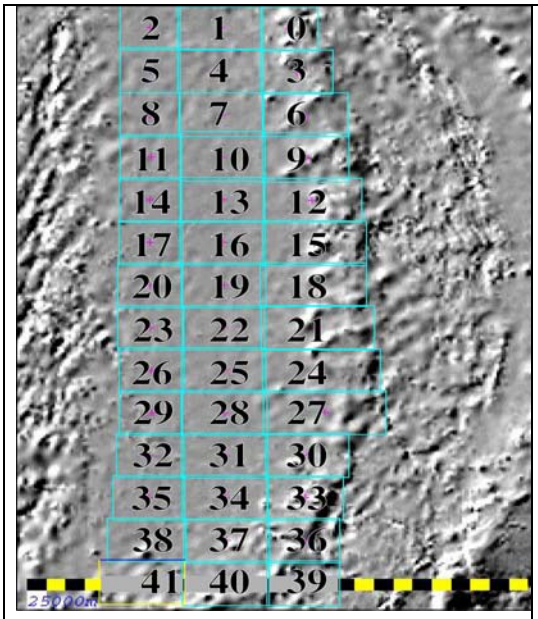


Figure 4. Index of subarea maps.

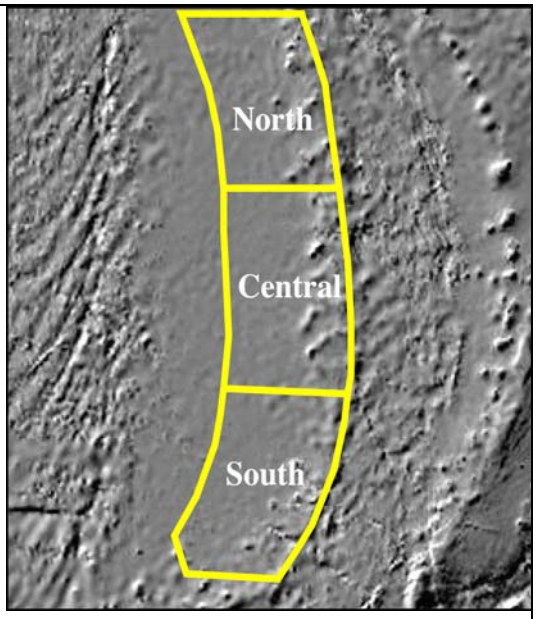


Figure 5. Index of regional maps

The Area: West Mariana Ridge and eastern half of the Parece Vela Basin

The area to be mapped during the Marianas cruises was defined in Mayer et al., 2002 as the western insular slope of the West Mariana Ridge and eastern Parece Vela Basin, both of which are located west of Guam and the Commonwealth of the Northern Mariana Islands (Fig. 2, white polygon). In order to satisfy the requirements of UNCLOS Article 76, the region between the ~1500 and 4800-m isobaths were mapped to provide the necessary bathymetry for the development of a potential U.S. extended continental shelf claim beyond the U.S. EEZ.

The general region is located in the eastern Philippine Sea and is composed of the Parece Vela Basin on the west to the Mariana Trench on the east (Fig. 2). Geologically, the region is the western portion of the Mariana island-arc system, with all the structural and physiographic elements of a classic island-arc-trench system (Karig, 1971). The specific area of the island-arc system mapped during this cruise is the eastern part of the back-arc basin (eastern Parece Vela Basin) and an inactive volcanic arc (West Mariana Arc).

The geological history of these two elements has been discussed by Karig (1971; 1975), Mrozowski and Hayes (1979) and Stern et al. (2003). There is general

agreement that the Parece Vela Basin formed as a back-arc basin in the Late Oligocene to Early Miocene (~30 to ~17 Ma) by seafloor spreading along a N-S-trending axis (Mrozowski and Hayes, 1979; Kasuga and Ohara, 1997). However, Kasuga and Ohara (1997) propose a second stage of spreading occurred late in the basin's evolution by a ridge axis rotated to NNW-SSE. A later suggestion by Okino et al. (1998) is that the Parece Vela Basin spreading center during this second stage was a series of short *en echelon* segments broken by numerous fracture zones. Apparently, seafloor speading ceased in the Parece Vela Basin about 17 Ma and the basin is presently inactive (Karig, 1971; Sdrolias, et al., 2004; Stern et al., 2003).

The West Mariana Ridge is an inactive volcanic island arc that appears to have ceased activity at ~5 Ma in the Late Miocene to Early Pliocene (Karig, 1971; Stern et al., 2003). Karig (1971) suggested the West Mariana Ridge has subsided at least 1 km since volcanic activity ceased.

The eastern Parece Vela Basin is blanketed by a thick apron of Middle to Early Miocene volcanoclastic sediments derived from the now-dormant West Mariana Ridge. Seismic profiles of the eastern side of Parece Vela Basin shows sediment thicknesses in excess of 1500 m (Karig, 1971). Deep Sea Drilling Project Sites 53 and 59 and Ocean Drilling Site 450 drilled the distal portion of the eastern Parece Vela Basin and generally recovered only ~100 m of sediment before encountering Miocene basement (Karig, 1975; Kroenke et al., 1981). Deposition of volcanic ash ceased in the Late Miocene (~10 Ma) and was replaced by slowly accumulating pelagic brown clay and volcanoclastics (Karig, 1971).

This cruise represents the second cruise to systematically collect multibeam bathymetry in this particular region of the eastern Parece Vela Basin and West Mariana Ridge although the Hydrographic Department of Japan has carried out extensive multibeam and multichannel seismic surveys immediately to the west and north of the survey area (Kasuga and Ohara, 1997; Okino et al., 1998; Okino et al., 1999).

Daily Log

JD 320 (Friday Nov. 16, 2007)

The ship departed Garapan, Saipan at 1300 L (JD 320 0300 Z) and steamed directly for the patch test site. No data were allowed to be collected until we reached the eastern boundary of the survey area. The transit line commenced with Mariana Line 103. I was notified that the autotracking system was not working and the survey lines would have to be steered by hand; certainly not ideal, but doable.

JD 321 (Saturday Nov. 17,2007)

We arrived at the patch test area at 1300 L in a sea state of ~3-ft swells and 10-knt winds. An XBT and two XSVs were launched just prior to the CTD station and then the deep-water CTD cast was made. Figure 6.

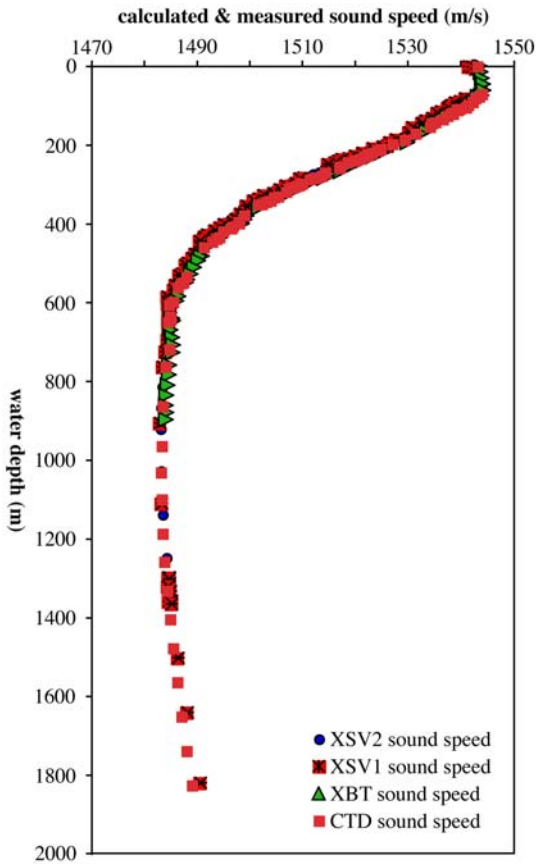


Figure 6. Comparison of sound speed calculated from CTD (red squares) and XBT (green triangles) and measured from XSVs (blue circle and red X squares) casts prior to patch test.

shows comparisons of calculated and measured sound speeds in the top 2000 m of water column. The XBT showed excellent calibration to the CTD and XSVs so the patch test was begun. The patch test was completed at 2300 L and we steamed to begin mapping on line 107.

JD 322 (Sunday Nov. 18, 2007)

Line 107 was begun at 1644Z (02444L). A major crash on the UNH Windows XP system on the UNH dual-boot laptop occurred in the morning. This required a long phone call back to the UNH-CCOM IT manager to talk through the required repair of the operating system. The entire operation took ~3 hr to complete. At the end, the Windows XP operating system seemed to be up and running once again.

The NAVO watchstander forgot to end logging of Line 108 on both the Simrad and Knudsen systems at the end of the Julian Day (1000L) and to restart logging at the beginning of the new Julian Day. Consequently, Line 108 bridges JD 321 and JD322. The raw GSF file did increment at the new Julian Day and started a new file (62mba07322_p_100.d01).

The first 2007 line (Line 107) that overlaps a 2006 line showed an average +8 dB backscatter relative to the 2006 backscatter. An additional processing script was added to the *doss* script: glgain –add –port -4 –stbd -4 original.ss_bp adjusted.ss_bp. The script saves the original file as *filename.ss_bp_orig* and the adjusted file as *filename.ss_bp*.

Conditions were ideal for mapping all day.

JD 323 (Monday Nov. 19, 2007)

Routine day of mapping. The NE Trades were blowing a constant 30 kts, and by afternoon had created an 8-ft swell. The swell was quartering our bow, creating rolls of ±5˚ with occasional 10˚ rolls. However, the data continue to look good. A cross-line check using 16980 common soundings between Line 108 and the 2006 dipline (Line 61) in the area shows a mean difference between the two surfaces of 2.53 m (σ= ±9.49 m) (Fig. 7) at a mean water depth of 4544 m, giving a depth precision of 0.05% of water depth.

By evening the winds had come up to 40 kts and the seas were 10 to 12 ft. The ship motion was fairly severe with a corkscrew motion giving pitching and rolling in excess of 10˚, but the data continued to look acceptable.

Mapping was halted during the night for an hour by a demand from NAVO in Stennis asking for a reboot of the shipboard server. Apparently, they were having a problem downloading our data. A strongly worded request went back to NAVO that they not interfere with our UNCLOS mapping because this is not a NAVO mission.

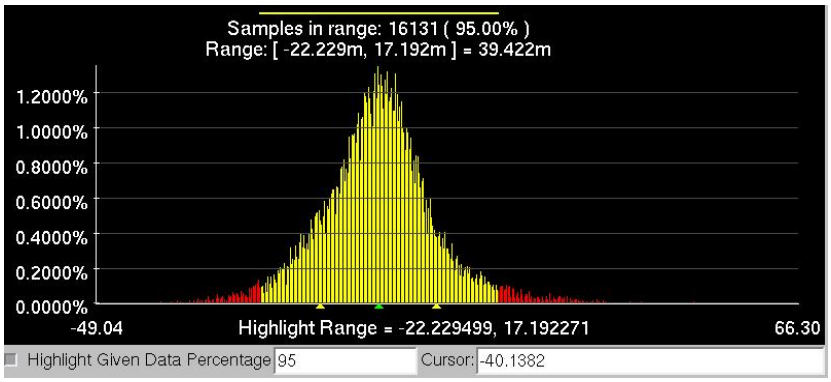


Figure 7. Cross-line check of Line 108 and Dipline 61. Horizontal scale is difference in soundings in meters and vertical scale is percentage of soundings differences in each difference bin.

JD 324 (Tuesday Nov. 20, 2007)

The winds were reduced to ~20 kts by early morning and the seas subsided somewhat but were still 8 to 10 ft and stayed that way all day. Lines 112 and 113 show the effects of the ±5˚ of pitching and ±10˚ of rolling with lots of dropouts, but the data were good enough to continue mapping.

JD 325 (Wednesday Nov. 21, 2007)

Conditions improved during the night and wind was down to 15 kts by morning and the sea had subsided to ~6 ft, however, . The data quality improved with the conditions. At 2254Z during Line 115 the helmsman lost the line and got far off course. The line was terminated; we circled around and resumed the line as Line 116.

The Knudsen 3.5-kHz subbottom profiler produced excellent records throughout the bad weather (8. The differences between the sound speed measured at the transducers and the value calculated for the transducer depth from the XBT cast stayed less than 0.3 m/s and refraction was not evident in the data.

The ISS-60 locked up at 0115Z and Line 17 was terminated, we doubled back on the track and started Line 18. The Knudsen profiler started recording a lot of noise around 0530Z on Line 18. After 10 minutes of very noisy data the bottom signal was lost. When the bottom return was reacquired, the data were very clean.

The portion of EM121A Line 18 around 0500 to 0635Z shows pronounced amount yaw. The yaw was caused by a combination of poor manual steering, required because the ship's autotrack was inoperable, and a 20-knt wind on the ship's quarter. The lack of yaw steering in the EM121A is noticeable on this line.

The Central area was completed at 0635Z (1425L) and we deadheaded to the start of the dipline in the South area.

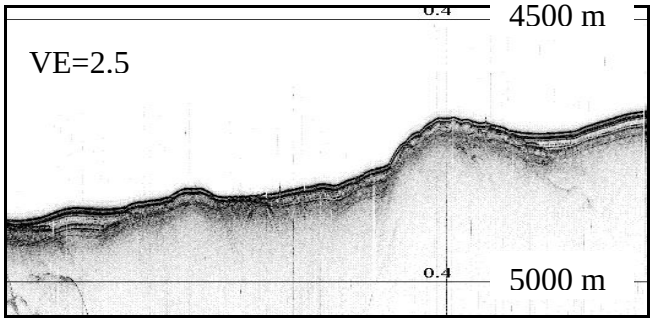


Figure 8. Example of Knudsen 3.5-kHz subbottom profile taken from Line 114.

A satellite measurement of low-level winds in the western Pacific (Fig. 9) that showed the large tropical low that has caused all our recent weather. The low was forecast to move north, well away from our location.

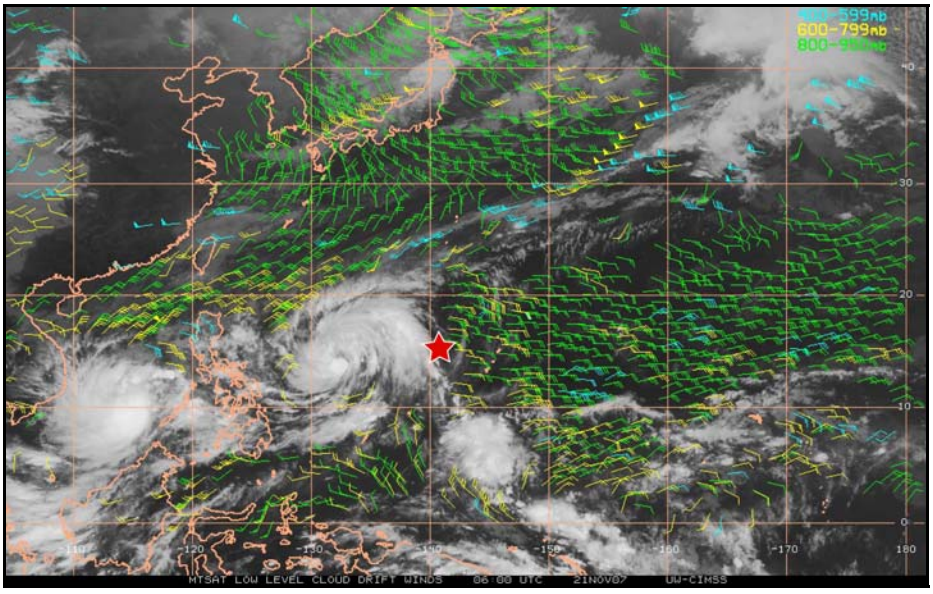


Figure 9. Low-level winds for 21 November 2007Z. Position of ship is shown by red star. From http://cimiss.ssec.wisc.edu/tropcal/real-time/westpac/winds/wgmsir.html.

During Line 120 it was discovered that the backscatter recorded in the Simrad raw.all file was corrupted between 00:58:47Z to 02:15:33Z. That section was removed

from the backscatter mosaic and this section was rerun during the transit to the Central area to fill-in holidays.

JD 326 (Thursday Nov. 22, 2007)

The seas calmed down during the night and the winds were only ~15 kts during the morning. The dipline for the South area (Line 120) was completed in the early morning. It appeared that every time the pulse length on the multibeam was changed, the Simrad logger created a new raw.all file. This resulted in 6 files for the dipline (Line 120a through 120f). It was decided to leave the pulse length at 12 ms. The first N-S line (Line 121) was run to the west of the crest of the West Mariana Ridge to determine the actual depths of the summits.

The Knudsen system created several short line segments during Line 121 for unknown reasons. Each new segment advanced the line number.

At 0515Z we crossed the summit of a volcano with a depth of 40 m. The multibeam and the Knudsen echosounder both could not track the bottom in these shallow depths but the bridge echosounder kept a bottom lock and recorded the 40-m depth.

JD 327 (Friday Nov. 23, 2007)

Conditions remained with ~10- to 15- knt Trade Winds but the seas had subsided to 3- to 5-ft swells. Conditions were perfect for mapping.

A sequence of multipaths off the adjacent seamount, occurred several times on Lines 122 and 123 (Fig. 10) that are clearly artifacts. The near-and mid-range area of the soundings in the artifact areas show a sequence of soundings that are ~1000 m lower than the upper sequence (left panel, Fig. 10). When the deeper sequence is edited out (right panel, Fig. 10), a large hole occurs in the data. This phenomenon occurred three times in Line 122 and twice in Line 123 and in each case the artifact was edited out, leaving a hole in the data (Fig. 11). The hole will be mapped on the next line.

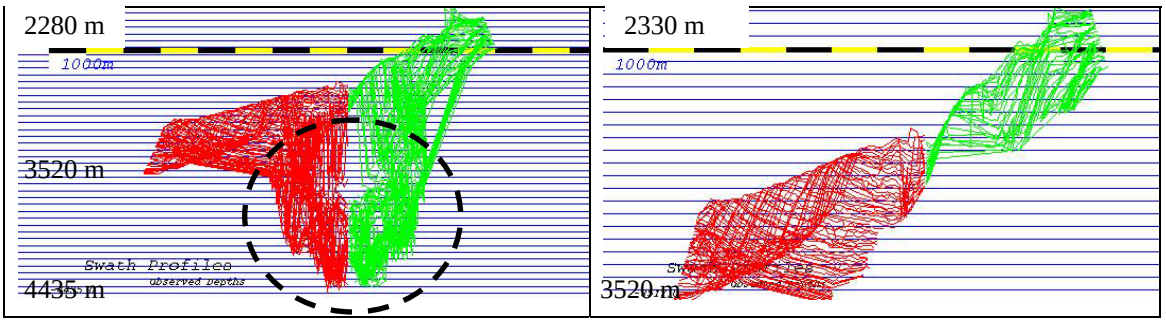


Figure 10. Line 122 multipath soundings (black dashed oval). Left panel is unedited; right panel is edited.

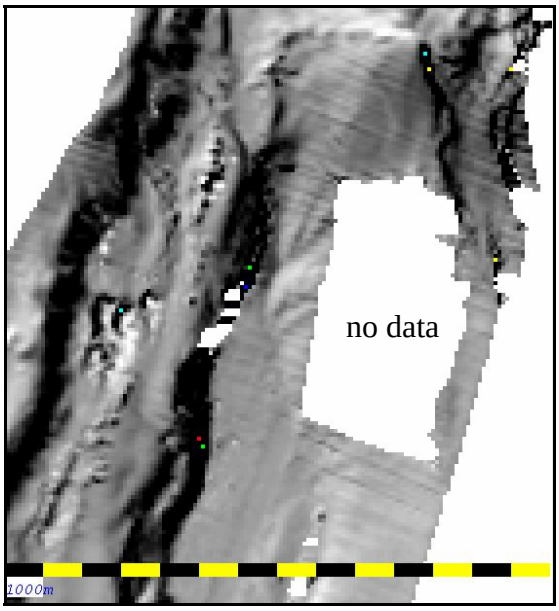


Figure11. Hole left in DTM of Line 122 after removing multipath soundings.

JD 328 (Saturday Nov. 24, 2007)

The wind picked up in the early morning and by early afternoon they were blowing a steady 20 kts and the seas were 6 to 8 ft. The seas were again quartering our bow, making for an uncomfo

JD 329 (Sunday Nov. 25, 2007)

The wind continued to blow at a steady 20 kts and the seas stayed at 6 to 8 ft, both quartering our bow. Yaw is evident in the data but the data quality is still high.

A cross-line check of dip-line Line 120 vs. Line 127 shows a mean difference in 15,689 soundings of 5.6 m at a mean water depth of 3141 m, giving a precision of 0.1% (2σ ±73.2 m) of the water depth (Fig.12).

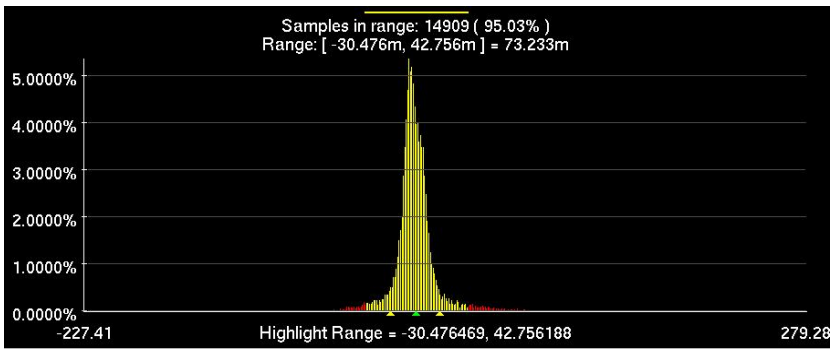


Figure 12. Cross-line check of Line 120 vs. Line 127.

After the completion of Line 130, we transited to the eastern side of the South area and ran a line south along the entire eastern edge to ensure all of the 2500-m isobath was in hand.

JD 330 (Monday Nov. 26, 2007)

The entire day was spent filling in holidays in the data, traveling from south to north to complete the mapping of the West Mariana Ridge summit area. Wind and seas continued from yesterday and the data quality are still good.

JD 331 (Tuesday Nov. 27, 2007)

The weather continued to be rough throughout the day with rain, winds at 20 kts and seas running 6 to 8 ft. A large subtropical disturbance west of us (Fig. 13) caused all the weather and the forecast was for the disturbance to stay stationary for the next 24 hr. The data continue to be good in spite of the sea state.

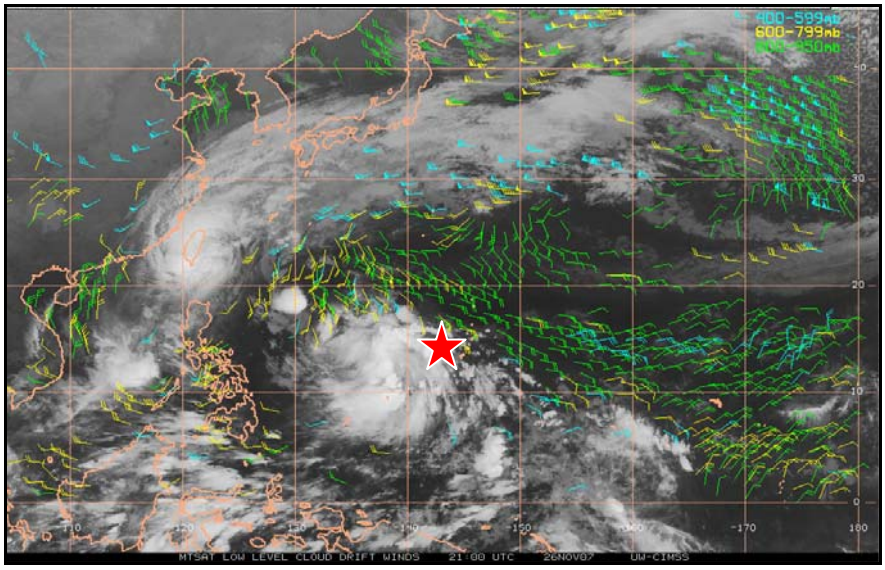


Figure13 Low-level winds for November 27, 2007. Ship position shown by red star.

The filling-in of holidays was completed just before the end of the Julian day (end of JD 330). We then transited to the start of Line 147 that continued the long NE-SW lines working west in the South area.

The EM121A inexplicitly lost bottom detection for ~20 minutes on a relatively flat and smooth bottom. The bottom tracking gate with decreased to the immediate depths and the bottom was detected. The pulse width had been reset to 7 ms and but we were now in 3000-m water depths. The pulse width was increased to 15 ms and no further problems occurred.

JD 332 (Wednesday Nov. 28, 2007)

The wind and seas calmed down a bit in the morning but were still on our quarter giving us a fairly uncomfortable ride with of yaw in the data. By mid afternoon, the wind and seas were calm, the ride settled down and the data quality improved.

Some kind of noise/interference is periodically showing up on the Knudsen 3.5-kHz profiler and the MBES data (Fig. 14). The noise suddenly appears and just as suddenly disappears after 30 to 40 minutes. The radio operator was not transmitting during the noisy interval but the Master says the ship is having grounding problems. There is no sign of the noise on the multibeam data.

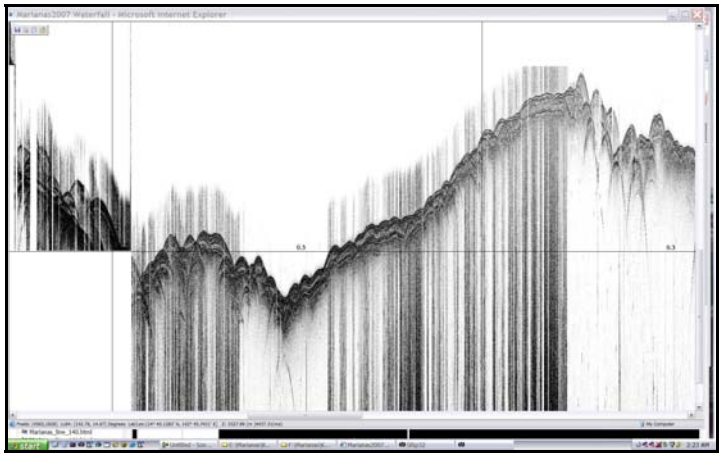


Figure 14 Interference on the 3.5-kHz profiler.

JD 333 (Thursday Nov. 29, 2007)

Routine day of mapping in ideal conditions. The periodic interference continued to occur and appeared to be related to something the ship's crew was doing with the electrical wiring on the mast. After recording the times the interference occurred, it was discovered the deck department was using a needle gun on the deck plates directly above the MBES transducers. When I asked them to stop, the interference disappeared. I kindly requested to the Captain that the needle gun be put away for the duration of the cruise.

JD 334 (Friday Nov. 30, 2007)

Routine day of mapping in ideal conditions. A cross-line check between Dipline 120 and Line 161 shows a precision of 0.1% (σ = ±8.4 m; n = 11,798) of water depth.

JD 335 (Saturday Dec. 1, 2007)

Routine day of mapping in ideal conditions.

JD 336 (Sunday Dec. 2, 2007)

Routine day of mapping. The wind rose throughout the morning and by noon it was blowing a steady 30 kts. The wind caused the ship to crab and yaw artifacts throughout the data.

JD 337 (Monday Dec. 3, 2007)

The POS/MV crashed at 0745Z. Line 181 was ended, the POS/MV was rebooted and we continued the line as Line 182. The NE Trades continued to blow at a steady 25 kts throughout the night and day. The seas were ~6 ft on our quarter, making for an uncomfortable corkscrew ride and generating a lot of yaw artifacts in the bathymetry because of the difficulty of steering a straight course. However, even with the yaw artifacts, a cross-line check of dipline 120 vs. Line 182 (Fig.15) shows a precision of 0.1% (s = 8.5 m; n = 18,526).

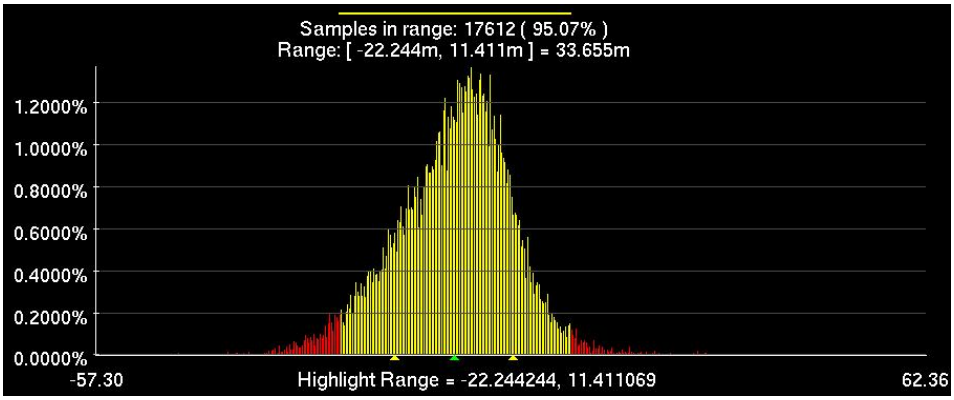


Figure 15. Cross-line check of Dipline 120 vs. Line 182.

The wind and seas subsided somewhat in the mid afternoon, improving the ride and the data quality.

JD 338 (Tuesday Dec. 4, 2007)

The ship's starboard thruster began arcing and required the ship to run on only the port thruster for about 2 hr while the starboard thruster was cleaned and brushes were inspected. Running on only one thruster reduced our speed to ~5 kts for the 2 hours. During this slow-speed time, the multibeam dropping numerous pings and the ship had considerable crab, both of which degraded the data. Although data were collected during the 2 hr of the repair, the data contained so many dropped pings that they were considered not acceptable. We came about and returned to the point where we began the repairs and reran the line. Line 188 was not gridded into the DTM. Only 3 hr of mapping were lost for the repairs.

JD 339 (Wednesday Dec. 5, 2007)

It was discovered that the watchstander did not increment the GSF file on the turn between Line 189 and 190 so that the GSF file 62mba07338_p_100.d02 has data from both Line 190 and Line 191, but without the turn.

The day had relatively calm seas with only ~15 kts of wind.

The data backup RAID server (NAS1) locked up at the end of Line 194 at 0700Z. Repeated efforts to reboot it initially failed. Finally, after about an hour, the system rebooted. No data were lost and, because NAS1 is only a backup to NAS2, there was no concern for the mapping mission.

JD 340 (Thursday Dec. 6, 2007)

Cloudy and rainy but the seas and wind were down from yesterday and conditions were good for mapping. Routine day of mapping.

JD 341 (Friday Dec. 7, 2007)

The winds were back up to a steady 30 kts and the seas built all day, making for another lumpy, uncomfortable ride in 6- to 8-ft seas. The data show lots of dropouts on the northbound lines because of bubble sweep. However, a cross-line check of Dipline 120 vs. Line 201 still shows a depth precision of 0.1% (2σ=19 m; n=17,412) of water depth.

JD 342 (Saturday Dec. 8, 2007)

Routine day of mapping in lumpy 6-ft seas with 20-kt winds. Data quality good. The wind and seas calmed during the afternoon and by evening the seas were down to 3 to 4 ft.

JD 343 (Sunday Dec. 9, 2007)

Three to 4-ft seas and 10-kt Trade Winds made for a relatively smooth ride and very high-quality data. Routine day of mapping. A cross-line check of Line 205 with Dipline 120 (Fig. 16) shows a mean difference of 2 m (σ=±9 m; n=17,166), which is equivalent to be 0.2% of water depth for 95% of the soundings; well within Kongsberg Simrad specifications for the EM121A.

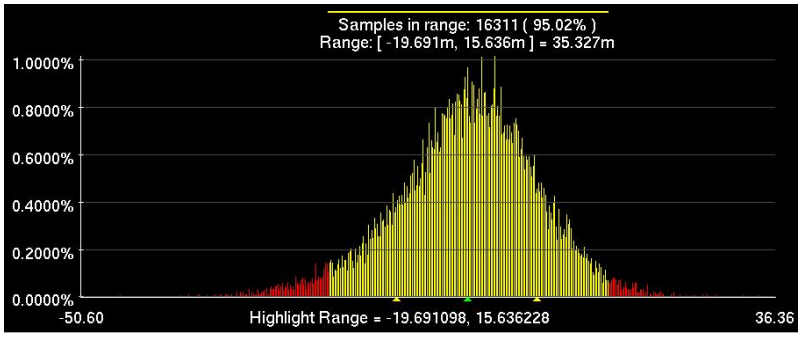


Figure 16. Cross-line check of Line 205 with Dipline 120.

JD 344 (Monday Dec. 10, 2007)

The Simrad Merlin logging system locked up at the start of Line 206 and about 20 minutes of data were lost. The lost section will be mapped at the completion of the last long NE-SW line (Line 207) in the South area. Line 208 completed the long NE-SW lines in the South area. The seas were 4- to 6-ft and the NE Trades blew a constant 15 kts. Data quality was good to excellent with only a bit of yaw artifact.

We began to fill in holidays starting with a few in the South area. The large holiday created by the removal of a section of Line 120 was the major fill-in in the South area.

A mix-up in numbering lines occurred during the night watch so that there is no Line 212 (raw.all or GSF).

JD 345 (Tuesday Dec. 11, 2007)

The fill-ins of holidays in the South area were completed early in the morning and we transited to the Central area and began filling in holidays in the 2006 data. Conditions were very good for mapping and the data quality was excellent.

A hang-up of the ISS-60 resulted in GSF file *62mba07345_p_100.d07* containing both Simrad files *0220_101207_114930_raw.all* (Line 220) *and 0221_101207_134117_raw.al* (Line 212).

JD 346 (Wednesday Dec. 12, 2007)

Routine day of mapping filling in holidays in the Central area. The weather was almost calm with 2-ft seas and 10-kt wind. During the night, the watch messed up the file naming so that the 3.5-kHz lines *2007_346_1809_LF_238* and *2007_346_1831_LF_238* and Simrad line *0238_101207_180932_raw.all* are included in GSF file *62mba07346_p_100.d11*. The Simard Merlin logging system was advance to line 240 so that there is no line 239.

JD 347 (Thursday Dec. 13, 2007)

Routine day of mapping filling in holidays in the Central area.

JD 348 (Thursday Dec. 14, 2007)

Routine day of mapping filling in holidays in the Central area.

JD 349 (Friday Dec. 15, 2007)

The mapping was competed at 0700L (2200Z JD348) and we began the transit to Saipan.

References Cited

Karig, D. E., 1971, Structural history of the Mariana Island arc system. Geological Society of America Bulletin, v. 82, p. 323-344.

Karig, D.E., Ingle, J.C., et al. (eds.), 1975, Initial Reports of the Deep Sea Drilling Program, v. 31. US Government Printing Office, Washington.

Karig, D.E., 1975, Basin genesis in the Philippine Sea, in Karig, D.E., Ingle, J.C., et al. (eds.), Initial Reports of the Deep Sea Drilling Program, v. 31, p. 857-879 US Government Printing Office, Washington.

Kasuga, S. and Ohara, Y., 1997, A new model of back-arc spreading in the Parece Vela Basin, northwest Pacific margin. The Island Arc, v. 6, 316-326.

Kroenke, L., et al., 1981, Site 450: East side of the Parece Vela Basin, in Kroenke, L., Scott, R., et al. (eds.) Initial Reports of the Deep Sea Drilling Project, v. 59, p. 487-502. US Government Printing Office, Washington.

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.

Mrozowski, C.L. and Hayes, D.E., 1979, The evolution of the Parece vela Basin, eastern Philippine Sea. Earth and Planetary Science Letters, v. 46, p. 49-67.

Okino, K., Kasuga, S., and Ohara, Y., 1998, A new scenario of the Parece Vela Basin genesis. Marine Geophysical Researches, v. 20, p. 21-40.

Okino, K., Ohara, Y., Kasuga, S. and Kato, Y., 1999, The Philippine Sea: New survey results reveal the structure and history of the marginal basins. Geophysical Research Letters, v. 26, p. 2287-2290.

Sdrolias, M., Roest, W.R., and Müller, R.D., 2004, An expression of Philippine Sea plate rotation: the Parece Vela and Shikoku Basins, Tectonophysics, v. 394, p. 69-86.

Stern, R.J., Fouch, M.J., and Klemperer, S.L., 2003, An overview of the Izu-Bonin-Mariana subduction factory. In Eiler, J. (ed.) Inside the subduction factory, Geophysical Monograph 138, American Geophysical Union, Washington D.C., p. 175-222.

Table 3. Cruise Statistics

Dates	JD320 to 348
Weather delays	0 days
Total non-mapping days (transits)	2.5 days
Total mapping days	28.5 days
Line kilometers of survey	16,688 km
Total area mapped	92,151 km^2
Beginning draft	5.48 m
Ending draft	5.40 m
Average ship speed for survey	12.5 kts
Total Marianas area mapped	185,151 km^2

Table 4. Conversion table of NAVO raw.all and NAVO GSF file names to UNH file names by Julian Day

JD	Data Folder	NAVO file name _raw.all	UNH file name _raw.all	NAVO GSF file name
320	**071116**	**6_161107_140429**	**Marianas_line_103 (tran)**	**62mba07320_p_100.d01**
320	071116	6_161107_151507	Marianas_line_104 (tran)	no file
320	071116	6_161107_153037	Marianas_line_105 (tran)	No file
320	071116	7_161107_154114	Marianas_line_106 (tran)	62mba07320_p_100.d02
321	**071117**	**0010_171107_092511**	**Marianas_line_patch1**	62mba07321_p_100.d03
321	071117	0012_171107_100927	Marianas_line_patch3	62mba07321_p_100.d05
321	071117	0013_171107_105251	Marianas_line_patch4	62mba07321_p_100.d06
321	071117	0014_171107_112812	Marianas_line_patch5	62mba07321_p_100.d07
321	071117	0015_171107_115501	Marianas_line_patch6	62mba07321_p_100.d08
321	071117	0103_171107_163426	Marianas_line_107	62mba07321_p_100.d11
321	071117	0108_171107_232753	Marianas_line_108	62mba07321_p_100.d013
322	**071118**	**file continued from day 071117**	**Marianas_line_108 (cont.)**	**62mba07322_p_100.d01**
322	071118	0109_181107_140249	Marianas_line_109	62mba07322_p_100.d03
323	**071119**	**0110_191107_000010**	Marianas_line_110	62mba07323_p_100.d01
323	071119	0111_191107_034126	Marianas_line_111	62mba07323_p_100.d02
323	071119	0112_191107_174556	Marianas_line_112	62mba07323_p_100.d04
324	**071120**	**0113_201107_000001**	**Marianas_line_113**	**62mba07324_p_100.d01**
324	071120	0114_201107_072558	Marianas_line_114	62mba07324_p_100.d02
324	071120	0115_201107_211240	Marianas_line_115	62mba07324_p_100.d03
324	071120	0116_201107_231643	Marianas_line_116	62mba07324_p_100.d05
325	**071121**	**0117_211107_000002**	**Marianas_line_117**	**62mba07325_p_100.d01**
325	071121	0118_211107_011906	Marianas_line_118	62mba07325_p_100.d03
325	071121	0119_211107_023945	Marianas_line_119	62mba07325_p_100.d04
325	071121	0120_211107_080507	Marianas_line_120a(dipline)	62mba07325_p_100.d05
325	071121	0121_211107_165314	Marianas_line_120b(dipline)	No file
325	071121	0121_211107_165447	Marianas_line_120c(dipline)	No file
325	071121	0121_211107_165644	Marianas_line_120d(dipline)	No file
325	071121	0121_211107_165910	Marianas_line_120e(dipline)	No file
325	071121	0121_211107_172556	Marianas_line_120f(dipline)	No file
325	071121	0121_211107_211107	Marianas_line_121	62mba07325_p_100.d06
326	**071122**	**0122_221107_000007**	**Marianas_line_122**	**62mba07326_p_100.d01**
326	071122	0123_221107_121014	Marianas_line_123	62mba07326_p_100.d03
327	**071123**	**0124_231107_000000**	**Marianas_line_124**	**62mba07327_p_100.d01**
327	071123	0125_231107_015831	Marianas_line_125	62mba07327_p_100.d02
327	071123	0126_231107_152427	Marianas_line_126	62mba07327_p_100.d03
328	**071124**	**0127_241107_000001**	**Marianas_line_127**	**62mba07328_p_100.d01**
328	071124	0128_241107_052607	Marianas_line_128	62mba07328_p_100.d02
328	071124	0129_241107_194421	Marianas_line_129	62mba07328_p_100.d03

Table 4 continued

JD	Data Folder	NAVO file name _raw.all	UNH file name _raw.all	NAVO GSF file name
329	**071125**	**0130_251107_000001**	**Marianas_line_130**	**62mba07329_p_100.d01**
329	071125	0131_251107_113449	Marianas_line_131	62mba07329_p_100.d02
330	**071126**	**0132_261107_010615**	**Marianas_line_132**	**62mba07330_p_100.d01**
330	071126	0133_261107_022908	Marianas_line_133	62mba07330_p_100.d02
330	071126	01343_261107_041347	Marianas_line_134	62mba07330_p_100.d03
330	071126	0135_261107_072615	Marianas_line_135	62mba07330_p_100.d04
330	071126	0136_261107_081257	Marianas_line_136	62mba07330_p_100.d05
330	071126	0137_261107_101723	Marianas_line_137	62mba07330_p_100.d06
330	071126	0138_261107_112850	Marianas_line_138	62mba07330_p_100.d07
330	071126	0139_261107_125355	Marianas_line_139	62mba07330_p_100.d08
330	071126	0140_261107_1132418	Marianas_line_140	62mba07330_p_100.d09
330	071126	0141_261107_163430	Marianas_line_141	62mba07330_p_100.d10
330	071126	0142_261107_172220	Marianas_line_142	62mba07330_p_100.d11
330	071126	0143_261107_184858	Marianas_line_143	62mba07330_p_100.d12
330	071126	0144_261107_204344	Marianas_line_144	62mba07330_p_100_A.d13
330	071126	0145_261107_220000	Marianas_line_145	62mba07330_p_100_B.d13
331	**071127**	**0146_271107_003606**	**Marianas_line_146**	**62mba07331_p_100.d01**
331	071127	0147_271107_153042	Marianas_line_147	62mba07331_p_100.d02
332	**071128**	**0148_281107_000002**	**Marianas_line_148**	**62mba07332_p_100.d01**
332	071128	0149_281107_011636	Marianas_line_149	62mba07332_p_100.d02
332	071128	0150_281107_022707	Marianas_line_150	62mba07332_p_100.d03
332	071128	0151_281107_045247	Marianas_line_151	62mba07332_p_100.d04
332	071128	0152_281107_093313	Marianas_line_152	62mba07332_p_100.d05
332	071128	0153_281107_112436	Marianas_line_153	62mba07332_p_100.d06
332	071128	0154_281107_135510	Marianas_line_154	62mba07332_p_100.d07
333	**071129**	**0155_291107_000001**	**Marianas_line_155**	**62mba07333_p_100.d01**
333	071129	0156_291107_033742	Marianas_line_156	62mba07333_p_100.d02
333	071129	0157_291107_15736	Marianas_line_157	62mba07333_p_100.d03
333	071129	0158_291107_132408	Marianas_line_158	62mba07333_p_100.d04
333	071129	0159_291107_155754	Marianas_line_159	62mba07333_p_100.d05
333	071129	0160_291107_172007	Marianas_line_160	62mba07333_p_100.d06
333	071129	0161_291107_214152	Marianas_line_161	62mba07333_p_100.d07
334	**071130**	**0162_301107_000001**	**Marianas_line_162**	**62mba07334_p_100.d01**
334	071130	0163_301107_072246	Marianas_line_163	62mba07334_p_100.d02
334	071130	0164_301107_082505	Marianas_line_164	62mba07334_p_100.d03
334	071130	0165_301107_101819	Marianas_line_165	62mba07334_p_100.d04
334	071130	0166_301107_160855	Marianas_line_166	62mba07334_p_100.d05
334	071130	0167_301107_190911	Marianas_line_167	62mba07334_p_100.d06
334	071130	0168_301107_204829	Marianas_line_168	62mba07334_p_100.d07
335	**071201**	**0169_011207_000001**	**Marianas_line_169**	**62mba07335_p_100.d01**
335	071201	0170_011207_003210	Marianas_line_170	62mba07335_p_100.d02
335	071201	0171_011207_011913	Marianas_line_171	62mba07335_p_100.d03
335	071201	0172_011207_102620	Marianas_line_172	62mba07335_p_100.d04
335	071201	0173_011207_112707	Marianas_line_173	62mba07335_p_100.d05

Table 4 continued

335	071201	0174_011207_120816	Marianas_line_174	62mba07335_p_100.d06
335	071201	0175_011207_123855	Marianas_line_175	62mba07335_p_100.d07
335	071201	0176_011207_131807	Marianas_line_176	62mba07335_p_100.d08
335	071201	0177_011207_161448	Marianas_line_177	62mba07335_p_100.d09
336	**071202**	**0178_021207_000001**	**Marianas_line_178**	**62mba07336_p_100.d01**
336	071202	0179_021207_060629	Marianas_line_179	62mba07336_p_100.d02
336	071202	0180_021207_092822	Marianas_line_180	62mba07336_p_100.d03
336	071202	0181_021207_110007	Marianas_line_181	62mba07336_p_100.d04
336	071202	0182_021207_202506	Marianas_line_182	62mba07336_p_100.d05
336	071202	0183_021207_235520	Marianas_line_183	62mba07336_p_100.d06
337	**071203**	**0184_031207_000003**	**Marianas_line_184**	**62mba07337_p_100.d01**
337	071203	0185_031207_143152	Marianas_line_185	62mba07337_p_100.d02
337	071203	0186_031207_171323	Marianas_line_186	62mba07337_p_100.d03
337	071203	0187_031207_182029	Marianas_line_187	62mba07337_p_100.d04
337	071203	0188_031207_194309	Marianas_line_188 (bad)	62mba07337_p_100.d05
338	**071204**	**0189_041207_002136**	**Marianas_line_189**	**62mba07338_p_100.d01**
338	071204	0190_041207_120009	Marianas_line_190	62mba07338_p_100.d02
338	071204	0191_041207_131732	Marianas_line_191	62mba07338_p_100.d02 (cont)
338	071204	0192_031207_142613	Marianas_line_192	62mba07338_p_100.d03
339	**071205**	**0193_051207_004021**	**Marianas_line_193**	**62mba07339_p_100.d01**
339	071205	0194_051207_034730	Marianas_line_194	62mba07339_p_100.d02
339	071205	0195_051207_085003	Marianas_line_195	62mba07339_p_100.d03
339	071205	0196_051207_221829	Marianas_line_196	62mba07339_p_100.d04
339	071205	0197_051207_234803	Marianas_line_197	62mba07339_p_100.d05
340	**071206**	**0198_061207_000001**	**Marianas_line_198**	**62mba07340_p_100.d01**
340	071206	0199_061207_005327	Marianas_line_199	62mba07340_p_100.d02
340	071206	0200_061207_152214	Marianas_line_200	62mba07340_p_100.d03
341	**071207**	**0201_071207_000000**	**Marianas_line_201**	**62mba07341_p_100.d01**
341	071207	0202_071207_055711	Marianas_line_202	62mba07341_p_100.d02
341	071207	0203_071207_194710	Marianas_line_203	62mba07341_p_100.d03
342	**071208**	**0204_081207_000001**	**Marianas_line_204**	**62mba07342_p_100.d01**
342	071208	0205_081207_101235	Marianas_line_205	62mba07342_p_100.d02
343	**071209**	**0206_091207_003401**	**Marianas_line_206**	**62mba07343_p_100.d01**
343	071209	0207_091207_140918	Marianas_line_207	62mba07343_p_100.d02
344	**071210**	**0208_101207_000000**	**Marianas_line_208**	**62mba07344_p_100.d01**
344	071210	0209_101207_034905	Marianas_line_209	62mba07344_p_100.d02
344	071210	0210_101207_063513	Marianas_line_210	62mba07344_p_100.d03
344	071210	0211_101207_122617	Marianas_line_211	62mba07344_p_100.d05
344	071210	0213_101207_160459	Marianas_line_213	62mba07344_p_100.d06

Table 4 continued.

JD	Data Folder	NAVO file name _raw.all	UNH file name _raw.all	NAVO GSF file name
344	071210	0211_101207_122617	Marianas_line_211	62mba07344_p_100.d05
344	071210	0213_101207_160459	Marianas_line_213	62mba07344_p_100.d06
345	**071211**	**0214_111207_012301**	**Marianas_line_214**	**62mba07345_p_100.d01**
345	071211	0215_111207_022814	Marianas_line_215	62mba07345_p_100.d02
345	071211	0216_111207_032537	Marianas_line_216	62mba07345_p_100.d03
345	071211	0217_111207_075339	Marianas_line_217	62mba07345_p_100.d04
345	071211	0218_111207_093915	Marianas_line_218	62mba07345_p_100.d05
345	071211	0219_111207_104306	Marianas_line_219	62mba07345_p_100.d06
345	071211	0220_111207_114930	Marianas_line_220	62mba07345_p_100.d07
345	071211	0221_111207_134117	Marianas_line_221	62mba07345_p_100.d07
345	071211	0222_111207_151350	Marianas_line_222	62mba07345_p_100.d08
345	071211	0223_111207_163301	Marianas_line_223	62mba07345_p_100.d09
345	071211	0224_111207_180628	Marianas_line_224	62mba07345_p_100.d10
345	071211	0225_111207_200152	Marianas_line_225	62mba07345_p_100.d11
345	071211	0226_111207_211736	Marianas_line_226	62mba07345_p_100.d12
345	071211	0227_111207_221914	Marianas_line_227	62mba07345_p_100.d13
346	**071212**	**0228_121207_000001**	**Marianas_line_228**	**62mba07346_p_100.d01**
346	071212	0229_121207_011514	Marianas_line_229	62mba07346_p_100.d02
346	071212	0230_121207_023136	Marianas_line_230	62mba07346_p_100.d03
346	071212	0231_121207_045457	Marianas_line_231	62mba07346_p_100.d04
346	071212	0232_121207_060340	Marianas_line_232	62mba07346_p_100.d05
346	071212	0233_121207_071812	Marianas_line_233	62mba07346_p_100.d06
346	071212	0234_121207_081047	Marianas_line_234	62mba07346_p_100.d07
346	071212	0235_121207_090753	Marianas_line_235	62mba07346_p_100.d08
346	071212	0236_121207_103258	Marianas_line_236	62mba07346_p_100.d09
346	071212	0237_121207_130700	Marianas_line_237	62mba07346_p_100.d10
346	071212	0238_121207_180932	Marianas_line_238	62mba07346_p_100.d11
346	071212	0240_121207_210437	Marianas_line_240	62mba07346_p_100.d12
346	071212	0241_121207_223225	Marianas_line_241	62mba07346_p_100.d13
347	**071213**	**0242_131207_000544**	**Marianas_line_242**	**62mba07347_p_100.d01**
347	071213	0243_131207_005431	Marianas_line_243	62mba07347_p_100.d02
347	071213	0244_131207_013554	Marianas_line_244	62mba07347_p_100.d03
347	071213	0245_131207_022015	Marianas_line_245	62mba07347_p_100.d04
347	071213	0246_131207_031554	Marianas_line_246	62mba07347_p_100.d05
347	071213	0247_131207_061341	Marianas_line_247	62mba07347_p_100.d06
347	071213	0248_131207_075844	Marianas_line_248	62mba07347_p_100.d07
347	071213	0249_131207_090913	Marianas_line_249	62mba07347_p_100.d08
347	071213	0251_131207_114451	Marianas_line_250	62mba07347_p_100.d09
347	071213	0252_131207_144625	Marianas_line_251	62mba07347_p_100.d10
347	071213	0253_131207_180340	Marianas_line_252	62mba07347_p_100.d11
348	**071214**	**0254_141207_005512**	**Marianas_line_253**	**62mba07348_p_100.d01**
348	071214	0255_141207_022219	Marianas_line_254	62mba07348_p_100.d02
348	071214	0256_141207_030929	Marianas_line_255	62mba07348_p_100.d03

Table 4 continued.

348	071214	0257_141207_032955	Marianas_line_256	62mba07348_p_100.d04
348	071214	0258_141207_073716	Marianas_line_257	62mba07348_p_100.d05
			END OF CRUISE	

tran is transit line

Table 5. UNH line numbers and Knudsen file names by Julian Day

JD	Date	UNH Line no.	Knudsen File no. .sgy
320	**071116**	**Marianas_line_106 (tran)**	**2007_320_1538_LF_022**
320	071116	Marianas_line_107	2007_320_1538_LF_023
321	**071117**	**Patch test**	**2007_321_0000_LF_023**
321	071117	Patch test_	2007_321_0631_LF_024
321	071117	Patch test	2007_321_1351_LF_103
321	071118	Marianas_line_104	2007_321_1634_LF_104
321	071118	Marianas_line_108	2007_321_2328_LF_108
322	**071118**	**Marianas_line_109**	**2007_322_1402_LF_109**
323	**071119**	**Marianas_line_110**	**2007_323_0000_LF_110**
323	071119	Marianas_line_111	2007_323_0341_LF_111
323	071119	Marianas_line_112	2007_323_1746_LF_112
324	**071120**	**Marianas_line_113**	**2007_324_0000_LF_113**
324	071120	Marianas_line_114	2007_324_0726_LF_114
324	071120	Marianas_line_115	2007_324_2112_LF_115
324	071120	Marianas_line_116	2007_324_2316_LF_116
325	**071121**	**Marianas_line_117**	**2007_325_0000_LF_117**
325	071121	Marianas_line_118	2007_325_0119_LF_118
325	071121	Marianas_line_119	2007_325_0239_LF_119
325	071121	Marianas_line_119a	2007_325_0543_LF_123
325	071121	Marianas_line_120 (dip)	2007_325_0805_LF_120
325	071121	Marianas_line_121a	2007_325_2151_LF_121
325	071121	Marianas_line_121b	2007_325_2220_LF_122
325	071121	Marianas_line_121c	2007_325_2220_LF_123
325	071121	Marianas_line_121d	2007_325_2225_LF_124
325	071121	Marianas_line_121e	2007_325_2225_LF_125
326	**071122**	**Marianas_line_122d**	**2007_326_0525_LF_129**
326	071122	Marianas_line_122f	2007_326_0525_LF_131
326	071122	Marianas_line_123	2007_326_0525_LF_132
327	**071123**	**Marianas_line_124**	**2007_327_0000_LF_124**
327	071123	Marianas_line_125a	2007_327_0158_LF_125
327	071123	Marianas_line_125b	2007_327_1250_LF_127
327	071123	Marianas_line_126	2007_327_1524_LF_128
328	**071124**	**Marianas_line_127**	**2007_328_0003_LF_124**
328	**071124**	**Marianas_line_128**	**2007_328_0526_LF_125**
328	071124	Marianas_line_129	2007_328_1944_LF_126

Table 5 continued

JD	Date	UNH Line no.	Knudsen File no.
329	**071125**	**Marianas_line_130**	**2007_329_0000_LF_127**
329	071125	Marianas_line_131	2007_329_1135_LF_128
330	**071126**	**Marianas_line_132**	**2007_330_0106_LF_129**
330	071126	Marianas_line_133	2007_330_0229_LF_130
330	071126	Marianas_line_134	2007_330_0413_LF_134

330	071126	Marianas_line_135	2007_330_0726_LF_135
330	071126	Marianas_line_136	2007_330_0813_LF_136
330	071126	Marianas_line_137	2007_330_1017_LF_137
330	071126	Marianas_line_138	2007_330_1128_LF_138
330	071126	Marianas_line_139	2007_330_1253_LF_139
330	071126	Marianas_line_140	2007_330_1324_LF_140
330	071126	Marianas_line_141	2007_330_1634_LF_141
330	071126	Marianas_line_142	2007_330_1722_LF_142
330	071126	Marianas_line_143	2007_330_1849_LF_143
330	071126	Marianas_line_144	2007_330_2043_LF_144
330	071126	Marianas_line_145	2007_330_2200_LF_145
331	**071127**	**Marianas_line_146**	**2007_331_0036_LF_146**
331	071127	Marianas_line_147	2007_331_1530_LF_147
332	**071128**	**Marianas_line_148**	**2007_332_0000_LF_148**
332	071128	Marianas_line_149	2007_332_0115_LF_149
332	071128	Marianas_line_150	2007_332_0227_LF_150
332	071128	Marianas_line_151	2007_332_0452_LF_151
332	071128	Marianas_line_152	2007_332_0933_LF_152
332	071128	Marianas_line_153	2007_332_1124_LF_153
332	071128	Marianas_line_154	2007_332_1355_LF_154
333	**071129**	**Marianas_line_155**	**2007_333_0000_LF_155**
333	071129	Marianas_line_156	2007_333_0337_LF_156
333	071129	Marianas_line_1576	2007_333_1157_LF_157
333	071129	Marianas_line_158	2007_333_1324_LF_158
333	071129	Marianas_line_159	2007_333_1558_LF_159
333	071129	Marianas_line_160	2007_333_1720_LF_160
333	071129	Marianas_line_161	2007_333_2142_LF_161
334	**071130**	**Marianas_line_162**	**2007_334_0000_LF_162**
334	071130	Marianas_line_163	2007_334_0722_LF_163
334	071130	Marianas_line_164	2007_334_0825_LF_164
334	071130	Marianas_line_165	2007_334_1018_LF_165
334	071130	Marianas_line_166	2007_334_1609_LF_166
334	071130	Marianas_line_167	2007_334_1909_LF_167
334	071130	Marianas_line_168	2007_334_2048_LF_168
335	**071201**	**Marianas_line_169**	**2007_335_0000_LF_169**
335	071201	Marianas_line_170	2007_335_0032_LF_170
335	071201	Marianas_line_171	2007_335_0119_LF_171
335	071201	Marianas_line_172	2007_335_1026_LF_172

Table 5 continued

JD	Date	UNH Line no.	Knudsen File no.
335	071201	Marianas_line_173	2007_335_1127_LF_173
335	071201	Marianas_line_174	2007_335_1208_LF_174
335	071201	Marianas_line_175	2007_335_1238_LF_175
335	071201	Marianas_line_176	2007_335_1318_LF_176
335	071201	Marianas_line_177	2007_335_1614_LF_177
336	**071202**	**Marianas_line_178**	**2007_336_0000_LF_178**
336	071202	Marianas_line_179	2007_336_0606_LF_179

336	071202	Marianas_line_180	2007_336_0928_LF_180
336	071202	Marianas_line_181	2007_336_1100_LF_181
336	071202	Marianas_line_182	2007_336_2025_LF_182
336	071202	Marianas_line_183	2007_336_2355_LF_183
337	**071203**	**Marianas_line_184**	**2007_337_0000_LF_184**
337	071203	Marianas_line_185	2007_337_1432_LF_185
337	071203	Marianas_line_186	2007_337_1713_LF_186
337	071203	Marianas_line_187	2007_337_1820_LF_187
337	071203	Marianas_line_188 (bad)	2007_337_1943_LF_188
338	**071204**	**Marianas_line_189**	**2007_338_0021_LF_189**
338	071204	Marianas_line_190	2007_338_1200_LF_190
338	071204	Marianas_line_191	2007_338_1317_LF_191
338	071204	Marianas_line_192	2007_338_1426_LF_192
339	**071205**	**Marianas_line_193**	**2007_339_0040_LF_193**
339	071205	Marianas_line_194	2007_339_0347_LF_194
339	071205	Marianas_line_195	2007_339_0850_LF_195
339	071205	Marianas_line_196	2007_339_2218_LF_196
339	071205	Marianas_line_197	2007_339_2348_LF_197
340	**071206**	**Marianas_line_198**	**2007_340_0000_LF_198**
340	071206	Marianas_line_199	2007_340_0053_LF_199
340	071206	Marianas_line_200	2007_340_1522_LF_200
341	**071207**	**Marianas_line_201**	**2007_341_0000_LF_201**
341	071207	Marianas_line_202	2007_341_0557_LF_202
341	071207	Marianas_line_203	2007_341_1947_LF_203
342	**071208**	**Marianas_line_204**	**2007_342_0000_LF_204**
342	071208	Marianas_line_205	2007_342_1012_LF_205
343	**071209**	**Marianas_line_206**	**2007_343_0003_LF_206**
343	071209	Marianas_line_207	2007_343_1409_LF_207
344	**071210**	**Marianas_line_208**	**2007_344_0000_LF_208**
344	071210	Marianas_line_209	2007_343_0349_LF_209
344	071210	Marianas_line_210	2007_344_0635_LF_210
344	071210	Marianas_line_211	2007_344_1229_LF_211
344	071210	Marianas_line_213	2007_344_1605_LF_213

Table 5 continued

JD	Date	UNH Line no.	Knudsen File no.
345	**071211**	**Marianas_line_214**	**2007_345_0123_LF_214**
345	071211	Marianas_line_215	2007_345_0228_LF_215
345	071211	Marianas_line_216	2007_345_0325_LF_216
345	071211	Marianas_line_217	2007_345_0753_LF_217
345	071211	Marianas_line_218	2007_345_0939_LF_218
345	071211	Marianas_line_219	2007_345_1043_LF_219
345	071211	Marianas_line_220	2007_345_1149_LF_220

345	071211	Marianas_line_221	2007_345_1341_LF_221
345	071211	Marianas_line_222	2007_345_1513_LF_222
345	071211	Marianas_line_223	2007_345_1633_LF_223
345	071211	Marianas_line_224	2007_345_1806_LF_224
345	071211	Marianas_line_225	2007_345_2001_LF_225
345	071211	Marianas_line_226	2007_345_2117_LF_226
345	071211	Marianas_line_227	2007_345_2219_LF_227
346	**071212**	**Marianas_line_228**	**2007_346_0000_LF_228**
346	071212	Marianas_line_229	2007_346_0115_LF_229
346	071212	Marianas_line_230	2007_346_0231_LF_230
346	071212	Marianas_line_231	2007_346_0454_LF_231
346	071212	Marianas_line_232	2007_346_0603_LF_232
346	071212	Marianas_line_233	2007_346_0718_LF_233
346	071212	Marianas_line_234	2007_346_0810_LF_234
346	071212	Marianas_line_235	2007_346_0907_LF_235
346	071212	Marianas_line_236	2007_346_1033_LF_236
346	071212	Marianas_line_237	2007_346_1307_LF_237
346	071212	Marianas_line_238	2007_346_1809_LF_238
346	071212	Marianas_line_238	2007_346_1831_LF_239
346	071212	Marianas_line_240	2007_346_2104_LF_240
346	071212	Marianas_line_241	2007_346_2232_LF_241
347	**071213**	**Marianas_line_242**	**2007_346_0005_LF_242**
347	071213	Marianas_line_243	2007_346_0054_LF_243
347	071213	Marianas_line_244	2007_346_0136_LF_244
347	071213	Marianas_line_245	2007_346_0220_LF_245
347	071213	Marianas_line_246	2007_346_0316_LF_246
347	071213	Marianas_line_247	2007_346_0613_LF_247
347	071213	Marianas_line_248	2007_346_0758_LF_248
347	071213	Marianas_line_249	2007_346_0909_LF_250
347	071213	Marianas_line_250	2007_346_1144_LF_251
347	071213	Marianas_line_251	2007_346_1446_LF_252
347	071213	Marianas_line_252	2007_346_1803_LF_253
348	**071214**	**Marianas_line_253**	**2007_347__LF_254**
348	071214	Marianas_line_2543	2007_347__LF_255
348	071214	Marianas_line_255	2007_347__LF_256
348	071214	Marianas_line_256	2007_347__LF_257
348	071214	Marianas_line_257	2007_347__LF_258
		END OF CRUISE	

Table 6. Location of XBT cast

XBT number	Latitude N	Longitude E
28	16.066355	144.043818
29	16.579492	143.266000
30	16.694233	142.918245
31	17.208907	141.945150
32	17.281630	141.813917
36	17.399145	141.699870
37	17.127052	142.038931
38	17.407612	142.005013
39	17.643397	141.989990
40	18.541387	141.818995
42	18.061695	141.849723
43	18.032737	141.851595
44	18.782852	141.867530
45	17.313130	141.897510
46	16.997380	141.917514
47	16.119537	141.973292
48	16.516987	141.825147
49	16.700520	141.749870
50	17.996942	141.730942
51	17.857915	141.616731
52	16.598193	141.696988
53	15.724827	141.629313
54	16.230755	141.597217
55	16.907050	141.554330
56	18.154663	141.474837
57	17.304855	141.413932
58	16.049553	141.491845
59	16.052108	141.371745
60	15.791393	141.270997
61	15.308838	142.027312
62	15.235833	143.246800
63	15.315381	143.282927
64	14.128280	142.839030
65	13.032857	142.486052
66	14.178862	142.907421
67	14.422560	142.998503
68	15.359548	143.349202
69	14.929050	143.088412
70	13.634375	142.605273
71	13.522775	142.514013

Table 6 continued

XBT number	Latitude N	Longitude E
72	14.538692	142.892767
73	14.720972	142.960871
74	14.888615	143.023552
75	15.589338	143.226612
76	14.368105	142.769402
77	13.209767	142.338167
79	13.362653	142.335107
80	13.831440	142.509618
81	14.561689	142.782047
82	15.003989	142.947493
83	15.353103	143.396533
84	14.149255	142.946192
86	13.652578	142.567675
87	14.110028	142.77002
88	14.898988	143.155967
89	15.608088	143.186425
90	15.105110	142.925748
91	14.795630	142.809847
92	13.516742	142.332780
93	13.516788	142.253303
94	14.431853	142.594205
95	14.697123	142.693425
96	14.802065	142.732715
97	15.118277	142.861025
98	15.450101	143.013770
99	14.864057	142.676383
100	13.689697	142.238037
101	13.334193	142.036213
103	14.674132	142.576888
104	15.139333	142.709782
105	15.246678	142.660611
106	14.387457	142.339111
107	14.098167	142.257862
108	13.765067	142.107067
111	14.101745	142.142985
112	14.128438	142.153043
113	14.743145	142.382568
114	15.063410	142.502441
115	15.589200	142.731967
116	15.350592	142.500748
117	14.141112	142.048388

Table 6 continued

XBT number	Latitude N	Longitude E
118	13.571542	141.836198
119	13.730507	141.785888
120	14.869788	142.211215
121	15.501677	142.448030
122	15.734972	142.426302
123	15.174845	142.216130
124	14.566052	141.988233
125	13.271100	141.505713
126	13.173010	141.477767
127	13.589730	141.520980
128	14.736092	141.942432
129	15.714952	142.199998
130	14.901607	141.895052
131	14.619771	141.789600
132	14.251810	141.652035
133	13.621185	141.489095
134	13.202563	141.261637
135	13.656800	141.321093
136	14.841502	141.763183
137	15.624132	142.056495
138	14.692265	141.598030
139	13.491337	141.150065
140	13.537208	141.057845
141	14.634750	141.467090
142	15.689257	141.752880
143	14.472093	141.296973
144	13.245247	140.839908
145	13.850287	140.955663
146	15.137185	141.435442
147	15.262628	141.483447
148	15.340533	141.403368
149	15.288430	141.383773
150	14.090660	140.935840
151	13.975295	140.783528
152	14.173223	140.857367
153	14.217462	140.873780
154	15.502597	141.354669
155	14.904882	141.021305
156	14.540600	140.885010
157	13.695782	140.570037
158	13.307095	140.750553

Table 6 continued

XBT number	Latitude N	Longitude E
159	13.627978	141.879590
160	14.388250	142.697005
161	15.732212	142.886882
162	16.475068	142.712630
163	16.401040	142.627262
164	16.311203	142.890267
165	16.992297	142.916438
166	16.856505	142.861083
167	17.123027	142.673047
168	16.539405	143.017872
169	17.273956	142.903662
170	17.715171	142.898698
171	17.721773	142.839275
172	18.305343	142.758723
173	17.452325	142.956363
174	16.732725	142.608887
175	17.020680	142.591080
176	16.819135	142.987045
177	16.653800	143.108903
178	15.830548	143.325863
179	16.669673	143.325863
181	17.864232	143.210710
182	18.348707	143.178777

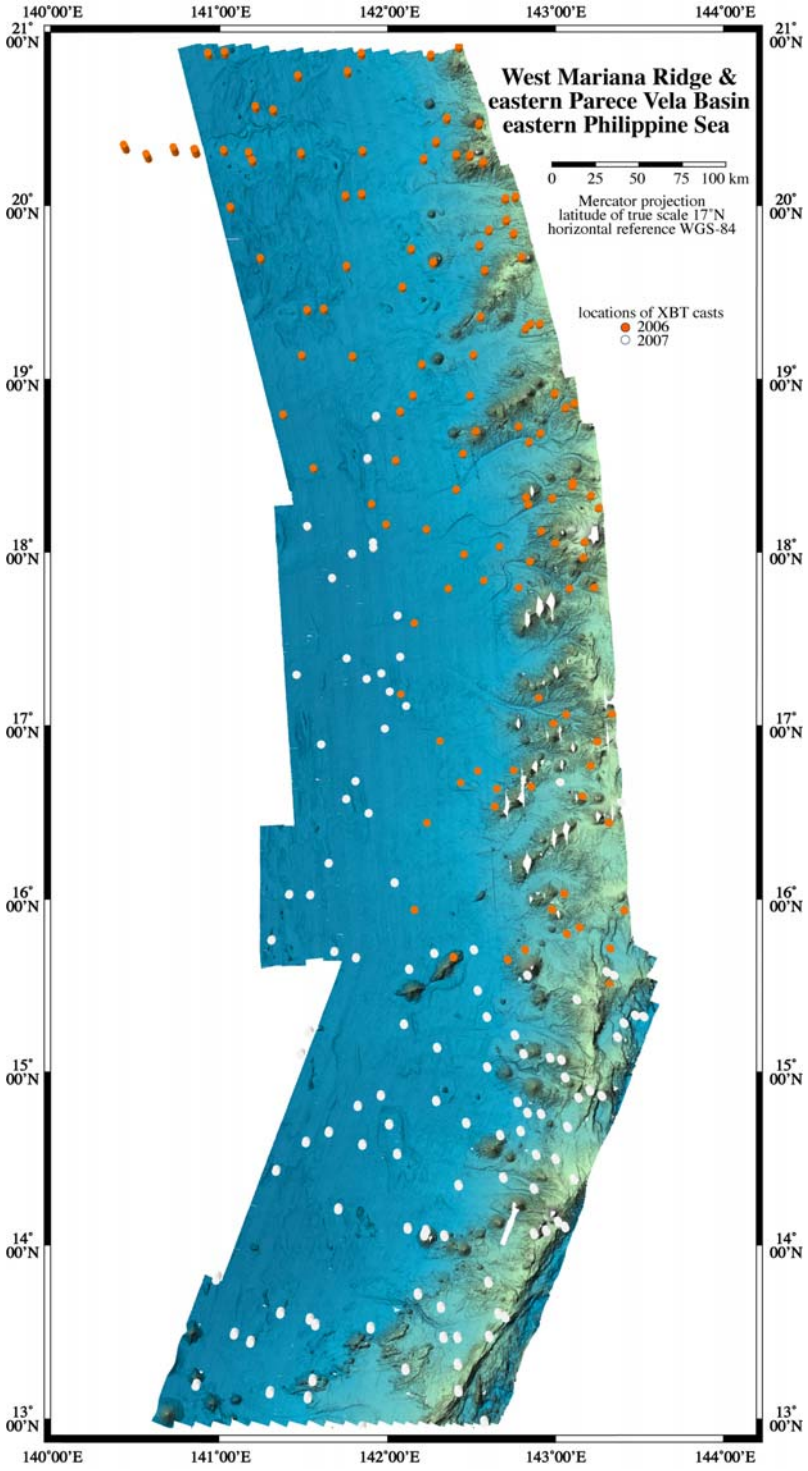


Figure 17. Map of 2006 (orange) and 2007 (white) locations of XBT and CTD casts. Backdrop is the newly acquired bathymetry. See Table 6 for details.

Appendix 1. Cruise Calendar

November 2007

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	JD320 16 depart Saipan 1300 L	JD321 17 transit & patch test
JD322 18 commence mapping in Central	JD323 19 mapping in Central	JD324 20 completed mapping Central	JD325 21 Dipline 120	JD326 22 started mapping South	JD327 23 mapping in South	JD328 24 mapping in South
JD329 25 mapping in South	JD330 26 mapping in South	JD331 27 mapping in South	JD332 28 mapping in South	JD333 29 mapping in South	JD334 30 mapping in South	JD335 1 mapping in South

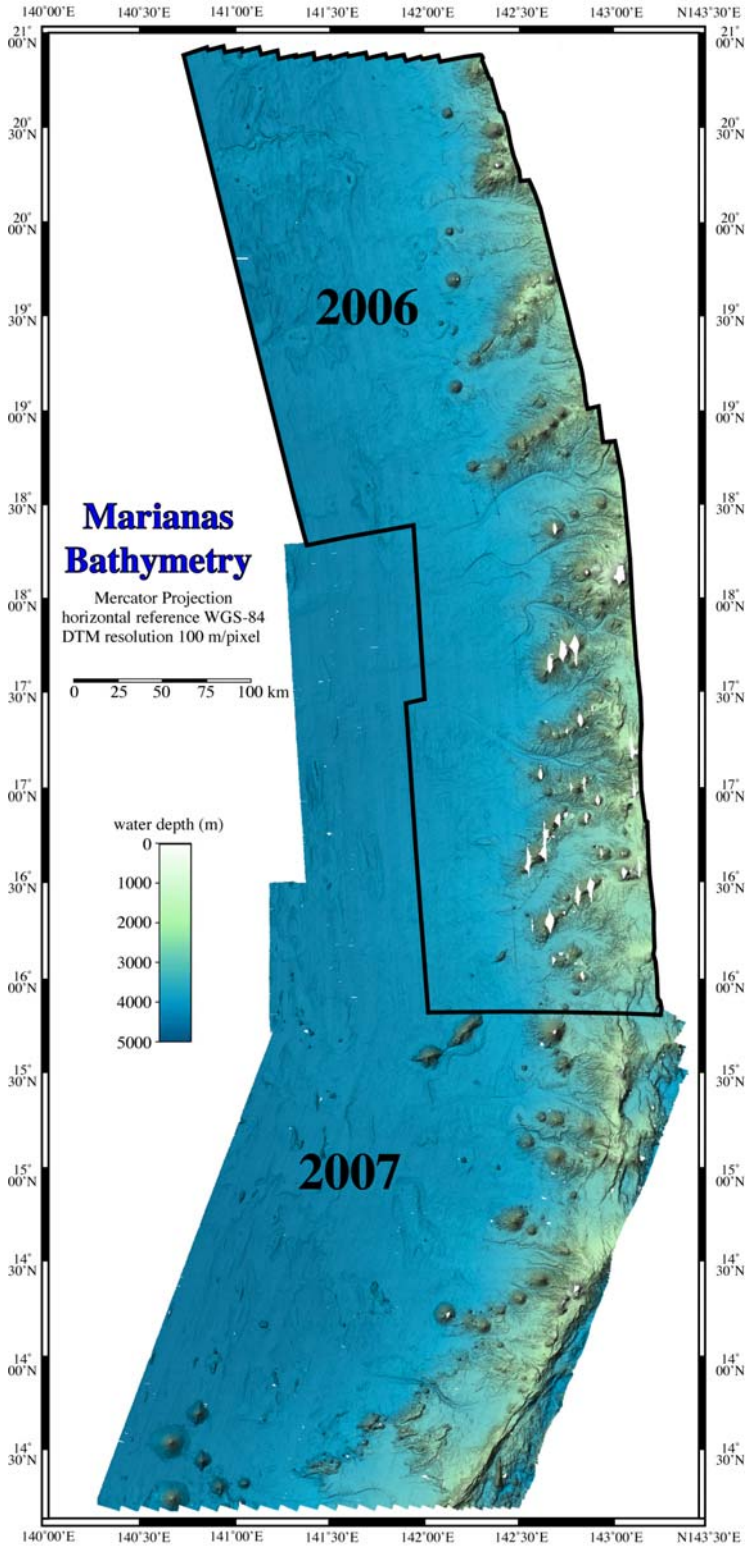
December 2007

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
JD336 2 mapping in South	JD337 3 mapping in South	JD338 4 mapping in South	JD339 5 mapping in South	JD340 6 mapping in South	JD341 7 mapping in South	JD342 8 mapping in South
JD343 9	JD344 10 completed mapping South	JD345 11 holiday filling South	JD346 12 holiday filling Central	JD347 13 holiday filling Central	JD348 14 holiday filling Central	JD349 15 end of mapping
JD350 16 transit to Saipan	JD351 17 arrive Saipan 0800 L	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

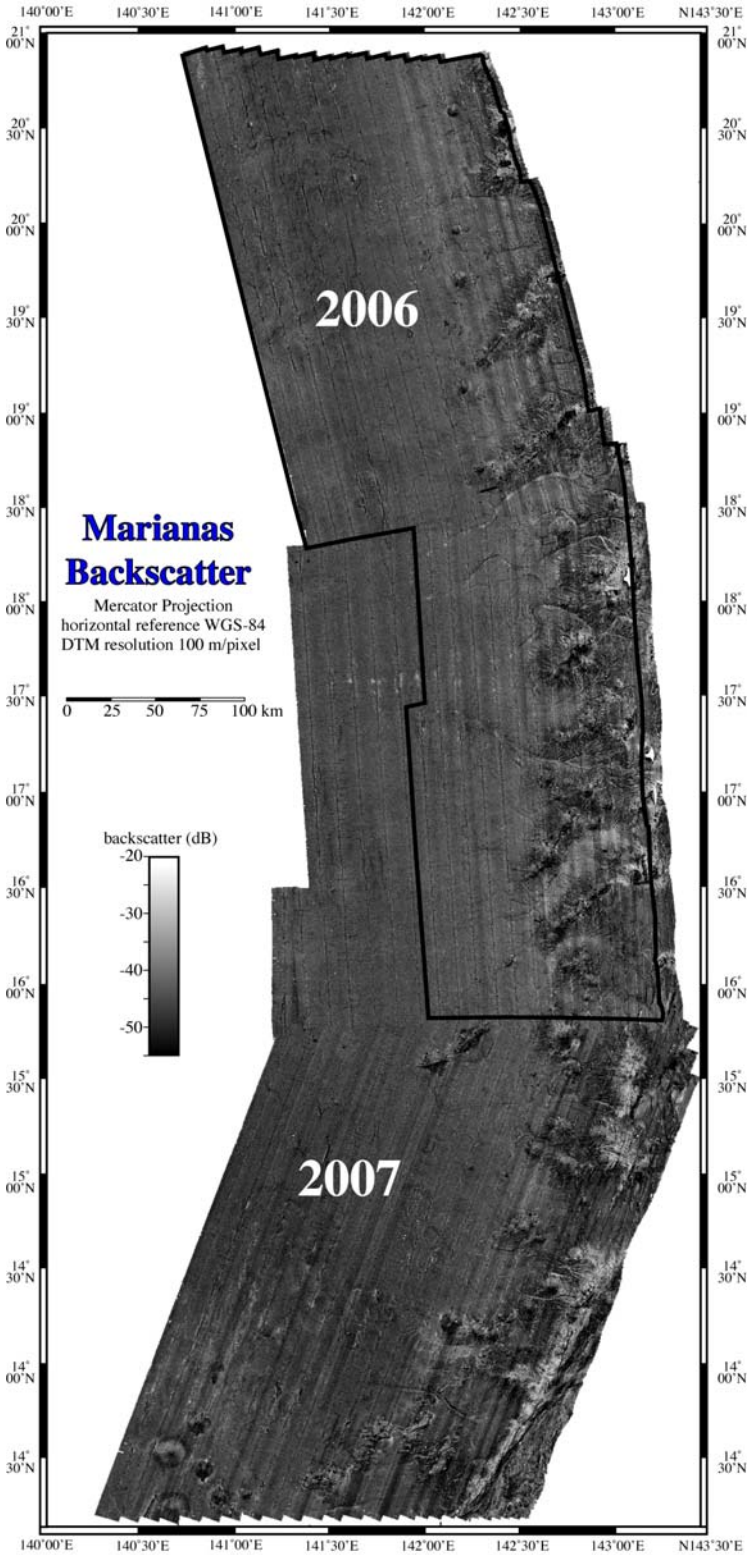
Appendix 2. Cruise Personnel

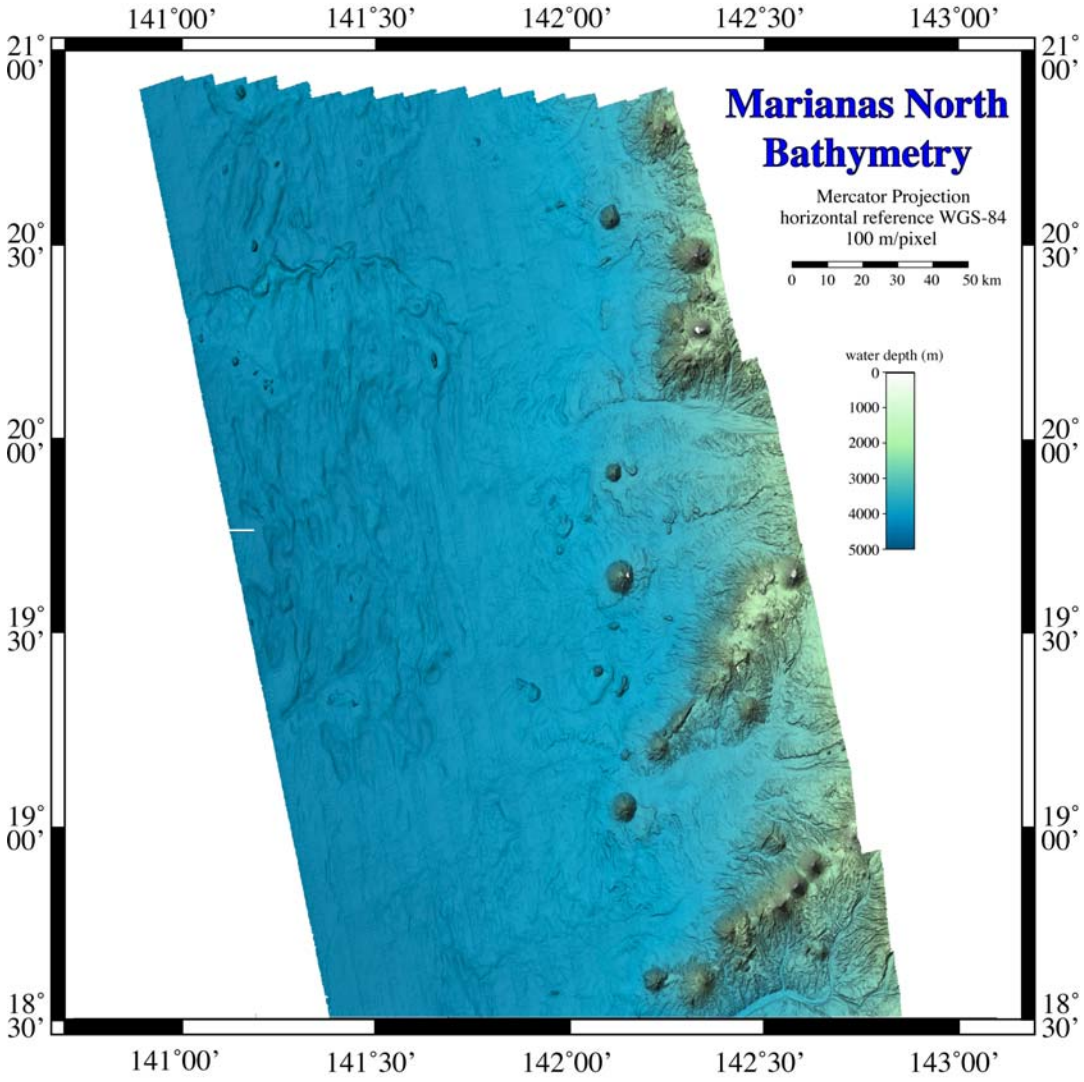
Dr. James V. Gardner	UNH/NOAA representative/Chief Scientist
Mr. Gordon Marsh	Senior NAVO Representative
Capt. Dan Ziemer	Ship's Master
Ms. Melissa R. Odom	NAVO data manager
Mr. William Ulm	NAVO Lead Oceanographer
Mr. Harold Littles	NAVO Lead Bathymetrist
Mr. Joseph G. Woods	NAVO Surveyor
Ms. Shirley Dorsey	NAVO Surveyor
Ms. Laura Casey	NAVO Surveyor
Mr. Guy M. Lizana	NAVY Lead Electronics Technician
Mr. Honore L. Hazeur	NAVY Electronics Technician

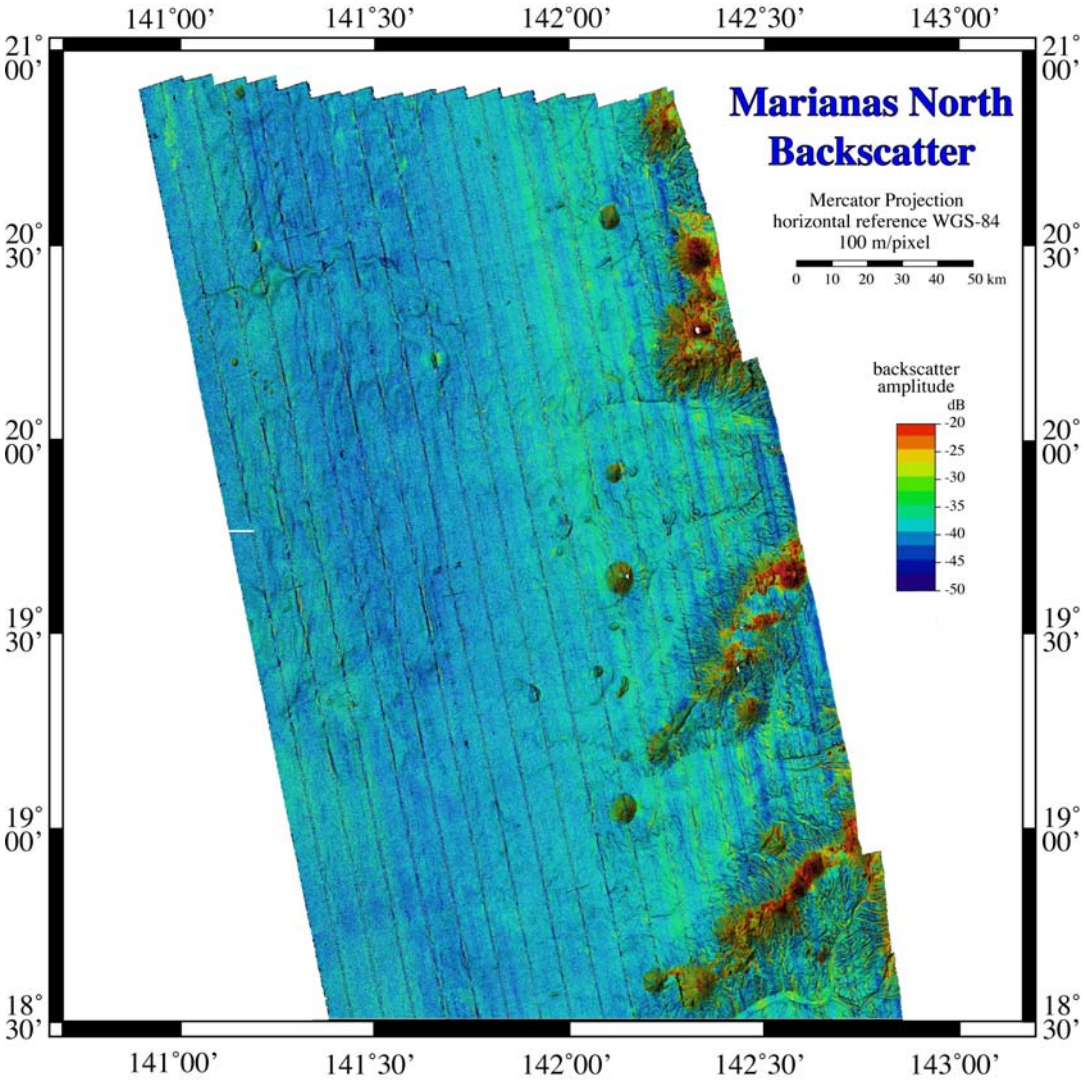
Appendix 3. Color shaded-relief bathymetry and acoustic backscatter maps of western insular margins of Guam and the Northern Mariana Islands; overviews and area maps.

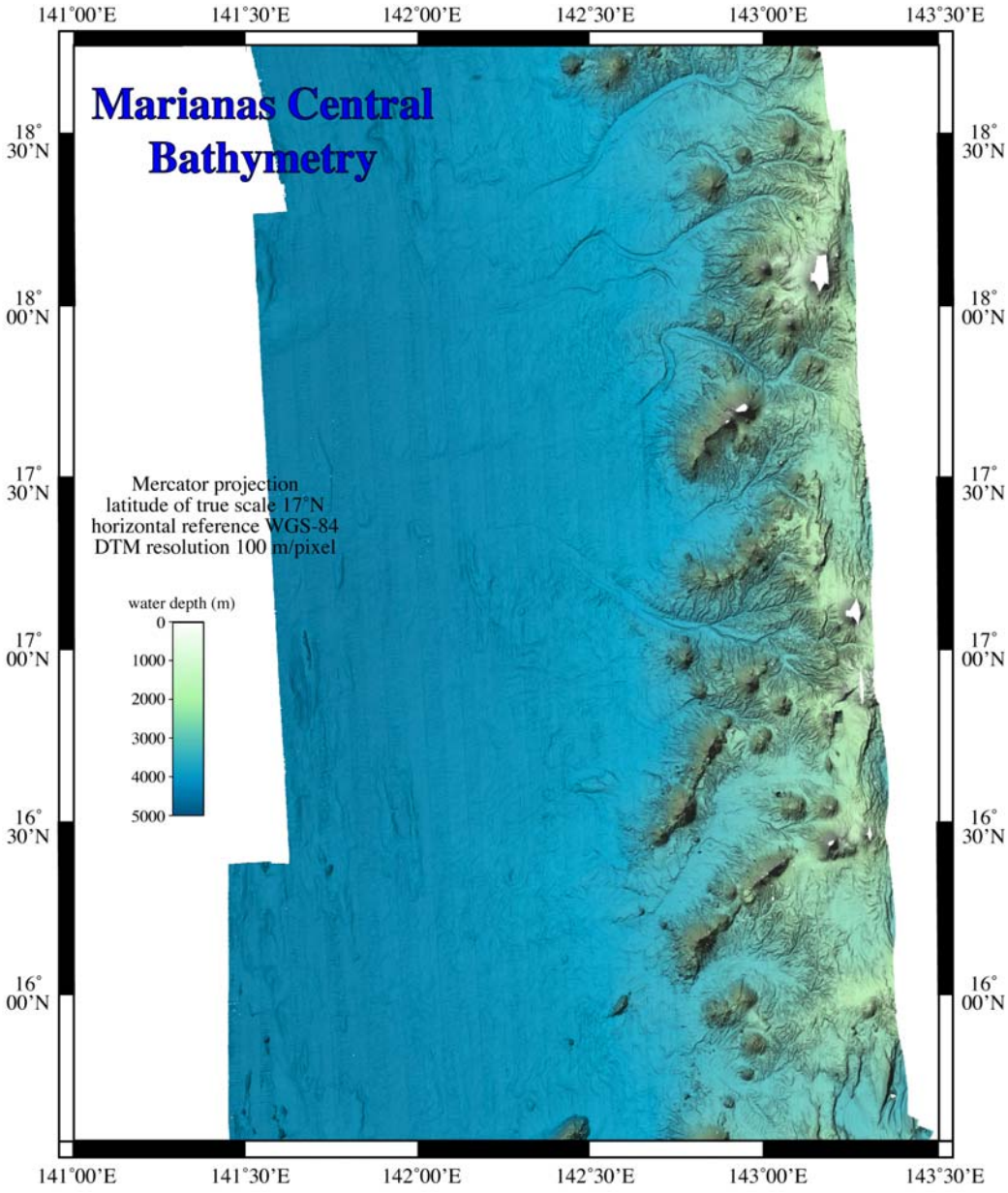


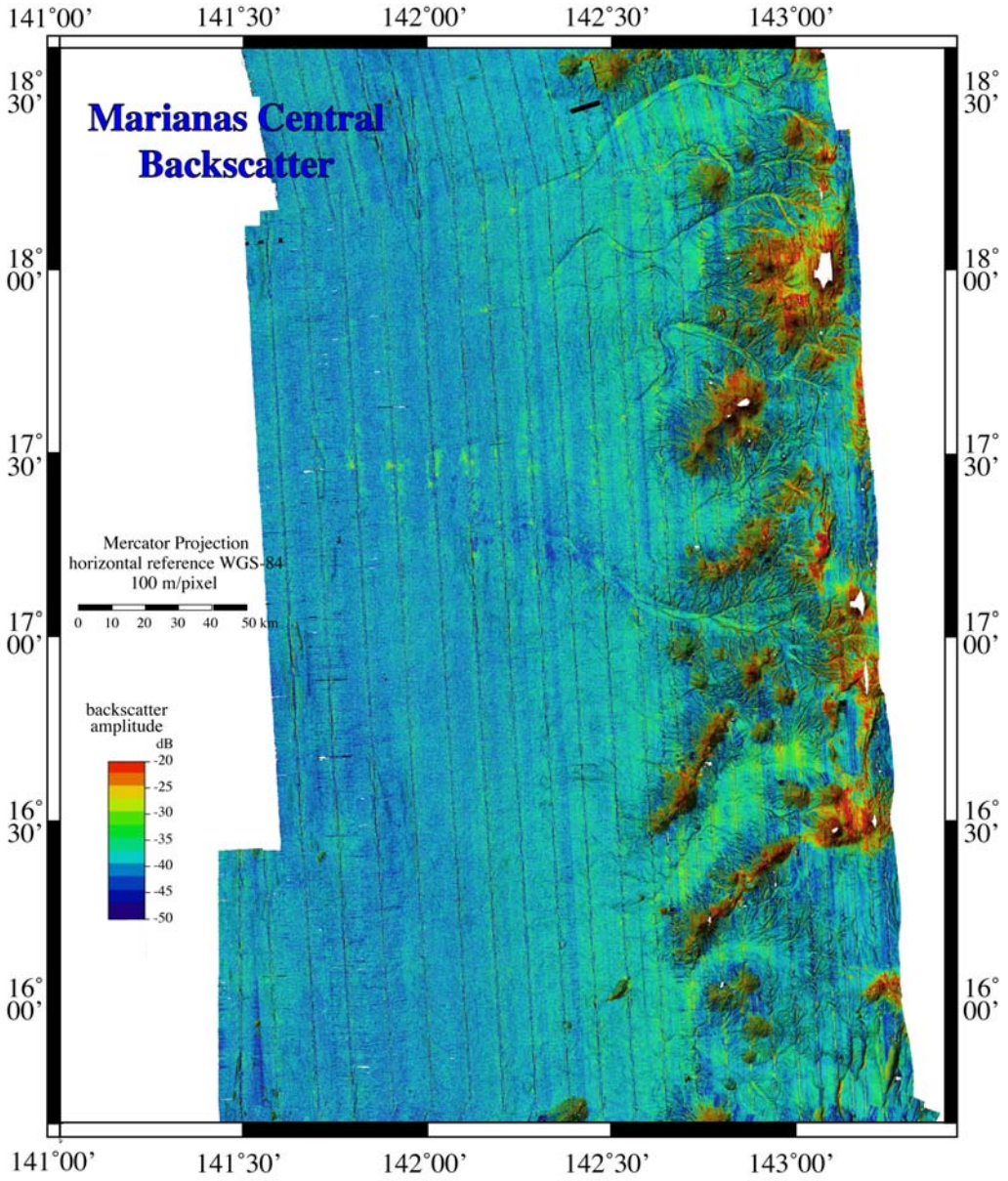
Appendix 3 continued

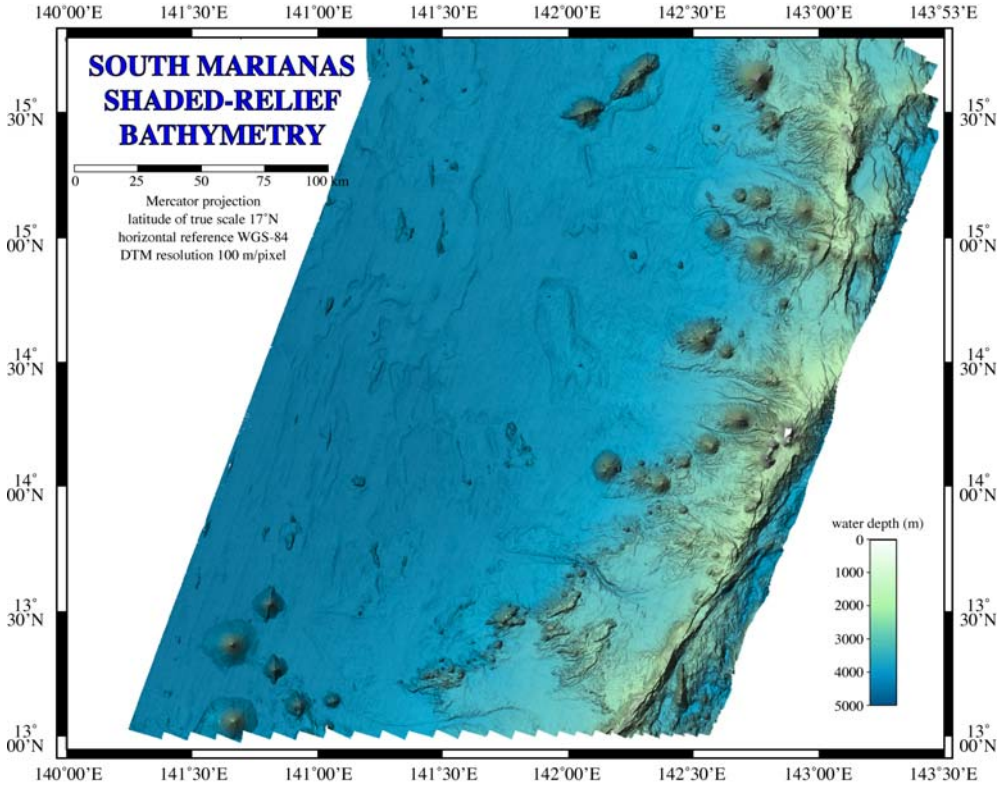


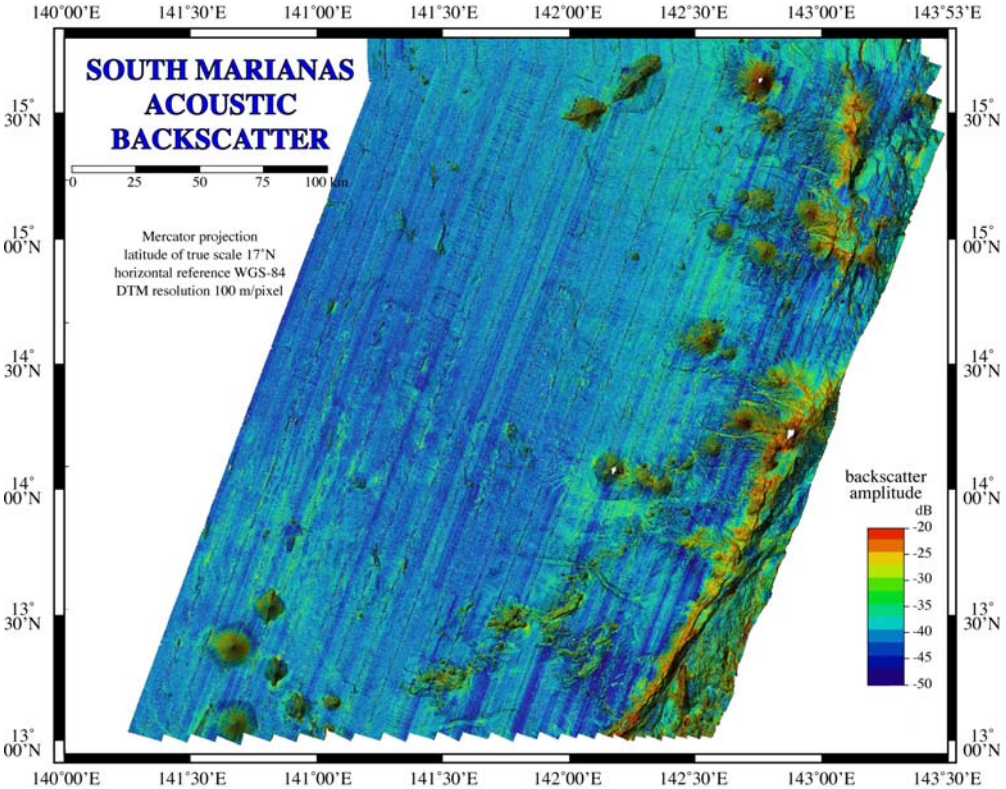

Marianas North
Bathymetry
Mercator Projection
horizontal reference WGS-84
100 m/pixel
0 10 20 30 40 50 km
water depth (m)
0
1000
2000
3000
4000
5000
141°00'
141°30'
142°00'
142°30'
143°00'
21° 00'
20° 30'
20° 00'
19° 30'
19° 00'
18° 30'


Marianas North
Backscatter
Mercator Projection
horizontal reference WGS-84
100 m/pixel
0 10 20 30 40 50 km
backscatter
amplitude
dB
-20
-25
-30
-35
-40
-45
-50
141°00’
141°30’
142°00’
142°30’
143°00’
21°
00’
20°
30’
20°
00’
19°
30’
19°
00’
18°
30’


Marianas Central
Bathymetry
141°00'E
141°30'E
142°00'E
142°30'E
143°00'E
143°30'E
18° 30'N
18° 00'N
17° 30'N
17° 00'N
16° 30'N
16° 00'N
Mercator projection
latitude of true scale 17°N
horizontal reference WGS-84
DTM resolution 100 m/pixel
water depth (m)
0
1000
2000
3000
4000
5000


Marianas Central
Backscatter
141°00'
141°30'
142°00'
142°30'
143°00'
18° 30'
18° 00'
17° 30'
17° 00'
16° 30'
16° 00'
Mercator Projection
horizontal reference WGS-84
100 m/pixel
0 10 20 30 40 50 km
backscatter
amplitude
dB
-20
-25
-30
-35
-40
-45
-50


SOUTH MARIANAS
SHADED-RELIEF
BATHYMETRY
0 25 50 75 100 km
Mercator projection
latitude of true scale 17°N
horizontal reference WGS-84
DTM resolution 100 m/pixel
water depth (m)
0
1000
2000
3000
4000
5000
140°00'E
141°30'E
141°00'E
141°30'E
142°00'E
142°30'E
143°00'E
143°53'E
15° 30'N
15° 00'N
14° 30'N
14° 00'N
13° 30'N
13° 00'N


SOUTH MARIANAS
ACOUSTIC
BACKSCATTER
0 25 50 75 100 km
Mercator projection
latitude of true scale 17°N
horizontal reference WGS-84
DTM resolution 100 m/pixel
backscatter
amplitude
dB
-20
-25
-30
-35
-40
-45
-50
140°00'E
141°30'E
141°00'E
141°30'E
142°00'E
142°30'E
143°00'E
143°53'E
15° 30'N
15° 00'N
14° 30'N
14° 00'N
13° 30'N
13° 00'N