Cruise Report

R/V Oceanus
OC1209A

Cascadia Initiative - Year 2, Leg 6
September 10-22 2012
Newport OR - Newport OR

Anne Tréhu & Jeff McGuire
co-chief scientists

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## Cruise Participants

**Captain and Crew R/V Oceanus:**

Captain: Jeff Crews
Chief Engineer: Bob Ashley
Chief Mate: John Forgione
Second Mate: Tony Monocandilos
Engineer: Colin Caskey
Engineer: Jay Jean-Bart
Cook: Kris Alberty
Steward: Taylor Williams
Bos'n: Doug Beck
AB: Marc Simpson
AB: Jon Saunders

**Science Party:**

Co-Chief Scientist: Anne Trehu (OSU)
Co-Chief Scientist: Jeff McGuire (WHOI)
Marine Technician: Dave O'Gorman (OSU)
OBS Team (all from LDEO):
- Andrew Barclay
- Ted Koczynski
- David Gassier
- Vincent Oletu
- Geetika Kapoor

Watchstanders:
- Angie Boysen (OMSI)
- Min Ding (WHOI)
- Ben Heath (UO)
- MacKenzie Mark-Moser (OSU)

*science party: (kneeling) Kapoor, Gassier, O'Gorman; (standing) McGuire, Trehu, Oletu, Heath, Mark-Moser, Barclay, Boysen, Ding, Kaczynski*

**Overview and Recommendations:**

The objective of Leg 6 of the second Cascadia Initiative (CI) field season was to deploy 14 LDEO-TRM ocean bottom seismometers (OBS) and 10 LDEO classic OBSs. All but two of the instruments included an absolute pressure gauge (APG). Most of the instruments were located in the Year 2 Focused Array (FA) near the Mendocino Triple Junction. The drop locations are shown in the following map and table.

This was the third cruise during which TRMs were deployed, and lessons learned during previous 2 cruises were put into effect. One lesson was that the time between recovery and redeployment (July 24 - September 10, or 6.5 weeks) was the minimum possible. Spare parts arrived as late as the day of departure and considerable rebuilding of instruments was done at sea. An additional 2 weeks between cruises would have permitted shipping of the data loggers and sensors back to LDEO, where conditions for working on them would have been better. It would also have allowed for more time for shipping replacement parts.

We found that the heave-compensating winch in AHC mode (automatic heave compensation) worked very well even in moderately rough seas (wave period of ~5 s and wave height of at least 6 ft). Small floats were added to release that holds the TRM on the deployment wire to keep it upright when the instrument reached the seafloor (see cover photo). We recommend turning on the heave compensator as soon as possible after the instrument hits the water.

Although we acquired CTDs, we recommend that future OBS deployment cruises on R/V Oceanus leave the CTD in port and use XBTs to acquire information on the physical properties of the ocean. When a cruise includes CTD, panels are removed from the side of the deck to facilitate deployment of the CTD. When there are no CTDs planned, solid panels close off that part of the deck, resulting in a dryer deck.

Acoustic surveys to locate the OBS on the seafloor were conducted for all instruments deployed in water depth greater than 430 m. The final position of instruments lowered on the wire in water depth <430 m was assumed to be the position of the ship when the OBS reached the seafloor, corrected from the layback between the ship's GPS antenna and A-frame.

The importance of having the science party monitor their own set of station drop points independently from the bridge was illustrated at one site when it became apparent during the pre-drop survey that the bridge drop location was ~1 km east of the science party location.

Generally OBS operations were conducted from ~7 am until midnight (local time). After completing transits between sites, we acquired CTD data )(appendix 1) and 4/12 kHz chirp data over potential cold seeps and bubble vents (appendix 2).

*note: All underway data (ADCP, echosounder, CTD, navigation, meteorology) have been transferred from the Rolling Deck to Repository (www.rvdata.us), and should be accessible by search for cruise OC1209A data via NGDC or NODC.*

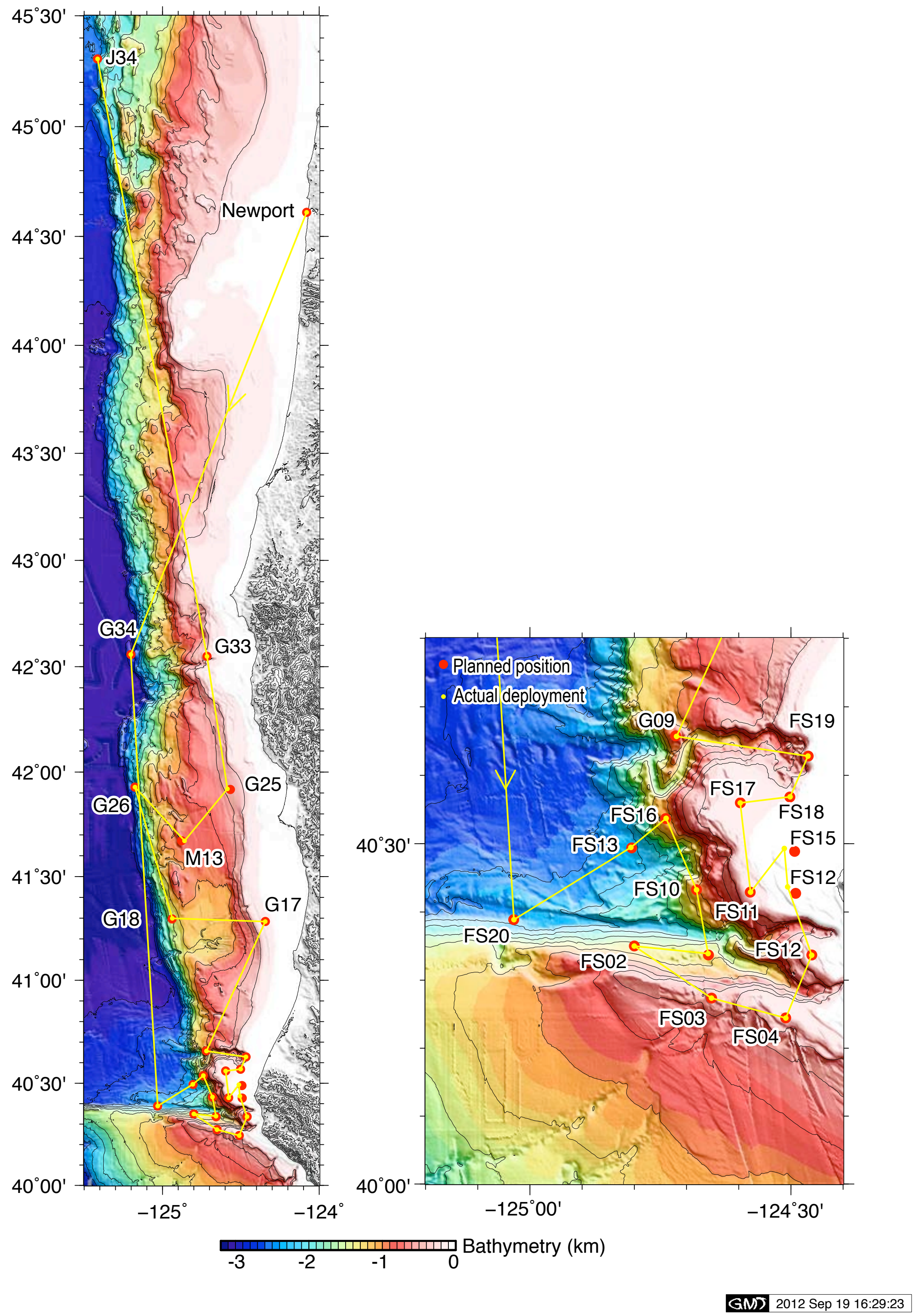



*Figure 1. Bathymetric map showing the Leg 6 OBS deployment positions. The yellow line shows the deployment order. For the complete trackline, along which ADCP and 4/12 kHz data were acquired, see appendix 2.*

| Site Name | OBS I.D. | Final Station Latitude (deg) | Final Station Latitude (min) | Final Station Latitude (hemi) | Final Station Longitude (deg) | Final Station Longitude (min) | Final Station Longitude (hemi) | Final Station Latitude (decimal degrees) | Final Station Longitude (decimal degrees) | Final Station Depth (m) | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G34 | | 42 | 33.326 | N | 125 | 12.0584 | W | 42.55543333 | 125.2009733 | 2953.5 | OBS |
| G26 | | 41 | 55.4955 | N | 125 | 10.6496 | W | 41.924925 | 125.1774933 | 2356.8 | OBS |
| G25 | | 41 | 55.1953 | N | 124 | 35.1662 | W | 41.91992167 | 124.5861033 | 430.4 | TRM |
| G17 | | 41 | 17.035981 | N | 124 | 20.67661 | W | 41.28393302 | 124.3446102 | 123 | TRM-P |
| G09 | | 40 | 39.41 | N | 124 | 43.1198 | W | 40.65683333 | 124.7186633 | 842 | TRM |
| FS19 | | 40 | 37.67686 | N | 124 | 28.00294 | W | 40.62794766 | 124.4667157 | 87 | TRM-P |
| FS18 | | 40 | 34.090762 | N | 124 | 30.09391 | W | 40.56817937 | 124.5015651 | 107 | TRM-P |
| FS17 | | 40 | 33.58592 | N | 124 | 35.79152 | W | 40.55976533 | 124.5965253 | 146 | TRM-P |
| FS16 | | 40 | 32.2886 | N | 124 | 44.367 | W | 40.53814333 | 124.73945 | 1073.2 | OBS |
| FS13 | | 40 | 29.5885 | N | 124 | 48.3908 | W | 40.49314167 | 124.8065133 | 2332.2 | OBS |
| FS10 | | 40 | 25.9774 | N | 124 | 40.9152 | W | 40.43295667 | 124.68192 | 1075.7 | OBS |
| FS11 | | 40 | 25.751688 | N | 124 | 34.66679 | W | 40.4291948 | 124.5777798 | 132 | TRM-P |
| FS15 | | 40 | 29.554548 | N | 124 | 30.75808 | W | 40.4925758 | 124.5126347 | 52 | TRM-P |
| FS12 | | 40 | 26.22415 | N | 124 | 30.35421 | W | 40.43706917 | 124.5059035 | 60 | TRM-P |
| FS08 | | 40 | 20.199217 | N | 124 | 27.59064 | W | 40.33665361 | 124.459844 | 120 | TRM-P |
| FS07 | | 40 | 20.3511 | N | 124 | 39.5757 | W | 40.339185 | 124.659595 | 1297.2 | OBS |
| FS04 | | 40 | 14.680779 | N | 124 | 30.58055 | W | 40.24467965 | 124.5096759 | 159 | TRM-P |
| FS03 | | 40 | 16.388936 | N | 124 | 39.15788 | W | 40.27314893 | 124.6526314 | 345 | TRM |
| FS02 | | 40 | 21.065 | N | 124 | 47.8794 | W | 40.35108333 | 124.79799 | 1402.8 | OBS |
| FS20 | | 40 | 23.3731 | N | 125 | 1.8682 | W | 40.38955167 | 125.0311367 | 2377.9 | OBS |
| G18 | | 41 | 18.0976 | N | 124 | 56.1793 | W | 41.30162667 | 124.9363217 | 1463.6 | OBS |
| M13 | | 41 | 40.2869 | N | 124 | 51.5786 | W | 41.67144833 | 124.8596433 | 908.9 | TRM |
| G33 | | 42 | 32.899512 | N | 124 | 42.97091 | W | 42.54832521 | 124.7161818 | 213 | TRM* |
| J34 | | 45 | 18.3568 | N | 125 | 24.817 | W | 45.30594667 | 125.4136167 | 2583.1 | OBS* |

Note: Depths for stations G17, FS19, FS18, FS17, FS11, FS15, FS12, FS08, FS04, FS03, G33 are from the echosounder at the station
GPS to A frame 148.5ft
GPS to hull transducer 115ft
heading is from the on-bottom time in the das logs
* no APG
Final TRM positions are the on-bottom location adjusted for the layback except for G09 and M13 which were surveyed in due to their water depth

*Table 1. Final OBS positions, as determined from acoustic ranging to the instruments for the deeper sites and from the drop position for shallow sites for which the OBS was lowered to the seafloor on the wire. In the latter case, positions have been corrected for the setback between the GPS antenna and the A-frame.*

| Site | Latitude (deg) | Longitude | Longitude (deg) | Final Depth (m) | Planned Latitude (deg) | Planned Longitude (deg) | Planned Depth (m) | Distance between planned and final location (m) | Difference between planned and final depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| FS02 | 40.35108 | 124.79799 | -124.79799 | 1403 | 40.35010 | -124.80002 | 1000 | 201 | 403 |
| FS03 | 40.27315 | 124.65263 | -124.65263 | 345 | 40.27348 | -124.65225 | 390 | 48 | -45 |
| FS04 | 40.24468 | 124.50968 | -124.50968 | 159 | 40.24447 | -124.50965 | 150 | 23 | 9 |
| FS07 | 40.33919 | 124.65960 | -124.65960 | 1297 | 40.33678 | -124.65800 | 1270 | 303 | 27 |
| FS08 | 40.33665 | 124.45984 | -124.45984 | 120 | 40.33678 | -124.46020 | 110 | 33 | 10 |
| FS10 | 40.43296 | 124.68192 | -124.68192 | 1076 | 40.43252 | -124.68070 | 1100 | 113 | -24 |
| FS11 | 40.42919 | 124.57778 | -124.57778 | 132 | 40.42900 | -124.57750 | 120 | 33 | 12 |
| FS12 | 40.43707 | 124.50590 | -124.50590 | 60 | 40.42725 | -124.49125 | 50 | 1655 | 10 |
| FS13 | 40.49314 | 124.80651 | -124.80651 | 2332 | 40.49392 | -124.80518 | 2270 | 141 | 62 |
| FS15 | 40.49258 | 124.51263 | -124.51263 | 52 | 40.48865 | -124.49355 | 30 | 1681 | 22 |
| FS16 | 40.53814 | 124.73945 | -124.73945 | 1073 | 40.53687 | -124.73963 | 1050 | 141 | 23 |
| FS17 | 40.55977 | 124.59653 | -124.59653 | 146 | 40.55963 | -124.59705 | 150 | 43 | -4 |
| FS18 | 40.56818 | 124.50157 | -124.50157 | 107 | 40.56838 | -124.50160 | 110 | 22 | -3 |
| FS19 | 40.62795 | 124.46672 | -124.46672 | 87 | 40.62792 | -124.46710 | 90 | 32 | -3 |
| FS20 | 40.38955 | 125.03114 | -125.03114 | 2378 | 40.38862 | -125.03058 | 2360 | 112 | 18 |
| G09 | 40.65683 | 124.71866 | -124.71866 | 842 | 40.65772 | -124.72058 | 704 | 192 | 138 |
| G17 | 41.28393 | 124.34461 | -124.34461 | 123 | 41.28390 | -124.34410 | 123 | 43 | 0 |
| G18 | 41.30163 | 124.93632 | -124.93632 | 1464 | 41.29610 | -124.93900 | 1466 | 22 | -2 |
| G25 | 41.91992 | 124.58610 | -124.58610 | 430 | 41.91690 | -124.56730 | 358 | 1815 | 72 |
| G26 | 41.92493 | 125.17749 | -125.17749 | 2357 | 41.92800 | -125.17572 | 2297 | 368 | 60 |
| G33 | 42.54833 | 124.71618 | -124.71618 | 213 | 42.54860 | -124.71600 | 214 | 34 | -1 |
| G34 | 42.55543 | 125.20097 | -125.20097 | 2954 | 42.55730 | -125.20210 | 2940 | 228 | 14 |
| J34 | 45.30595 | 125.41362 | -125.41362 | 2583 | 45.30570 | -125.41450 | 2574 | 75 | 9 |
| M13 | 41.67145 | 124.85964 | -124.85964 | 909 | 41.67170 | -124.87840 | 748 | 1561 | 161 |

*Table 2. Comparison between the originally planned and final OBS positions. In four cases, OBSs were moved 1-2 km from the original site because of bathymetric features that were not apparent in the bathymetry available prior to the cruise (FS12, FS 15, G25) or proximity to active venting features (M13).*

**Cruise Narrative:** (all times are given first in local PDT with UTC time in parentheses)

**Sept 10.** We left the dock in Newport at noon, with a forecast for 40 kt winds. The transit to the first site (G36B) was uneventful.

**September 11.** Arrived at first deployment site (G36B) at 00:42 (0742 UTC). One Lamont OBS was successfully deployed in a gale and heavy seas.

Plan was adjusted to deploy fewer OBSs on the way to the focused array to take advantage of the fact that the transit direction had a following sea, thus making productive use of time that would otherwise be a weather watch. The forecast is for strong winds and high seas through September 13.

Arrived at site G26B and prepared an OBS for deployment. When it was almost ready, the sensor packaged dropped from the deployment arm. The sensor package was replaced, but the second package also dropped from the arm, injuring Ted Koczynski. We then realized that there was a manufacturing defect in a whole set of burn wires designed to release the sensor package from the deployment arm. Attempts to deploy at G26B were deferred until this problem could be resolved, and we began the transit to site FS20B in order to make efficient use of time that was too rough for deployment but fine for transit with a following sea.

Arrived at FS20A at ~20:30 (0330 UTC on Sept 12). FS20B was deployed without a hitch. We then proceeded to FS13B.

**September 12.** Arrived at FS13B at 00:30 (0730 UTC). Deployment went smoothly: ~2 hrs of preparation on site prior to drop and a total of
4.25 hours to complete deployment and survey. Finished survey at 04:45 (1145) and began a slow transit to FS16B. Weather is improving.

Arrived at FS16B at 07:30 (1430 UTC). A last-minute hitch occurred when the instrument failed its final checkout 2.5 hrs after arriving on site. Current was being sent to the burn wire. This resulted in a delay of ~ 2 hrs for the drop. Total time on site was 4.25 hrs.

Arrived at FS10B at 13:47 (2047 UTC). OBS was in the water 1.25 hrs later (2203), and total time on site was 2.25 hrs (survey completed at 2308 UTM).

Arrived at FS07B at 16:54 (2354 UTC). Another smooth deployment - in the water 1.25 hrs later and the entire deployment and survey process completed in 2.25 hrs.

Arrived at FS02 at 20:35 (0335 UTC on Sept. 13). A loose connector on the OBS resulted in a 45 minute delay, but the OBS was in the water ~2.5 hrs after arrival on site and surveying was completed at 11:33 pm (0633 UTC). The LDEO crew then went for some well-deserved rest after a very long and productive day.

**September 13**. The night was spent surveying the axis of the Mendocino transform fault at 5 kts with the 4 and 12 kHz echo sounders to see if there were any bubble vents or interesting near-surface structures and to allow the LDEO OBS team to get some rest. We were on site FS03B at 7:30 am (1430 UTC) to start assembling a TRM. Weather conditions have improved considerably, with winds below 5 kts and a greatly diminished swell.

The first TRM went successfully over the side at 12:11 pm and was on the bottom at 12:41 pm (1941 UTC) in 348 m of water. The heave-compensating winch worked very well. Because the OBS was lowered on a wire and the final wire length was very close to the water depth indicated by the 12 kHz sounder, we decided that an acoustic survey to locate the OBS on the seafloor was not necessary.

We were on site for the second TRM deployment (FS04B) at 14:47 (2147 UTC). The TRM went into the water at 18:18 (0118 on day 258 UTC) and was on the bottom at 18:33 pm (0133) in 160 m of water. Again, the heave-compensating winch worked very well. Because the OBS was lowered on a wire and the final wire length was very close to the water depth indicated by the 12 kHz sounder, we decided that an acoustic survey to locate the OBS on the seafloor was not necessary. The release was recovered and we started the transit to the next site at 19:06 (0206 UTC).

We arrived on site for the third TRM deployment (FS08B) at 23:13 (0433 UTC).

**September 14.** The TRM went into the water at site FS08B just after midnight (000:02 am local or 0702 on day 258 UTC) and was on the bottom at 0:15 am (0715 UTC) in 120 m of water. The release was on deck 5 minutes later, and we were underway to the next site at 1:08 am (0808 UTC). Again, the heave-compensating winch worked very well. Because the OBS was lowered on a wire and the final wire length was very close to the water depth indicated by the 12 kHz sounder, we decided that an acoustic survey to locate the OBS on the seafloor was not necessary.

During the night, from 2:00-5:03 am (0900-1203 UTC), we acquired two CTDs in the axis of the Mendocino Transform Fault at water depths of 1810 and 2040 m, respectively. See table for the coordindates of these sites.

At 5:03 am we began heading to FS12B to conduct a detailed bathymetric survey of sites FS12B and FS15B. These are the two shallowest sites (50 and 30 m respectively according to pre-cruise analysis of bathymetry from GeoMapApp). Navigational charts indicated that these sites were located near the western boundary of a region of rough topography and suggested that smoother seafloor might be found ~1.5 km NW of each site. We surveyed the region at 4-6 kts with the 12 kHz echosounder set to a range window of 25-75 m. Smoother seafloor was indeed found to the NW of each planned site and new coordinates for FS12B were identified. FS12B was deployed in 60 m of water.

We continued surveying to define the rough/smooth boundary. New coordinates were found for FS15B. Meanwhile, the LDEO OBS team worked to prepare 2 TRMs in parallel.

FS15B went into the water at 19:55 (0225 on day 259 UTC) and was on bottom at 0234 in 52 m of water. Transit to FS11B began at 20:40 pm (0340).

FS11B was in the water at 23:21 (0621 on day 260 UTC) and deployment with the release on deck by 23:37 (0637). OBS team went to sleep, and the night watch prepared to acquire CTDs.

**September 15.** Three CTDs were acquired spaced ~4.5 km apart in the axis of the Mendocino Transform Fault (see Appendix 1). CTD operations were completed at 6:32 am (1332 UTM), and transit was begun to FS17B.

Approaching FS17B, the 4 and 12 kHz echosounders were set to a range of 100 m to get high resolution images of the seafloor and shallow subsurface because the GeoMapApp gridded bathymetry indicated a steep slope immediately to the west of the site. However, the echosounder indicated only a broad anticline with its axis a few hundred meters east of the site and ~30 of sediment above 4 kHz "basement" at the site. We continued surveying the seafloor in the region of FS17B while TRM preparation continued.

There was a bit of excitement in the lab as 2 small birds (probably Townsend warblers) came into the lab and galley area. We caught them in an apron and released them outside.

FS17B went into the water at 13:59 (2059 UTC) and was on the bottom at 14:12 (2112). The release was back on deck a few minutes later. Oceanus then transited to FS18 for an acoustic survey of the seafloor in the region of FS18B. No significant subsurface structure was detected on the 4 kHz record in the vicinity of FS18B.

FS18B went into the water at 19:51 pm (0251 on day 260 UTC) and was on the bottom at 20:00 (0300). Release was back on deck at 20:04.

**September 16.** R/V Oceanus transited to G09 to survey the region and find a suitable site. G09 is on a ridge in the outer accretionary complex. As a result of the survey, the site for G09 was modified moved SW by ~800 m.
An acoustic flare was reported by the bridge at 2:20 am (0920 UTC) but was not observed by the watch standers on either the 4 or 12 kHz display. However, when the stored 4 and 12 kHz data were replayed and rescaled, a strong flare appeared in the 12 kHz data, suggesting the presence of a plume of bubbles. No flare is detectable on the 4 kHz data. Signals interpreted to be of biological origin are detected at both frequencies. Examination of the kea files confirmed that the observed flare was in approximately the location where a flare had been detected by the bridge. The seafloor morphology at G09 is similar to that at Hydrate Ridge and other structures in the Cascadia forearc where methane vents have been observed.

Soon after passing over the flare, R/V Oceanus headed back east to site FS19B to be on site in the morning to deploy the last station in the Focused Array. The importance of having the science party monitor their own set of station drop points independently from the bridge was illustrated at FS19B when it became apparent during the pre-drop survey that the bridge drop location was ~1 km east of the science party location. The seafloor was flat at both sites, but the science party site was 30 m deeper (~90 m versus 60 m), so it was chosen.

FS19B went into the water at 9:36 am (1636 UTC) and was on the bottom at 9:43 am (1643). The release was back on deck a few minutes later. Approx. 1 hr was spent rearranging frames on the fantail before beginning the transit to the location where the flare was observed near G09B.

We arrived in the vicinity of G09B at ~11:55 am (1855 UTC) and surveyed the area for acoustic flare while the TRM was being prepared for deployment. The acoustic flare observed the previous night was observed again at 11:55 (1855) and at 14:20. No other flares were observed. G09B went into the water at 14:43 (2143) and was on the bottom at 15:56 (2256). The release was on deck at 16:21 (2321). This deployment provided an excellent test of the heave-compensating winch, as this instrument was deployed in 830 meters of water with a 6 ft swell with period of ~5-6 s. Tension on the line was generally between 1000 and 2000 lb with occasional excursions from 500 to 3000 lbs. From 16:21 to 18:05, frames were rearranged on deck to prepare for the final set of deployments. An acoustic survey to locate G09B on the seafloor was begun at 18:25 pm and completed at 18:50 pm.

R/V Oceanus began the 40 nm transit to site G17B at 18:50 pm on September 16 (0150 UTC on Day 261) and arrived on site at 10:46 pm (0546).

**September 17.** G17B was in the water at 00:45 am (0745 UTC) on September 17 and on the bottom at 00:54 am. The release was confirmed and the release was on deck at 1:03 am, and the 27 nm transit was begun to G18B.

We arrived at the site for G18B at ~6 am (1300 UTC) and had the CTD in the water for station CAST06 at 6:05 am (1305). CAST06 went to 1460 m depth (~15 m above the seafloor) and was completed, with the CTD strapped down, flushed and rinsed at 7:20 am (1420). We then began a 4 and 12 kHz survey to characterize the seafloor and investigate an alternate site located 365 m NE of the original site. The survey showed that the seafloor steepened ~200 m SW of the original site and was flat for a radius of at least 500 m around the new site. During the CTD, we had a surprise visit from a barn owl who watched us from the stack of TRM support frames for several minutes.

G18B was in the water at 11:37 am (1910 UTC) and on the bottom in 1465 m of water at 12:10 pm (2010). The acoustic survey was completed at 12:48 pm (1948) and we were underway for the 40 nm transit to G26B.

We arrived at G26B at 16:44 (2344). The OBS was in the water 17:13 (0013 on day 262), and on the bottom in 2360 m at 18:07 pm (0107). The acoustic survey began at 18:16 (0116) and completed at 19:04 (0204). A humpback whale mother and calf were spotted from the bridge during the evening.

After completion of the survey at G26B, we transited toward M13B, passing over a ridge that was a possible candidate for a bubbling vent. A strong flare was observed. M13B was in the water at 23:11 (0611) and on the bottom at 00:30 am (0730). The release was on deck at 00:53 am (0753). Because of the relatively deep water (902 m), we decided to do an acoustic survey. The survey was begun at 01:09 am and completed at 01:26 am.

**September 18.** After completing deployment of M13B, we returned to the site east of M13B where a strong acoustic flare had been observed to acquire CTD CAST07. The CTD was deployed at 01:58 and recovered at 02:28 am (0858-0928 UTC). We remained stationary over the flare until 05:45 am (1245), when we left to transit towards site G25B, taking a zigzag route that passed over a number of local topographic highs with summits ranging from 800 to 550 m. Acoustic flares were not observed over the deeper topographic highs, but were observed over most of the shallower highs.

We arrived on site for G25B at around noon. G25B was in the water at 13:56 (2056 UTM) and on the seafloor at 14:33 (2133). The release was on deck at 14:42 and transit to G33B began at 15:29 (2229).

We arrived on site for G33B at 21:17 (0417 UTC on day 263). G33B was in the water at 23:41 (0641) and on the bottom at midnight (0700). The release was confirmed and on deck at 0:07 am (0707) and the long transit to J34 began.

**September 19.** During the transit, we passed over sites where acoustic flares have been seen in the past (north and south Hydrate Ridge, SE Knoll; Heeschen et al., 2003). We arrived at site J34B at 15:56 (2257 UTC). J34B was in the water at 15:57 and on the bottom at 16:58 (2358). The location survey was completed at 17:49 (0049 on day 264), and we begun the transit back to Newport. On the way, we completed 12 kHz surveys of North and South Hydrate Ridge, retracing waypoints from 2008.

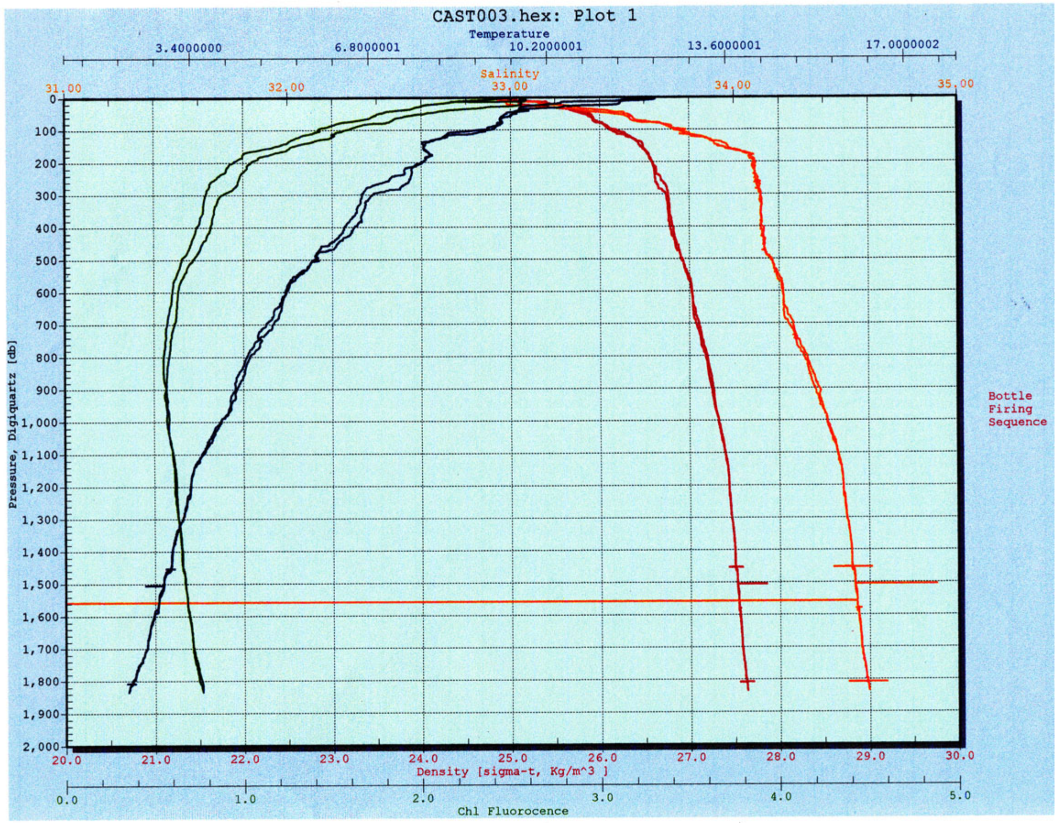
**September 20**. Arrived in Newport at 10 am.

*An unexpected stowaway who greeted us at dawn one morning. A similar (or the same) barn owl landed on the R/V Melville several hundred kms away on the Blanco FZ a few hours later!*

**Appendix 1. CTD data**

| Station name | Latitude (degrees) | Longitude (degrees) | Day of Year | Time (UTC) | Maximum Depth (m) |
|---|---|---|---|---|---|
| CAST01 | 40.36513 | -124.65054 | 258 | 0905 | 1810 |
| CAST02 | 40.36932 | -124.70473 | 258 | 1041 | 2040 |
| CAST03 | 40.36883 | -124.77879 | 259 | 0755 | 1852 |
| CAST04 | 40.37888 | -124.82703 | 259 | 0950 | 2250 |
| CAST05 | 40.38291 | -124.88214 | 259 | 1201 | 2280 |
| CAST06 | 41.29625 | -124.93894 | 261 | 1246 | 1460 |
| CAST07 | 41.67150 | -124.88425 | 262 | 0854 | 719 |

Below are screen grabs of the results of the down-going and up-going casts for stations CAST02-CAST07. The screen grab for CAST01 was not saved.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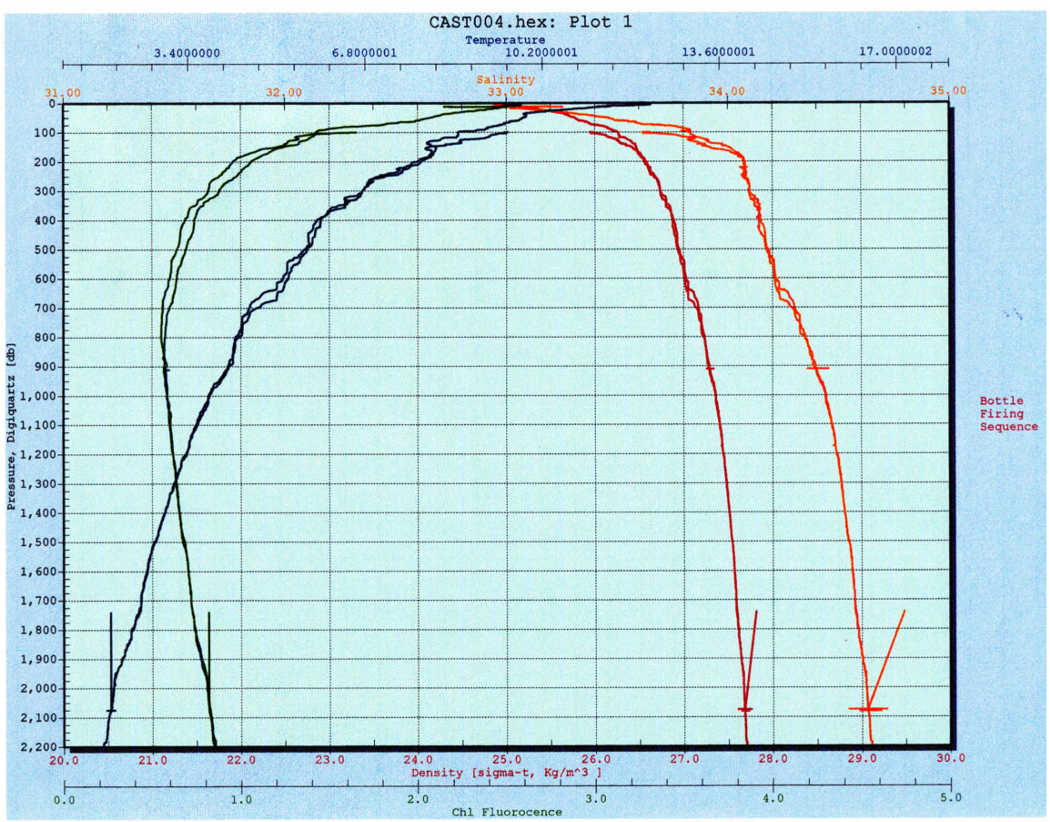
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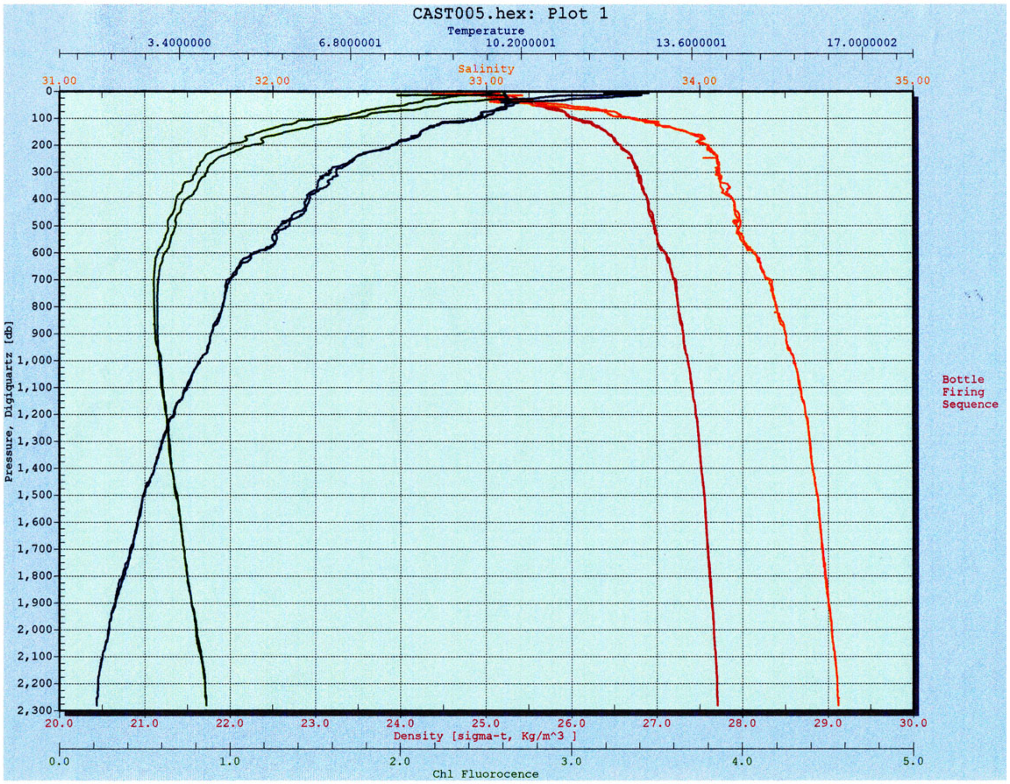
Chl Fluorocence


CAST005.hex: Plot 1
Temperature
3.4000000
6.8000001
10.2000001
13.6000001
17.0000002
Salinity
31.00
32.00
33.00
34.00
35.00
Pressure, Digiquartz [db]
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
2,300
Bottle
Firing
Sequence
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0
Density [sigma-t, Kg/m^3 ]
0.0
1.0
2.0
3.0
4.0
5.0
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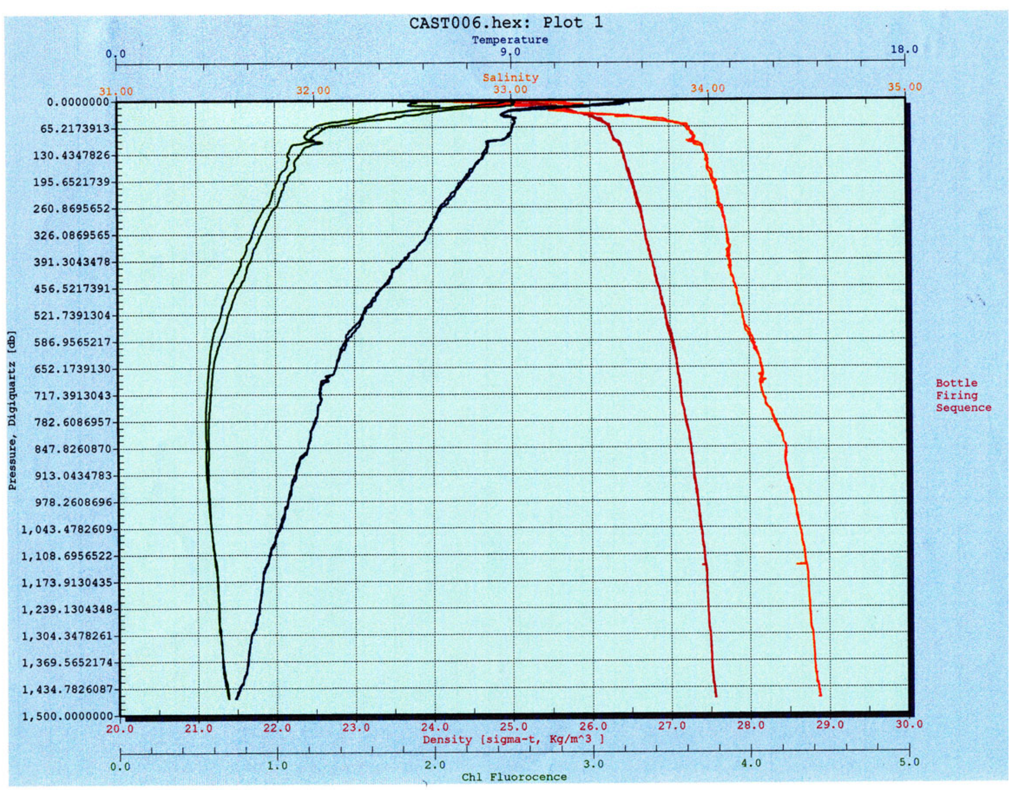
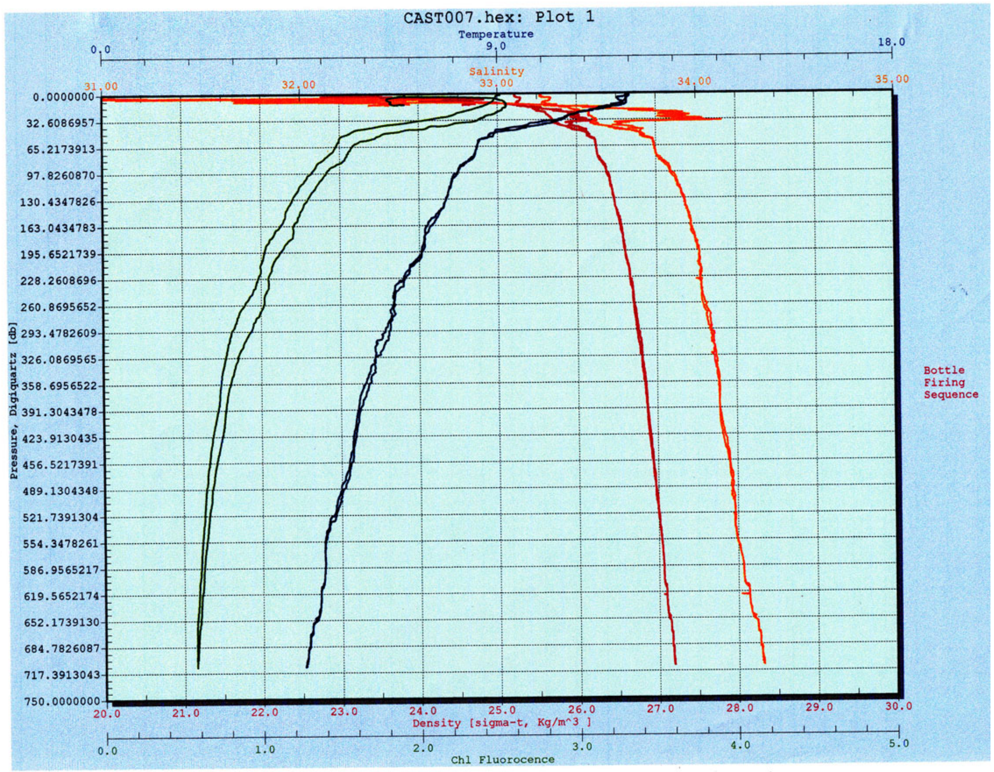

CAST006.hex: Plot 1
Temperature
0.0
9.0
18.0
Salinity
31.00
32.00
33.00
34.00
35.00
Pressure, Digiquartz [db]
0.0000000
65.2173913
130.4347826
195.6521739
260.8695652
326.0869565
391.3043478
456.5217391
521.7391304
586.9565217
652.1739130
717.3913043
782.6086957
847.8260870
913.0434783
978.2608696
1,043.4782609
1,108.6956522
1,173.9130435
1,239.1304348
1,304.3478261
1,369.5652174
1,434.7826087
1,500.0000000
Bottle
Firing
Sequence
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0
Density [sigma-t, Kg/m^3 ]
0.0
1.0
2.0
3.0
4.0
5.0
Chl Fluorocence



CAST007.hex: Plot 1
Temperature
0.0
9.0
18.0
Salinity
31.00
32.00
33.00
34.00
35.00
0.0000000
32.6086957
65.2173913
97.8260870
130.4347826
163.0434783
195.6521739
228.2608696
260.8695652
293.4782609
326.0869565
358.6956522
391.3043478
423.9130435
456.5217391
489.1304348
521.7391304
554.3478261
586.9565217
619.5652174
652.1739130
684.7826087
717.3913043
750.0000000
Pressure, Digiquartz [db]
Bottle
Firing
Sequence
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0
Density [sigma-t, Kg/m^3 ]
0.0
1.0
2.0
3.0
4.0
5.0
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**Appendix 2: ADCP and subbottom profiling data.**

ADCP data were acquired during the entire cruise, and 4 and 12 kHz subbottom profiling data were acquire at all times except for during deployments, when the 12 kHz transducer was used by the OBS group. The map on the next page shows track lines along which 4/12 kHz data are available in Knudsen kea and keb formats. These can be viewed with the free Knudsen data reader. The image on the upper right shows an acoustic flare interpreted to indicate a plume of bubbles emanating from the crest of an accretionary ridge ~800 m west of site M13.