

R/V *Marcus G. Langseth* Cruise MGL1510

3D Seismic Survey Around IODP Expedition 313 Sites, NJ Shelf

1 June – July 6, 2015

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FUNDING AGENCY

National Science Foundation (NSF-MG&G; Candace Major, Program Manager).

INTRODUCTION

The survey was designed to collect 3D multichannel seismic (MCS) reflection data on the New Jersey continental shelf in a 50 x 12 km rectangle around 3 IODP Expedition 313 sites. We used a hybrid acquisition system combining a single 3 km streamer with a P-Cable array comprising twenty-four 50 m streamers. The long-offset data will provide excellent velocity control for stacking plus waveform vs. offset data needed for a variety of analyses. The spatially dense data from the P-Cables will yield high resolution images to the depths drilled by Exp 313. The product will give the research community its first access to a high-resolution 3D volume of continuously cored and logged shallow-water successions containing a clear record of sea-level change and shoreline evolution.

SCIENTIFIC RATIONALE

Data collected in the hybrid manner we intend will augment recently drilled and logged NJ

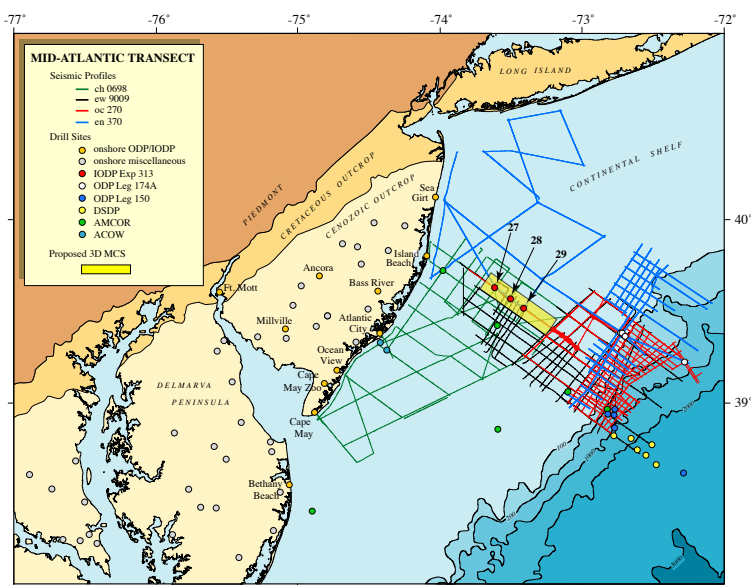


Figure 1 - Location of 3D grid (yellow rectangle) plus relevant drill sites and previous 2D profiles.

shelf successions with superb 3D seismic images. This will provide an improved understanding of factors that shape the shallow-water sedimentary record and, by tracking the record of shoreline migration, will lead to greater insight into the impact of sea-level rise on coastlines the world around. Roughly 10% of humanity lives along continental margins. Knowing the interaction of shoreline and shallow-water environments with ongoing base level changes serves highly relevant societal interests.

The survey covers a 50 x 12 km box around IODP Exp 313 drillsites that were cored and logged in 2009 in 35 of water, 45-65 km offshore New Jersey (Figure 1; Mountain, Proust, McNroy et al., 2010). Goals were to: 1) identify surfaces representing late Paleogene-Neogene base-level changes and compare their ages with sea-level variations implied by the $\delta^{18}\text{O}$ glacioeustatic global proxy; 2) estimate rates and mechanisms of sea-level change during this “Icehouse” time period; and 3) evaluate/ and improve models predicting lithofacies successions, depositional environments and seismic architecture in response to such sea-level changes and other processes that imprint the shallow-water record. Expedition 313 collected 1311 m of very good to excellent quality cores with 80% recovery. The deepest hole penetrated 757 mbsf to upper Eocene sediments. Slim-line logs included spectral gamma ray, resistivity, magnetic susceptibility, sonic and acoustic televiewer.

Expedition 313 borehole data provide lithostratigraphy, geochronology and paleobathymetry. The seismic survey complements the drilling results by providing geomorphology revealed by coherency in horizontal (travel-time) slices within the seismic volume. These combined data will

identify and trace the development of diagnostic features such as river systems, shorelines, delta channels, sediment failure scars, etc., none of which can be resolved in existing 2D seismic data to the degree required to map shifting shallow-water depositional settings.

Embracing a community-based strategy, the co-PIs of cruise MGL1510 will manage data processing up to the point of an interpretable 3D volume. Rapid turn-around of the data is ensured by using a commercial processor. Data will be made available to the scientific community to use as the foundation of follow-on, PI-driven proposals that improve understanding of factors shaping the New Jersey margin in particular, and that imprint the sedimentary record at continental margins in general. The survey cruise provided hands-on training for seven early career scientists at sea.

MCS ACQUISITION AND RECORDING

Streamers

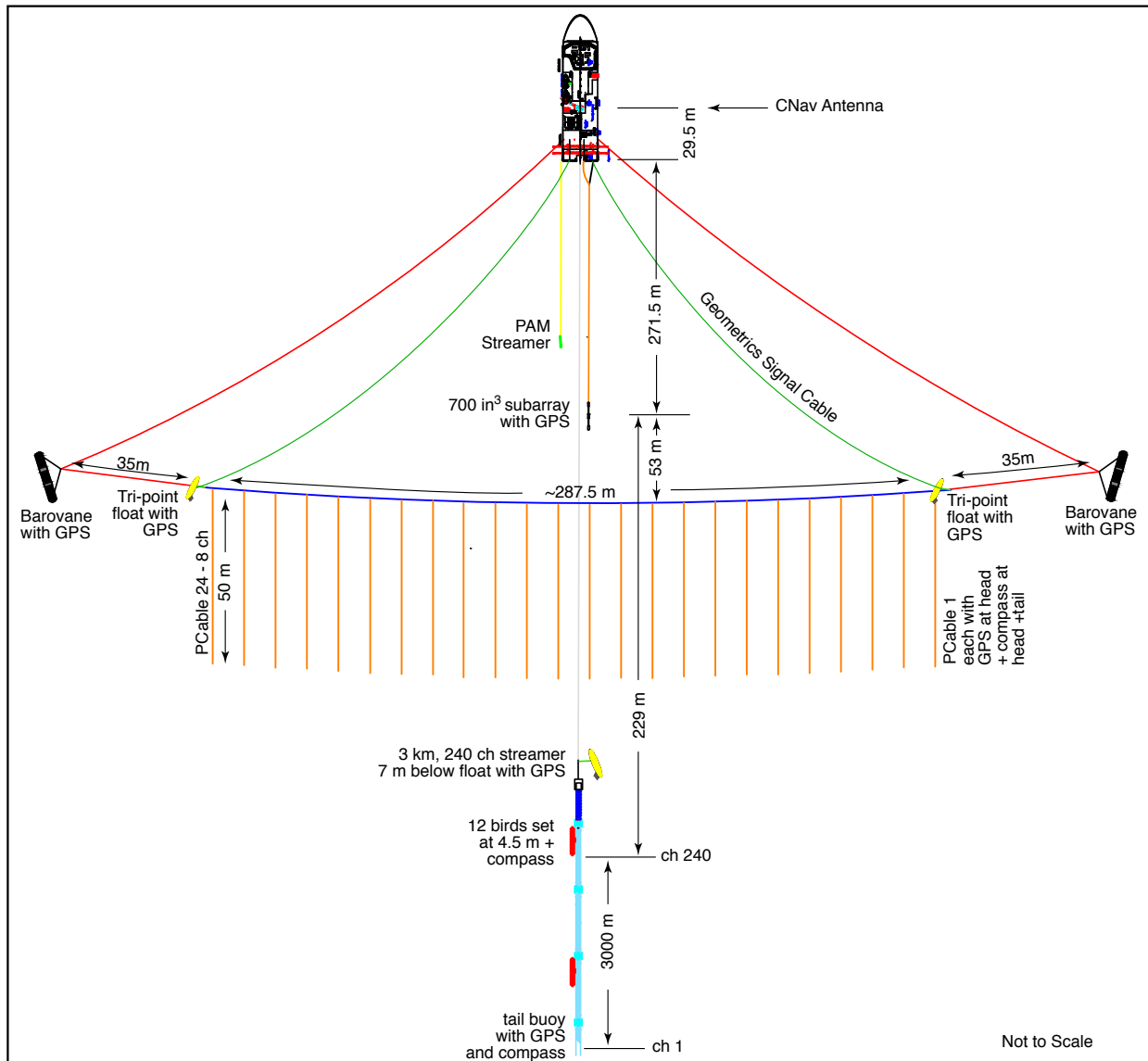
A single 3 km streamer (**Figure 2**) was towed directly astern with distance between center of the source array to center of the first streamer channel of 229 m. An athwartship cross cable, extended laterally by two barovanes roughly 357.5 m apart trailed 24 50-m PCables 53 m behind of the center of the source array.

3 km streamer configuration

- 240 channels x 12.5 m group length. Channel 1 was the farthest offset and channel 240 was closest to the ship. Each channel comprised 12 hydrophones.
- A heavy tow leader kept the streamer below the gun array and the PCable assembly. A streamer float 1-3 m behind the trailing end of the PCable assembly positioned the forward end of the 25 m streamer stretch section 7 m below the sea surface. A 75 m section of inactive streamer was between that stretch section and the beginning of the active streamer, with the center of the first group another 6.25 m back from there.
- 12 birds with depth indicators and compasses: bird 1 was closest to the ship.
- The intended streamer depth was 4.5 ± 1 m. On rare occasions the depth of the first two 12.5-m sections was 1 to 2 meters deeper. In rough weather the streamer was lowered to 5.5 or 6.5 m towing depth to reduce noise.

P-Cable configuration

- 24 x 50 m streamers were trailed from a single cross cable; Cable 1 = starboard, 24 = port
- approximate streamer depths 2.1-3.7 m, monitored by sensors in the junction box at the head of each streamer
- 2 compasses per streamer: in the junction box at the cable head and in the tail drogue.
- 8 channels per streamer (1 hydrophone per channel) spaced at 6.25 m, for total of 192 channels
- Record length was 4 seconds with 0.5 msec sampling at the beginning, but changed to 1 msec on JD 177 (June 26) due to network / telemetry issues.



Source

- Single linear array of four Bolt air guns (120, 180, 180, 220 in³) was along the ship's centerline in positions 4,5,7 and 9 (Figure 3). Positions 4+5, plus 9+10 are 'over-under' cluster configurations. The lower 180 in³ was moved to position 6 on JD 158 due to physical damage to both 180 in³ guns.
- The guns were suspended from a float to maintain a 4.5 m towing depth 271.5 m behind the ship's stern (Figure 2.)
- Shot spacing was 12.5 m; at 4.5 kt over the ground this was ~5.4 sec between shots.

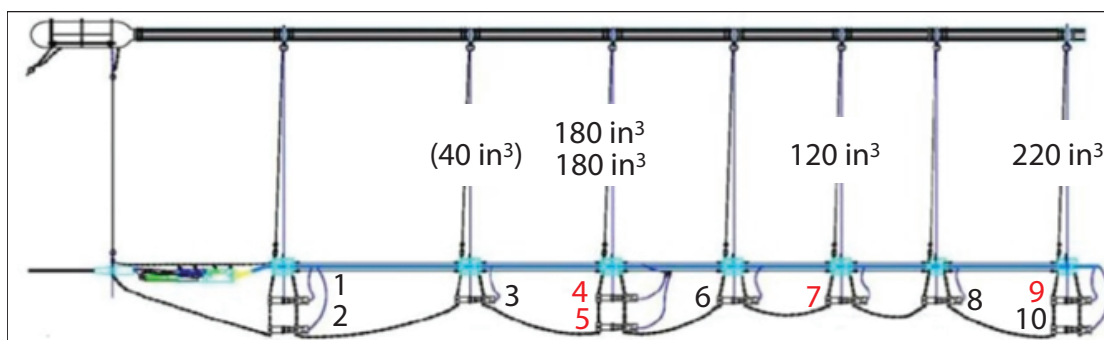


Figure 3 - 700 in³ air gun array with 40 in³ mitigation gun pressurized and ready when needed.

Recording

Seismic data were written directly to disk by two separate systems:

Recording type	Sercel Syntrak 960-24 recording system
Sample rate	0.5 ms
Recording length	4 seconds w/ no Deep Sea Delay
Low Cut Filter	2.0 Hz Digital Filter / 12 dB/OCT
High Cut Filter	412Hz Digital Filter / 276 dB/OCT w/ linear Phase
Data format	SEG-D 8058 Rev 1 (demultiplexed) with External Header.
Media	Seisnet recording system, data recorded directly to disk

Recording type	Geometrics P-Cable recording system
Sample rate	0.5 ms and 1.0 ms after JD xxx
Recording length	4 seconds w/ no Deep Sea Delay
Low Cut Filter	No Low Cut Filter
High Cut Filter	824Hz Digital Filter / 276 dB/OCT w/ linear Phase
Data format	SEG-D 8058 Rev 1 (demultiplexed) with External Header.
Media	data recorded directly to disk

The NCS NavPoint system tracked ship's location based on C-NAV positioning and generated a trigger pulse every 12.5 m along track. This provided the Geometrics Geoel system with time-zero for PCable recording and alerted the DigiShot system to issue a gun-fire pulse. Spectra, in addition to steering the vessel when online and collecting data, assembled headers for the Syntrak system which wrote data to the 2D recording system. Following JD xxx when we were not recording 2D data, Spectra continued to be used for tracking the vessel's progress along line and guiding the Bridge, but it no longer had 2D headers to write to disk. At these times the NCS system operation was unchanged from before.

3.5 kHz Profiles

The Knudsen sub-bottom profiler was set to internal trigger, but we experienced no interference with the EM122. Our transmission pulse length was 2 ms on a 200 ms interval at transmission power level 1. We applied no additional gain or TVG. Recording was in SEG-Y, KEA and KEB formats. As prescribed by the IHA, the system was turned off during transits to

and from the survey area and during the unscheduled transit to standoff Manasquan Inlet to pick up equipment and personnel on JD 181 (June 30).

Multibeam

A Kongsberg EM122 multibeam system was operated throughout the cruise. To collect dense, high quality bathymetry, the beam angles were constrained to be recorded 70° port and starboard and the maximum coverage was set manually to 200 m both port and starboard. Because there was roughly 150 m between adjacent sail lines, the majority of the survey grid (where water depths ranged from 21 to 75 m) would receive 100% swath coverage.

At the start of the cruise we used the NOAA database of water sound velocities automatically updated as available. Swath bathymetry data were smoothed (not ping-edited), gridded and plotted daily using MBsystem and GMT scripts developed on previous cruises and provided by James Gibson (LDEO.) Several days of plotted data showed unrealistic features in the processed bathymetry and we began using velocity files derived from daily XBT drops. Although small, unrealistic along-track features were still apparent in the plotted data, their effects could be minimized with track-parallel illumination (**Figure 4.**)

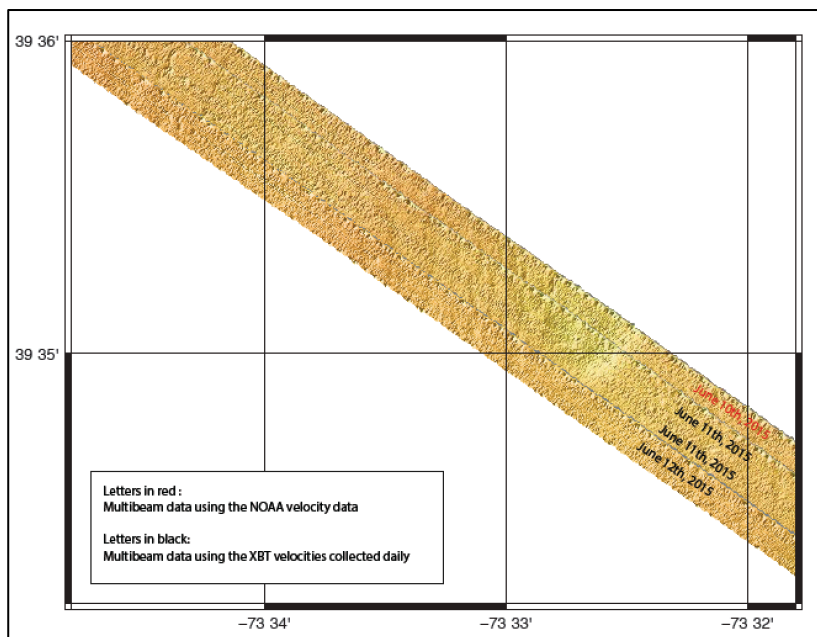


Figure 4. Processed EM122 data using velocity data from NOAA database (single NE track, red font) and shipboard XBT cast (other 3 tracks, black font.)

SEISMIC SURVEY

Survey Design

The choice was made to collect a rectangular grid of data longer in the regional dip direction than in strike. The alternative could better evaluate shoreline-parallel variations in stratigraphic evolution, but would image fewer clinoform top- fore- and bottom-set settings. A "compromise" square grid was rejected due to the inefficiency of spending more time in turns. We settled on a 12x50 km rectangular grid centered on IODP Exp 313 sites 27-29. The rectangle was slightly

seaward of the center of these sites to provide 3D images of multiple Paleogene faults and thick mid-Miocene foresets and possible debris aprons, all of which are best developed seaward of Site 29.

Surveying efficiency was optimized by running a counterclockwise "racetrack" pattern beginning in the SE corner. Landward-directed tracks began along the long NE edge of the rectangle. Pre-plotted lines began at shot point (sp) 1001 on the seaward end of the rectangle, ending at sp 5001 on the landward end. Sail lines were 300 m apart; PCable cmp lines were ~6.25 m apart, resulting in a 3D swath on each pass that was 150 wide

Turns were made to port, transiting ~6 km and returning on the reciprocal course. As a result, the survey grid progressed as two separate rectangles 50 km long that grew in width towards the SW and eventually joined near the end of the time at sea. Interruptions due to protected species power-downs or equipment failure, plus deviations due to ship traffic or floating fishing gear were re-surveyed as time allowed. Gaps due to failure of the Geometrics acquisition only, without shutting down the guns while shipboard corrections were made, more often than not had uninterrupted long-offset data continuing through the gap.

To maximize the coverage of 3D PCable data in the time available, we recovered the 3 km streamer on June 28 (JD 179) and never deployed it again. This saved time on turns (virtually no runout at the end of a line and smaller turning radius without the Sercel streamer.)

Breakdown of Survey Time

The unofficial time devoted to various activities were as follows:

Primary acquisition	461.4 hrs (55.3 %)
Re-shooting + in-fill	58.3 hrs (7.0 %)
Turning	123.2 hrs (14.8 %)
Down time due to equipment failure + repair.....	160.0 hrs (19.2 %)
Powerdown for protected species	6.2 hrs (0.7 %)
Waiting on weather	0 hrs (0.0 %)
Deviation due to ship traffic or fishing gear	2.3 hrs (0.3 %)
Transit.....	18.5 hrs (2.2 %)
Initial set-up + final recovery	23.5 hrs (2.8 %)

OPERATIONS

JD 152 (June 1)

The day began with a brief introductory meeting of the Science Party at 1230 on June 1, 2015. R/V *Marcus G. Langseth* left the dock at the SUNY Maritime College, Throggs Neck, New York, at 1250 (all times are UTC.) The overcast journey down the East River, into New York harbor, into Raritan Bay and out into the New York Bight was uneventful. The harbor pilot was away at 1547. A Fire & Boat Drill was held at 1700. At ~1930 the ship slowed to ~3 kt to deploy, tension, recover and measure distances of the PCable assembly. The starboard barovane went in the water at ~2030.

Deployment of the float outboard of the starboard end of the P-Cable bridle followed. Deployment of the P-Cable bridle proceeded smoothly, interrupted only by replacement of one of the junction boxes, which had a continuity fault. The port barovane and port bridle float were then deployed. The operation concluded successfully at ~0130.

JD 153 (June 2)

From ~0130 to ~0230, the P-Cable bridle was towed, in both upwind and downwind directions, to assess stability. The junction boxes, which were designed to be towed at the same depth as the guns will be towed (~4.5 m), were towing slightly shallower, with a range of 2.1-3.7 m (depths without streamers attached). Distance between barovanes was ~438 m, slightly more (~6.5 m) than the distance envisioned (presumably the result of stretching of the AMSTEEL BLUE strength member, which is not supposed to stretch at all).

Recovery of the barovanes and P-Cable cross cable began ~0230.

All equipment was aboard by ~0450. The cross cable was measured as it was retrieved and significant permanent stretch (~8 m) was noted. It was estimated that the total stretch when deployed and under tension may be as much as 20 m. After equipment recovery, the vessel turned SE at 7 kt to move into deeper water (~45 m) before deploying the 3 km streamer at 4.5 kt.

Streamer deployment began at ~0705 and the tail buoy was in the water by 0710. All birds were in the water by 0920 and work began to attach the head stretch. It was necessary to try several STUs (Streamer Tension Units) in order to find one that worked. The streamer was completely in the water by ~1120, though not yet moved to its final tow point.

At 1236 the starboard paravane was back in the water and the measured P-Cable cross-cable was deployed. P-Cable deployment proceeded without incident until problems with digitizer 23 at 1627. Once resolved, the entire P-Cable array was aft, the tri-point head float and paravane were deployed by 1807. The 3 km streamer towpoint was moved around to center line at 1816. The PAM was deployed and operating at 1837 (though required amplitude adjustments by the PSOs for it to be useful.) The 700 cu. in. sub-array was deployed at 1908.

Start of line (SOL) MGL1510-2860 at 2022 (first shot recorded 2041). The vessel is at the SE corner of the survey area, shooting to the NW. The air guns (4 guns, 700 cu. in. total volume) are firing at a rep. rate of ~5.5 s, ship's speed is nominally 4.5 kts (over ground).

Weather is not optimal: 1.5-2 m seas, winds from the NE at 22-25 kts; intermittent showers. This weather is slated to persist until at least the morning of June 4.

A discussion with Dave Martinson elucidated issues of timing/recording. Syntrack issues the primary trigger picked that is up by both seismic recording systems. The DigitShot airgun control fires the air gun array so that it reaches peak energy EXACTLY 160 ms after the trigger command. The P-Cable system, by contrast, begins recording at the trigger pulse. So, the P-Cable system should be recovering the direct wave from the gun array (although that was difficult to observe on the long-streamer shot gathers). When examined, the display of the P-Cable data shows the seafloor at ~200 ms, the 160 ms start of recording + the approximate ambient water depth in ms (~40), with no D-wave visible. After calculations we realized the D-wave travel path to trace 1 of the center P-Cables 12 and 13 is very close to that of the seafloor reflection. Hence seafloor and the D-wave obscure one another. Although longer, the travel

path to trace 1 of the outboard P-Cables 1 and 24 are likewise very close and the seafloor reflection and the D-wave arrive just a few msec apart and at this stage are indistinguishable.

More discussion surrounded the variable tow depths of the long-offset cable. The outer end is towing optimally (~3.5 m), but the inner half is too deep (up to ~18 m). We will see how it looks on the reciprocal course later this evening, but we must try to improve it with one or more strategies (another tail float?), yet to be determined.

JD 154 (June 3)

End of line (EOL) MGL1510-2860 at 0248. 4,089 shots total. Begin turn to port.

SOL 1924 at 0355. (first shot 5080) Shooting to the SE. At the end of this profile (~1000 hrs), at least part of the P-Cable assembly will be retrieved (to repair GPS unit on port-side cross-cable float) and to attempt to re-ballast the long-offset cable.

EOL 1924 at 1016. (last shot 865) Continuing to SE to begin recovering gear for repair to GPS unit on port-side cross-cable float and reballasting of long-offset streamer. The PAM was recovered at 1025; the guns were on deck at 1050; the port paravane was out of the water and alongside at 1220 and retrieving roughly half the 3 km streamer was done by 1342. Streamer redeployment began and 3 birds were added and ~45 lbs of weights were removed from the front half of the streamer, and by 1543 the streamer was re-deployed and the paravane was lowered into the water. The PAM was deployed at 1630, the air guns were in and the mitigation gun was cleared by the PSO's to begin firing, and ramp up began at 1836.

SOL 2836 at 1934. (first shot 881) Shooting to the NW. Weather improving; sun coming out occasionally.

JD 155 (JUNE 4)

EOL 2836 at 0148. (last shot 5137) 4,262 shots total. Turning to port, to begin MGL 1510-1900.

SOL 1900 at 0258 (first shot 5111). Shooting direction to the SE.

Premature EOL 1900 at 0451. At 0451, we ended the line prematurely because of loss of GPS on the port barovane. The GPS on the port cross-cable head float (tri-point float) had failed earlier and we had been operating with only the barovane GPS on the port side: we can operate with only one of these two GPS units on each side of the ship (the second provides redundancy). The failure of both port-side GPS units made it necessary to recover the port barovane and head float for repairs. The gun array was on deck at 0530 and the port barovane and head float were secured by 0630.

It turned out that a wire had been cut on the barovane (between generator and GPS unit). On the tri-point float, the battery had come loose and its movement had damaged the unit. There is a spare unit for the float GPS, but the wire on the barovane had to be soldered. Furthermore, the epoxy bonding agent to be applied around the soldered wire required six hours to harden sufficiently to be deployed. In consultation with Steinhaus, it was decided to take the time to

repair both units to provide full redundancy in case of future failure. We could not start shooting for several hours in any case (until dawn, followed by an observation period and ramp-up). It was judged that the redundancy provided by having both GPS units functional was worth an extra delay.

The P-Cable with repaired GPS beacons in the tri-point and paravane floats was fully re-deployed by 1313. We turned, approached the SE corner of the survey grid, ramped up the guns, beginning with the mitigation (40 cu. in.) gun, and resumed surveying.

SOL 2812 at 1740 (first shot 851). Shooting direction to the NW. Wind continues on our ~beam from the ENE at 25-30 knots in overcast skies.

EOL 2812 (last shot 5137) at 2358. Turning to port. Next line will in part be a re-shoot of line 1900 (original shotpoints 3988-3828), followed by the rest of the line, not yet shot, which will also be called 1900R (original shotpoints 3827-EOL).

JD 156 (June 5)

SOL 1900R at 0107 (first shot 5110). Shooting to the SE. Winds from the ENE, ~15-25 kts. Seas variable, ~1.5-2 m.

Low pressure alarm went off at 0239. Valve failure on starboard compressor. Port-side compressor being put on-line. Mitigation gun (40 cu. in.) on-line at 0241. Back to full volume; all four guns on-line at 0243. Valves repaired and switched back to starboard compressor.

Last infill shot 3989 at 0251, followed by first re-shoot shot 3988; last re-shoot shot 3828 at 0305.

At ~0416, the ship veered off line to port because of an error on the bridge (“pushed the wrong button”). Vessel was back on track by ~0429. This event will leave a gap that will probably require infill.

EOL 1900R at 0729 (last shot 865). Wind ENE 20 kts, seas 2m. Turning to start line 2788.

SOL 2788 at 0839 (first shot 872). Shooting to the NW. Wind NE ~22 kts, seas ~2 m.

EOL 2788 at 1453 (last shot 5137).

SOL 1876 at 1603 (first shot 5109). Shooting to the SE. Wind NE ~20 kts, seas ~2 m.

EOL 1876 at 2228 (last shot 865). Turning to port. Winds NE at ~15 kts, seas subsiding.

SOL 2764 at 2336 (first shot 884). Shooting to the NW. Winds NE, 10-15 kts.

JD 157 (June 6)

0234 (shot point 2924) – electrical leakage in one of the two 180 cu. in. guns. Austin made the decision to put the second gun string in, rather than to shut the offending gun off and go with a smaller total volume. Meanwhile, proceeding down line 2764.

0246 – the 180 cu. in. gun may still be firing; they have turned up the electrical signal to that gun. Discussion as to whether the second string will be deployed; it might be better to wait until EOL.

0254 – Steinhaus up; discussion. Initial contention – no air leak, gun firing. But then the PSO reported additional noise on her acoustic system, suggesting an air leak. That modified the decision, to deploy the second string.

0300 – Deploying the second gun string. When it is in, and the mitigation (40 cu. in.) gun is firing, the first string will be turned off and the second string will be activated. No ramp-up will be required. Then, we will turn to port and re-shoot the “missing” portion of the line. Traffic to port is currently preventing such a turn.

0310 – second string going in the water.

0315 – turning on the mitigation gun (40 cu.in.) on the string just deployed; that gun firing.

0318 – starting to recover the first string.

0340 – First string recovered and starting turn to starboard to rejoin line 2764 and shoot the missing part of line 2764. At ~0405, Robert Steinhaus explained that the cause of the problem was that the solenoid block of gun 4, string 1 had been damaged by being hit hard by the gun hanging below gun 4. The heavy steel block was both dented and cracked by the impact.

String 2 was being towed immediately behind the ship to provide a mitigation gun. The plan was to redeploy gun string 1, with gun 4 repaired, during the run back to rejoin line 2764. Gun string 1 was in the water at 0448 (with string 2 also still deployed). However, the sensor in the new solenoid block turned out to be bad and it was necessary to recover string 1 again. The gun strings became entangled during this recovery at 0525.

0558 – The entanglement of the arrays resulted in damaged air lines to string 1, which was at this time firing the mitigation gun, so that the mitigation gun was shut down. After 8 minutes of no mitigation gun firing, there could be no more acquisition until daylight, following the required observation and ramp-up periods. Conditions during the night have been foggy, which created the additional concern that it may not be possible to observe the required radius even at dawn.

0620 – All guns on deck and secured. Work to repair gun string 1 continued. Steinhaus outlined a plan to deploy a single small (40 cu. in.) gun separately over the side as a mitigation gun to avoid the need to deploy string 2, and risk entanglement, in the event of a recurrence of problems with string 1.

0939 – Gun array 1 deployed, but the PSOs unable to begin observation period because of fog.

1127 – Fog sufficiently cleared for PSO watch to begin. Ramp-up to follow 30 minutes later.

1150 -- Dave Martinson away in workboat, rendezvous with launch to return him to shore.

1158 -- begin ramp-up.

SOL 1852 at 1420 (first shot 5000). Shooting to the SE. Winds WNW, 5-10 kts.

EOL 1852 at 2035 (last shot 865). Turning to port.

SOL 2740 at 2143 (first shot 885). Shooting to the NW. Winds NE, ~13 kts.

JD 158 (June 7)

EOL 2740 at 0356 (last shot 5137). Wind E, 7.6 kts, seas 0.5 m.

SOL 1828 at 0504 (first shot 5128). Shooting to the SE. Wind 9 kts, seas 0-1 m.

0827 – Veered off line to port (E) to avoid an unresponsive boat at SP 2820. The boat was finally contacted at 0837 and we began to turn back toward line 1828. The maximum offline distance was 201 m.

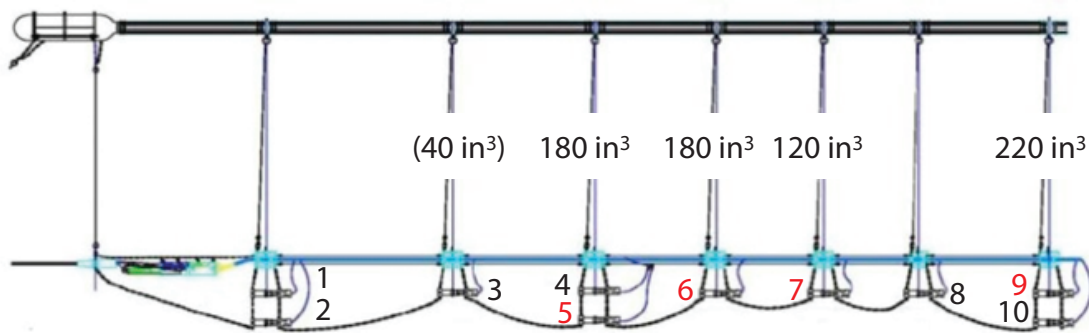
0854 – Back on line 1828 at SP 2523.

~0920 – Possible timing errors for gun 4 noted. Robert Steinhaus thinks that the gun is firing properly because the signals being received are good. Instead, he feels that it is a sensor problem, once again caused by the lower gun jumping on firing and hitting the upper gun. Will recover guns at the end of the line to address the issue, rearranging the guns to avoid the problem in future.

1050 – Mitigation gun in the water.

EOL 1828 at 1126 (last shot 865). Wind 10 kts NE, seas 0.5-1 m.

1130 - Started firing mitigation gun and began recovery of gun array 1 while continuing on course to SE. The 180 in³ gun 5 continues to slam into overhanging 180 in³ gun 4, in this case damaging transducer blast detect inside the solenoid housing. Previously it cracked the housing, and worse, severed the air hose. Solution = repair gun 4 but turn it off (available as spare) and install 180 in³ gun in position 6 immediately aft of the 4,5 cluster. Will now shoot guns 5+6 (180 in³ each), 7 (120 in³), and 9 (220 in³.) Gun 3 is the 40 in³ mitigation gun, to be used when needed before switching over to 40 in³ mitigation that has been rigged on its own off one of the starboard tail buoy sheives.



We had our first power-down of the cruise for dolphins at 1245, just before starting the next line. All clear by 1304.

SOL 2716 at 1307 (first shot 855). Shooting to the NW. Winds NE, 5-8 kts. Power down for turtles floating by port at 1449, then diving out of sight when amidships; all clear and shooting again at 1455. Whale blow 3km off port bow; PSO guessed it was a fin whale. Power down for turtle 1816-1821.

NCS reported no headers recorded on all P-Cable data from first 2 lines of cruise, 2860 and 1924, because of incorrect cabling between computers. The former is outermost NE line of grid;

could be expendable. The latter is near the center, is therefore important, and for efficiency will be re-shot as very next line after this one.

EOL 2716 at 1940 (last shot 5137). Turning to port. Next line will be 1924R (re-shoot of second line of survey, June 3, with no headers, near the center of the grid, see comment above).

Powering down for a turtle, 2034-38, during the turn.

SOL 1924R at 1644 (first shot 5110). Shooting to the SE. Winds ESE, <5 kts. Seas calm. 1655-1701 power down – turtle siting.

JD 159 (June 8)

EOL1924R at 0330 (last shot 865). Turning to port.

SOL 2692 at 0431 (first shot 866). Shooting to the NW. Winds SE, ~5 kts, seas 0.5 m.

0734 – Signals from P-Cables 19-24 dropping out (SP 2794).

0752 – P-Cable nav ends line at SP 2987; Spectra nav still on.

0754 – Guns on internal at 60 s intervals to maintain sound in the water while troubleshooting P-Cable issue. System was restarted. Received communication from cables 1-18, but nothing past that. The problem was determined to be in the water on the P-Cable. The line was ended.

EOL 2692 at 0809 (last shot 3149). Wind S, 12.5 kts, seas 0.5-1 m.

0812 – All guns off.

0814 – Port turn to reverse course to SE to recover P-Cable, up to cable 19. The problem seems to be the cable 19 connection box, which will be replaced. Gun string 1 was aboard at 0850.

The P-Cable was retrieved to cable 19 and by 1106 the box for cable 19 was replaced. Electronics checked out OK by 1120 and all was readied for re-deploy. But while beginning to put the gun string in the water at 1315, P-Cable telemetry beyond box 18 failed again. The problem is more likely in cross-cable, between 18 and 19, than in box 19 (this is the 3rd failure at this location; slim chance we've picked 3 bad boxes.) So, we began recovery again, beginning with the PAM onboard at 1318. P-Cable up to box 19 was onboard at 1452. The cross-cable between 18 and 19 was swapped out; re-deployment began again at 1553. No further problems with 19. Began reverse course to get back to survey grid at 1653. At 1717, P-Cable 15 went dead. Indications point strongly to bad digitizing canister for 15. Chose to accept dead 15 for now (Don't want to risk getting back on-line in the dark + have to wait until AM; want to minimize number of in-outs for streaming gear; but do NOT intend to collect remaining data with 23 P-Cables ... will replace canister 15 next time P-Cable is onboard. The co-PI team will re-evaluate that June 9, AM.) PAM deployed at 1757; rest of deployment went as planned. Approaching start of grid at 1948.

SOL 2668 at 2030 (first shot 876). Shooting to the NW. Winds SSE, 17-22 kts, seas ~1 m.

2137 – P-Cable streamers 21-24 bad. Last good shot 1547. Getting people up. Ending the profile.

2159 – P-Cable streamers back on-line. They recycled the system, and the signals returned. Shots 1548-1813 have been collected without streamers 21-24. Continuing down line 2668. P-Cable streamer section 15 still bad. PCable recording started missing single shots at 2-10 min intervals at ~2300 and this continued until end of line.

JD 160 (June 9)

EOL 2668 at 0301 (last shot 5137).

SOL 1804 at 0417 (first shot 5029). Shooting SE. Winds SW, ~16 kts. Seas ~1.5m.

As the vessel approached the end of the line, it was necessary to decide whether to replace the digitizing cannister for P-Cable 15 during the turn. Seas were fairly high and the SW wind direction would dictate a SE course to keep the barovane in the lee during recovery. Robert Steinhaus estimated 8-10 hours would be required for the operation. The co-PI team discussed how best to proceed (at ~1000) and agreed to continue collecting data with 23 P-Cables for the time being. Digitizer 15 will be replaced either the next time the P-Cable is recovered for other reasons or perhaps when seas are calmer if no other reasons for P-Cable recovery have arisen in the meantime.

EOL 1804 at 1040 (last shot 865). Winds SW, 22 kts. Seas 1-2 m.

SOL 2644 at 1148 (first shot 890). Shooting to the NW. Winds S 19 kts. Seas 1-2 m.

EOL 2644 at 1812 (last shot 5137). Winds S, ~19 kts. Seas 1 m. P-Cable system switching to backup to see if that corrects the random late shots (early triggers) that began ~2300 y'day.

SOL 1780 at 2017 (first shot 3529). Winds SW, ~20 kts. Seas 1- 2m. P-Cable system not operating; no telemetry. Shooting to long cable only.

Update, 2200 – After consulting with the beach on the networking problem affecting the P-Cable system, we are re-programming the digitizers in the system, 1 at a time, while proceeding down line 1780.

2255 (SP 2718) – air pressure dropping; starboard compressor problem. Turning all sources off but the 40 cu.in. mitigation gun.

2258 (SP 2681) – port compressor running; all guns firing.

2353 (SP 2072) – in order to fix the starboard compressor, the port compressor must also be shut down. For the duration of this repair (perhaps 15 minutes), we will fire the mitigation gun off the accumulator, and hope that we have enough air, firing that gun every ~7 minutes, to allow us to continue to shoot through the night, per our IHA.

JD 161 (June 10)

0006 – guns back at full volume (SP 1929); firing off the port compressor (discharge valve replaced on the starboard compressor). Proceeding down line 1780; P-Cable still being re-programmed.

0108 – P-Cable back on line. Proceeding down line 1780.

EOL 1780 at 0135 (last shot 960). Turning to port.

SOL 2620 at 0248 (first shot 878). Shooting NW. Winds SW, ~16-18 kts.

0748 – P-Cable 21 dropped out (SP 4160).

0801 - P-Cable disarmed (SP 4299) to deactivate streamer 21 alarm shutting entire P-Cable down.

0803 – P-Cable back online (SP 4336), but P-Cables 15 and 21 are down. Will attempt to restore 21 during turn at EOL. We do not wish to jeopardize acquisition by cables that are still functioning by attempting remedial measures while still on line 2620.

EOL 2620 at 0925 (last shot 5737). Winds W, ~6 kts. Seas 0.5 m.

0941 – Digitizer for P-Cable 21 reprogrammed during turn and it is back on line. Only P-Cable 15 is still down.

SOL 1780R at 1030 (first shot 5110). Shooting SE. Winds NW 6 kts. Seas 0.5 m. This is a reshoot of the line first acquired last night (JD 160) with only the long-offset streamer for most of its length (while the P-Cable was down). Near start of a line a sport fishing boat overtook us on port, close enough for the Bridge to blast 5 warnings to stay clear. No apparent deviation by boat (biggest risk was it hitting vane floats or tail buoy, etc. All trailing gear too deep to be tangled.) Bridge reports commercial clam draggers have been working near center of survey grid; other traffic (sport fishing boats and other vessels) has been all around, no one area more than another. Shark fishermen are reporting good catches.

Random bad shots (early trigger) on P-Cable system most likely due to faulty signal cable between starboard tri-point float and ship. Paying out 7 m signal cable, reducing tension, and keeping speed thru water < 4.6 kt has eliminated problem. Could return in rough weather regardless of continuing efforts. Replacing signal cable requires recovering all trailing gear, up to + including starboard door; estimated duration of operation 10-12 hrs. If done, we'd also replace digitizing canister on cable 15. But the weather is perfect, we need to get some lines done, we know the problem the signal line / dropped shots issue can be managed, so we'll tolerate the continued loss of cable 15 until faced with situation to invest long time in pulling everything aboard. Preferred place to begin such down-time, if lucky enough to have a choice, would be the NW corner of the grid, running SE, any time except the 4hr window 10pm-2am local time. That would put us at start of next line past sundown next day, forcing an overnight wait for ramp-up.

Bothersome artifacts in processed swath bathymetry (deep center beam; across track furrows) suggest using XBT rather than NOAA online velocity. Although water intake velocity profiler has been matching NOAA values to < 1m/sec for entire cruise, latest XBT shows distinct differences below surface -- esp. a min of 1471 m/sec at 21 m and slow steady increase to 1473 at water bottom. NOAA profile has been a steady decrease from surface to min of 1484 at seafloor. Will use XBT data along next line to compare side-by-side with NOAA (new line 1756 will be along side old line 1780R.)

EOL 1780R at 1713 (last shot 865).

Turtle shut down in turn 1757-1805.

SOL 2596 at 1821 (first shot 879). Heading NW. Winds light, seas essentially calm, with only gentle swell. Turtle power down 1947-52. 2156 – gun 6 (180 cu. in.) down, replaced immediately with spare (in-water) gun of same size. We will repair the broken gun during the next line turn at the SE corner of the grid.

JD 162 (June 11)

EOL 2596 at 0106 (last shot 5137). Turning to port.

SOL 1756 at 0212 (first shot 5129). Shooting SE. Winds SW, ~11 kts.

0329 – P-Cable streamer 21 failed, last shot 4332.

0337 – Geo eel controller restarted, recording SP 4249

0446 – P-Cable 21 failed again, SP 3574

0449 – Geo eel controller being restarted

0450 – Geo eel restart, SP 3501

Geo eel restarts bring 21 back online. However, the entire P-Cable is off line during such restarts. The first time for ~6 minutes and the second for ~2 minutes.

0531 – 21 out again. SP 3127.

0534 – Back online after restart. SP 3071. Entire P-cable down for ~3 min during restart.

0601 – 21 out again. SP 2800.

0608 – P-Cable back on line (SP2727); entire P-cable system shut down once more for several minutes. The frequency of P-Cable 21 failures is increasing. Therefore, in consultation with R. Steinhaus, decided to disable P-Cable 21 to prevent additional failures and thereby avoid the shutdowns of the entire P-Cable system necessitated while restarting Geo eel to bring 21 back on line. We will run the remainder of this line without P-Cables 21 and 15. At the end of the line, in addition to gun maintenance, we will recover the P-Cable to 15 and both repair 15 and seek a solution to the 21 problem. The signal cable has not been a problem, so there is no need to recover the entire P-Cable.

EOL 1756 at 0901 (last shot 865). Winds SW 13 kts. Seas 0.5 m. Turning to port to course 034 to perform gun maintenance and recover P-Cable to cable 15.

1035 - Streamer 15 on deck. Water and rust in digitizer connector show obvious water leakage; interior water likely as well. Digitizer replaced; so was the 2-ft jumper cable from cross-cable to junction box. Previous drop-outs on cable 21 pointed to junction box +/-or jumper; both replaced and checked out at 1155. Turned starboard to begin run-in.

1234 - Mitigation gun firing 1/min, PAM in water 1249.

1253 - Capacitance down + voltage leakage in 2 channels of cable 24; elect to retrieve without landing port vane and do it without turning. Will miss start of line but it's a re-shoot for ~6 km into the grid where the first fill-in gap is the target.

1256 – P-Cable 24 brought aboard; completely replaced; it had wrapped around the cross cable during deployment.

1346 - Full P-Cable array repaired and back in water.

1413 - Gun string (with repaired 180 cu. in gun) in water + firing.

SOL 2668R at 1451 (first shot 1503). Shooting NW. Wind 16 kn from S, seas 0.5 m. First shot 800 m before fill-in hole. Line designed to fill-in 3 holes on previous lines:

2668R sp xxxx-xxxx at yyyy-yyyy hrs fills in sp zzzz-zzzz on line abcd

2668R sp xxxx-xxxx at yyyy-yyyy hrs fills in sp zzzz-zzzz on line abcd

2668R sp xxxx-xxxx at yyyy-yyyy hrs fills in sp zzzz-zzzz on line abcd

The schematic notations above illustrate a process which will be part of MGL1510 surveying from now on. While shooting “prime” lines (those sail-lines we have not yet shot before), we will also be shooting profiles like 2668R, which represent a complex combination of “infill” (sometimes covering ground we have covered before) and “re-shoot”, i.e., filling gaps in coverage caused by all causes - marine mammals, equipment malfunctions, navigational deviations (e.g., caused by necessity to avoid passing ships). Specific shot numbers associated with gap filling survey operations, the timing of which will be governed by the locations of such gaps within the designated survey area, are detailed elsewhere, but the accompanying figure illustrates the approach. All of these operations are necessitating (and will necessitate) more survey time than originally planned; the co-PIs envision an approach to NSF seeking the shiptime necessary to complete the 3D volume as originally proposed.

EOL 2668R at 2014 (last shot 5137). Turning to port.

SOL 1732 at 2130 (first shot 5125). Shooting SE. Winds SW, ~15-18 kts.

JD 163 (June 12)

EOL 1732 at 0345 (last shot 865). Turning to port. During the turn, the active gun string will be pulled to replace a faulty solenoid on gun 6 (one of the two 180 cu. in. guns in the string). This will lengthen the turn by ~30 min.

SOL 2860R at 0548 (first shot 854). Shooting NW. Winds SW, 14 kts. Seas 0.5-1 m. At some point near the change of line, the GPS on the starboard barovane failed, meaning that we are dependent on the starboard tri-point float GPS and have no back-up GPS on that side.

0621 – Lost main (starboard) compressor (SP 1222). Operating only 40 cu. in. mitigation gun.

0626 – Back to full volume: 700 cu. in. (SP 1284). Using port compressor.

0805 – Shut down main array and went back to mitigation gun (SP 2403) so that the engineering department could repair the main, starboard compressor and return to using it (the smaller port compressor is primarily a back-up unit).

0816 – Back to full power running off starboard compressor (SP 2535).

1157 - deploying mitigation gun to be able to pull gun array for work in turn.

1305 - mitigation gun recovered, gun array in water, powered up, firing.

SOL 1708 at 1342 (first shot 5147). Shooting SE. Winds SSW, 10 kts. Seas 0.5-1 m.

EOL 1708 at 2018 (last shot 865). Turning to port.

SOL 2572 at 2125 (first shot 875). Shooting NW. Winds SSW, ~16-18 kts.

2221 – power down for a whale; mitigation gun firing.

2252 – back at full volume.

2317 –P-Cable recording system has not been writing any data since the beginning of this line; re-booting the system; c/s ~2.5 kts.

JD 164 (June 13)

0031 – first good shot on line 2572 – SP 2774.

0039 – c/s 4.5 kts.

0347 – Missed SPs 4027-4045 because of gun trigger communication errors.

EOL 2572 at 0408 (last shot 5137). Winds SW, 19 kts. Seas 1 m.

SOL 1852I at 0509 (first shot 5129). Shooting SE. Winds SW 19 kts. Seas 1 m. This is an infill line; long gap in line 1852, shot on June 6. 1852I also covers gaps in lines 1924 and 1876.

0509 – Start infill line 1924, SP 5129.

0530 – End infill line 1924, SP 4920.

0604 – Start infill line 1876, SP 4582.

0611 - End infill line 1876, SP 4275.

0706 – Infill line 1876 SP 3972.

0709 – Infill line 1876 SP 3947-3899.

0728 – Start infill line 1852I SP 3756.

EOL 1852I at 1017 (last shot 1942). Winds W, 13 kts. Seas 1 m. Turning to port before reaching end of grid to reshoot a long gap in line 2692.

SOL 2692R at 1122 (first shot 1913). Shooting NW. Winds W 14 kts. Seas 1 m.

1248 - joined line within grid at sp 2774 to reshoot long PCable gap covering more than half of the line and extending to its NW end.

1230 - 45' ocean sloop approaching from port not responding to radio or horn until 500 yds. off our beam; tightened sails for close haul, engaged engine and with MGL a/s to 3.0 kn SOG at 1258, passed 300 yds. ahead of us at 1308.

1333 - end reshoot of PCable gap at sp 3194

1434 - pod of 15 common short-beaked dolphins 2.4 km off stbd; power down

1438 - solitary fin whale farther off stbd
1508 - no further sightings; back to full volume
1549 - power down for solitary fin whale
1623 - back up to full volume

SOL 1684 at 1748 (first shot 5125). Shooting SE. Winds N, ~14 kts, seas ~0.5 m.
EOL 1684 at 2319 (last shot 865). Turning to port.

JD 165 (June 14)

SOL 2548 at 0126 (first shot 885). Shooting NW. Winds SE, ~ 7 kts., seas ~0.5 m.
EOL 2548 at 0747 (last shot 5137). Winds S 3kts., seas 0.5 m.

SOL 1660 at 0854 (first shot 5141). Shooting SE. Winds SW ~2 kts., seas 0.5 m.

1027 - Power down (fin whale). Last good shot SP 4144. 40 cu. in. mitigation gun firing from 1028, SP 4132. Oily smooth sea surface, winds nil from the W, foggy, half-dozen 25-35 ft recreational fishing boats within view, MGL sounding fog horn. This central area of survey grid (near Exp313 site 28) is popular with animal life and fishermen (both anglers and commercial druggers) and unfortunately is our most important area in the survey rectangle (tie to Site 28 and provide images of the especially thick m5.4 depositional sequence.)

1030 - Shut down (mitigation gun off). Whale entered exclusion zone. Last shot of mitigation gun SP 4099.

1111 – Starting ramp up. The whale was last seen at 1041; ramp up can begin 30 minutes after last sighting.

1142 – Ramp up complete. Collecting data again: first shot at full volume SP 3349.

1154 - PCable recording lockup; last good sp 2951; still getting fire pulse + nav; a/s to 3.3 kn

1309 - PCable back up at sp 2378

1337-1345 - turtle power down sp 2074-1974

1411-1417 - turtle power down sp 1640-1614

1437-1445 - turtle power down sp 1376-1299

1451-1453-1456 - turtle power down sp 1234; shut down sp 1204; back to full volume sp 1172

1457 - POSNET computer software crash, no gun or tail buoy nav; effectively this is EOL

EOL 1660 at 1518 (last shot 911, but see above). Winds NE, ~5 kts, seas flat

During the turn, the NCS group moved over to its backup computer, suspecting that the lockup problem was in a network card managing traffic among the many devices. Initializing + testing the new system took the entire turn and a few shots into the run-in.

Meanwhile the POSNET failure was determined to be with the shipboard receiver; this navigation has so far not been used for P-Cable nav, so its loss won't affect 3D data. We don't

have a spare receiver, but further diagnosis may show the problem is with the power supply, and we have workarounds for that.

SOL 2572R at 1645 (first shot 961). Progressing NW. Winds SE 0-5 kts, seas flat

We've got the flattest seas, calmest wind of the trip thus far, but that means turtles are at the surface and causing power downs.

1711-1718 - turtle power down, sp 1239-1331

1727-1740 - turtle power down, sp 1435-1581

1756-1809 - dolphin power down, sp 1773-1918

1830 - a/s to 3.0 kts to retract port vane several meters and avoid high-flyer long-line float

1844 - float passed 2-3 m outside port vane; appeared loose and not connected to any other gear

1859-1911 - turtle power down, sp 2482-2620

1932-1938 - turtle power down, sp 2864-2932

EOL 2572R at 2252 (last shot 5137). Turning to port.

JD 166 (June 15)

SOL 1636 at 0008 (first shot 5130). Shooting SE. Winds SE, ~ 11 kts.

EOL 1636 at 0625 (last shot 865). Winds SE, ~8-9 kts. Seas 0.5 m.

SOL 2524 at 0733 (first shot 859). Shooting NW. Winds SE ~5kts. Seas 0.5m.

0838 - a/s to 4.0 kn stw due to leakage PCable (no individual streamer); return to 4.5 kn at 0920

EOL 2524 at 1402 (last shot 5137).

SOL 1612 at 1510 (first shot 5143). winds SW 12-15 kn, seas 0.5 m. Thick fog for most of line.

EOL 1612 at 2208 (last shot 865). Turning to port.

SOL 2500 at 2316 (first shot 872). Shooting NW. Winds S, ~7 kts. Seas ~0.5 m.

JD 167 (June 16)

0233 (SP 3007) – 120 cu. in. gun misfiring. Austin decided to shut that gun off and replace it with a 40 cu. in. in the water. Continuing line. Austin requested that Steinhaus be awakened.

0240 (SP 3077) – Conference with Steinhaus. We are not permitted to do what Austin decided to do; furthermore, the array with the 40 replacing the 120 is no longer tuned. As an extended turn for gun maintenance cannot occur on the inboard end of the survey, the decision was made to pull the string now for maintenance, while proceeding down the line. Gun array off; only mitigation gun firing. c/s 3.3kts.

0250 (SP 3152) – P-Cable stopped recording. Getting it back up.

0257 (SP 3206) – P-Cable back on line. Guns not yet external.

0258 (SP 3213) – Back on-line. Mitigation gun only.

0313 – Gun string on deck.

0330 – the 120 cu.in. gun is being replaced in the string. Problem was with either the gun or its solenoid, so a new gun with a new solenoid should solve the problem.

0349 – Increased speed to 4.2 kts for redeployment of gun string. The gun string was in the water by 0356. The array was successfully test fired before being deployed to its final position.

0402 – Resumed survey: continuing on line 2500, first shot point SP 3701.

EOL 2500 at 0625 (last shot 5137). Winds N, 10 kts. Seas ~0.5 m.; foggy

SOL 1588 at 0733 (first shot 5148). Shooting SE. Winds N, ~14 kts. Seas ~0.5 m.; foggy

1349-1355- turtle power down, sp 1081-1014

EOL 1588 at 1408 (lsp 865) Winds S 7 kn, seas flat; hazy

1417 - gun array in to replace 120

1518 - gun array re-deployed

SOL 2476 at 1557 (first shot 858) , winds S at 8 kts, seas 0.5 m.

1742-1748 - turtle power down, sp 2002-2075

1742-1745 - EM122 locked up

EOL 2476 at 2213 (last shot 5137). Turning to port.

SOL 1564 at 2323 (first shot 5102). Shooting SE. Winds NE, ~ 2 kts. Seas ~0.5 m. Squalls in the area.

JD 168 (June 17)

EOL 1564 at 0532 (last shot 865). Winds NW, ~5-7 kts. Seas ~1 m.

SOL 2452 at 0640 (first shot 857). Shooting NW. Winds NW, ~10-12 kts. Seas ~1 m.

EOL 2452 at 1301 (last shot 5137). Winds NW, ~10-12 kts. Seas ~1 m.

SOL 1540 at 1409 (first shot 5140). Winds N, ~20 kts. Seas ~1 m.

EOL 1540 at 2031 (last shot 865). Turning to port.

SOL 2428 at 2141 (first shot 863). Winds ~ENE, ~11-13 kts, seas 0.5-1.0 m.

2340 – a second seafloor evident on the long-offset data ~1 s below the primary seafloor is becoming evident. Looks like an artifact, perhaps caused by a gun auto-fire. We are checking evidence for that on deck; nothing obvious. The problem is intermittent. PSO can hear a second shot on the PAM. Steinhaus thinks it may be a double pop.

2354 – turns out the problem is gun #6, one of the two 180 cu. in. guns. Fire signal to that gun has been moved over to the spare 180 on the array; problem solved. However, problem has occurred for the whole line (~2 hours old), so SOL to sp 2428 will need to be re-shot. Final diagnosis: to minimize chance of magnetizing parts of the solenoid housing, Bolt recently replaced steel washers with aluminum; one such washer in gun #6 disintegrated during use and ?caused premature recoil of the solenoid? All solenoid housings on shipboard spare guns we might use are now being retrofitted with old style, and will be swapped in if/when the gun string comes back on board.

JD 169 (June 18)

0015 - Steinhaus et al. replayed previous line (1540) and found dbl pop problem began at SP 1290, ~300 shots from the EOL of 1540. That will need to be re-shot, too.

EOL 2428 at 0406 (last shot 5137). Winds ~SE, ~7-9 kts, seas 0.5 m.

0409 – Begin recovering gun string 1 to replace the problem 180 cu. in. gun during turn to ensure there's a back-up. The gun string was on deck at 0427 and back in the water by 0452.

SOL 1516 at 0524 (first shot 5147). Shooting to SE. Winds ~SE, ~8-9 kts, seas 0.5 m.

1147-1152 - tail buoy not responding (sps 1104-1048)

EOL 1516 at 1210 (lsp 865) winds SE 0-5 kn, seas 0-.5 m

1501-1529 - tail buoy out again (sps 1975 - 2246)

1521 (2168) - 1533 (2281) - steering transferred to bridge during launch + recovery of boat transferring Jamie + Craig to shore-bound vessel

SOL 2404 at 1316 (fsp 858) - winds E 4 kn, seas 0.5 m

EOL 2404 at 2009 (lsp 5137) - winds SE 12-15 kn, seas 0.5-1 m

SOL 1756I at 2201 (fsp 5136) - winds SE 12 kn, seas 1 m; re

2223 - leakage in PCable + loss of all telecomm began a record-fast turn-around time for recovery, repair, redeployment. Mitigation gun enabled on array while PAM brought aboard by 2243. Gun array recovered; port Barovane out of water + secure at 2346; meanwhile the port Tri-pt float recovered and the cross cable recovery began.

JD 170 (June 19)

At 0033 the stern-deployed mitigation gun was active. At 0044 PCables #24-5 aboard; #4 was missing - bale welded to plate joining it to digitizer snapped off adjacent to the weld. Cable, digitizing canister and connecting cable lost. Replaced, powered up and no further leakage; decided to redploy as fast as possible + if within mitigation window resume shooting without need for full shutdown until daylight. Gun array back in water at 0325 without planned maintenance addressing wear on guns 4,5 and 7; will do that later. 0405 ramp up complete and guns firing at full volume.

SOL 1756I at 0406 (fsp 1654) - resume infill

EOL 1756I at 0515 (lsp 865)

SOL 2572S at 0624 (fsp 860) - winds S 8 kn, seas 0.5 m re-shoot of 2572R

EOL 2572S at 1043 (lsp 3707) - end of re-shoot; sharp (bulb) turn to pick up re-shoot going SE
1047 - pulling gun array for maintenance postponed from last rapid turn-around

SOL 1900I at 1251 (fsp 3886) - SOL winds W 6 kn, seas 0.5 m; foggy

1405 - Robert reports 3 km streamer shows leakage suggesting water incursion in as many as 40 groups; visual check of real-time shot gathers doesn't look as serious as that; we should look at processed long offset data to choose among 4 options: 1) leave everything as is until more channels go south or we have other reason to pull in; 2) commit to ~ 24 hr turn-around to pull 3km, replace bad sections, redeploy and possibly have to retrieve to re-ballast, then back in water + running; 3) commit to 6 hr recovery, leave 3 km onboard, complete remaining survey with PCables only; or 4) run small number of wide-spaced lines in remaining grid, pull in 3 km, then complete remaining survey with PCables only. For now follow option 1, but examine pre-stack constant offset gathers ("single trace monitor") for 4 types of channels: obviously good (e.g. ch 100), obviously bad (199), perhaps OK with a little visible buzz (157), and seem OK visually but Robert's test shows leakage (xxx).

EOL 1900I at 1719 (lsp 865)

Turtle power-downs at 1322-1332 and 1648-1654

SOL 2380 at 1822 (fsp 874) - wind W 6 kn, seas 0.5

Turtle power-downs at 1912-1920

2205 - PCable failure; no telemetry beyond cable 5; suspect bad interconnect cable.

EOL 2380 at 2219 (lsp 3503) - end due to PCable problem past cable # 5.

Reversed course at 2225 to recover gear while heading seaward. Tri-pt float aboard and begin recovering PCables at 2315. Junction box on cable 16 snapped off cross cable; later the tail of cable 16 showed shark bite just ahead of compass. Bracket holding J-box 8 to cross cable had failed and was lost; as precaution, all brackets to J-boxes were tightened during deployment. Interconnect cable btw 5 and 6 shows signs that oil used inside cable has begun to degrade insulation on interior wires.

JD 171 (June 20)

All gear back in water and starting ramp-up at 0311.

SOL 1660S at 0341 (fsp 2978) - wind E 0-5 kn, seas flat

0344-0433 re-shoot sps 2950-2379 of line 1660R

0502 - Syntrak locked up; Steinhaus awakened, restarted system 0513; no 2D nav sps 2040-1912

0608-0644 re-shoot sps 1290-865 of line 1660R

EOL 1660S at 0644 (lsp 865)

SOL 2356 at 0746 (fsp 860) - wind E 5 kn, seas 0.5 m

0953-0958 - power down for turtles

EOL 2356 at 1409 (lsp 5137)

SOL 1492 at 1514 (fsp 5148) - winds E 12 kn, seas 0.5 m

EOL 1492 at 2128 (lsp 865)

SOL 2332 at 2335 (fsp 871) - winds SE 5 kn, seas 0.5 m

EOL 2332 at 0451 (lsp 5137)

JD 172 (June 21)

SOL 1468 at 0557 (fsp 5138) - winds S 16 kn, seas 1 m

0754-0816 - squalls, wind ~ 40 kn, lightning; bridge took control

0916-0922 - tail buoy nav offline

EOL 1468 at 1226 (lsp 865)

SOL 2308 at 1327 (fsp 866) - SOL winds S 25 kn, seas 1.5 m; auto-track not holding line, control handed off to bridge from SOL

1556 - dbl pop on guns; intermittent and hard to id which gun

1634 - by shutting off guns 1 at a time, learned 120 cu in gun in position 7 was the one; turned off and standby 120 at position 8 was turned on

EOL 2308 at 2002 (lsp 5137) - mit gun firing off stern during recovery to replace solenoid housing on gun 7; gun array back in water at 2103 and firing at full volume; mit gun off + recovered

SOL 1444 at 2120 (fsp 5129) - winds WSW 12-15 kn, seas 1 m

2205 - PCable locked up for 60 shots starting at sp 4707

2225 - for about 10 mins, reflections near tail of streamer, closest ~trace 60 at 2.8 secs (greater fwd + aft) from ~ tail (trace 1) to trace 120

JD 173 (June 22)

EOL 1444 at 0355 (lsp 865)

SOL 2284 at 0457 (fsp 857) - winds WSW 15 kn, seas 2 m

EOL 2284 at 1138 (lsp 5137)

SOL 1420 at 1244 (fsp 5144) - winds NW 5 kn, seas 1 m; many reverse moveout events at tail of shot gather real-time display, probably off seaward-facing slope of sand waves a few meters high; should compare with ship's location when these were seen previously; lots of high amplitude noise on nearest traces as well, most likely our own propellar noise reverberating in water column in this shallow water.

1350 - power down, then 1 min later shut-down for 2-3 fin whales; 1 began 500 m from starboard vane, then swam directly across our stern about 500 m behind the head float of the streamer (all guns off at that point); 2-3 gathered off port and we left them aster; began ramp up at 1453 and returned to full volume at 1524

1706-1712 - power down for turtles

1732-1738 - power down for turtles

1800-1815 - tail buoy out; charging during turns can't keep battery going for 6 hr lines

EOL 1420 at 1916 (lsp 865)

SOL 2260 at 2019 (fsp 871) - winds WSW 10 kn, seas 0.5

2033 - fishing float with flag passed on stbd and caught on signal cable; no apparent harm to PCable data, but unknown gear worked its way 3/4 way down signal line and stopped; float visible at surface; will leave in place for now

EOL 2260 at 0239 (lsp 5137)

JD 174 (June 23)

SOL 1396 at 0355 (fsp 5133) - winds SW 6 kn, seas 1 m; have been sending power to tail buoy during turns to charge battery, but battery has been running out before end of line; this time will let battery discharge completely during line

EOL 1396 at 1028 (fsp 865)

SOL 2236 at 1131 (fsp 859) - wind S 12, seas 1 m

1304 - power to tail buoy turned back on

EOL 2236 at 1757 (lsp 5137)

SOL 1372 at 1905 (fsp 5130) - wind S 20, seas 1 m; modified IHA arrived from NMFS, inc Level B takes of Fin whales to 36 and Short-Beak common dolphins to 2113

JD 175 (June 24)

EOL 1372 at 0135 (lsp 865)

SOL 2212 at 0242 (fsp 876) - wind SW 35 kn, seas 1.5 m

0707 - gun 4 (180 cu in) autofiring; disabled + replaced by gun 5 at 0709

EOL 2212 at 0914 (lsp 5137) - c/s to 3.5 SOG to prepare for gun work during turn: stern mit gun lowered off stern and firing; pulling airgun string to check all shackles, chains and replace gun 4 with fresh gun+solenoid housing; found broken chain; all repaired during turn + redeployed

SOL 1348 at 1030 (fsp 5148) - wind N 13 kn, seas 1.5 m

1426-1432 - power down for turtles

1452-1457 - power down for turtles

EOL 1348 at 1652 (lsp 865)

1717 -1722 - power down for turtles during turn

SOL 2164 at 1757 (fsp 873) - SOL wind N 6, seas 1 m

1856 - PCable locked up, suspect Cable 13; restartt; locked up again; cold re-start

1936 - long minutes of no success, system finally up; disabled 13; then leakage appeared and increased and current diagnosis is failure in signal cable (fishing float?), but recording OK

2005 - turtle power-down; back up 2011

2150 - Spectra3 failure; video card? will trouble shoot during next turn

JD 176 (June 25)

EOL 2164 at 0024 (lsp 5137) - rebooted Spectra3 during turn, all systems returned OK

0357 - PCable 7 dropped out

0402 - PCable re-started, cable 7 seems OK; no apparent leakage; not same issue as cable 13 lockup (cable 13 still disabled)

SOL 2116 at 0902 (fsp 885) - winds 10-12 kn, seas 0.5 m

0902 - from the first shot, PCables not recording in Geometrics; re-start, no cable 16 comm; chose to disable 16 + continue line to NW + hope to lose no more, then turn + pull gear heading SE and determine problem + repair cables 13, 16 and possibly replace signal cable that still has fishing gear; with luck we'll have enough light to re-deploy and begin next NW line in this critical corridor between 3D areas that need to be joined

0925 - floating fishing gear close to starboard, ship diverted several m to port to avoid; it passed under the signal cable and over the cross cable

0927 - sp 1109-1155 Geometrics back up with cables 13, 16 disabled; but NCS Trawler not communicating positions

0931 - sp 1156 NCS Trawler off to re-boot, causing no trigger signal, so all guns off (no 2D)

0942 - sp 1215 all systems back up but concern that data may be writing to files correctly; to be certain both Geometrics and NCS computers were re-started and synched; we checked later and found worry was unfounded, data was OK

0945 - sp 1287 all systems (Spectra, Geometrics, NCS) back up and recording

1229 - diverting to avoid floating fishing gear off to port
 1250 - ship diverted 525 m to starboard to avoid gear; it passed ~2 m outside of port vane
 1309 - back on line 2116
 1445 - PCable 10 total failure; probably lost; EOL
EOL 2116 at 1457 (lsp 4671)
 1502 - begin recovering PAM, guns, vanes, TriPoint, PCables
 1700 - all PCable onboard, missing 13 + 16; 10 hanging by jumper cable
 1727 - replaced 13, 16 + repaired 10 and redeploying
 1932 - leakage in 5-6 interconnect; recovered + replaced (2 more spares left)
 2004 - gun array out
 2252 - turning towards next line; telemetry with PCable prevents 1/2 msec sample rate; hardware issue probably in cross-cable communications causing poor network comm; can't solve in software (eg go to shorter record lengths); trouble shooting could take a long time and cause more problems rolling interconnects on/off reel; choose 1 msec for remainder of survey

JD 177 (June 26)

SOL 2068 at 0106 (fsp 873) - SOL winds S 7 kn, seas 0.5 m
 0306 - gun # 10 (220 in³) not firing; disabled at 0307, enabled gun # 9
EOL 2068 at 0732 (fsp 5137) - pulled gun array in turn, replaced gun #10 by 0829

SOL 1300 at 0845 (fsp 5134) - SOL winds S 6-12 kn, seas 1 m
 1114 - PCable failure
 1149 - PCable back up

1230 - conf with Robert, Todd + Captain: weather outlook uncertain but chance that seas could build to >4 m means leaving PCables in water puts them at high risk bc they are fixed at 2.1-3.7 m and cannot be changed. Decision is to pull them when wind veers to SE (probably late tomorrow am) But leave the 3 km cable in the water. Downside = 1) wear on interconnects going over sheave at rail, then onto reel and 2) time needed for recovery/redeploy. Upside = 1) guard against building to higher than expected so that we can't recover, and seas damaging / losing cables, 2) opportunity to replace 5-6 interconnect (last one deployed, possible source of problems since then), and 3) chance to work on stbd vane: a) repair GPS unit, remove fouled fishing gear, check wear on towing harness (first time used; not yet checked.) Robert still urges we consider taking 3 km cable out and leaving onboard for remainder. I asked latest time to decide y/n he said when time to redeploy (possibly Sun pm / Mon am.) Interim guard against Geometrics lockup due to telecom issue: disable cable 24 - this reduces traffic on network (like changing resample rate from 0.5 to 1 msec). If insufficient, next step w/b disable cable 23 (traces are all serial; disabling cable 1 kills all the others as well.) Downside = narrower 3D

coverage, requiring adjacent lines must be moved over 1 cmp; easy to do. This means 4% less coverage per unit time.

EOL 1300 at 1516 (lsp 865)

SOL 2020 at 1615 (fsp 872) - SOL winds NE 10-12, seas 1 m

1631 - Geometrics failure; lengthy effort to re-start unsuccessful; can't communicate with any devices, although the power supply for all streamers is functioning; suspect either signal cable or interconnect cable between TriPt float / end of signal cable and junction box 1. Hail Mary effort checked slip ring on deck reel for signal cable; that was working fine. Option 1: continue in 2D long offset mode until weather either a) stops that operation, or b) if we shoot through it, weather abates and we pull PCables to make repairs. Option 2: EOL here and pull all PCables + replace signal cable with new spare. If lucky that will solve current problem and if dbl lucky will be done with enough time to return to 3D. But we'll still have telecom problem somewhere in the cross cable. Geometrics will have 2 more interconnects at the airport Sunday night. Chose opt

1705-1715 - c/c to stbd to avoid fishing gear

1740 - recovering PAM, start of PCable turn-around

1830 - port TriPt float aboard; recovering cross cable; all PCables + connectors appear OK; cable btw turbine and GPS stbd TriPt deeply worn; replaced; metal housing for camera at head of PCable 1 damaged interconnect to stbd TriPt; replaced cable, removed camera + housing; communication to all cables restored; but 0.5 msec recording and 24 cables continues to lockup; to be safe, continue 1 msec sampling, disable Cable 16 (occasional spikes)

2130 - redeploying PCables

JD 178 (June 27)

0020 - PAM redeployed

SOL 1276 at 0105 (fsp 5105) - SOL wind SE 2, seas flat

EOL 1276 at 0751 (lsp 865)

SOL 2020R at 0853 (fsp 866) - SOL wind E 14, seas 1.5 m

0945 - leakage values increasing as are winds; stw reduced to 4.3 kn

1400 - winds veering slightly to S of E, holding at 10-14 kn, GOES map suggests chance winds will continue to veer to SE, then S and finally SW by tomorrow, with rain; plan based on anticipated bad weather by mid-late afternoon today and bulb turns to remain filling gap between NW-bound and SE-bound grids now revised; at end of current line will now turn to port to do prime line along SW edge of SE-bound grid and re-assess weather on line-by-line basis, keeping in mind the need to minimize number of adjacent tracks shot in opposite directions within the gap we're filling

0853-0910 - infill

0910-1003 - reshoot

EOL 2020R at 1539 (lsp 5137)

SOL 1252 at 1643 (fsp 5130) - SOL winds ESE 12, seas 1.5; heading SE adding to outside edge of survey grid so long as weather holds and PCable is performing OK (Cable 16 still disabled, 1msec)

1659 - stopped sending power to tail buoy

2223 - winds within few deg of due E for entire line, now 20-30 kn, seas 2 m and short (6 sec); noise on 3 km strmr has increased; dove streamer from steady 4.5 m to equally steady 6.5 m and now much quieter; STU 1700-1800 lbs (usually 1400 or so); PCable is surprisingly quiet, no leakage issues

EOL 1252 at 2323 (lsp 865)

JD 179 (June 28)

SOL 1996 at 0023 (fsp 873) - SOL winds E 25-30, seas 2-3 m; now with seas on stern stbd quarter and we're headed for shallower water we expect winds and seas will lessen; raised streamer to 5.5 m at SOL; at 0057 noise was still too much and lowered it back to 6.5 m

EOL 1996 at 0648 (lsp 5137)

SOL 1228 at 0750 (fsp 5135) - SOL wind SSW 5-10 kn, seas 2 m

0910 - port vane GPS died (an no stbd vane GPS for several days)

EOL 1228 at 1422 (lsp 865) - at EOL raised streamer from 6.5 to 4.5 m

SOL 2188 at 1533 (fsp 857) - SOL wind WSW 15-20, seas 2.0 m

1614 - lowered streamer to 5.5 m; still noisy, lowered to 6.5 m at 1617

1920-1926 - power down for turtle

EOL 2188 at 2159 (lsp 5137)

SOL 1204 at 2312 (fsp 5133) - SOL wind SW 15 kn, seas 1.5 m

2322 - PCable telecom lockup; either slip rings, signal cable or interconnect to Jbox 1; can't recover, repair, redeploy before dark; will finish this line as 2D, then at seaward end of grid pull all gear (3 km strmr as well) and repair Geometrics as needed, but redploy only PCables; chance for more 2D after completing 3D a) in gap, b) major infills, c) some/all planned extension to the SW; but to be realistic, ought to expect at least 1 more turn-around with PCable repair before time runs out late Sunday July 5.

JD 180 (June 29)

EOL 1204 at 0544 (lsp 865)

0545 - PAM coming aboard; bale snapped off at weld on PCable 24 like many previous, but was retained by safety lanyard of braided Spectran installed at last deployment; replaced digitizer on PCable 16 to address telemetry issues; replaced jumper cable at Jbox 11 to address leakage; replaced Jbox 4 due to bad compass; replaced tail compass on PCable 1; interconnect to Jbox 1 tested fine, so problem must be in signal cable; new signal cable installed; underwater GPS power turbines replaced on both vanes (stbd turbine was fouled with a plastic bag that must have floated into it); 3 km streamer clearly was dragged on the seafloor: fairing was torn away and armored wrap was polished shiny with grains of fine sand embedded among the strands

1101 - 3 km streamer tail buoy onboard; continuing repairs to underwater generator on stbd vane

1230 - begin PCable re-deployment w/out 3 km, replacing parts known to be faulty + new ones discovered by eye; but by 1459 telemetry problems begin to show up with increasing frequency; rest of day was frustrating chase of elusive errors that were manifest by erratic triggers of each cable

JD 181 (June 30)

0010 - decision made to give up for night - too late to solve and resume shooting before mitigation interval would prevent this; retrieved all gear (including vanes) and laid out cables 1-9 + cross cable on streamer deck to facilitate trouble-shooting in morning

0526 + 0545 - turned off Knudsen then EM122 for transit to nearshore

1105 - hove-to off Manasquan Inlet to pick up Geometrics engineer and spare parts; Dan Shehan onboard at 1130, c/s to 11 kn to return to survey grid; after safety orientation, Dan was apprised of electronic + mechanical situation and began doing his own evaluations

1313 - diagnosis pointed to faulty signal cable; wound 2nd spare signal cable on reel + tested with cables 1-9 on deck

1402 - Knudsen and EM122 turned back on

1435 - all tests OK w/ new signal cable, 2 diff first cable interconnects, Jbox, jumpers + digitizers; also 2 separate power supplies had no failures; prepare to return to surveying

1744 - stbd vane in water

2045 - begin 30 min ramp up, most of the way along a SE line

SOL 1948 at 2118 (fsp 2454) - wind SE 10-15, seas 1-2 m

EOL 1948 at 2351 (fsp 951)

JD 182 (July 1)

0000 - UTC leap second caused multiple errors in time-based systems during turn; auto pilot caused esp. sharp turn that nearly stalled the port vane; correction led ship off intended course and ended in a figure-eight turn to reach start of next line

SOL 2140 at 0133 (fsp 869) - winds SE 5 kn, seas 1 m

0217 - unknown Spectra error moved steering to port

EOL 2140 at 0801 (lsp 5041)

0835 - intense 15-min squall with lightning and SW winds 60+ kn moved us off planned turn

SOL 1972 at 0913 (fsp 5135) - winds W 15 kn, seas 1 m
1402 - clock errors in EM122; reset and corrected at 1424
1518 -1524 - power down for turtle
EOL 1972 at 1529 (lsp 961)

1633-1639 - powerdown for turtle during turn

SOL 2092 at 1646 (fsp 933) - winds W 3 kn, seas 1 m
1650-1656 - PCable failure; missing shots; could be SOG too high; c/s to 4.3 kn
1720-1726 - power down for turtle
1723-1725 - PCable failure; missing shots; could be SOG too high; c/s to 4.0 kn
EOL 2092 at 2308 (fsp 5041)

SOL 1420R at 2353 (fsp 5036) - winds 18 kn, seas 1 m; filling 1 whale and 4 turtle gaps; PCable failures due to slow network causing lockup at 0037-0044, 0225-0244 and 0556 that effectively ended the line

JD 183 (July 2)

EOL 1420R at 0556 (fsp 1044) - called EOL at last PCable failure

SOL 2044 at 0655 (fsp 865) - SOL winds 9 kn, seas 1 m
0701-0727 - repeated troubles with slow network, uncertain which cable is at fault (23? 12? 16? 11?); Dan says problem could be in signal cable that changes impedance when stretched over the outgoing sheave; we slowed SOG / STW from 4.5+ kn to 4.1-4.3 kn to reduce data rate and drag on signal+cross cable
EOL 2044 at 1347 (lsp 5041)

SOL 1948A at 1456 (fsp 1456) - SOL wind NW 8 kn, seas 1m; this is last long line in the gap we've worked to close for last several days; will breathe easier when this line is finished; will then clean up large in-fills and then small in-fills, then return to extending survey towards the intended SW edge of proposed grid
EOL 1948A at 1911 (lsp 2404) - woo-HOO; then turn sharp to stbd

SOL 1300R at 1952 (fsp 1952) - SOL wind ENE 12 kn, seas 0.5 m; starting well ahead of gap needing infill; at end filling 6 min turtle gap on line 1324; these lines shot in direction opposite to the prime lines 1300 + 1324
EOL 1300R at 2226 (lsp 3972) - begin long run to next line turning to stbd

SOL 1660R at 2351 (fsp 4533) - SOL winds NE 12 kn, seas 0.5 m; after 1660R several jogs to fill 1 long and several short (5-6 min) turtle gaps on nearby lines

JD 184 (July 3)

EOL 1660R at 0538 (lsp 961) - bridge turned abruptly for next line, missed some of start

SOL 2116 at 0610 (fsp 988) - SOL wind N 12 kn, seas 0.5 m; several short reshoots along this line

0946-0954 - PCable 12 digitizer failed; Dan re-started Geometrics and A-OK; ultimate cause not known at this time

EOL 2116 at 1237 (fsp 5041)

SOL 1204A at 1338 (fsp 5071) - SOL wind NNE 8 kn, seas 0.5 m; turtle power-down at 1429; PCables off for 6 min starting 1430; restarted OK

EOL 1204A at 2018 (lsp 961)

SOL 2428R at 2135 (fsp 962) - SOL wind ESE 4 kn, seas 0.5 m; 3 PCable failures in this line, each 6 mins; re-shoot line 2380 beginning 0116 to eol at 0401 (sps 3357-5041)

JD 185 (July 4)

EOL 2428R at 0401 (lsp 5041) - PCable failure and diversion around fishing vessel during turn

SOL 1180 at 0512 (fsp 5105) - SOL wind W 8 kn, seas 1 m; continued PCable failures, brought back up in ~ 6mins

1006-1007 - compressor failure, low pressure alarm, guns shut off for 1 min; back up OK

1117 - beginning of serious PCable failures, all from cable 12 onward, suggesting prob either in Jbox12 or interconnect cable btw 12 and 13; EOL, pull gear to cable 12 to diagnose/replace

EOL 1180 at 1155 (lsp 1471) - EOL to pull gear; will redeploy and move to next line; routine turnaround beginning with recovering PAM at 1159, JBox 12 and interconnect 12-13 replaced at 1349 followed by testing, PCables going out again at 1430, PAM in the water at 1639, ramp-up complete at 1713; then a long turn and lineup with next line in survey grid

SOL 1156 at 1839 (fsp 953) - SOL wind NE 12 kn, seas 1 m

JD 186 (July 5)

EOL 1156 at 0112 (lsp 5041)

SOL 1132 at 0243 (fsp 5050) - SOL wind NE 8 kn, seas 0.5 m; end-game strategy: shorten the next couple of lines to focus on landward end of long SW edge of proposed grid to get what we can of the thick foreset and more nearly level topsets of the m5.4 sequence, leaving the seaward lowstand runout strata; then will turn back into completed grid and spend 10-12 hrs in-filling roughly 5 gaps also in the high-value m5.4 region of interest; this should be completed in the early hours of July 6 towards the NW quadrant of the grid, aiming us towards the dock
EOL 1132 at 0656 (lsp 2420)

SOL 1108 at 0815 (fsp 2306) - SOL wind NE 5 kn, seas 1 m
EOL 1108 at 1238 (lsp 2420)

SOL 1084 at 1412 (fsp 5045) - SOL wind NW 4 kn, seas 1 m
EOL 1084 at 1809 (lsp 2420) - end of primary grid; now loop back into grid and cross highest value fill-in gaps; Perfect Storm problems: turtle power-down, PCable failure (box 2), Spectra navigation lockup - all between 1458-1513 (sps 4565-4408); another PCable failure at 1518-1524

1832-1838 - turtle powerdown during turn

1840 - large school (100 +) of large (> 3 ft) ?yellowfin tuna? overtook vessel along port, passing within 150 m of the guns (while shooting) and a few feet below the surface when amidships, then passed on ahead, showing no distraction by our ship, propellers or airguns

1909-1916 - turtle powerdown during turn

1921 - start of series of tracks across several gaps left by turtle power-downs and brief equipment failures; in most cases we recorded well ahead and well past a gap, ensuring complete coverage

JD 187 (July 6)

0444 - continued across the several lines requiring in-fill or re-shoot without incident and closed up the last infill between sp 4794-4903 on line 2380 (sequence 100 for the cruise) at 0444; hi-fives all around and then to the stern to retrieve PAM, the gun array, the floats, vanes and PCables