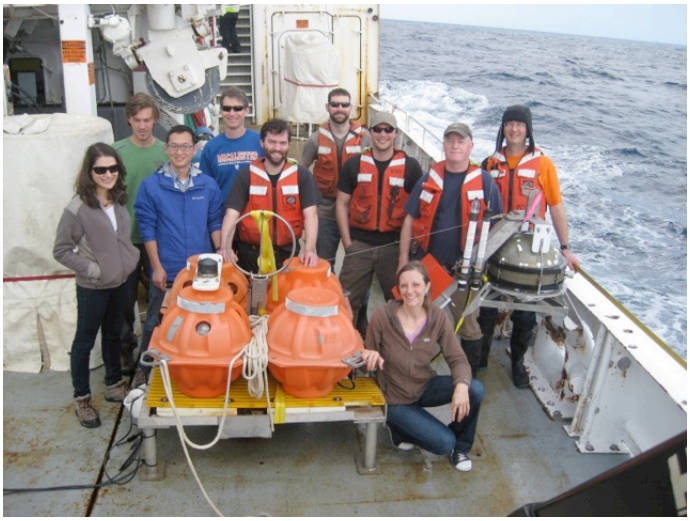
Cruise Report EN-537, *R/V Endeavor*

Eastern North America Margin
Community Seismic Experiment
Broadband OBS Deployment Cruise

April 1-14, 2014
Narragansett-Narragansett



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Project Overview

How do continents break apart? Does magmatism and partial melting induce weakening and subsequent rifting? Or do pre-existing zones of weakness nucleate rupture? How do these processes control the subsequent evolution of the rifted margins? These questions are fundamental for understanding the dynamic processes driving active deformation of Earth's interior, as well as the long-term geological evolution of the planet. The ENAM Community Seismic Experiment (Figure 1) is designed to allow for multiscale imaging of crustal and mantle lithospheric structure and stacked geomorphologic features over a regionally extensive, shoreline-crossing footprint of the ancient North American rifted margin. It will provide an unprecedented geophysical data set to be used by the community to tackle the fundamental questions set forth in the GeoPRISMS and Earthscope science plans about the pre-, syn- and post-rift evolution of rifted continental margins and modification of continental lithosphere by deformation, magmatism and sedimentation. This experiment augments the Earthscope Transportable Array (TA) with 30 broadband ocean bottom seismometers (OBS) spanning a 400 x 500 km area offshore North Carolina, with three addition onshore broadband stations on the Outer Banks to span the gap between the TA and the OBS network. Embedded in this onshore/offshore passive seismic array, we will acquire seismic reflection and refraction data offshore with the R/V Marcus Langseth, and refraction data onshore with a land-explosion seismic experiment. This onshore/offshore acquisition plan will include two major active-source seismic lines in the rift direction from the Blue Ridge Terrane onto oceanic crust, two offshore strike lines to characterize along-strike variations, and unprecedented 3D imaging of the crust and mantle across the rifted margin using active-source recordings on the broadband array. Additional multichannel seismic (MCS) data acquisition in this region will enable characterization of crustal and sedimentary structure of the continent-ocean transition zone, as well as the structural setting and architecture of the Cape Fear and Currituck slides on the adjacent shelf and slope.

All of the data acquired by this project will made available to the community immediately, which will enable the broadest possible benefit from these data and thus maximize the science and education derived from them. This multi-faceted seismic experiment also offers an immense opportunity for education of young scientists. We are building an integrated education effort during and after acquisition. The science and field parties for data acquisition will largely consist of young scientists, who are chosen by application. Following the cruises, we will hold two short courses on multi-channel seismic reflection and wide-angle reflection/refraction data processing using the newly acquired data. Participants will also be chosen by application, and it is hoped that many of them will have also participated in data acquisition. In addition to providing educational opportunities, these short-courses will produce the basic active-source data sets -- processed reflection profiles and initial velocity models of the refraction profiles – that will be made available to the community immediately. Following the short-courses, we will hold a workshop to encourage close collaboration between the onshore and offshore, passive and active seismic research communities and

to facilitate partnerships for post-cruise analysis. Our project will impact the general population by enabling unique public outreach opportunities and by addressing broad and important questions related to geohazards along the ENAM.

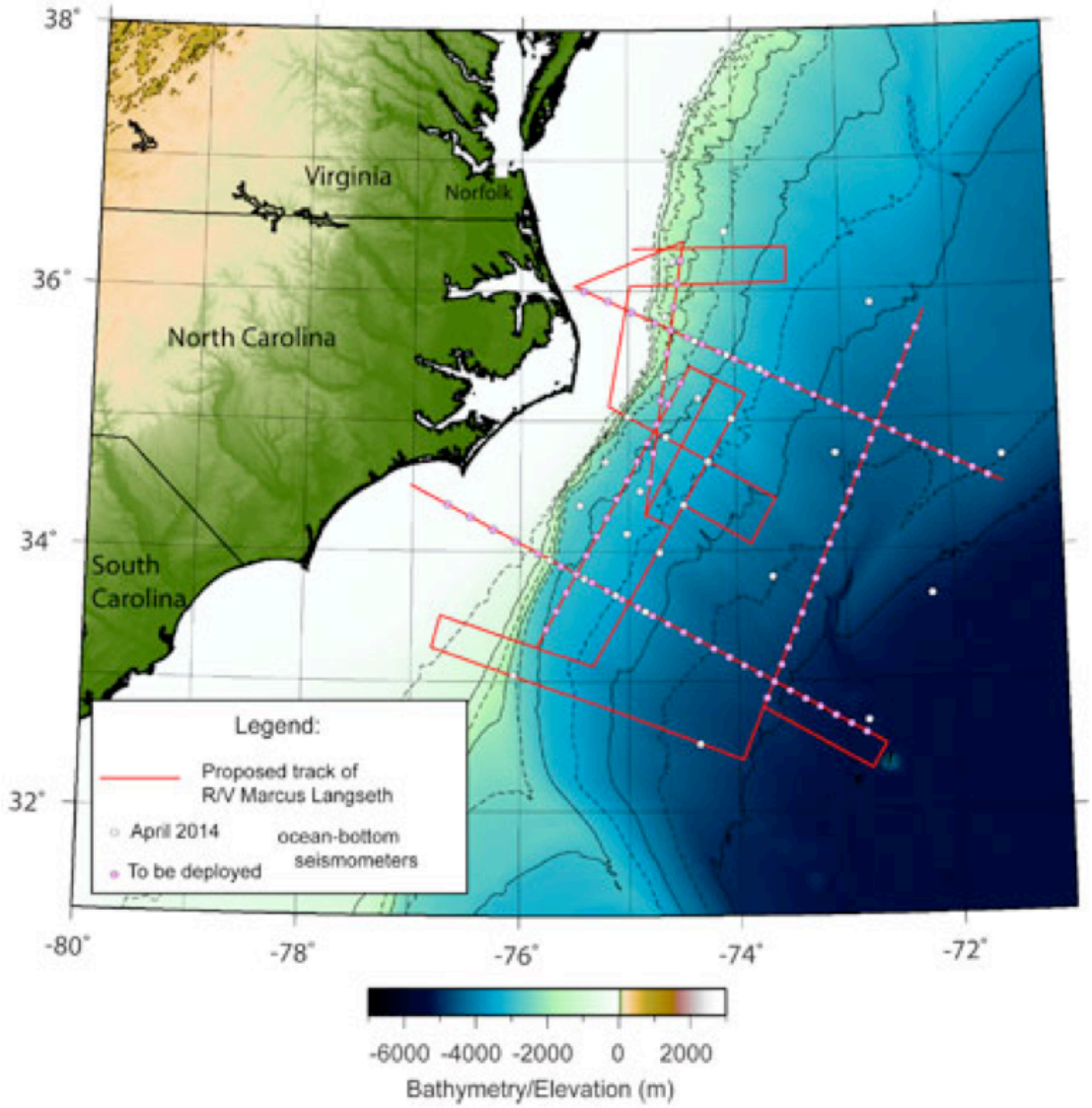

Figure 1. Map of the ENAM Community Seismic Experiment. White dots represent broadband OBS deployed during this cruise. Pink dots and red lines represent short-period OBS and Langseth ship tracks, respectively, associated with active-source refraction experiment planned for Fall 2014. See Figures 2 and 3 for detailed views of the broadband component of ENAM.

Broadband OBS Deployment

The goal of this cruise was to deploy the broadband OBS component of the ENAM experiment (Figures 2 and 3). We deployed 30 instruments, all WHOI design, with Guralp 3T seismometers recorded on Quanterra dataloggers at 100 Hz sampling. In addition, each station includes a differential pressure gauge

sampled at 20 Hz. Twenty of the instruments are deployed in a dense grid with nominal station spacing of 30-40 km, spanning the base of the continental slope. These instruments site astride the East Coast Magnetic Anomaly, and are aimed at imaging variations in magmatic processes associated with continental breakup using a full suite of body and surface-wave techniques. The remaining 10 instruments are deployed in a wider backbone array with nominal spacing of 125-175 km, and they will be useful for placing the detailed margin structure into the context of the surrounding continental and oceanic lithosphere, as well as correlating segmentation on the margin to subsequent segmentation of the oceanic lithosphere. Of these 10, the location of one (station x01) is specifically on the Currituck submarine landslide block, with the goal of using compliance and other techniques to better understand slide structure. All sites are in deep water (>1300 m) due to expected high noise levels at shallow depth.

All instruments were successfully deployed and acoustically surveyed on the seafloor. In addition to Chief Scientists Gaherty and Wagner, the science party included: three watchstanders selected from an open application process: Youyi Ruan (Post-Doc, Brown University); Leah Sabbath (recent graduate from University of Rochester, starting graduate work at Caltech in the fall); and Nick Hall (undergrad, Colorado College); four WHOI OBS technicians (engineer Alan Gardner, Dan Kane, Tim Kot, and Dave Dubois); and Endeavor Restech Erich Gruebel. Neither Wagner nor the three watchstanders had previously experienced an oceanographic cruise or OBS activities.

The science party developed a standard routine to deploy and survey each OBS. The WHOI team handled all deck operations: approaching the site, they would prep the instrument for deployment, and once on site they would do the deployment. In the lab, upon site approach the co-chief scientist on duty would confirm the site location with the bridge, including making minor adjustments to the drop point based on detailed GMT maps of the planned locations, using the most up-to-date bathymetric data from the NSF Marine Geoscience Data System (MGDS: www.marine-geo.org). Early in the cruise, Wagner discovered that the Endeavor ADCP (acoustic dopler profiling system) provided useful predictions of the drift that might be expect for each drop, and we adjusted drop points as appropriate (see narrative). The watchstander on duty recorded the log sheet for all key deployment data (launch time, location, water depth, serial numbers, etc.) and then utilized the acoustic deck box to track the instrument to the bottom. While dropping, the co-chief scientist calculated four survey points S, W, N, and E of the drop site (distances based on water depth) and communicated these to the bridge. Once the instrument was on bottom, the bridge would sail the survey, and the watchstander would run the code MKAL to survey the instrument location. Final locations were recorded on the logs as well as in saved MKAL files and screenshots, and the deployment was complete. Tables in the appendix provide the deployment chronology, as well as complete data on planned and actual launch locations, and final surveyed (seafloor) locations.

Instruments and recorded seismic data will be recovered in spring 2015.

Other data collected during the cruise is fairly minimal. Underway data consisted of ADCP and some combination of 3.5 kHz and 12 kHz subbottom

profiles, although data is generally discontinuous because all acoustic equipment would be turned off during OBS acoustic operations. Twice during the cruise we did CTD casts to evaluate the accuracy of the acoustic wavespeed libraries used for the survey calculations. Observed wavespeeds were quite close to predicted so we did not do any corrections. All ancillary and underway data are provided through the MGDS.

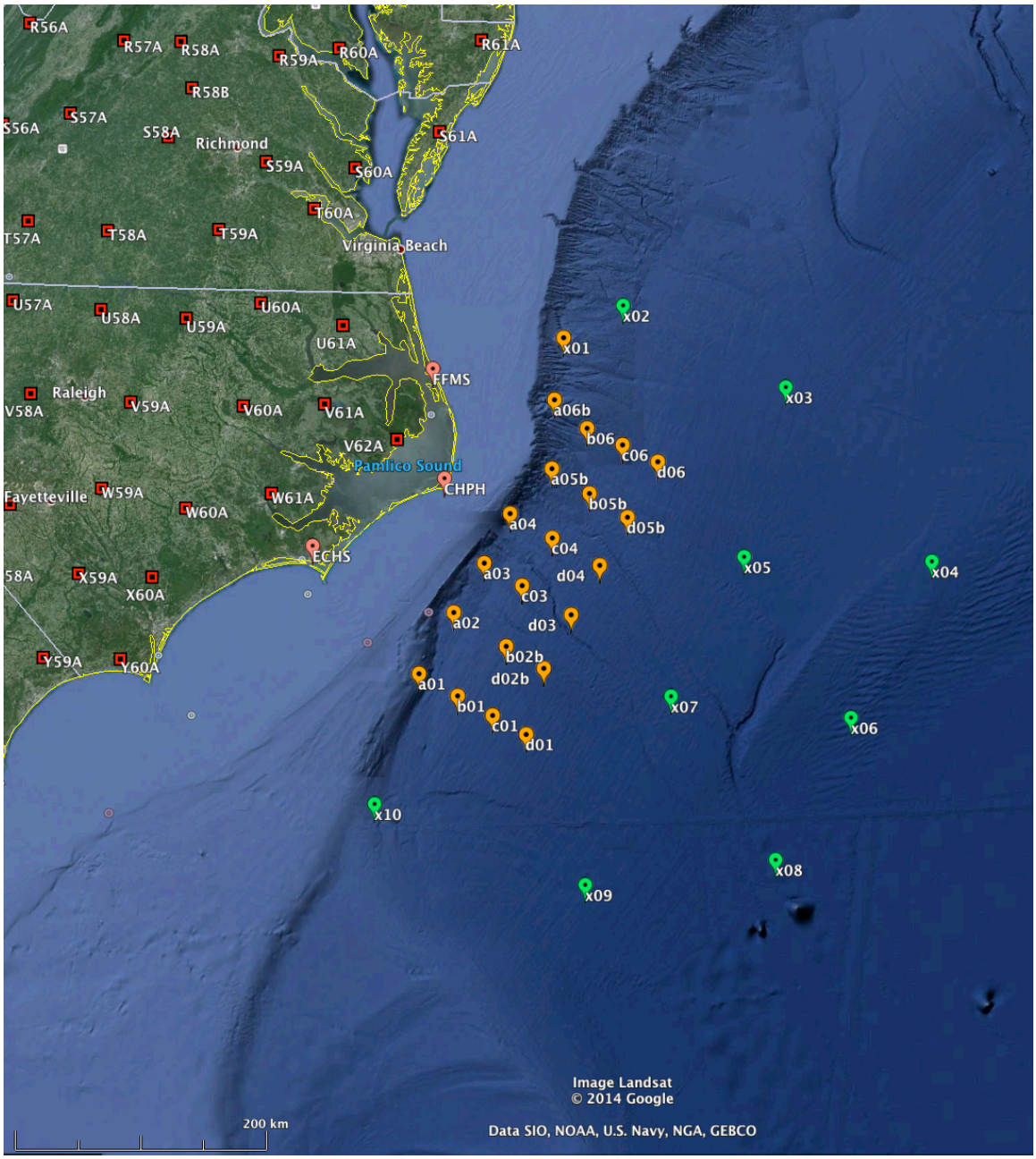

Figure 2. ENAM Broadband seismic deployment, including both onshore and offshore components. OBS deployed on this cruise are shown with orange and green circles. Temporary PASSCAL sensors deployed on the Outer Banks region of NC in May 2014 are shown with pink circles. Red squares show the USArray Transportable Array.

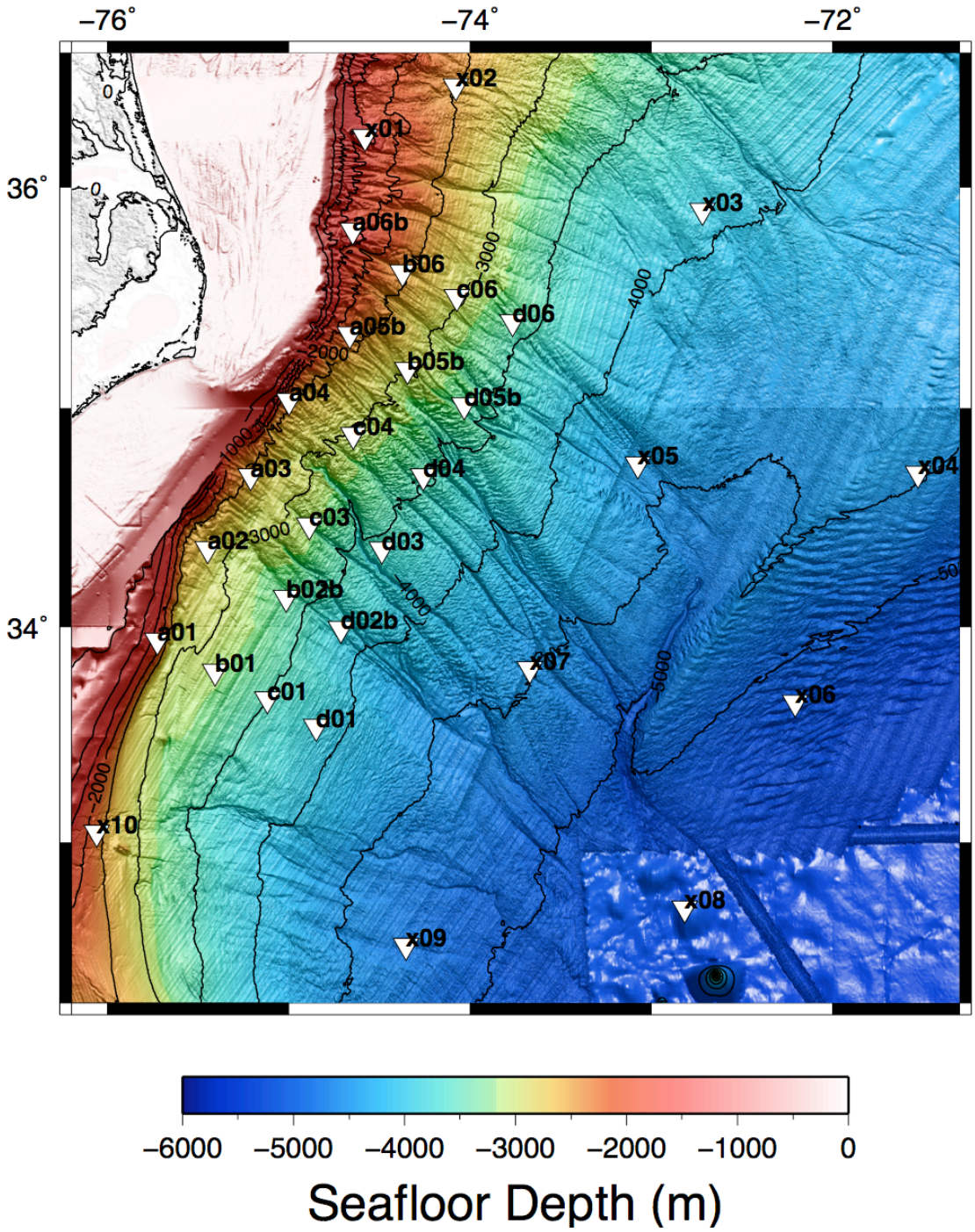

Figure 3. Broadband OBS sites plotted on highest available resolution seafloor bathymetry. Site depths range from approximately 1300-5200 m (see Table 2). Bathymetry is color-coded with contour lines drawn at 500 m intervals.

Cruise Narrative

UTC is 4 hours ahead of (later than) local time. All times listed here are local time. Narrative by Wagner (0300-1500 local) and Gaherty (1500-0300 local).

April 1, 2014 – JD 091

0930 (approximately) – depart Senesco shipyard in North Kingston and transit south. Excellent weather, chilly leaving Rhode Island (~40 F) but warmed noticeably (and got much more rolling, and slower through the water) when hit the gulf stream. Made ~11 knots on way down. Everyone slept in and got sea legs.

April 2, 2014 – JD 092

1600 -- arrived at first site, labeled x02. Deployed without incident. Use python script to track to the seafloor, and program mkal to do survey. Students learned both with help of Alan. Complete by 1930.

2215 – arrived at x01. Had difficulty with sensor once it was on deck. Swapped out sensor and deployed without incident. Sensor subsequently found to have faulty internal wiring and was fixed. Site complete by 0040 on 4/3.

April 3, 2014 – JD 093

0300 – arrived at site a06b. This site was relocated (from a06) to the north and west to avoid snapper/grouper spawning area as per NSF. Again upon deck check a sensor failed. This one appeared to have faulty locking mechanism and was not locked – perhaps significant damage. Swapped out. Plan to drop sensor just NW of site to account for drift and land on local high. Drifted to the SE as expected… got pretty close to intended location. Needed to add a leg to the survey due the the drift… just filled in the SE leg of the diamond. Dolphins playing at the site. Deployment complete by 0600.

For b06, current was 1.5 m/s N, and just over 1m/s E for the upper 600 meters. So we moved the drop site 750 m SSW of desired location to try to hit the target. Water coming up onto the deck from swells today. Breakfast coming up into sink as well. Arrived at original drop site at around 8am, then headed slowly to new drop site. New planned drop site at 35 36.516 -74 22.746. Dropped at 8:21 am. Actual drop site 35 36.549 -74 22.712. Actual distance from intended site is 674 m. Tracking started looking like it was dropping super fast, and then it looked like the station was coming back up. We think that's because at first we were drifting away from the station and then we were drifting towards the station. Ranges were decreasing for about 6 minutes before ranges increased again. Confirmed at bottom. Survey started at 9:30am. Had to extend survey a bit further NW to include point due to drift. Current was so strong that the ship swung significantly further NW than even that extended point. Had to steer SW to get to the point to the SE.

For c06, dropped station 890 m SSW of desired point according to current (1 m/s N, 0.5 m/s E for 800 m at least). Set survey around desired point, not drop point.

Arrived at drop point at 1:17 pm local time, confirmed station at bottom at 12:35 local time. Started survey at 2:45 pm local time. Survey completed by 3:30 pm local time. Location went in the direction we expected, but also went an extra 615 meters past our planned spot.

1720 – arrived at d06. Bathymetry indicates small channel with spot on NE edge of it. Currents at site moderately strong (0.2m /s N, 0.5 m/s) but deep water, so drop near site with expectation of drift northeast. Final relocation is 0.86 km NE of original spot. Deck box was a bit flakey – required multiple power cycles to get it to track the drop to sea floor. Otherwise good. Headed out for long transit to x04.

April 4, 2014 – JD 094

0745 – arrived at x04. Current not as bad here 0.4m/s south, 0.25 m/s east, for top ~300 m. put drop location at 34 42.18 and -71 30.978. Deck crew need a bit of extra time setting up. Ready to drop at 8am. Sensor in the water at 12:03:46 UTC, or 8:03 am local time. Took until 9:52am to land. Then headed out on survey. Survey went fine, but station drifted west rather than SE. Whoops. Finished at this station at about 11:45 am local time.

1930 – arrived at x05. Deep water site, bathymetry shows a fracture zone or small channel. Spot seems to be on upper edge of the gentle side (NW) of the channel, and ADCP shows modest current (few tenths of m/s) straight west, away from channel. Drop at the spot. Final location appears to be 1.4 km west of the drop spot – much further than predicted from upper 500 m, but a very good spot. Makes sense that the ADCP based corrections might under estimate in deep water?

April 5, 2014 – JD 095

Super rocky night. No one is feeling well. Nick is sick so often he's started to see specks of blood in his vomit. Leah started her shift early to cover for him.

0600 – arrive d05b. Station location is on a very localized high. Will try to hit that as best as possible. Ship is moving pretty slowly due to rough waters. Last stretch to station at 5 – 6 kts. Put station in at 6:15 am local time. Adjusted drop location to the SSW to account for currents 0.4 m/s N and 0.2 m/s E over 800 m. At shallow depths, the current looked westward, but then holds steady at a slight eastward trend below ~100 m or so. New drop location is about 35 0.6 N and -74 2.2 W. Landed at about 168 m from intended site, so good we did the 700 m correction.

1140 – arrive b05b… lots of current… 0.6m/s N and 0.4 m/sW over 700 m. This give us an offset to the SW of ~800 m for our dropsite. Just as we were getting ready to mosey to the drop site, we learned that the vertical component of this sensor looks like a triangular boxcar electronic noise (?!) signal despite being locked. We're out of spares, so this seemed as good a place as any to put this sensor. Dropped the station at 11:53 am local time. Dropped to about 2950 and we confirmed landing. Did survey around ideal location not dropped location.

Final location is 523 m ne of ideal. We dropped 800 m sw of ideal… so undercorrected somewhat. Still not too bad.

1620 – arrived site a05b. This site was moved west several km to avoid the protected spawning area, leading to shifts in b05 and d05 as well. *Placed on spot of planned SP station 418, so that station can probably be placed elsewhere*. Currents quite strong (1 and 1.2 m/s E and N to 550 m) so calculated new location to the SE, but still NE of channel. Drift prediction was 1.35 km, actually relocated location from drop is 1 km. Otherwise no problems.

2150 – arrived site a04. Very close to shelf edge, near errors in bathymetry files (at 35N merge). Confirmed no big channels in highest res bathymetry, but numerous small one. Aimed for a small ridge. Currents strong (1/1.2 N/E, to 700 m) but want a bit of drift north-east of planned site, so dropped ~100 m SE of spot, with goal of ending up < 1km NE. Drift was only 0.5 km NE so should be in good shape. Clean drop.

April 6, 2014 – JD 096

0200 – arrive site c04. Fairly flat seafloor, no major channels. Currents modest (<0.4 m/s on both directions) so dropped at spot. Station went in at 34 52.319 74 38.915. Finished dropping at about 3:34 local time. But alas, there was a current. We dropped within 60 m of intended final location, but the intended final location ended up being 1.144 km NNE of ideal. Still on good flat ground, should be ok. Surprising large drift perhaps due to deeper water. *Keep in mind for SP drops and recoveries.*

0645 -- d04. There was just a bit of current: went with .3 m/s N and .1 m/s E over 500 m, which gives 249 m displacement to the SSW for our drop location. New drop location is 34 41.202 and -74 15.628. The water is a fair bit choppier than it was at c04. Bummer. Nick turned in right after c04, Leah is coming on line 15 min early to start this one up. We're a good 4 hours ahead of schedule which is great. These upcoming deep ones will take longer though. Plan to do a ctd test after this station. Sensor went in at 7:05am local time. Estimated water depth 3413 at site, so drop will take a bit. Final location… we slightly undercorrected, but not by a lot despite deep water… station ended up about 200 m NE of intended site.

Immediately after deploying D04, we did a CTD test for acoustic velocity as a function of depth. Initially planned to only go to 1000 m but found that the sound velocity was unexpectedly high (1530 m/s) in the upper 800 m, dropping to closer to the expected 1500 m/s by about 900 m. Decided to keep going to 1500 m total. Sound velocity decreased to 1490 and then held steady from there on. CTD data available from MGDS.

2250 – x06. Site bathymetry shows odd hummocky seafloor, only 0.3 m/s (E and N) current in upper 300 m. Calculated shift was 200 m. Dropped near the spot, didn't attempt correction. Leah and Erich did 2nd CTD cast after the drop, went down to 1200 m depth. Seemed to reach just about the minimum of the SOFAR

channel. Average velocity over this depth interval slightly higher than used at the site, but very close. Continue to use library values for surveys.

April 7, 2014 – JD 097

1020 – x07. The surrounding area looks remarkably flat and boring, so not too worried about drift. Looks like we have 400 m of .4 West and maybe a very slight north component. Ended up going with .01N, 0.25 W (e.g -0.25) over 700 m. Results in 276 m displacement almost due east of the site. Depth is 4493 from 100 m grid and 4498 in ETOPO1. In the end, we dropped the site 290 m. East of the intended site, and it ended up 225 m. West of the intended site. So we undercorrected again, but still better than nothing.

1900 – arrive site d03. Again fairly flat seafloor, big channel a few miles to the SW but nothing close to be concerned about. Average velocity very low and variable with depth so didn't adjust drop site. Drop and survey went smoothly with no problems.

April 8, 2014 – JD 098

0035 – arrive site c03. Flat seafloor with hint of a channel just SW of drop. Strongish currents (0.5 m/s on both E/N) to the northeast. Desire to stay fairly close to the point due to future MCS line through here, but don't want to get near channel, so drop about 300 m SW of planned spot. Slightly rough seas, tag line pinched on edge of hardhat during initial lift and broke a piece off. Checked and no damage to any critical equipment so went ahead with the deployment. Drop and survey smooth.

0645 – arrive a03 after a very steam. Took us much longer to get here than expected due to the bad weather and high seas that have come in. The current is very strong… at least 1m/s N & E for the upper 500 m. So dropped the station 1.04 km SW of intended site. It's really nasty weather out there. Approached the site headed into the current… looks like the ship is losing abt 3 kts to the current. Got the station in ok. We launched the site at about 7am local time. At breakfast, the captain informed me that "that was it for now" and that we would not be doing the survey until the weather improved to avoid going broadside to the wind and waves. So we're just in a holding position for now. The station made it to the bottom. We're firing up mcal just for the fun of it to see if we can get a sense of the station location. We'll fire up a separate run of Mcal for the formal survey once we can start that. Started the survey at about 9am local time (abt 1 hr delay). Location looks good… preliminary at 375 m of intended site, with us having overcorrected by that much. Bailed on the survey by 9:30… too rough. Did manage to pass over the station. We return to do the survey on April 12.

1450 – arrive a02 after a slow transit in storm. Weather slightly improving so we can safely deploy this site today. Current profiler is poorly resolved on approach but current looks strong. Dropped it 632 m SW of intended point. Looks like it lande 324 m NW of intended point… so small undercorrection. Weather had improved, no issues with survey. Some difficulty getting mcal to take the survey points, but eventually got them.

Very slow transit to b02, due to broad swells directly into the starboard side. Did about 5 knots, doubling transit to site. In addition, long-line fishing vessel with 10 miles of gear out was sitting on our spot. We had to swing up and around and go to another spot 6 km down the line. Renamed it b02b, and also shift d02b further southeast to keep reasonable spacing, but still keep on mcs lines.

2130 – arrive b02b. Currents fairly strong so aim for a spot 0.5 km SE of previously new drop point. Pouring rain and a couple of large waves washed fantail, but deployment went fine. However, WHOI guys decided not to prep the next instrument during the drop, so that will need to be done either on approach at the next site, or on site. Survey uneventful.

April 9, 2014 – JD 099

0350 – arrive d02b after a slow transit in rough seas. WHOI prepped on the final approach to d02 when the ship was moving more slowly. Very little current so no additional correction made to the drop site. Site went in at about 4 am local time. Actual drop site ended up ~290 m due west of intended site, mostly because of current drifting the ship while they were getting the station up and over. Should be ok. Now just a long transit to x08.

1913 – arrive x08 after long transit. Small typo in entering the site location results in target being 2 nmile east of planned, but went with it given that these outer sites are not tightly located. Topo maps suggest large bulbous mounds – no evidence of them in the 3.5 khz, which smoothly decreases. Water depth of about 5250 m at drop point. Drop was smooth, acoustics good, all went smoothly. Currents were variable with depth and average near zero on the adcp – final drop point was less than 0.5 km away, not much given the water depth.

April 10, 2014 – JD 100!

SLOW transit to x09 – 7 knots max. Apparently it was a rough night. The door from main lab to deck was sealed with all 8 levers. Needed the cheater bar to open them.

1015 -- arrived at x09 (11 hr transit). Current is to the southeast, so dropping station about 370 m to the NW of intended site (not overly crucial at this location). Final station location is about 280 m SE of desired location…so slight under-correction. Finished the survey by about 2pm local time. Now another really long transit to x10 – long but smooth– nice weather, lots of time on deck.

2230 – arrive at x10. Go straight for spot. Currents moderate (0.8/0.5 m/s N/E) but don't correct, just adjust survey approximately 0.8 km NE. Currents kept captain from quite getting to the spot. Strong gradient on seafloor but no canyons or anomalies.

April 11, 2014 – JD 101

0445 -- Made great time between x10 and a01. Tail wind had us moving at 13 kts. Arrived on site at about 4:45 am local time. Pretty solid current… did a little average to get .6625 N and .375 E for 700 m. So drop spot is 840 m. to the SW.

Very shallow site, somewhere in the 1700 m range. Dropped at 4:58 am. Landed and started survey at 5:45 am. Done by 6:20 am. Looks like the sensor landed within about 100 m of intended site. Nice. Off to b01.

0800 -- Short ride to b01. Arrived at around 8am. Drift correction was made for .5m N and .2 m E current over 600 meters depth, which results in about 510 m of drift to the NNE. Drop location was moved to the southwest accordingly. Landed about 52 meters from intended site. Nice! All done by 10:45 am local time. Cruising on to c01.

1215 -- c01 also uneventful drop. Arrived on site at around 12:15 pm. No current to speak of. Drop ended up being a couple hundred meters from desired location just with boat drift. We'll see where it ends up… hopefully not far. Sensor landed at 2pm, and the survey was done by 3:15 pm. Ended up 224 meters from the intended point. Not too bad.

1650 – arrive at d01. Relatively smooth bathymetry gradient to the SE, small current (0.3/0.1 m/s N/E) down to only 300 m. Drop on the spot. No issues.

2015 – begin transit to a03. This is the site that we did not completely survey due to bad weather. Given the excess time remaining, and only one more OBS to deploy, we decide to transit back to the NW on the way up to x03.

April 12, 2014 – JD 102

0210 – after a rapid (12 knot) 6 hour transit, arrive at a03. We enable the instrument (15 pings – working and unlocked Guralp) and do a survey. Position moves very slightly:

	original	resurvey
lat	34 41.4645	34 41.4648
lon	75 12.6551	75 12.6575
depth	2637	2639

Given that first location is based on a single line of survey points (albeit very close to the instrument), suggests that current survey might be overkill? Should analyze stability of results from mkal.

0315 – start very speedy (almost 13 knots – peaking at 15!) transit to the NE to x03. Gulf stream plus tail wind makes for very fast time. Cut over 4 hours off of the 10-knot ETA.

1440 – arrive final site, x03. Beautiful day, no wind, calm seas. Take group photos around the OBS, then drop. Currents small and average out, don't do a correction. Drop and survey are uneventful. Landed about 570 m. due west of our intended target. Turn for Narragansett!

Table 1. Cruise Chronology

Schedule of R/V **Endeavour**

Activity	Latitude1	Longitude1	Latitude2	Longitude2	Distance (km)	Depth (km)	Transit time (hrs)	ETA On Site	ETA Complete
Port Narragansett	41.43444	-71.46250							4/1/14 8:00
Transit to and deploy x02	41.43444	-71.46250	36.44942	-74.07769	597.971	2.450	32.3	4/2/14 16:17	4/2/14 19:32
Transit to and deploy x01	36.44942	-74.07769	36.228	-74.579	51.276	1.300	2.8	4/2/14 22:18	4/3/14 0:38
Transit to and deploy a06b	36.228	-74.579	35.8054	-74.6487	47.310	1.370	2.6	4/3/14 3:11	4/3/14 5:59
Transit to and deploy b06	35.8054	-74.6487	35.61398	-74.37402	32.695	2.460	2.3	4/3/14 8:15	4/3/14 11:39
Transit to and deploy c06	35.61398	-74.37402	35.50342	-74.07853	29.465	2.940	1.6	4/3/14 13:15	4/3/14 15:45
Transit to and deploy d06	35.50342	-74.07853	35.39065	-73.7853	29.416	3.380	1.6	4/3/14 17:20	4/3/14 20:20
Transit to and deploy x04	35.39065	-73.7853	34.7013	-71.51501	220.795	4.490	11.9	4/4/14 8:15	4/4/14 12:15
Transit to and deploy x05	34.7013	-71.51501	34.74618	-73.06998	142.511	4.330	7.7	4/4/14 19:57	4/4/14 23:39
Transit to and deploy d05b	34.74618	-73.06998	35.0146	-74.03416	93.040	3.340	5.3	4/5/14 4:55	4/5/14 8:19
Transit to and deploy b05b	35.10039	-73.97554	35.1732	-74.3498	35.052	2.900	2.1	4/5/14 10:28	4/5/14 13:28
Transit to and deploy a05b	35.2625	-74.36832	35.3385	-74.6622	28.028	2.420	1.9	4/5/14 15:23	4/5/14 17:53
Transit to and deploy a04	35.41709	-74.74307	35.03136	-75.00288	48.896	2.400	2.6	4/5/14 20:31	4/6/14 0:01
Transit to and deploy c04	35.03136	-75.00288	34.87033	-74.65146	36.736	3.060	2.0	4/6/14 2:00	4/6/14 4:45
Transit to and deploy d04	34.87033	-74.65146	34.68878	-74.2595	41.144	3.460	2.2	4/6/14 6:58	4/6/14 11:43
Transit to and deploy x06	34.68878	-74.2595	33.65115	-72.20165	221.909	5.140	11.1	4/6/14 22:51	4/7/14 3:45
Transit to and deploy x07	33.65115	-72.20165	33.80464	-73.66842	136.998	4.440	6.6	4/7/14 10:21	4/7/14 14:21
Transit to and deploy d03	33.80464	-73.66842	34.35328	-74.48988	97.222	3.570	4.6	4/7/14 18:56	4/7/14 21:56
Transit to and deploy c03	34.35328	-74.48988	34.54605	-74.89439	42.884	3.210	2.3	4/8/14 0:15	4/8/14 3:15
Transit to and deploy a03	34.54605	-74.89439	34.69404	-75.20878	33.178	2.550	3.5	4/8/14 6:47	4/8/14 9:41
Transit to and deploy a02	34.69404	-75.20878	34.35677	-75.45224	43.583	2.600	5.2	4/8/14 14:51	4/8/14 17:21
Transit to and deploy b02b	34.35677	-75.45224	34.13468	-75.01772	47.001	3.260	4.2	4/8/14 21:35	4/9/14 0:47
Transit to and deploy d02b	34.13468	-75.01772	33.98943	-74.70860	32.771	3.730	3.1	4/9/14 3:51	4/9/14 7:11
Transit to and deploy x08	33.9894	-74.7086	32.69	-72.82	227.329	5.200	12.0	4/9/14 19:13	4/9/14 23:13
Transit to and deploy x09	32.69	-72.842	32.51941	-74.3532	143.108	4.700	10.1	4/10/14 9:21	4/10/14 13:57
Transit to and deploy x10	32.51941	-74.3532	33.04194	-76.06587	170.590	2.120	8.7	4/10/14 22:39	4/11/14 0:39
Transit to and deploy a01	33.04194	-76.06587	33.93747	-75.72717	104.194	2.000	4.2	4/11/14 4:53	4/11/14 6:23
Transit to and deploy b01	33.93747	-75.72717	33.79316	-75.40779	33.609	3.160	1.8	4/11/14 8:12	4/11/14 10:48
Transit to and deploy c01	33.79316	-75.40779	33.66539	-75.12044	30.167	3.450	1.5	4/11/14 12:19	4/11/14 15:19
Transit to and deploy d01	33.66539	-75.12044	33.54076	-74.8458	28.997	3.800	1.6	4/11/14 16:53	4/11/14 20:14
Transit to and resurvey a03	33.54076	-74.8458	34.69404	-75.20878	132.237	2.550	5.9	4/12/14 2:10	4/12/14 3:16
Transit to and deploy x03	34.69404	-75.20878	35.89433	-72.71283	263.191	3.840	11.4	4/12/14 14:41	4/12/14 17:53
Transit to Narragansett	35.89433	-72.71283	41.58	-71.41	641.230		34.6	4/14/14 4:30	

Table 2. OBS Stations

	Planned			Launched			Surveyed				
Station	**Latitude**	**Longitude**	**Depth (m)**	**Latitude**	**Longitude**	**Depth (m)**	**Latitude**	**Longitude**	**Depth (m)**	**Drift (km)**	**WHOI OBS**
x02	36.4494	-74.0777	2450	36.4496	-74.0777	2550	36.45264	-74.07898	2548	0.352	*s69*
x01	36.2280	-74.5790	1300	36.2283	-74.5755	1330	36.22521	-74.57926	1329	0.478	*s66*
a06b	35.8054	-74.6487	1370	35.8067	-74.6504	1361	35.80447	-74.64880	1325	0.291	*s27*
b06	35.6140	-74.3740	2460	35.6092	-74.3785	2486	35.61594	-74.37216	2517	0.949	*s22*
c06	35.5034	-74.0785	2940	35.4960	-74.0824	2933	35.50614	-74.07262	2933	1.428	*s14*
d06	35.3907	-73.7853	3380	35.3866	-73.7712	3368	35.39265	-73.76569	3351	0.839	*s33*
x04	34.7013	-71.5150	4490	34.7027	-71.5163	4478	34.70107	-71.52750	4459	1.042	*s67*
x05	34.7462	-73.0700	4330	34.7467	-73.0598	4395	34.74576	-73.07541	4388	1.429	*s05*
d05b	35.0146	-74.0342	3400	35.0095	-74.0362	3337	35.01380	-74.03274	3334	0.572	*s59*
b05b	35.1732	-74.3498	2900	35.1669	-74.3540	2973	35.17589	-74.34507	2960	1.287	*s30*
a05b	35.3385	-74.6622	2270	35.3286	-74.6716	2760	35.33576	-74.66454	2230	1.016	*s42*
a04	35.0314	-75.0029	2400	35.0309	-75.0040	2293	35.03490	-75.00037	2293	0.554	*s68*
c04	34.8703	-74.6515	3060	34.8705	-74.6508	3039	34.87977	-74.64646	3023	1.105	*s01*
d04	34.6888	-74.2595	3460	34.6715	-74.2608	3413	34.68995	-74.25789	3417	2.068	*s74*
x06	33.6512	-72.2017	5140	33.6518	-72.2014	5101	33.65075	-72.20569	5153	0.410	*s61*
x07	33.8046	-73.6684	4440	33.8046	-73.6653	4452	33.80358	-73.67051	4476	0.497	*s48*
d03	34.3533	-74.4899	3570	34.3537	-74.4890	3574	34.35591	-74.48870	3584	0.243	*s19*
c03	34.5461	-74.8944	3210	34.4588	-74.8954	3181	34.46493	-74.88876	3246	0.910	*s72*
a03	34.6940	-75.2088	2550	34.6873	-75.2167	2824	34.69108	-75.21096	2639	0.670	*s65*
a02	34.3568	-75.4522	2600	34.3519	-75.4558	2771	34.35749	-75.44882	2779	0.891	*s46*
b02b	34.1347	-75.0177	3260	34.1305	-75.0191	3326	34.13467	-75.01573	3338	0.559	*s37*
d02b	33.9894	-74.7086	3730	33.9896	-74.7118	3752	33.99055	-74.71291	3760	0.148	*s23*
x08	32.6900	-72.8200	5200	32.6900	-72.8198	5221	32.69324	-72.81649	5271	0.471	*s71*
x09	32.5194	-74.3532	4700	32.5216	-74.3562	4689	32.51686	-74.35362	4725	0.581	*s20*
x10	33.0419	-76.0659	2120	33.0426	-76.0645	2211	33.04750	-76.05991	2243	0.693	*s70*
a01	33.9375	-75.7272	2000	33.9305	-75.7313	1723	33.93665	-75.72658	1755	0.808	*s38*
b01	33.7932	-75.4078	3160	33.7889	-75.4099	3132	33.79279	-75.40814	3123	0.464	*s53*
c01	33.6654	-75.1204	3450	33.6646	-75.1178	3492	33.66590	-75.11810	3485	0.151	*s45*
d01	33.5408	-74.8458	3800	33.5400	-74.8469	3800	33.53897	-74.84953	3808	0.271	*s73*
x03	35.8943	-72.7128	3840	35.8943	-72.7115	3873	35.89335	-72.71903	3890	0.690	*s28*

Table 3. Science Party

Scientist	Institution	Position
James Gaherty	Columbia University	Chief Scientist
Lara Wagner	Univ. of North Carolina	Co-chief Scientist
Nicholas Hall	Colorado College	Watchstander
Youyi Ruan	Brown University	Watchstander
Leah Sabbeth	Univ. Rochester / Caltech	Watchstander
Alan Gardner	WHOI	OBS Engineer
David Dubois	WHOI	OBS Technician
Timothy Kane	WHOI	OBS Technician
Daniel Kot	WHOI	OBS Technician
Erich Gruebel	Univ. of Rhode Island	Resident Technician

Table 4. R/V Endeavor Crew

Crew Name	Position
Rhett McMunn	Captain
Shanna Post-Maher	Chief Mate
Chris Armanetti	2nd Mate
Patrick Quigley	Bosun
Oscar Sisson	AB
Dave Sterling	AB
Kevin Walsh	AB
Chris Wrobleski	AB
Chris Baker	Chief Engineer
George Maltby	Engineer
Nick Tosto	Engineer
Michael Duffy	Chief Steward
Michael Brennan	Messman