

**Cascadia Initiative**  
**Cruise TN-331 R/V *Thomas G. Thompson***  
**(Cascadia 2015 Leg 3)**  
**October 1, 2015 – October 15, 2013**  
**Newport, Oregon to Newport, Oregon**



Co-Chief Scientists  
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William Wilcock, University of Washington

## Table of Contents

Background .....	3
Cruise Objectives and Assessment.....	3
Science Party.....	7
Crew .....	9
Cruise Narrative.....	10
OBS Operations.....	32
Table 1. Positions of OBSs provided at start of Cruise.....	33
Table 2. Positions of TRM OBSs taken from Jason Dives .....	35
Note on Jason Navigation.....	36
Acknowledgements.....	37

## Background

As part of the 2009 American Recovery and Reinvestment Act (ARRA) spending, NSF's Earth Sciences (EAR) and Ocean Sciences (OCE) divisions each received \$5M in facility-related investment. The funds are targeted toward Facilities that support EarthScope and GeoPRISMS science objectives, with an initial emphasis on onshore/offshore studies of the Cascadia margin. The ARRA funds have been used by UNAVCO, IRIS, and OBSIP to improve seismic and geodetic datasets in the Cascadia region, including improvements to real-time GPS capabilities, densification of the onshore seismic networks, and the construction and deployment of an array of 60 ocean-bottom seismographs (OBSs) for offshore community experiments.

The Cascadia Initiative (CI) is an onshore/offshore seismic and geodetic experiment that addresses questions ranging from the structure of the megathrust and its potential for large earthquakes to volcanic arc structure, and to the formation, deformation and hydration of the Juan de Fuca and Gorda plates. An article in the GeoPRISMS Newsletter (Spring 2011, issue No. 26) described CI scientific objectives, the outcome of an open community workshop held in October 2010 to develop deployment plans for the offshore component of the experiment, and formation of the Cascadia Initiative Expedition Team (CIET). Over its planned 4-year data acquisition period, the offshore portion of the Cascadia Initiative has involved the deployment and recovery of ~280 OBSs at ~160 different sites and a total of about 25 cruises. A article by Toomey et al. (*Oceanography* 27(2):138–150, <http://dx.doi.org/10.5670/oceanog.2014.49>), gives more background about the Cascadia Initiative.

## Cruise Objectives and Assessment

The primary objective of TN-331 is to recover 29 OBSs built by the Lamont Doherty Earth Observatory (LDEO) of Columbia University. Nineteen of the OBS are Trawl Resistant Mount (TRM) instruments deployed at depth below 1000 m; 8 TRMs at depths <250 m are equipped with popups (a buoy on a line) that can be released acoustically and used to lift the instruments (denoted as TRMPs, below) and 11 TRMs at depths >250 m will be recovered with the assistance of the Jason ROV. Ten OBS are LDEO ARRA instruments mostly deployed at depths of ~3000 m which can be recovered with their own buoyancy after acoustic commands are sent to release anchor. A secondary objective of the cruise, if time permits, is to recover three OBS that have been lost on previous legs, WHOI ARRA at site G36B which was deployed in 2012 and which has a faulty acoustic release and SIO ABALONES at sites FS19 and BB850 which were deployed in 2014 and which failed to lift from the seafloor despite successful release commands. Another, secondary objective of the cruise is to conduct a 24-hour shallow-water test of a prototype TRM package that has pressure sensors designed to measure the tilting of the instrument.

The cruise achieved its primary objective by recovering all 29 LDEO OBSs. In addition two lost SIO ABALONES were recovered, a 12-hour test of the prototype TRM package was completed and bathymetric data was obtained in a region of interest to the south of the

Blanco transform during an interval that was too rough for Jason work. Unfortunately, it proved impossible to recover the lost WHOI ARRA because the seas were too rough for Jason to dive when the ship was on site near the end of the cruise.



### Cascadia Initiative 2015 Leg3 on the TGT

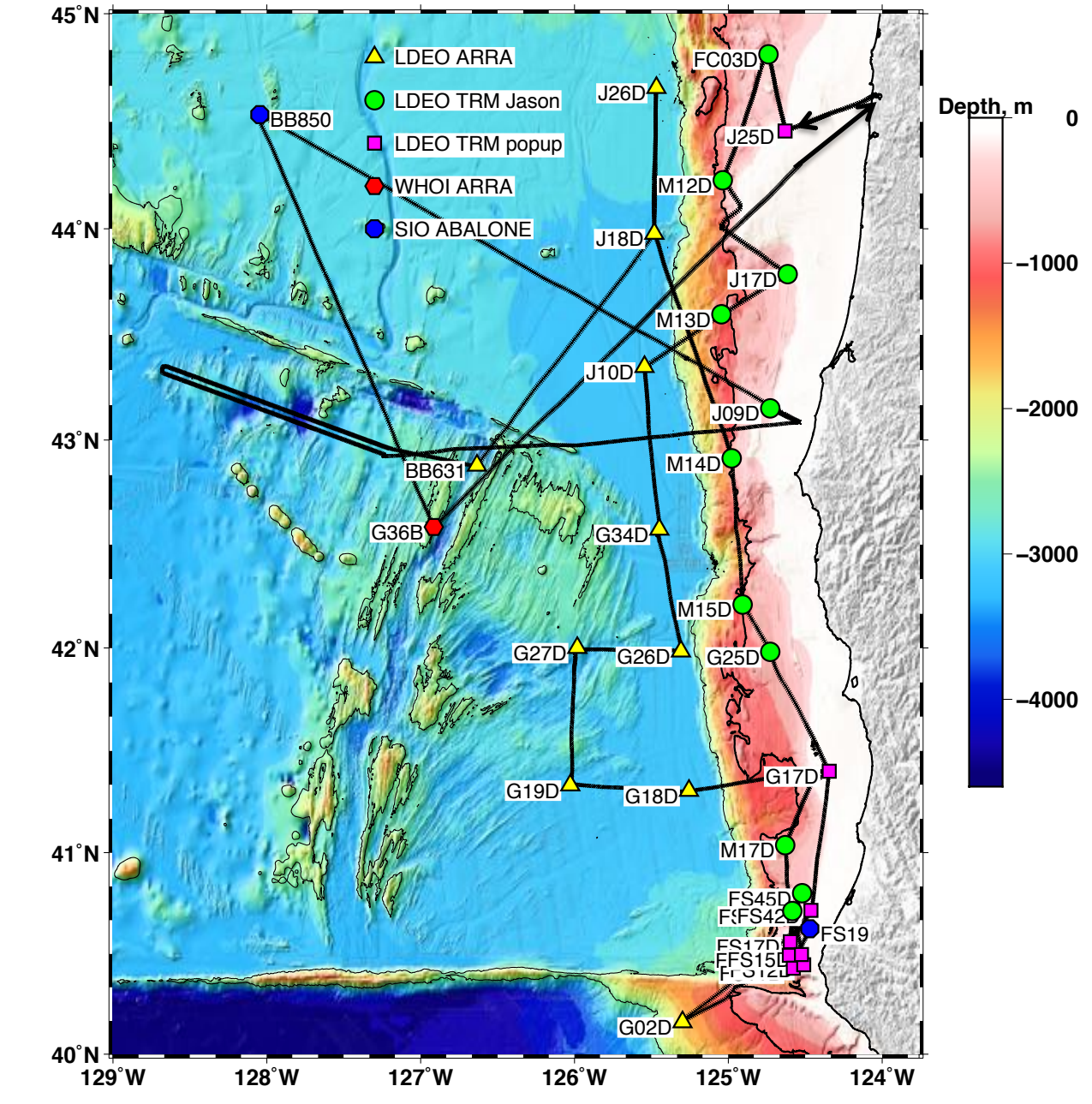


Figure 1. TN-331 cruise track with recovery sites indicated.

### Cascadia Initiative 2015 Leg3 on the TGT

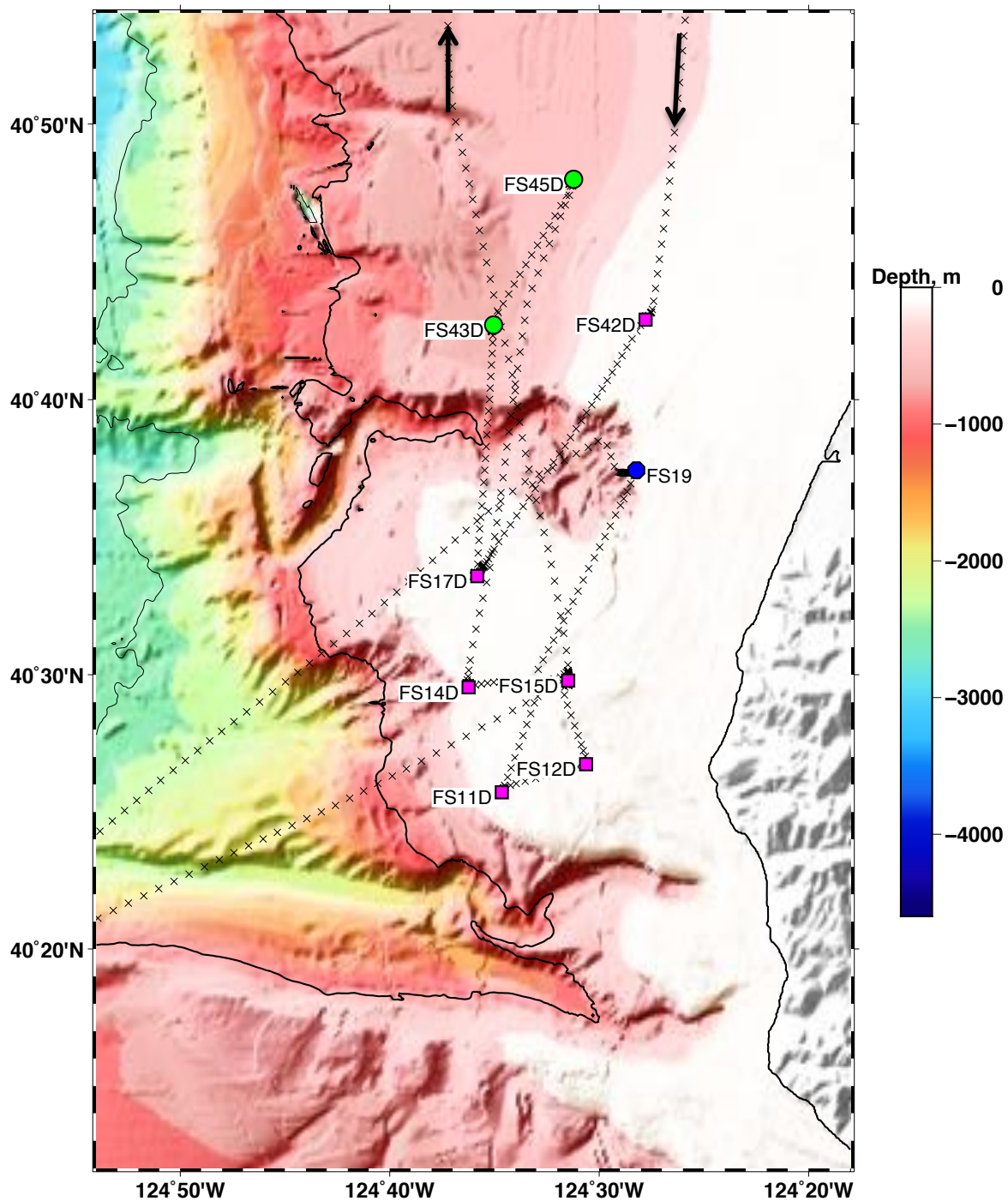


Figure 2. TN-331 cruise track and recovery sites near Cape Mendocino.

## TN-331 Science Party

Casey Agee	Navigator	WHOI-Jason
Patrick A'hearn	Marine Tech.	U. Washington
Andrew Barclay	OBS Team	Lamont-Doherty Earth Obs. (LDEO)
Carlos Becerril	OBS Team	LDEO
Samuel Bell	Apply to Sail (ATS)	Brown U.
Nicholas Benz	ATS	U. Texas-Austin
John Clapp	OBS Team	LDEO
Erika Cleary-Sprick	Leidos	Leidos
Don Collasius	Engineer	WHOI-Jason
Tito Collasius	Team Leader / Navigator	WHOI-Jason
Vanessa Crandell-Beck	ATS	(grad. Humbolt State U.)
Melody Eimer	ATS	Washington U. (St. Louis)
Erica Emry	ATS	Penn. State U.
Erik Fredrickson	ATS	U. Washington
Charles Garcia	Grad. Student	U. Washington
Scott Hansen	Navigator	WHOI-Jason
Stephen Jalickee	Marine Tech.	U. Washington
Akel Kevis-Stirling	Pilot	WHOI-Jason
Theodore Koczynski	OBS Team	LDEO
Dean Livelybrooks	Co-Chief Scientist	University of Oregon
Walter Masterson	OBS Team	LDEO
Loral O'hara	Engineer	WHOI-Jason
Blake Parris	Grad. Student	U. Oregon
Jim Pelowski	Data Processor	WHOI-Jason
Hugh Popenoe	Engineer	WHOI-Jason
Ellen Svadlenak	ATS	(grad. Oregon State U.)
Richard Tucker Sylvia	ATS	U. Rhode Island
Jim Varnum	Pilot	WHOI-Jason
Korey Verhein	Pilot	WHOI-Jason
Rose Wade	ATS	U. Washington
William Wilcock	Co-Chief Scientist	University of Washington
Alexis Wright	ATS	USGS Santa Cruz







### **TN-331 Crew**

Eric Haroldson	Captain
Bruce Barnaby	Chief Mate
Kimberly Butte	Second Mate
Kirsten Brewster	Third Mate
Pamela Blusk	Able Bodied
Brian Clampitt	Able Bodied
Thomas Gray Wicker	Able Bodied
Michele Barutha	Able Bodied
Todd Schwartz	Able Bodied
Vasillia Stamatiou	Ordinary
Mark Johnson	Chief Engineer
James Swanton	First Assistant Engineer
Michael Koch	Second Assistant Engineer
Andrew Bartell	Third Assistant Engineer
Leo Gabriel	Oiler
Orlando Thompson	Oiler
Mario Yordan	Oiler
Jim Loria	Oiler
Sarah Wicker	Chief Steward
India Gramatica	Second Cook
Terrance Singerline	Messman

## Cruise Narrative

This cruise departed on October 1, 2015 from Newport, Oregon. This is the third and final Cascadia leg of the 2015 field season and the final leg of the Cascadia Experiment. The objective is to recover 29 LDEO ocean bottom seismometers (OBSs), 8 of which are TRM OBSs equipped with popups, 11 are TRM OBSs requiring Jason and 10 are LDEO ARRA OBSs. If time permits 3 OBS lost on previous cruises will be recovered with Jason and a test will be conducted of a prototype TRM package.

**Tuesday, Sept 29.** Chief Scientists William Wilcock and Dean Livelybrooks arrived in Newport with apply-to-sail participants arriving during the day and into the evening. Set up had commenced the day before involving the Jason team working to remobilize Jason and one member of the LDEO team configuring the deck layout. The rest of the LDEO Ocean Bottom Seismograph group started work in the morning.

**Wednesday, Sept 30.** Beautiful fall day. An early morning meeting was held with the Captain, First Mate and leaders of the Jason and OBS groups to discuss the recovery strategies and order of recoveries. The plan is to recover TRM popup J25D first since it requires daytime recover and would thus, be impossible to recover on the way into port unless the cruise was finishing ~12 hours early. While the weather is good, we will then recover deep water TRMs starting with FC03D and working south with ARRA recoveries interspersed as necessary to give the Jason and OBS groups rest.

**Thursday, October 1.** The science safety meeting was held at 08:30 local time (LT). Ship departed dock at approximately 09:30. At 10:15 we mustered for a safety drill and then an orientation for Jason led by team leader Tito Collasius.

Arrived at **J25D** at 11:50 LT after short transit from port. Some small problems with noise when enabling TRMP were encountered. Signal sent to release pop-up at 12:34 LT and buoy promptly sighted off the starboard bow. Ship comes alongside, buoy was captured, line fed into recovery system employing Winch Pool heave-compensating winch. The package was lifted off bottom, and on deck at 13:30 LT. Transit to next station began at 13:40 LT.

### 1) Station J25D

On Station Time:	10/01/2015 18:50 UTC (10/01/2015 11:50 LT)
On Station Location/Depth:	44° 27.448' N, 124° 37.918' W / 135.4m
OBS Type:	LDEO TRM pop-up (TRMP)
Release Sent:	01/10/2015 19:34 UTC
Instr. off Bottom (ARRA):	N/A
Buoy on Surface (TRMP):	01/10/2015 19:53 UTC
Instrument on Deck	01/10/2015 20:30 UTC
Begin transit to next	01/10/2015 20:40 UTC
Time on Station:	1.8 hr

Arrived at **FC03D** at 15:29 LT in beautiful weather and very mild seas. We deployed the spool elevator followed by Jason (dive number J2-844). Jason recovered the elevator but could not immediately find the TRM which was not at the surveyed position. While rotating Jason it was detected near the 37.5 m range of the sonar display 33 m ENE of the survey location (see note at after Table 2 regarding offsets in Jason navigation). For some presently unknown reason the

Table 1 in the OC1409 cruise report lists the location of FC03D as (44° 48.816'N, 124° 44.28' W) while Table 2 and the survey screen shot give it as (44.813285° -124.738318°) = (44° 48.797'N, 124°44.299' W). We used the latter and the difference corresponds quite closely to the observed Jason offset. Dean meticulously checked all the other locations and all other discrepancies are a few meters at most and consistent with differences due to rounding. Jason attached the spool line to the TRM, watched the elevator release and then left the seafloor to be recovered after a 2 hour 38 minute dive. The elevator proved difficult to snag. The ship locked the starboard Z-drive to avoid any chance of entangling the line below the elevator which made maneuvering difficult as we approached the package broadside. After >1.5 hours it was finally snagged with grappling hook and it then took another half hour for the ship to move towards the TRM location and reduce the tension on the elevator line sufficiently to recover it to deck. The 1000 ft of line and TRM were then reeled in with the heave-compensating winch in about 1.5 hours. We left the site at 23:19 LT.

## 2) Station FC03D

On Station Time:	10/01/2015 22:29 UTC (10/01/2015 15:29 LT)
On Station Location/Depth:	44° 48.816'N, 124° 44.28' W, 432 m (the location from Table 1 in the OC1409 cruise report)
OBS Type:	LDEO TRM
Elevator in water	23:03 UTC
Jason in water	23:12 UTC
Jason at elevator	23:42 UTC
Jason at TRM	02/10/2015 00:05 UTC
Jason at TRM with elevator	00:23 UTC
Elevator release sent	Not logged
Elevator at surface	Not logged
Jason Recovered	01:50 UTC
Elevator on deck	03:59 UTC
TRM on deck	05:57 UTC
Begin Transit to the next	06:19 UTC
Time on Station:	7.8 hour

**Friday, October 2.** Arrived at **M12D** at 09:18 UTC (02:18 local time) in calm seas. Lowered elevator, then deployed Jason and Medea (dive number J2-845) at 09:47 UTC. Jason dove to find bottom at approximately 937m. Again, the OBS was found to be about 30m N of position taken from OC1409A cruise report (and survey), sitting just at edge of Jason sonar range. Inspection of survey screenshots for M12D and FC03D revealed some undersampling in terms of number of solutions computed per survey run. We are currently at a loss to explain these two position discrepancies except to note the challenges of surveying. Another operational hypothesis is an offset between Oceanus hydrophones and GPS receiver, but this doesn't explain systematic shifts resulting from ship's variable headings during surveying. Will ensure spreadsheet listing stations takes position from Jason recovery logs. Rest of recovery was uneventful, after OBS was found, Jason grabbed the Lamont elevator, set next to the TRM, and connected elevator cable/line to TRM. Jason then withdrew to 200m depth while the Thompson backed away south from the instrument. Burn signal sent to elevator resulted in rise off ocean floor 10 minutes later. Elevator was recovered, line fed into heave-compensated winch, and instrument was hoisted to deck. Upon preliminary access to battery and logger pods, it was

discovered that the battery cable was pulled out of logger pod, that the pod had flooded, and that logger-internal batteries were smouldering. Thus, M12D data was lost.

### 3) Station M12D

On Station Time:	10/02/2015 09:38 UTC (10/02/2015 02:38 LT)
On Station Location/Depth:	44° 13.632'N, 125° 02.124' W, 971 m (fix!) (the location from Table 1 in the OC1409 cruise report)
OBS Type:	LDEO TRM
Elevator in water	09:38 UTC
Jason in water	09:47 UTC
Jason at elevator	10:52 UTC
Jason at TRM	02/10/2015 10:41 UTC
Jason at TRM with elevator	NN UTC
Elevator release sent	Not logged
Elevator at surface	12:08
Jason Recovered	12:09 UTC
Elevator on deck	not logged
TRM on deck	15:22 UTC
Begin Transit to the next	15:27 UTC
Time on Station:	5.9 hour

Arrived at site **J17D** at 19:27 UTC (12:27 local time), at location 43° 47.236'N, 124° 36.806'W with water depth nominally 285 m. Released elevator and promptly followed with Jason, descended to sea floor. Visibility there was poor and, again, TRM was found 49m NE of stated position on bearing of 39 degrees, according to Jason navigation systems. We will confirm positions relative to those surveyed by back-referencing Jason navigation after latter are corrected. Jason then found elevator, brought to TRM, attached elevator shackle, withdrew to 200m water depth (to SE of TRM). Elevator release to where it rose from bottom required approx. 20 minutes. The rest of the recovery was normal, with Jason/Medea recovery, recovery of the Jason nav 'stick' on starboard waist deck, recovery of elevator, then TRM. No problems, and we departed station at 16:43 local time.

### 4) Station J17D

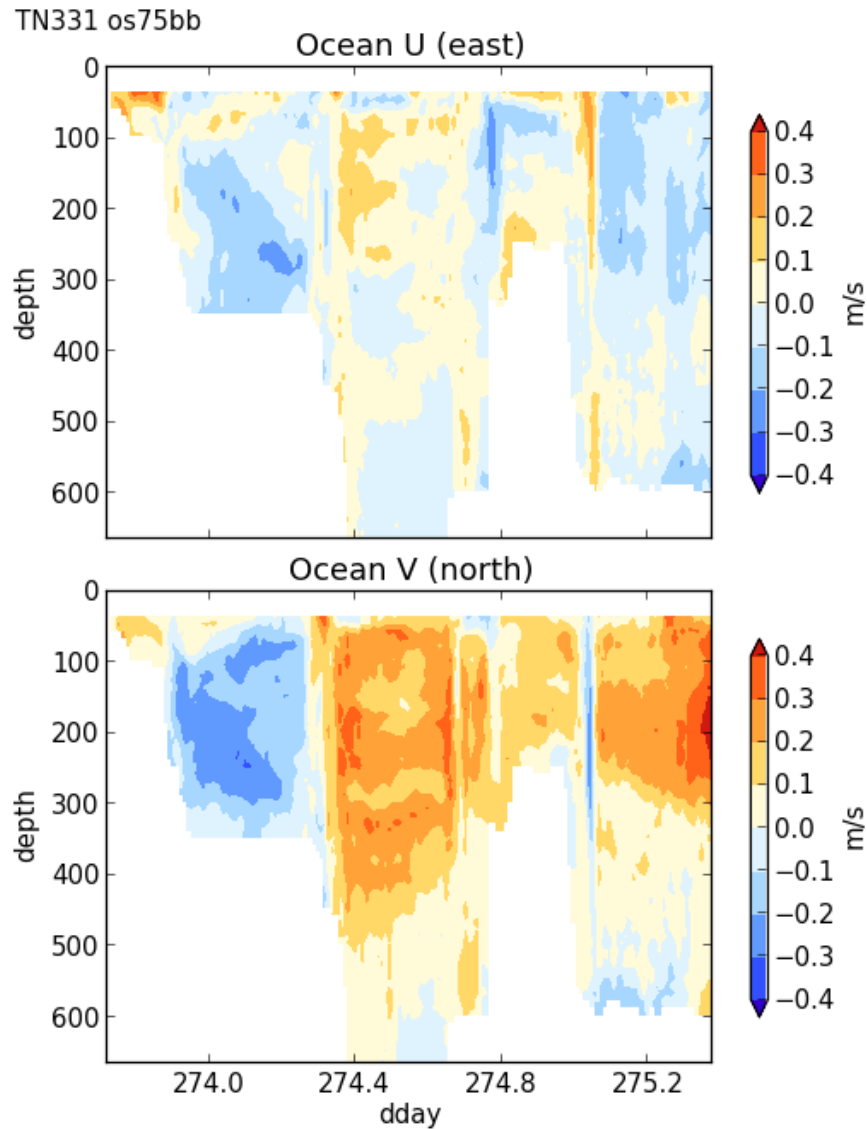
On Station Time:	10/02/2015 19:27 UTC (10/02/2015 12:27 LT)
On Station Location/Depth:	43° 47.236'N, 124° 36.806'W, 285 m
OBS Type:	LDEO TRM
Elevator in water	19:35 UTC
Jason in water	19:45 UTC
Jason at TRM	20:24 UTC
Jason at elevator	20:29 UTC
Jason at TRM with elevator	20:40 UTC
Elevator release sent	Not logged
Elevator at surface	21:42
Jason Recovered	22:40 UTC
Elevator on deck	Not logged
TRM on deck	23:30 UTC
Begin Transit to the next	23:43 UTC
Time on Station:	6.3 hour



Arrived at site **M13D** at 18:40 LT to recover TRM in 990 m of water. Launched elevator and Jason in quick succession and descended with Jason to seafloor. Yet again the position of the TRM is offset ~40 m from the surveyed position to the north. Attached elevator line to the TRM with Jason and ascend to 200 m depth and 400 m horizontal offset. Sent 2 x 15 minute burn commands followed by 10 minute rest and another 15-minute burn command. Learned that last TRM required 17 minutes of burn, twice the first two, so possible batteries are low. Returned with Jason and released the elevator manually at 22:49. Jason recovered at 23:47

***Saturday, October 3***

Approached the elevator and when it was within 50' of the boat it went under the surface at 00:46. After a short discussion decided to wait on site to see if it surfaces on the grounds that the currents pulling it under may be tidal. It later became apparent that current drag on the line was causing N. drift of elevator. The following is a screenshot of the ADCP data for this evening. The 'drag event' on the elevator commences at about 275.1 when N-S current switches from S to N.



**os75bb: last time 2015/10/03 09:03:32**

Elevator was observed on ship's bridge at approx. 04:50 local time. Elevator rode progressively higher in the water, and the decision was taken to recover at 05:10 local time. Through fine efforts by the TGT deck crew with Lamont assists, the elevator was recovered and, through backing the ship, the line slackened enough to feed on the heave-compensated winch, connected at approximately 06:25 LT.

More fun with M13D. Heave-compensating winch having issues with the drive motor for its line leveler. Had to pay out ~400m of line to remove high spot on spool. Preliminary diagnosis, with assist from engineer Mark aboard the TGT, is the interior control panel is loose, tilting to back of winch, and causing faults. Instrument was then winched aboard by simultaneously pushing panel into winch mounts while actuating winch. Managed to land TRM on deck at 10:06 local time, sailing for next station at 11:00 LT.

#### 5) Station M13D

On Station Time:	10/03/2015 01:40 UTC (10/02/2015 18:40 LT)
On Station Location/Depth:	43° 35.839'N, 125° 02.678'W, 990 m
OBS Type:	LDEO TRM
Elevator in water	02:08 UTC
Jason in water	02:18 UTC
Jason at elevator	03:05 UTC
Jason at TRM	03:26 UTC
Acoustic release failed	04:40 UTC
Jason releases elevator	05:42 UTC
Elevator at surface	05:59 UTC
Jason Recovered	06:47 UTC
Elevator below surface	07:46
Elevator on deck	13:25 UTC
TRM on deck	17:06 UTC
Begin Transit to the next	18:00 UTC
Time on Station:	16.3 hours

Arrived at **J10D** at 20:25 UTC (13:25 local time), an ARRA deep-water OBS at depth 3074m. Location is 43° 20.928'N, 125° 32.676W, taken from Oceanus cruise report 1409A. The instrument acknowledged and the burn signal was sent at 13:28 LT. Ranging via the deck box indicated that the instrument lifted off the ocean floor at 13:47 LT. Instrumented spotted on the surface 15:09 LT in whitecapped seas. One issue was that the Instrument RDF beacon wasn't observable from TGT bridge, as latter's RDF unit didn't support instrument RDF frequency. This brought challenges in particular to daytime recovery, as instrument was difficult to spot on white-capped seas. We ask that the TGT consider installing an RDF that supports more frequencies. Instrument brought on deck at 15:28

#### 6) Station J10D

On Station Time:	10/03/2015 20:25 UTC (10/03/2015 13:25 LT)
On Station Location/Depth:	43° 20.928'N, 125° 32.676W / 3074m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	03/10/2015 20:28 UTC
Instr. off Bottom (ARRA):	03/10/2015 20:47 UTC
Intr. on Surface:	03/10/2015 22:09 UTC
Instrument on Deck	03/10/2015 22:28 UTC
Begin transit to next	03/10/2015 22:42 UTC
Time on Station:	2.28 hr

The next station is **G34D** but then we face a choice of either going back to the northeast to M14D and J09D in the hopes we can dive on a TRM or continuing south picking up ARRAs. The near shore weather forecast at 43°N (M14D & J09D) is poor for Saturday, marginally better on Sunday and good on Monday. At 40°N (Cape Mendocino) the weather is presently very poor (40 knot winds) but is also predicted to be good for several days starting on Monday. After discussions with the Jason group and Captain we decide to continue picking up ARRAs with the aim of arriving at Cape Mendocino around Monday morning.

The transit south is good because the seas are behind us. We arrive on station at **G34D** at 19:32 LT. The winds were blowing over 30 knots but subsiding so the Captain decided to wait an hour. An

hour later we sent the release and the OBS left the seafloor after a burn time of 29 minutes (nobody is quite sure why it is taking this long but the burn times were also long last year). The OBS was recovered 24 minutes after surfacing with winds gusting to 20 knots. After 30 minutes of disassembly, we left the station at 23:16 LT

#### 7) Station G34D

On Station Time:	10/04/2015 02:32 UTC (10/03/2015 19:32 LT)
On Station Location/Depth:	42° 34.339'N, 125° 26.915W / 3089m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	04/10/2015 03:37 UTC
Instr. off Bottom (ARRA):	04/10/2015 04:07 UTC
Intr. on Surface:	04/10/2015 05:18 UTC
Instrument on Deck	04/10/2015 05:42 UTC
Begin transit to next	04/10/2015 06:16 UTC
Time on Station:	3.73 hr

#### ***Sunday, October 4***

Arrived at station G26D at 09:18 UTC (02:18 LT). Release was sent at 02:33 LT and instrument was observed to be rising at 02:53. (Weather was improving slightly, so we cleared it with the bridge to release straight away rather than wait.) Recovery went well, with instrument floating up about 300m N of bow, clip-on in fairly heavy swells, on deck at 04:26 LT.

#### 8) Station G26D

On Station Time:	10/04/2015 09:18 UTC (10/04/2015 02:18 LT)
On Station Location/Depth:	41° 59.044'N, 125° 18.476W / 3099m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	04/10/2015 09:33 UTC
Instr. off Bottom (ARRA):	04/10/2015 09:53 UTC
Intr. on Surface:	04/10/2015 10:58 UTC
Instrument on Deck	04/10/2015 11:26 UTC
Begin transit to next	04/10/2015 12:11 UTC
Time on Station:	2.9 hr

Sailed beam-side to fairly heavy swell to station G27D, arriving at 07:54 LT. Ship's captain assessed safety on deck, then bridge gave permission to send release (sent 08:42 LT) and instrument was observed to be rising at 09:26 LT (after 2<sup>nd</sup> burn command sent). Rise rate was observed to be substantially slower than normal (~10m/s vs. normal of 40 m/s), likely due to only one weight being dropped. This increased rise time substantially. Despite repeating the release signal multiple times the rise rate did not increase. Once the ranged distance reached the distance the ship was sitting off the survey site (~800 m) it was inferred at 13:23 that the instrument was near the surface. At one point the bridge received several sounds from the radio beacon but we were unsure if this was the OBS or an LDEO engineering testing a handheld receiver. By systematically ranging while moving in different directions, we were eventually able at 15:43 to bring the ship within <60 m of the OBS as it drifted south but it was still not visible (the OBS was inferred to be on on the west side of the ship which was in the sun). We decided to cruise a 300 m diameter circle about the best-estimated position and shortly after starting this maneuver the OBS surfaced about 100 m away on the port side of the bow. While



the ship maneuvered to pick it up, the OBS spent most its time just below the surface, only occasionally rising high enough for the radio beacon to emit a signal, but its yellow outline below the surface could be visually tracked from the bridge. Fortunately, as we came along side to pick it up, it came to the surface and it was quickly snagged and came on board at 16:47. The LDEO team confirmed that one burn wire was still intact. The winds remained quite high during much of our time on site reaching 30 knots during the recovery

#### 9) Station G27D

On Station Time:	10/04/2015 14:54 UTC (07:54 LT)
On Station Location/Depth:	42° 0.111'N, 125° 58.885W / 2924m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	10/04/2015 15:42 UTC
Instr. off Bottom (ARRA):	10/04/2015 16:26 UTC
Observed on Surface:	10/04/2015 23:14 UTC
Instrument on Deck	10/04/2015 23:47 UTC
Begin transit to next	10/05/2015 00:00 UTC
Time on Station:	9.1 hr

Transited south to **G19D** with a brief stop when we lost power because jellyfish clogged up the strainer for engine cooling system. We arrived on station at 20:45 LT. This OBS released on the first 15 minute burn cycle, rose at ~50 m/s and was recovered quickly and uneventfully. We left the site at 10:39 LT.

#### 10) Station G19D

On Station Time:	10/05/2015 03:45 UTC (10/04/2015 20:35 LT)
On Station Location/Depth:	41° 19.895'N, 126° 1.672W / 3082m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	10/05/2015 03:50 UTC
Instr. off Bottom (ARRA):	10/05/2015 04:00 UTC
Observed on Surface:	10/05/2015 05:06 UTC
Instrument on Deck	10/05/2015 05:27 UTC
Begin transit to next	10/05/2015 05:39 UTC
Time on Station:	1.9 hr

Discussed plan of operations with Jason and LDEO group after picking up the next OBS at site G20D. We abandoned plans to pick up the most southerly ARRA G02D prior to going to Cape Mendocino. Instead we will pick up the popup at G17D because picking it up on the way back north risks having to wait on site for daylight if we arrive at night. We will then head to Mendocino and interleave pop-ups during the day and deeper TRMs with Jason at night. The recovery of the SIO instrument FS19 may be tricky and will aim to monitor the ADCP during preceding recoveries so we can time this dive for slack water.

### **Monday, October 5**

Transit west to site **G18D** was uneventful with winds diminishing to ~15 knots. We reached the site at 01:32 LT. Recovery was uneventful, after burn signal was sent, instrument rose at ~40 m/s and was observed on the surface at 03:10 LT. Instrument was quickly brought on board and we left station at 03:44 LT. Seas calming as we begin E transit to G17D.

### 11) Station G18D

On Station Time:	10/05/2015 08:32 UTC (01:32 LT)
On Station Location/Depth:	41° 18.281'N, 125° 15.351W / 3130m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	10/05/2015 08:39 UTC
Instr. off Bottom (ARRA):	10/05/2015 08:54 UTC
Observed on Surface:	10/05/2015 10:10 UTC
Instrument on Deck	10/05/2015 10:19 UTC
Begin transit to next	10/05/2015 10:44 UTC
Time on Station:	2.2 hr

Arrived at station **G17D**, a TRM pop-up, at 13:50 UTC (06:50 LT). Location is 41° 24.219'N 124° 26.638'W with initial water depth at ship's station of 150m. Seas have calmed considerably since late yesterday. Waited for sufficient light to observe pop-up buoy. Sent acknowledge signal without initial success (no response from instrument). Came in directly on top of instrument on SE bearing while attempting to communicate. Then set up 150 NE and traversed over instrument to SW. In checking the deployment cruise report, it was noted that there were stated longitudes in Table 1 (124° 20.646') differed from that in Table 2 (124.433193°) by ~5.4' latitude. Also, upon arriving at the initial waypoint given to the bridge (the western longitude derived from Table 2) it was noted that depth was ~145m while instrument depth is stated as 95-99m. This argues that the more eastern longitude from Table 1 is more accurate. Thus we transited to corrected station and attempted to communicate with the instrument. Communications were problematic, the instrument wasn't giving a clear response to an acknowledge signal, we transited a short 'X' over location without definitive response. We backed off station 170m and sent, twice on a 10m separation, the release signal, then scouted for a pop-up for 20 minutes without siting it. We then moved ship directly over station and attempted acknowledge signals with a different deck box and portable transducer. Again, we failed to receive an acknowledge. In the mean time we checked the Oceanus bridge log and the cruise timeline from that cruise and both confirmed that 124° 20.646'W is the correct station longitude (and confirm the original station latitude which stands uncorrected). Thus the decision was taken to move south into the main pop-up field and attempt to recover 2 more pop-ups during suitable daylight conditions, to be followed by Jason dives this evening. We will schedule a Jason dive on this station as we progress north after completing the TRMP/TRM recoveries off Cape Mendocino and recover ARRA G02D at the far south end of the array.

We transited to station **FS42D** at 40° 42.9'N, 124° 27.780'W and a depth of 94m. The winds increased during transit to >20 knots from SW and we passed into belt of fog at about 41° latitude. We approached to a 200m-standoff from station and sent the release. The buoy popped up almost immediately and was sighted off bow slightly to starboard. The buoy recovery proved a bit challenging, and pulling enough slack line to feed into the heave-compensated winch is problematic; kudos to the TGT deck crew for their excellent work. The instrument was brought on board at 14:33 local time and deconstructed while transiting to the next station.

### 12) Station FS42D

On Station Time:	10/5/2015 20:18 UTC (10/5/2015 13:18 LT)
On Station Location/Depth:	40° 42.906'N, 124° 27.780'W / 94m
OBS Type:	LDEO TRMP pop-up
Release Sent:	10/5/2015 20:37 UTC
Buoy on Surface (TRMP):	10/5/2015 20:39 UTC
Instrument on Deck	10/5/2015 21:33 UTC
Begin transit to next	10/5/2015 21:49 UTC

Time on Station: 1.5 hr

We arrived near station **FS17D** at 16:09 LT. There was some delay in sending the release signal as we maneuvered to near the station and ship was still 400 m away when the pop-up was released. Because the pop-up surfaced in the direction of the sun it proved quite hard to find. When we reached it, the line was taught so it took a while to recover. The ship should position itself closer prior to releasing pop-ups.

13) Station FS17D

On Station Time: 10/05/2015 23:09 UTC (10/05/2015 16:09 LT)  
On Station Location/Depth: 40° 33.586'N, 124° 35.820'W / 145m  
OBS Type: LDEO TRMP pop-up  
Release Sent: 10/5/2015 23:51 UTC  
Buoy spotted on Surface: 10/6/2015 00:18 UTC  
Instrument on Deck 10/6/2015 01:08 UTC  
Begin transit to next 10/6/2015 01:50 UTC  
Time on Station: 2.7 hr

The site was **FS43D**, the first of two Jason dives planned over night. The weather is now quite calm and the seas pleasant. The LDEO OBSIP group have fixed a mechanical problem that they think caused the elevator not to release on the last dive so we decide to recover Jason prior to releasing the elevator – we do not want to risk losing the elevator below the surface because we cannot recover Jason quickly enough. The Jason dive is uneventful lasting little more than 2 hours. The elevator release takes >15 minutes of burn time but we are able to recover it quickly. It takes a while to unspool ~750 m of unused cable off the elevator and spool it onto the heave compensated winch.

14) Station FS43D

On Station Time: 10/06/2015 02:33 UTC (10/05/2015 19:33 LT)  
On Station Location/Depth: 40° 42.716'N, 124° 35.033'W / 719m  
OBS Type: LDEO TRM  
Elevator in water 03:01 UTC  
Jason in water 03:07 UTC  
Jason at elevator 03:52 UTC  
Jason at TRM 04:16 UTC  
Jason recovered 05:13 UTC  
Elevator at surface 06:00 UTC  
TRM on deck 07:46 UTC  
Begin Transit to the next 08:00 UTC  
Time on Station: 5.5 hr

**Tuesday, October 6**

The 2<sup>nd</sup> Jason dive is at station **FS45D**, arriving on station at 40° 48.0018N 124° 31.2132W in 475m water. There is a small delay while the LDEO OBSIP team prepares the elevator and swaps out the release (the voltage had decreased from 18 V to 16 V on the one used at FS45D). Jason dive was successful, though OBS was found ~50m E of original position. Elevator connection to OBS was uneventful, Jason withdrew and was recovered. Burn notice sent at 04:30 local time,

and elevator was off bottom 15 minutes later, arrive at surface 8 minutes after. Elevator was recovered, excess line unspooled and spooled onto the heave comp winch, and TRM was on deck at 06:50 local time. Began transit to next station at 07:03 local time.

15) Station FS45D

On Station Time:	10/06/2015 09:00 UTC (10/06/2015 02:00 LT)
On Station Location/Depth:	40° 48.716'N, 124° 35.033'W / 719m
OBS Type:	LDEO TRM
Elevator in water	09:28 UTC
Jason in water	09:37 UTC
Jason at elevator	10:05 UTC
Jason at TRM	10:22 UTC
Jason recovered	11:26 UTC
Elevator at surface	11:54 UTC
TRM on deck	12:20 UTC
Begin Transit to the next	14:03 UTC
Time on Station:	5.05 hr

Site **FS14D**: ship arrived at station (40° 29.615'N, 124° 36.307'W in 175m water) at 15:40 UTC (08:40 LT). After completing off-spooling of 1500m elevator recovery line, deck work to move previous station's shell, pop-up release signal was sent at 09:16 LT and pop-up observed at 16:19. Recovery took place within a pod of (~8) whales feeding near surface. Pop-up was wrestled aboard and line fed into the heave-comp winch. Instrument on deck at 09:30 LT, then crack morning watch assisted LDEO personnel in deconstructing TRM while ship cruised at 6 kt to next station.

16) Station FS14D

On Station Time:	10/06/2015 15:40 UTC (10/06/2015 08:40 LT)
On Station Location/Depth:	40° 29.532'N, 124° 36.234'W / 141m
OBS Type:	LDEO TRMP pop-up
Release Sent:	10/6/2015 16:16 UTC
Buoy spotted on Surface:	10/6/2015 16:19 UTC
Instrument on Deck	10/6/2015 17:21 UTC
Begin transit to next	10/6/2015 18:00 UTC
Time on Station:	2.3 hr

Arrived at station **FS15D** (40° 30.148'N, 124° 31.497'W in 69m water) at 18:28 UTC (11:28 LT). Completing off-spooling 300m of recovery line from previous station, did deck work to move previous station's shell. Pop-up release signal was sent at 09:16 LT and pop-up observed at 16:19. Pop-up was wrestled aboard and line fed into the heave-comp winch. Instrument on deck at 09:30 LT, then crack morning watch assisted LDEO personnel in deconstructing TRM while ship cruised at 6 knots to next station.

While we were able to send/receive proper acknowledge (enable) from instrument at station, we tried multiple times to release, including toggling the release back and forth without observing the pop-up on surface. We note that we were unable to enable instrument at original setup at 600m from position, but able to at 150m from instrument. Ranging to instrument seemed to indicate it lie on bottom somewhat NE of original site, but the evidence is rather inconclusive. We closed the latch of the pop-up release and decided that we would revisit the site with Jason tomorrow. We would prefer to dive during the day so that we can observe whether the pop-up has released. We will go first with Jason to the surveyed position, and look NE if unable to locate. As daylight permits



attempting remaining (two) pop-ups today. On way to next station FS12D we cruised over original location and ranged to instrument, which gave minimum in ranging over original instrument position.

Arrived at station **FS12D** (40° 26.862'N, 124° 30.604'W in 58m water) at 18:28 UTC (11:28 LT). Release was sent promptly and pop-up sighted on surface 2 minutes later. Buoy was recovered and TRM was winched onto deck at 14:50 LT.

17) Station FS12D

On Station Time:	10/06/2015 21:13 UTC (10/06/2015 14:13 LT)
On Station Location/Depth:	40° 26.730N, 124° 30.624'W / 58m
OBS Type:	LDEO TRMP pop-up
Release Sent:	10/6/2015 21:19 UTC
Buoy spotted on Surface:	10/6/2015 21:21 UTC
Instrument on Deck	10/6/2015 21:50 UTC
Begin transit to next	Not logged
Time on Station:	2.3 hr

We moved to **FS11D** but then waited on site a while securing the. The pop-up worked well and we recovered the float and instrument without incident.

18) Station FS11D

On Station Time:	10/06/2015 23:07 UTC (10/06/2015 16:07 LT)
On Station Location/Depth:	40° 25.712N, 124° 34.650'W / 150m
OBS Type:	LDEO TRMP pop-up
Release Sent:	10/6/2015 23:26 UTC
Buoy spotted on Surface:	10/6/2015 23:28 UTC
Buoy recovered	10/6/2015 23:49 UTC
Instrument on Deck	10/7/2015 00:24 UTC
Begin transit to next	10/7/2015 00:35 UTC
Time on Station:	1.5 hr

Very calm seas. The next instrument up was FS19, the first of two lost SIO ABALONES. We wanted to ping to in prior to diving with Jason but then realized that Jeff Babcock's informational document failed to provide the transmit and receive frequencies for the acoustic release. We decided it would be easiest to use a Jason float pack rather than the LDEO line elevator. After some time spent on site spent moving the last TRM, we launched the float pack followed by Jason. The float pack was quickly found the seafloor and the ABALONE then located with the aid of the sonar 16 m North of the surveyed position (since this splits the 30 m difference between surveyed and Jason locations for LDEO instruments, we still have no insights into which navigation is correct). The ABALONE was tilted ~50° and appeared to be floating with one edge snagged to the seafloor. After bringing the float pack to the ABALONE and moving the ship away 30 m, we jiggled the OBS vigorously but it failed to release. We attached the shackle on the float pack to the handle on the ABALONE which was a bit tricky and then cut the anchor to the float pack. We then recovered Jason followed by the float pack / ABALONE. The weight on the ABALONE appeared to have released but was snagged on the blue line that attached the seismometer to the main package.

19) Station FS19D

On Station Time:	10/07/2015 02:09 UTC (10/06/2015 19:09 LT)
On Station Location/Depth:	40° 37.434N, 124° 28.224'W / 100m

OBS Type:	SIO ABALONE
Float pack in water	10/7/2015 02:36 UTC
Jason in water	10/7/2015 02:48 UTC
Jason at float pack	10/7/2015 03:00 UTC
Jason at ABALONE	10/7/2015 03:08 UTC
Float/ABALONE released	10/7/2015 04:15 UTC
Float at surface	10/7/2015 04:18 UTC
Jason recovered	10/7/2015 04:40 UTC
Instrument on Deck	10/7/2015 05:04 UTC
Begin transit to next	10/7/2015 05:46 UTC
Time on Station:	3.6 hr

### Wednesday, October 7

We then headed southwest to site **G02D**, arriving on station (0.5 nm away) at 09:42 UTC (02:42 local time). Release was sent and instrument came off bottom at 03:23 LT, rising at ~40m/s. Instrument was sighted on surface at approx. 11:05 and hauled aboard. So noted that the 0400-1200 shift is the best.

#### 20) Station G02D

On Station Time:	10/07/2015 09:42 UTC (02:42 LT)
On Station Location/Depth:	40° 9.523'N, 125° 17.782 W / 1736m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	10/07/2015 09:50 UTC
Instr. off Bottom (ARRA):	10/07/2015 10:23 UTC
Observed on Surface:	10/07/2015 11:05 UTC
Instrument on Deck	10/07/2015 11:26 UTC
Begin transit to next	10/07/2015 11:36 UTC
Time on Station:	1.9 hr

Transited to **FS15D**, a failed pop-up, to dive Jason and recover. At 250m from station we searched for buoy in case it had worked loose. We also enabled and tried one last release, searching for 5 minutes without luck (waters were quite flat, visibility fine). Then Jason dove at 09:14 local to first inspect the TRM release mechanism. Bottom was covered in boulders, with bathymetric range of approx. +/- 3m with visibility limited to about 3m. Initial dive went past TRM S to N (west of TRM, as established later) with a N-S oriented ridge obstructing sonar view of it. During approx. 1.5 hour search approx. 40-70m N of TRM, deck box was used to range to TRM, and point of minimum range beneath ship's transducer was established. Jason then worked S back to this point, cruising E of ridge and located TRM. Inspection established that TRM was tilted approx. 20 degrees from normal up, and so encrusted as to jam up release mechanism. The LDEO crew sent a release signal, and Jason operator was able to knock the release loose with pop-up buoy floating upwards. Jason then withdrew and was recovered.

#### 21) Station FS15D

On Station Time:	10/07/2015 15:00 UTC (08:00 LT)
On Station Location/Depth:	40° 29.796'N, 124° 31.476'W / 55m
OBS Type:	LDEO TRMP pop-up
Jason in water:	10/07/2015 16:14 UCT
Release Sent:	10/07/2015 18:17 UTC
Buoy spotted on Surface:	10/7/2015 ~18:20 UTC

Instrument on Deck	10/7/2015 19:22UTC
Begin transit to next	10/6/2015 19:39 UTC
Time on Station:	4.65 hr

Arrived at station **M17D**. The weather is unbelievably calm – we could be on Lake Washington. The recovery of the TRM went pretty smoothly. After attaching the elevator line, Jason decided to hang out on the surface while the elevator was released because this would shorten the time to go back down if the release failed and they could get on board before it surfaced.

#### 22) Station M17D

On Station Time:	10/07/2015 22:24 UTC (10/07/2015 15:24 LT)
On Station Location/Depth:	41° 2.217N 124° 37.790'W / 749m
OBS Type:	LDEO TRM
Elevator in water	10/07/2015 22:39 UTC
Jason in water	10/07/2015 22:56 UTC
Jason at elevator	10/07/2015 23:33 UTC
Jason at TRM	10/07/2015 23:37 UTC
Elevator at surface	10/08/2015 01:35 UTC
Jason recovered	10/08/2015 01:19 UTC
TRM on deck	10/08/2015 02:31 UTC
Begin Transit to the next	10/08/2015 02:51 UTC
Time on Station:	4.5 hr

Station **G17D**, a failed pop-up TRMP, came next. G17D is the station where the location in Table 2 of the cruise report of OC1409A was in error by about 5 minutes of longitude. We had obtained the correct location from Table 1 and p. 21 of that report but it was a little frustrating to find that there were now multiple locations in various documents and navigation system, differing by a few tens to hundred meters so we went back to the source and assumed the mean location given on p.21 of the OC1409A report (41.399611°, -124.344193°). After the experience with FS15D there was some concern that the bottom might be challenging. We mapped it on the way in and it was as flat as a pancake (5 m of relief over a couple of kilometers). We then circled around the location at 100 m attempting to rouse the acoustics without success before diving with Jason. We did not deploy the elevator since it would be hard to recover if the TRM could not be found – the mechanism that drops the weight assumes the line has been hooked to the TRM. We dove about 100 m west of the assumed TRM location and worked east to it rotating the vehicle periodically to look in all directions. The visibility was awful so we were completely dependent on the sonar which has a range of 50 m. We found no targets on the way to the assumed location. Given that the “on-seafloor” and “released” locations on p. 21 of the OC1409A report differed by 100 m in the N-S direction and all our prior surveyed locations had been south of where Jason found them, we decided to look north first. We found a target 90 m away from the assumed location at a bearing of 010° and sure enough it was the TRM. We confirmed that the release was closed – it was encrusted in biology. We then backed off to allow the elevator to be dropped 5 m from the target. We hooked it up and as for the last site. Brought Jason to the surface, released the elevator, recovered Jason, then the elevator and the TRM.

#### 23) Station G17D

On Station Time:	10/08/2015 04:57 UTC (10/07/2015 21:57 LT)
On Station Location/Depth:	41° 23.977N 124° 20.652'W / 99m
OBS Type:	LDEO TRMp failed
Jason in water	10/08/2015 06:05 UTC

Jason at TRM	10/08/2015 06:51 UTC
Elevator in water	10/08/2015 07:14 UTC
Jason at elevator	10/08/2015 07:23 UTC
Elevator at surface	10/08/2015 08:15 UTC
Jason recovered	10/08/2015 08:22 UTC
TRM on deck	10/08/2015 09:47 UTC
Begin Transit to the next	10/08/2015 09:55 UTC
Time on Station:	5.1 hr

Transited to station **G25D**, arriving on station at approx. 13:00 UTC (0:6:00 LT). Seas still calm, but with a bit of swell developing from NW. Began Jason dive at ~08:15 local time. All went well. We note that the instrument was 37 m away from its position, below, on a bearing of 352 degrees (essentially N). The crack combined 1<sup>st</sup> and 2<sup>nd</sup> watch ATS/student crew broke down instrument on deck and rewound line onto elevator for next dive in 45 minutes.

#### 24) Station G25D

On Station Time:	10/08/2015 13:00 UTC (10/08/2015 06:00 LT)
On Station Location/Depth:	41° 58.890N 124° 43.603'W / 682m
OBS Type:	LDEO TRM
Elevator in water	10/08/2015 15:12 UTC
Jason in water	10/08/2015 15:18 UTC
Jason at elevator	10/08/2015 16:10 UTC
Jason at TRM	10/08/2015 16:29 UTC
Elevator at surface	10/08/2015 17:45 UTC
Jason recovered	10/08/2015 17:40 UTC
TRM on deck	10/08/2015 19:02 UTC
Begin Transit to the next	10/08/2015 19:15 UTC
Time on Station:	6.25 hr

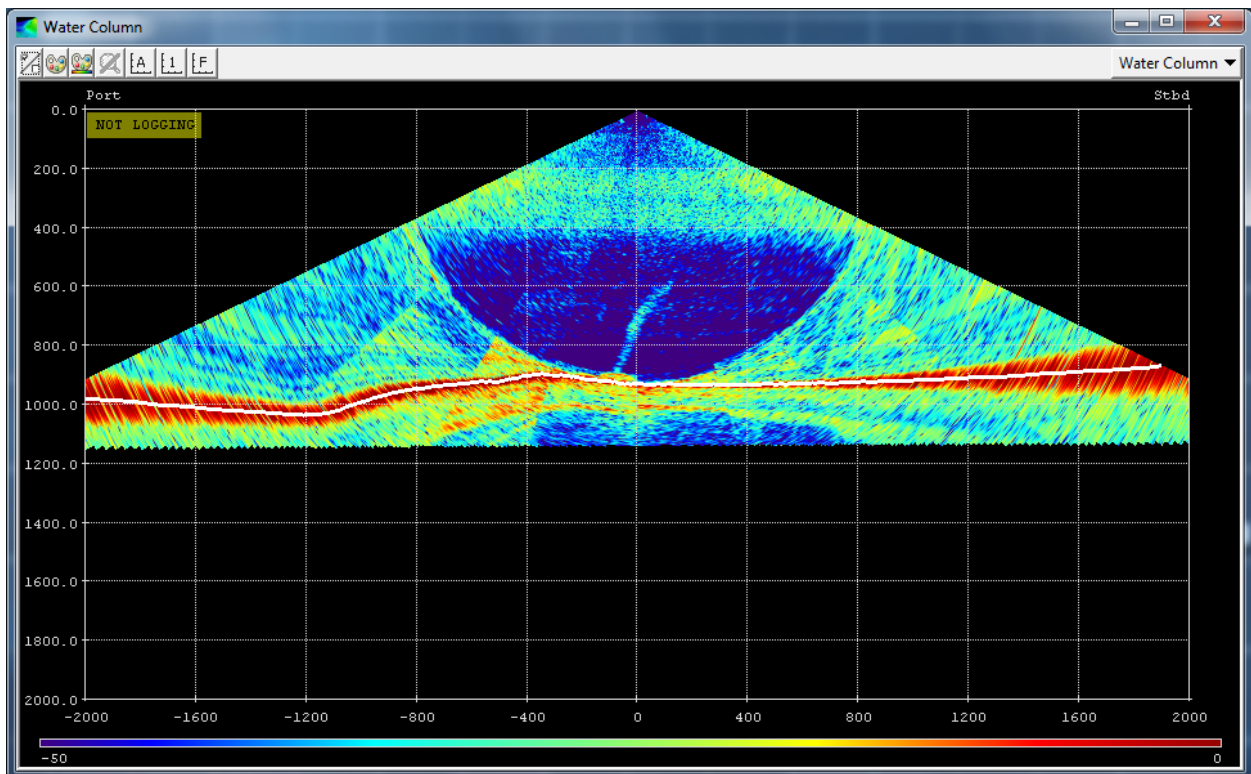
Approached station **M15D** at 20:30 UTC (13:36 LT). Seas still calm, but with more NW swell. Began Jason dive at 14:01 local time. Had some difficulties finding the OBS, which was eventually located 40m west of the surveyed position (based on previous offsets we first looked north and east). Once found, there were no problems connecting other than some issues with pan and tilt freezing due to software problems. Jason withdrew to the surface before the release signal was sent to the elevator.

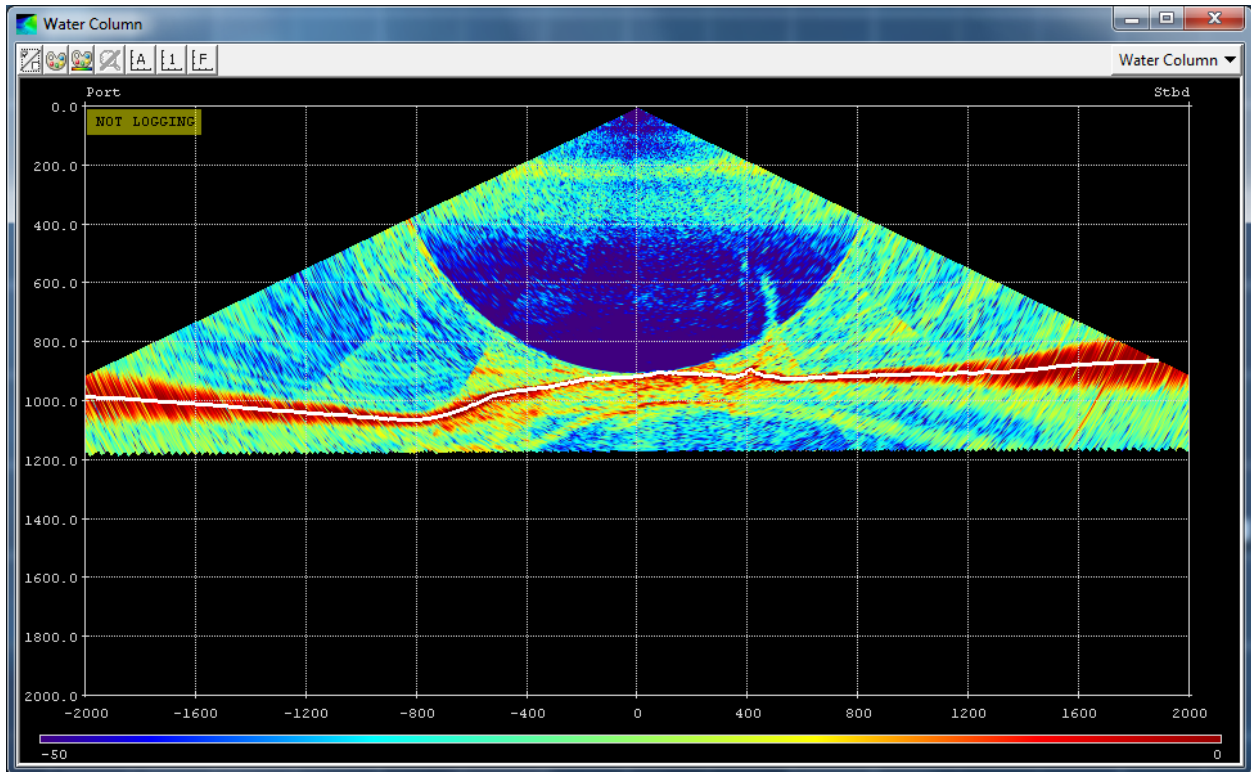
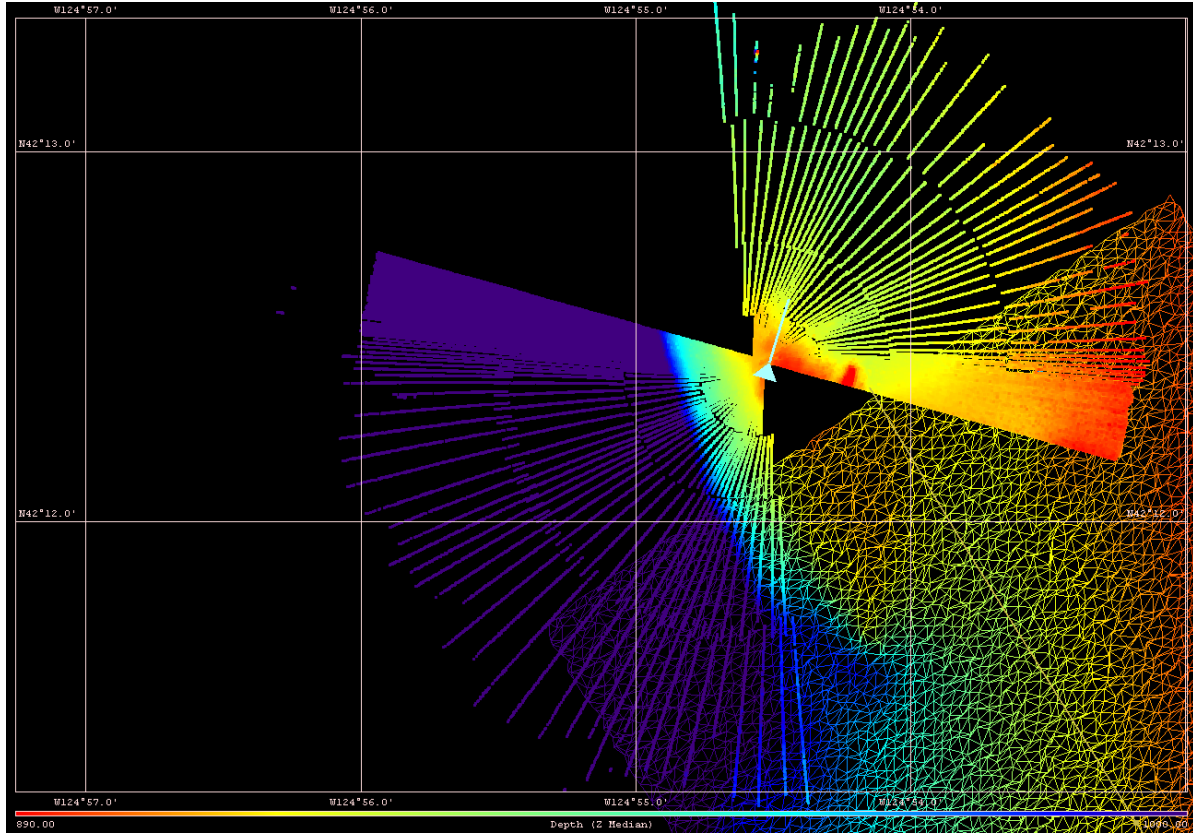
25) Station M15D

On Station Time:	10/08/2015 20:36 UTC (13:36 LT)
On Station Location/Depth:	42° 12.654N 124° 54.462'W / 936m
OBS Type:	LDEO TRM
Elevator in water	10/08/2015 20:49 UTC
Jason in water	10/08/2015 21:01 UTC
Jason at elevator	10/08/2015 22:21 UTC
Jason at TRM	10/08/2015 22:49 UTC
Elevator released	10/08/2015 23:47 UTC
Jason left seafloor recovered	10/08/2015 22:54 UTC
Elevator at surface	10/09/2015 00:08 UTC
TRM on deck	10/08/2015 02:13 UTC
Begin Transit to the next	10/08/2015 02:25 UTC
Time on Station:	3.8 hr

During the recovery Patrick A'Hearn identified two bubble plumes with the 35 kHz multibeam which are shown in the 3 images below. He writes "The 1st is the last ping before we stopped logging, which would be the NE/SW trending end of the gridded data shown in the 2<sup>nd</sup> image. "seep2". The seep source would appear to be along the eastern edge of a broad mound generally trending NW/SE from the ship position through the black, unrecorded triangle just to the edge of the gridded data. The mound is there, I saw it, but we didn't have logging on when we covered it. The 3<sup>rd</sup> image is the water column view simultaneous with map in the 2<sup>nd</sup> image. This seems to show another plume coming from the steep, distinct, red-colored bump to the starboard of the ship's position on the map. My estimate for the source location of the two plumes is:

42° 12.30'N, 124° 54.25'W  
42° 12.41'N, 124\* 54.21'W "





## Friday, October 9

We arrived at site M14D at about 11 PM after a fast transit. The swell is starting to build slightly but is still fairly small. We launched the elevator and dove Jason without incident and to our surprise landed right on top of the TRM (16 m at 070° from the surveyed position). The elevator was about 100 m away to the northwest so took a while to retrieve but once back at the TRM we quickly attached the line and left the bottom.

### 26) Station M14D

On Station Time:	10/09/2015 05:58 UTC (10/08/15 20:58 LT)
On Station Location/Depth:	42° 54.815N 124° 58.676'W / 997m
OBS Type:	LDEO TRM
Elevator in water	10/09/2015 06:15 UTC
Jason in water	10/09/2015 06:28 UTC
Jason at elevator	10/09/2015 07:08 UTC
Jason at back at TRM	10/09/2015 07:22 UTC
Elevator released	10/09/2015 08:40 UTC
Jason left seafloor recovered	10/09/2015 09:00 UTC
Elevator at surface	10/09/2015 09:45 UTC
TRM on deck	10/09/2015 12:05 UTC
Begin Transit to the next	10/09/2015 14:20 UTC
Time on Station:	8.4 hr

By the completion of M14D, the winds rose to 30 knots and the seas to ~10 feet, with pattern of high winds projected to withdraw to the north (seas flattening to the south first), but swell projected to rise through Friday into Saturday. Consultation with the Jason chief suggested that Jason would be unable to dive for at least 36 hours based on the rising swell. Thus we decided to cruise north to J18D, then north to J26D and back south to BB631, recovering these deep-water ARRA instruments. This strategy buys us time for a possible weather window of Jason dive-able seas on Sunday the 11<sup>th</sup>, to attempt J09D (final TRM) recovery.

We spent a frustrating day. Upon reaching J18D at 1400 LT we found 8-12 foot seas and fog with a visibility of 100 m (possibly 200 m looking for the flag and floats of an OBS with binoculars). We were uncomfortable releasing the OBS and so decided to wait for the fog to lift but after 2 hours it was if anything worse. We decided to proceed to J26D and then return to J18D since this would allow two nighttime recoveries that would be easier in fog given the visibility of the strobe lights on the OBS.

We reached site **J26D** at 1945 LT. The seas were similar to J18D but there was no fog and there followed a fairly routine recover. The Apply-to-Sail participants are now very proficient and can demobe an ARRA OBS in a few minutes

### 27) Station J26D

On Station Time:	10/10/2015 02:45 UTC (10/9/2015 19:45 LT)
On Station Location/Depth:	44° 39.461'N, 125° 28.022'W / 2880m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	10/10/2015 02:53 UTC



Instr. off Bottom (ARRA):	10/05/2015 03:12 UTC
Observed on Surface:	10/05/2015 04:14 UTC
Instrument on Deck	10/05/2015 04:32 UTC
Begin transit to next	10/05/2015 04:36 UTC
Time on Station:	1.9 hr

### Saturday, October 10

We returned to site **J18D** at 01:47 LT. Fog had lifted there, seas were still 8-10', and winds were about 18 knots from the S. The instrument recovery proceeded normally, the 2000-0400 + 0400-1200 shift quickly deconstructed the instrument, and we proceeded on.

#### 28) Station J18D

On Station Time:	10/10/2015 08:47 UTC (01:47 LT)
On Station Location/Depth:	43° 58.77'N, 125° 28.92'W / 3025m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	10/10/2015 08:50 UTC
Instr. off Bottom (ARRA):	10/05/2015 09:17 UTC
Observed on Surface:	10/05/2015 10:27 UTC
Instrument on Deck	10/05/2015 10:43 UTC
Begin transit to next	10/05/2015 11:12 UTC
Time on Station:	2.4 hr

We transited to site **BB631**, arriving on station at 19:09 UTC (12:09 LT). Winds were somewhat high (30 kt, but lowering), so we remained on station for a while, then sent the burn command at 12:24 LT after winds had dropped to ~20 kt. Instrument was observed leaving bottom and rising at a nominal rate of 40 m/min, surfacing at 21:13. Except for a bit of a challenge sighting the instrument in white-capped waters, the recovery was normal.

#### 29) Station BB631

On Station Time:	10/10/2015 19:09 UTC (12:09 LT)
On Station Location/Depth:	42° 52.655'N, 126° 38.195'W / 3330m
OBS Type:	LDEO ARRA ('float up')
Release Sent:	10/10/2015 19:24 UTC
Instr. off Bottom (ARRA):	10/05/2015 19:41 UTC
Observed on Surface:	10/05/2015 21:13 UTC
Instrument on Deck	10/05/2015 21:34 UTC
Begin transit to next	10/05/2015 22:25 UTC
Time on Station:	3.3 hr

After recovering BB631 we faced a bit of dilemma. We could either head to site J09 and wait for weather good enough for Jason to dive or could attempt an out and back multibeam survey to map some basins south of the southern half of the Blanco Transform – a mapping request of Jochen Braunmiller, Bob Dziak and Bob Embley. The weather at BB631 was not bad when we completed the recovery– the winds had decreased from 30 to <20 knots but there was still a big swell. The forecast for the J09D site suggested that swell will continue through Sunday evening and that the best opportunity to dive would be Monday morning –the Jason team would not want to dive in marginal conditions at night since the swell is hard to judge during launch and

recovery. While there is a chance the weather might improve to allow us to dive on Sunday afternoon, this would be counter to the forecast which still predicted a 9-11 ft swell into Sunday evening. After consulting with the Captain and Jason we decided to conduct an out-and-back multibeam survey with waypoints as follows

B1	42°	58.0042'N	127°	13.7166'W
B2	43°	21.0082'N	128°	39.0666'W
B3	43°	19.0570'N	128°	40.1630'W
B4	42°	55.9790'N	127°	14.5530'W

The plan was to return to J09 Sunday night and weather permitting deploy the LDEO Horizontal Pressure Gradient (HPG) test instrument at a shallow 60 m coastal site, dive with Jason on J09, and recover the HPV instrument after 12 hours before turning out attention to the WHOI and SIO offshore instruments requiring Jason recovery.

### *Sunday, October 11*

We initially planned the multibeam survey at 8 knots but had to reduce it to 6-7 knots to get decent data. Early on there were a lot of problems with dolphin vocalizations corrupting the multibeam data. The coverage swath was quite narrow for reasons we do not fully understand so we positioned the first lines 7.5 km south of the southernmost EM100 survey which has a line spacing of 10.9 km and the second return line 4 km further south of our first to reflect that fact that in some of the deeps the swath was <5 km wide. Multibeam surveying proceeded through the night, completing at 10-11-15 14:45 LT (21:45 UTC). Improving sea conditions provided for better data from the southern W->E pass, infilling a bit of the ragged edge of the more northern E->W pass.

After completing the multibeam surveying, we paused for deck work to position the LDEO experimental **HPG device** for prep. work on the way to its test site, at approx. 43° 05.127'N 124° 32.367' W in about 88m water depth. Then we proceeded to that station, arriving at 01:00 LT on 10-12-2015.

### *Monday, October 12*

After arriving at the **HPG test site** (coordinates, time above), the Lamont crew set out to prepare the test instrument for deployment. At 03:15 the instrument was buttoned up and placed in the water, reaching bottom at 03:37 LT (10:37 UTC). It was lowered on Dyneema line via the heave-compensated winch using the starboard crane. A release was sent and the line and release were recovered. We then proceeded to station J09D to attempt a recovery.

Arrived at station **J09D**, at TRM in 251m of water and requiring a Jason recovery. Things began after breakfast because the Jason team preferred a daylight launch to judge the swell. Dropped elevator and dove Jason at 08:00 LT. The recovery went quite well in fair weather, minimal wind waves and some long-period swell.

#### 30) Station J09D

On Station Time:	10/12/2015 12:00 UTC (05:00 LT)
On Station Location/Depth:	43° 9.09'N 124° 43.626'W / 251m

OBS Type:	LDEO TRM
Elevator in water	10/09/2015 15:14 UTC
Jason in water	10/09/2015 15:22 UTC
Jason at elevator	10/09/2015 15:58 UTC
Jason at TRM	10/09/2015 16:15 UTC
Elevator released	10/09/2015 08:40 UTC
Jason recovered	10/09/2015 17:02UTC
Elevator at surface	10/09/2015 16:56 UTC
TRM on deck	10/09/2015 18:18 UTC
Begin Transit to the next	10/09/2015 19:10 UTC
Time on Station:	7.2 hr

Transited back to the **HPG trial** station nearby (see above). Cruised slowly so as to arrive there at ~15:00, thus providing for recording ~12 hours (tidal cycle) of data. The HPG is an LDEO prototype that employs differential pressure gauges sensing between diagonal corners of a TRM frame (with 2 sets thus monitoring all 4 corners). The test frame also housed a float-down seismometer and one attached to the frame proper. The idea is to acquire vector information about waves passing over an OBS (via differential pressure measurements) and use it to estimate variable-pressure driven tilting effects on the seismometer, thus providing a means of numerically compensating for these effects (e.g., Z-channel tilt into horizontals) on seismic data. We observed westerly (sourced) swell moving through the site (at nearby J09D) with an estimated wave height of 5-7 feet during the duration of the experiment (~10:00 – 22:00 UTC). HPG test instrument brought back on board at 15:49 LT.

We had a discussion about which instrument to recover first since the forecast is reasonable for both Tuesday and Wednesday (although a little worse on Wednesday) and we are hopeful that we can dive at both. G36B is closer and would provide a more efficient route but BB850 is a higher priority instrument since it fills a gap in spatial coverage while G36B was duplicated by a second deployment in the same year. G36B is deployed in rough terrain and while it has been located acoustically (the instrument transponder failed midway through the acoustic survey), it may require a tedious visual search. BB850 should be easily locatable by the Jason sonar since it is in a sedimented region and has also been located acoustically. We decided to go first to site BB850 since we wanted to avoid the worst-case scenario of a unsuccessful search at G36B followed by change in weather that would prevent a dive at BB850.

### ***Tuesday, October 13***

After a 14-hour transit we arrived at station BB850 to attempt a rescue Jason dive on the Scripps Abalones instrument. Information we had about its location put it between 44° 31.959' and 44° 31.992' N, and 128° 2.724' and 128° 2.760' W (data from Nabelek, Brownmuller and SIO). At station we were able to receive an acknowledge from the instrument, and then sent a burn command and monitored slant range. It was clear after 45 minutes that the burn command didn't result in instrument rise from the seafloor, so Jason dove at 08:06 LT. Sea/weather conditions were long-period swell (~5-7') and light winds (5-6kt) from the east. Instrument was encountered on the bottom approx. 8m NW of location given by Brownmuller. Jason operator gave the instrument a nudge and it immediately came off the bottom, rising at a rate of ~40m/s. Jason withdrew and was recovered at 10:46 LT. All in all, a very efficient operation.

31) Station BB850

On Station Time:	10/13/2015 14:00 UTC (07:00 LT)
On Station Location/Depth:	44° 31.962'N 128° 2.733'W 2872m
OBS Type:	Scripps Abalones
Jason in water	10/09/2015 15:06 UTC
Jason at Abalones	10/09/2015 17:08 UTC
Jason recovered	10/09/2015 19:25 UTC
Abalones at surface	10/09/2015 ~18:25 UTC
Abalones on deck	10/09/2015 19:46 UTC
Begin Transit to the next	10/09/2015 19:57 UTC
Time on Station:	5.95 hr

***Wednesday, October 14***

We arrived at our final station, G36B, an attempt to rescue a WHOI ARRA instrument, at 23:30 (10-13-2015). An assessment was made about a Jason dive. As the winds had risen to ~25 kt overnight, it was determined not to attempt a nighttime dive. We stood on station until noon, reassessing sea conditions and weather at 08:00, 10:00 and 12:00 LT (10-14-2015) for possible dives. Unfortunately the weather did not improve and we set sail to return to Newport.

***Thursday, October 15***

The ship docks at Newport mid-morning. The LDEO OBSIP off load is completed that day.

### **OBS Operations**

We recovered 29 LDEO OBSs as originally planned, comprising 8 pop-up TRMs, 11 deeper-water TRMs recovered via Jason dives, and 10 deep water ARRA ('float up') instruments. We recovered 2 lost Scripps Abalones instruments via Jason dives. We provided for a successful test of an LDEO experimental instrument employing differential ('horizontal') pressure gradient (HPG) measurements in shallow water near Bandon, Oregon. We undertook multibeam surveying to supplement bathymetry immediately south of the Blanco Fracture Zone between 127° 13' and 128° 40'W and between 42° 55' and 42° 58'N. Three periods of somewhat high winds and moderate seas prevented us from diving Jason to recover a lost WHOI ARRA deep water instrument (G36D) at 42.582883N, -126.914845W.

## Tables

**Table 1.** Positions of OBSs provided at the start of the cruise. For the LDEO instruments these are from Table 2 of the OC1409A cruise report except that the longitude of site G17D was wrong in that table so we use the position from Table 1 of the OC1409A cruise report.

Site Name	Instrument type	Survey Latitude	Survey Longitude	Latitude Degrees, N	Latitude Minutes, N	Longitude Degrees, W	Longitude Minutes, W	Average Depth , m
FC03D	TRM	44.813285	-124.738318	44	48.797	124	44.299	432
J26D	ARRA	44.657678	-125.467035	44	39.461	125	28.022	2880
M12D	TRM	44.227	-125.03526	44	13.620	125	2.116	950
J18D	ARRA	43.977253	-125.481397	43	58.635	125	28.884	3050
J17D	TRM	43.78726	-124.613425	43	47.236	124	36.806	285
M13D	TRM	43.59732	-125.044638	43	35.839	125	2.678	990
J10D	ARRA	43.348497	-125.545077	43	20.910	125	32.705	3085
J09D	TRM	43.151395	-124.727096	43	9.084	124	43.626	252
M14D	TRM	42.913585	-124.97793	42	54.815	124	58.676	997
G34D	ARRA	42.572323	-125.448578	42	34.339	125	26.915	3089
M15D	TRM	42.210673	-124.90745	42	12.640	124	54.447	933
G25D	TRM	41.981126	-124.726679	41	58.868	124	43.601	688
M17D	TRM	41.036958	-124.629837	41	2.217	124	37.790	749
G17D	TRMP	41.399611	-124.3442	41	23.977	124	20.652	99
G18D	ARRA	41.304675	-125.255845	41	18.281	125	15.351	3130
FS45D	TRM	40.79999	-124.520245	40	47.999	124	31.215	477
FS43D	TRM	40.711938	-124.583875	40	42.716	124	35.033	719
FS42D	TRMP	40.715095	-124.463103	40	42.906	124	27.786	95

Site Name	Instrument type	Survey Latitude	Survey Longitude	Latitude Degrees, N	Latitude Minutes, N	Longitude Degrees, W	Longitude Minutes, W	Average Depth , m
FS17D	TRMP	40.559769	-124.596999	40	33.586	124	35.820	145
FS14D	TRMP	40.492342	-124.603917	40	29.541	124	36.235	145
FS11D	TRMP	40.428534	-124.577497	40	25.712	124	34.650	150
FS12D	TRMP	40.445633	-124.510457	40	26.738	124	30.627	55
FS15D	TRMP	40.49639	-124.524697	40	29.783	124	31.482	56
G02D	ARRA	40.160343	-125.297707	40	9.621	125	17.862	1741
G19D	ARRA	41.33158	-126.02787	41	19.895	126	1.672	3082
G27D	ARRA	42.001268	-125.98165	42	0.076	125	58.899	2939
G26D	ARRA	41.983815	-125.30827	41	59.029	125	18.496	3104
BB631	ARRA	42.878702	-126.63437	42	52.722	126	38.062	3320
J25D	TRMP	44.456704	-124.631025	44	27.402	124	37.861	136
G35B	WHOI ARRA	42.582883	-126.914845	42	34.973	126	54.891	2423
BB850	SIO ABALONE	44.532650	-128.045430	44	31.959	128	2.726	2875
FS19	SIO ABALONE	40.623900	-124.470400	40	37.434	124	14908.224	100



**Table 2** Positions of TRM OBSs taken from Jason Dives.

<b>Dive</b>	<b>Site</b>	<b>Azimuth*</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Dates</b>
J2-844	FC03D	257.44	44 48.805693	124 44.275856	20151002003046
J2-845	M12D	45.17	44 13.632653	125 02.104897	20151002111429
J2-846	J17D	192.89	43 47.255435	124 36.786043	20151002204717
J2-847	M13D	265.61	43 35.861069	125 02.669383	20151003033317
J2-848	FS43D	303.00	40 42.730518	124 35.022052	20151006042505
J2-849	FS45D	288.00	40 48.001198	124 31.177417	20151006105005
J2-850	FS19D	40	37.444060	124 28.221127	20151007033030
J2-851	FS15D	080.00	40 29.793542	124 31.465386	20151007181409
J2-852	M17D	116.83	41 02.228110	124 37.775224	20151007235430
J2-853	G17D	023.43	41 24.022174	124 20.638175	20151008074610
J2-854	G25D	259.53	41 58.890283	124 43.603218	20151008164611
J2-855	M15D	232.00	42 12.643490	124 54.478527	20151008225211
J2-856	M14D	113.95	42 54.817687	124 58.665607	20151009074411
J2-857	J09D	100.60	43 09.073929	124 43.636805	20151012162204
J2-858	BB850	84.10	44 31.959724	128 2.726902	20151013170906

\* Azimuth refers to direction of long axis of OBS frame and is indeterminate to +/- 180 degrees.

### **Note on Jason Navigation**

Throughout the cruise it was noted that there was an offset between the Jason navigation and the surveyed positions reported from cruise OC1409A as listed in Table 1. The Jason locations tended to be to the northeast. William Wilcock participated in cruise TN-332, immediately following cruise TN-331 and at the start of this cruise the Jason Team undertook a USBL survey in order to recalibrate their navigation. Akel Kevis-Stirling of the Jason team explained that it was not a simple task to deduce any Jason navigation offsets that existed prior to the recalibration survey and it was unlikely that a systematic Jason navigation error could account for the discrepancies. However, he acknowledged that there was some uncertainty in the Jason navigation for Leg TN-331.

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