Cascadia Initiative

Cruise OC1205A R.V. Oceanus

May 12, 2012 – May 21, 2012

Newport, Oregon to Newport, Oregon

John A. Collins, Woods Hole Oceanographic Institution

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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 MARGINS 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 (OBS) 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 will involve the deployment and recovery of ~280 OBSs at ~160 different sites and a total of about 14 cruises.

Cruise Objectives and Assessment

The primary cruise objective was to recover 23 WHOI OBS deployed in November 2011 as part of the Year-1 Cascadia Initiative OBS array. A secondary objective was to survey the location of station J48, which was not surveyed on the November deployment leg because of bad weather. The 23 WHOI OBS were deployed in a broad array extending from south of the Mendocino Fracture Zone, onto the Juan de Fuca plate, to the west of the Juan de Fuca Ridge, and north into Canadian waters (Figures 1, 2). For year-1 of this 4-year experiment, a total of 62 OBS from LDEO, SIO, and WHOI were deployed offshore British Columbia, Washington, Oregon, and California in mid-late 2011. The OBS were provided by the NSF-funded U. S. National Ocean Bottom Seismograph Instrumentation Pool (OBSIP) and by WHOI.

Thirteen OBS carry intermediate-period seismometers, and were designed and built by WHOI for the Amphibious Array with funding from the American Recovery and Reinvestment Act (ARRA). These instruments are deployed in a ~70 km spaced grid extending west from the central Juan de Fuca plate onto the Pacific plate. Ten OBS, funded by the W.M. Keck Foundation, carry broadband seismometers and strong-motion accelerometers. All 23 OBS carry a Differential Pressure Gauge (DPG). Because of their broadband response, the Keck OBS were broadly distributed across the Juan de Fuca plate and its borders to provide a reference array. These reference sites will be occupied during each of the four years of the Cascadia Initiative.

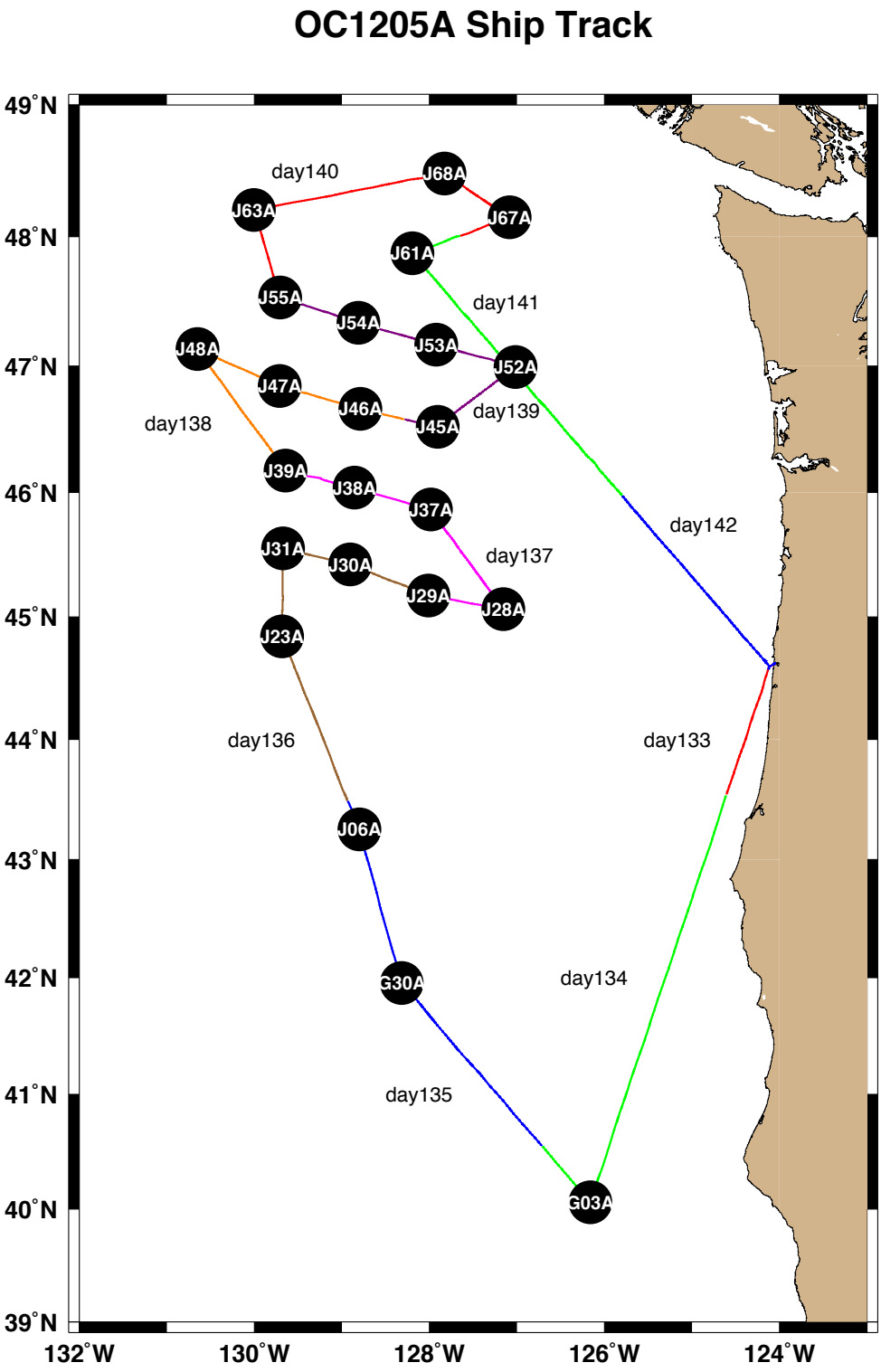

Figure 1. OC1205A cruise track. Day numbers show day-of-year 2012 (UTC). Black circles and associated numbers show location and names of all visited OBS sites. Cruise commenced on day 133 (2012-05-12), and ended on day 142 (2012-05-21).

OC-1205A Science Party

John Collins	Chief Scientist	Woods Hole Oceanographic Institution
Alan Gardner	OBS Engineer	Woods Hole Oceanographic Institution
Tim Kane	OBS Technician	Woods Hole Oceanographic Institution
Dan Kot	OBS Technician	Woods Hole Oceanographic Institution
Ben Pietro	OBS Technician	Woods Hole Oceanographic Institution
Dan Zietlow	Graduate Student	University of Colorado, Boulder
Kevin Gormally	Observer	Johns Hopkins Applied Physics Lab.
Jake Rhodes	Observer	SAIC - Advanced Systems Division, Long Beach, MS
David O' Gorman	Marine Technician	Oregon State University

OC-1205A R.V. Oceanus Crew

Jeff Crews	Master
Bob Ashley	Chief Engineer
John Forgione	First Mate
Tony Monocandilos	Second Mate
Jay JeanBart	Engineer
Henry "Chip" Millard	Engineer
Doug Beck	Bos'n
Patrick Breshears	AB
Marc Simpson	AB
Kris Alberty	Cook
Taylor Williams	Steward

Cruise Narrative

Thursday, May 10. Loaded WHOI equipment on Oceanus.

Friday, May 11. Set up main-lab. Considerably less total science space than on Wecoma. The lack of a good-sized wet-lab for storing deck equipment is a challenge. Between instrument debrief equipment, data offloading gear, deck hardware, and the individual laptops of the science party, all available bench space is occupied. Alan Gardner is awaiting a shipment of cables and connectors from SubConn, Nebraska. UPS assures delivery by 10:00 tomorrow. At 18:00 PDT, we received word from Roberta Barnes at the U.S. Sate Department that our Canadian clearance had come through.

Saturday, May 12. SubConn shipment is in a locked warehouse in Portland. Not obvious how we might get UPS to release the shipment before Monday so we decide to sail on schedule. Depart Newport 10:47 PDT after a fire and safety drill. We plan to work from South to North, hence G03A will be our first station.

Sunday, May 13. Still making 11.5–12 knots as we steam to station G03A.

Station G03A (OBS I.D. S87)

On Station:	05/13/2012 17:58 UTC (05/13/2012 10:58 PDT)
OBS Type:	Keck
Water Depth:	4058 m
Enable Command:	05/13/2012 17:58 UTC
Lock Guralp Command:	05/13/2012 18:00:47 UTC
Release Command:	05/13/2012 18:08:10 UTC
Surface Time:	05/13/2012 20:20 UTC
Time On Deck:	05/13/2012 20:37 UTC
Time on Station:	x hrs. y min.
Rise Rate:	32 m/min

Monday, May 14

Station G30A (OBS ID S88)

On Station:	05/14/2012 10:10 UTC (05/14/2012 03:10 PDT)
OBS Type:	Keck
Water Depth:	3115 m
Enable Command:	05/14/2012 10:10:30 UTC
Lock Guralp Command:	05/14/2012 10:12:56 UTC
Release Command:	05/14/2012 10:24:28 UTC
Surface Time:	05/14/2012 12:08 UTC
Time On Deck:	05/14/2012 12:32 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min

Station J06A (OBS ID S81)

On Station:	05/14/2012 20:20 UTC (05/14/2012 13:20 PDT)
OBS Type:	Keck
Water Depth:	3224 m
Enable Command:	05/14/2012 20:20:30 UTC
Lock Guralp Command:	05/14/2012 20:23:05 UTC
Release Command:	05/14/2012 20:28:23 UTC
Surface Time:	05/14/2012 22:11 UTC
Time On Deck:	05/14/2012 22:20 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min

Tuesday, May 15

Station J23A (OBS I.D. S80)

On Station:	05/15/2012 07:49 UTC (05/15/2012 00:49 PDT)
OBS Type:	Keck
Water Depth:	2649 m
Enable Command:	05/15/2012 07:49:40 UTC
Lock Guralp Command:	05/15/2012 07:51:40 UTC
Release Command:	05/15/2012 07:56:50 UTC
Surface Time:	05/15/2012 09:17 UTC
Time On Deck:	05/15/2012 09:21 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min

Station J31A (OBS I.D. T105)

On Station:	05/15/2012 13:20 UTC (05/15/2012 06:20 PDT)
OBS Type:	ARRA
Water Depth:	2624 m
Enable Command:	05/15/2012 13:20:06 UTC
Release Command:	05/15/2012 13:21:40 UTC
Surface Time:	05/15/2012 14:24 UTC
Time On Deck:	05/15/2012 14:35 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J30A (OBS I.D. T106)

On Station:	05/15/2012 17:41 UTC (05/15/2012 10:41 PDT)
OBS Type:	ARRA
Water Depth:	2791 m
Enable Command:	05/15/2012 17:41:05 UTC
Release Command:	05/15/2012 17:42:35 UTC
Surface Time:	05/15/2012 18:42 UTC
Time On Deck:	05/15/2012 18:53 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J29A (OBS I.D. T102)

On Station:	05/15/2012 22:31 UTC (05/15/2012 15:31 PDT)
OBS Type:	ARRA
Water Depth:	2827 m
Enable Command:	05/15/2012 22:31:45 UTC
Release Command:	05/15/2012 22:33:16 UTC
Surface Time:	05/15/2012 23:39 UTC
Time On Deck:	05/15/2012 23:45 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J28A (OBS I.D. S84)

On Station:	05/16/2012 03:03 UTC (05/15/2012 20:03 PDT)
OBS Type:	Keck
Water Depth:	2859 m
Enable Command:	05/16/2012 03:03:37 UTC
Lock Guralp Command:	05/16/2012 03:08:30 UTC
Release Command:	05/16/2012 03:21:12 UTC
Surface Time:	05/16/2012 04:46 UTC
Time On Deck:	05/16/2012 04:56 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min
Comment:	Release #1 went berserk during burn. Had to enable release #2 to confirm release and track OBS

Wednesday, May 16

Station J37A (OBS I.D. T109)

On Station:	05/16/2012 13:53 UTC (05/16/2012 06:53 PDT)
OBS Type:	ARRA
Water Depth:	2857 m
Enable Command:	05/16/2012 13:53:23 UTC
Release Command:	05/16/2012 13:55:23 UTC
Surface Time:	05/16/2012 14:58 UTC
Time On Deck:	05/16/2012 15:05 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J38A (OBS I.D. T114)

On Station:	05/16/2012 18:28 UTC (05/16/2012 11:28 PDT)
OBS Type:	ARRA
Water Depth:	2733 m
Enable Command:	05/16/2012 18:28:40 UTC
Release Command:	05/16/2012 18:30:38 UTC
Surface Time:	05/16/2012 19:36 UTC
Time On Deck:	05/16/2012 19:43 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J39A (OBS I.D. T101)

On Station:	05/16/2012 22:56 UTC (05/16/2012 15:56 PDT)
OBS Type:	ARRA
Water Depth:	2653 m
Enable Command:	05/16/2012 22:56:10 UTC
Release Command:	05/16/2012 22:57:50 UTC
Surface Time:	05/16/2012 23:56 UTC
Time On Deck:	05/17/2012 00:09 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Thursday, May 17

Station J48A (OBS I.D. 85)

On Station:	05/17/2012 07:09 UTC (05/17/2012 00:09 PDT)
OBS Type:	Keck
Water Depth:	2980 m
Enable Command:	05/17/2012 07:10:48 UTC
Start Acoustic Survey:	05/17/2012 07:13 UTC
End Acoustic Survey:	05/17/2012 08:31 UTC
Lock Guralp Command:	05/17/2012 08:32:11 UTC
Release Command:	05/17/2012 08:36:57 UTC
Surface Time:	05/17/2012 10:06 UTC
Time On Deck:	05/17/2012 10:15 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min
Comment:	No “Guralp Ready”.

Station J47A (OBS I.D. T108)

On Station:	05/17/2012 15:23 UTC (05/17/2012 08:23 PDT)
OBS Type:	ARRA
Water Depth:	2679 m
Enable Command:	05/17/2012 15:24:35 UTC
Release Command:	05/17/2012 15:26:05 UTC
Surface Time:	05/17/2012 16:24 UTC
Time On Deck:	05/17/2012 16:41 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J46A (OBS I.D. S86)

On Station:	05/17/2012 20:19 UTC (05/17/2012 13:19 PDT)
OBS Type:	Keck
Water Depth:	2741 m
Enable Command:	05/17/2012 20:19:56 UTC
Lock Guralp Command:	05/17/2012 20:21:27 UTC
Release Command:	05/17/2012 20:26:16 UTC
Surface Time:	05/17/2012 21:54 UTC
Time On Deck:	05/17/2012 22:04 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min

Station J45A (OBS I.D. T111)

On Station:	05/18/2012 01:23 UTC (05/17/2012 18:23 PDT)
OBS Type:	ARRA
Water Depth:	2750 m
Enable Command:	05/18/2012 01:23:29 UTC
Release Command:	05/18/2012 01:24:55 UTC
Surface Time:	05/18/2012 02:24 UTC
Time On Deck:	05/18/2012 02:49 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Friday, May 18

Station J52A (OBS I.D. T107)

On Station:	05/18/2012 07:14 UTC (05/18/2012 01:14 PDT)
OBS Type:	ARRA
Water Depth:	2614 m
Enable Command:	05/18/2012 07:14:34 UTC
Release Command:	05/18/2012 07:16:10 UTC
Surface Time:	05/18/2012 08:15 UTC
Time On Deck:	05/18/2012 08:40 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J53A (OBS I.D. S82)

On Station:	05/18/2012 12:23 UTC (05/18/2012 05:23 PDT)
OBS Type:	Keck
Water Depth:	2691 m
Enable Command:	05/18/2012 12:49:40 UTC
Lock Guralp Command:	05/18/2012 12:50:01 UTC
Release Command:	05/18/2012 12:57:55 UTC
Surface Time:	05/18/2012 14:28 UTC
Time On Deck:	05/18/2012 14:34 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min
Comment:	Very poor acoustics, likely a release issue.

Station J54A (OBS I.D. T115)

On Station:	05/18/2012 18:11 UTC (05/18/2012 11:11 PDT)
OBS Type:	ARRA
Water Depth:	2636 m
Enable Command:	05/18/2012 18:11:42 UTC
Release Command:	05/18/2012 18:12:36 UTC
Surface Time:	05/18/2012 19:11 UTC
Time On Deck:	05/18/2012 19:19 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J55A (OBS I.D. T112)

On Station:	05/18/2012 22:49 UTC (05/18/2012 15:49 PDT)
OBS Type:	ARRA
Water Depth:	2756 m
Enable Command:	05/18/2012 22:49:26 UTC
Release Command:	05/18/2012 22:50:57 UTC
Surface Time:	05/18/2012 23:50 UTC
Time On Deck:	05/18/2012 23:59 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J63A (OBS I.D. S83)

On Station:	05/19/2012 04:00 UTC (05/18/2012 21:00 PDT)
OBS Type:	Keck
Water Depth:	2847 m
Enable Command:	05/19/2012 04:00:09 UTC
Lock Guralp Command:	05/19/2012 04:01:38 UTC
Release Command:	05/19/2012 04:55:45 UTC
Surface Time:	05/19/2012 05:36 UTC
Time On Deck:	05/19/2012 05:44 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min

Saturday, May 19

Station J68A (OBS I.D. S89)

On Station:	05/19/2012 14:52 UTC (05/19/2012 07:52 PDT)
OBS Type:	Keck
Water Depth:	2554 m
Enable Command:	05/19/2012 14:52:31 UTC
Lock Guralp Command:	05/19/2012 14:54:08 UTC
Release Command:	05/19/2012 14:59:21 UTC
Surface Time:	05/19/2012 16:26 UTC
Time On Deck:	05/19/2012 16:31 UTC
Time on Station:	x hrs. y min.
Rise Rate:	33 m/min

Station J67A (OBS I.D. T104)

On Station:	05/19/2012 20:26 UTC (05/19/2012 13:26 PDT)
OBS Type:	ARRA
Water Depth:	2580 m
Enable Command:	05/19/2012 20:26:40 UTC
Release Command:	05/19/2012 20:28:26 UTC
Surface Time:	05/19/2012 21:30 UTC
Time On Deck:	05/19/2012 21:35 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Station J61A (OBS I.D. T113)

On Station:	05/20/2012 02:25 UTC (05/19/2012 19:25 PDT)
OBS Type:	ARRA
Water Depth:	2647 m
Enable Command:	05/20/2012 02:25:39 UTC
Release Command:	05/20/2012 02:27:56 UTC
Surface Time:	05/20/2012 03:28 UTC
Time On Deck:	05/20/2012 03:36 UTC
Time on Station:	x hrs. y min.
Rise Rate:	45 m/min

Sunday, May 20 (PDT)

Steaming back to Newport.

Monday, May 21 (PDT)

First line on dock at 10:07: PDT. (Second attempt to dock.)

OBS Operations

We recovered 23 OBS deployed at sites extending from south of the Mendocino Fracture Zone, onto the Juan de Fuca plate, to the west of the Juan de Fuca Ridge, and north into Canadian waters (Figures 1–2). These OBS were deployed from the R.V. Wecoma in November 2011. Since the deployment cruise, Oregon State University (OSU) retired the R.V. Wecoma and acquired the R.V. Oceanus. The R.V. Oceanus was operated by Woods Hole Oceanographic Institution (WHOI) from 1975 until WHOI was forced to retire her in November 2011. Oceanus and Wecoma were built to the same design, but sometime in the 1990's, Oceanus was modified to carry another deck. Her main-lab, main-deck and wet-lab were also modified at this time.

For our OBS operations, we found Oceanus cramped compared to Wecoma. The lack of a large wet-lab coupled with the loss of Wecoma's on-deck storage van, meant that much of the recovery gear had to be stored in the main-lab. Instrument de-brief, seismometer maintenance, and data-offloading stations took a large portion of the main-lab. Additional space was needed for the two observers from the Johns Hopkins Applied Physics Lab and SAIC, their computers and data storage gear.

All of the OBS were recovered off the starboard side using the Morgan knuckle-boom crane that was moved from Wecoma to Oceanus. Rather than placing the crane on the starboard-side aft as it was on the Wecoma, we positioned it just forward of the instrument recovery location. This enabled the crane to reach much, but not all, of the starboard-side waist-deck. We did not utilize space on the O-1 deck. OBS recoveries went well. Recoveries were moderately challenging during a 2-day period when we had winds of 20-25 knots and seas of 11' (significant wave height). The additional deck on Oceanus relative to Wecoma meant increased windage and bringing the OBS alongside was more challenging, particularly for the inexperienced.

We used the Edo hull-mounted 12 kHz transducer for all acoustic communication other than on-deck testing. As on Wecoma, acoustics were excellent. Mean ascent rates for the ARRA and Keck OBS were 48 ± 2 m/minute and 32 ± 1 m/minute, respectively.

Data Screening

Some of the 62 OBS deployed as part of the Year-1 array are located in areas of U.S. Navy operations, and consequently there is the potential that the OBS might record information that should not be made public for reasons of national security. In accordance with an MOU between the U.S. Navy and the National Science Foundation (NSF), the U.S. Navy have the right to redact portions of high-sample-rate (≥8 Hz sampling frequency) ground-motion and pressure data that it considers of national security interest. In order to minimize the impact on science, the U.S. Navy agreed to provide low-pass filtered versions of the high-sample-rate data as soon as possible after OBS retrieval and before the druise ends. The redacted data will be provided to the OBS group within 90 days of the end of the OBS recovery cruise.

For OC1205A, Navy representatives from John Hopkins Applied Physics Laboratory (APL) and SAIC participated in the cruise in order to protect the Navy's interests and to

provide low-pass filtered data. All data (high- and low-sample rate) from all stations (whether or not of Navy concern) were downloaded over a private I.P. network from the OBS to a single WHOI-owned external hard-drive attached to a Windows laptop. The Keck OBS data were downloaded using the Quanterra program *BalerAdmin*, while the data from the ARRA OBS were downloaded using the GNU program *wget*. These data were then copied by the Navy representatives onto one or more of their own computers and/or storage devices where all the high-sample-rate data were then low-pass filtered. The Navy representatives then made a data volume containing: (i) low-pass filtered versions of all high sample-rate data from all stations; (ii) unfiltered versions of the low sample-rate data from all stations; and (iii) unfiltered high-sample rate data from stations not of interest to the Navy. This "clean" data volume was then copied to a second WHOI external drive by the Navy representatives.

As a safeguard against loss of the original data, the single WHOI-owned disk drive containing all of the original data from all stations was retained by WHOI. This disk drive was labeled appropriately, hand-carried back to WHOI, and handed to the WHOI Security Officer for safekeeping. This drive will eventually be returned to an authorized U.S. Navy representative upon receipt of the screened data set. As a precaution against data offloading mistakes (e.g. networking outages, operator errors, blunders) the original data were retained on the OBS. These data will be erased from the OBS recording media within 15 days of the return of the OBS to the WHOI OBS Lab.

All things considered, data handling went well. One hiccup was discovered late in the cruise, but in sufficient time to develop a work-around. Some of the high-sample-rate DPG data offloaded from the ARRA OBS were recorded either ashore, or aboard ship prior to finalizing data acquisition parameters, at a rate of 50 Hz, rather than at the 40 Hz rate used during the actual deployment. Because 50 Hz and 40 Hz data receive the same channel code (BDH), these data were written by default to the same files. The Navy filtering program reads the sample interval of the first miniseed header only, and assumes that the sample interval is appropriate for all of the data in that file. Given that the first portion of the file contained data sampled at 50 Hz, this resulted in the 40 Hz seafloor data being incorrectly filtered. We developed a work-around by splitting the multiplexed data with *sdrsplit –r*.

Table 1. OBS Acoustic Survey Results

Site Number	OBS I.D.	Drop Date (UTC)	Drop Time (UTC)	Launch Latitude (deg)	Launch Latitude (min)	Launch Latitude (hemi)	Launch Longitude (deg)	Launch Longitude (min)	Launch Longitude (hemi)	Water Depth at Launch Position (m)	Sounding Velocity from Levitus Data Base (m/s)	Sounding Velocity from CTD and Data Base (m/s)	Surface Transducer Depth (m)	Bottom Transducer Height (m)	Depth From Data Inversion (m)	Station Depth (m)	Station Depth at Inverted Coords from Multibeam (m)	Distance Shift (m)	Direction Shift (deg east of north)	Initial Misfit (ms)	Final Misfit (ms)	95% Confidence Half-Width in E/W (m)	95% Confidence Half-Width in N/S (m)	95% Confidence Half-Width in Depth (m)
J48	S85	11/23/2011	22:47	47	07.900	N	130	39.154	W	2980	1486.5	1487.0	5.0	0.5	2940	2946	2973	170	146	27	1	1.4	1.7	0.4

J48 Surveyed on Recovery Cruise (OC1205A)
Confidence Interval calculated assuming data error is 2 ms
Delay in Acoustic Release Board is 13 ms.

Table 2. Final Station Location

Site Number	OBS I.D.	Drop Date (UTC)	Drop Time (UTC)	Station Latitude (deg)	Station Latitude (min)	Station Latitude (hemi)	Station Longitude (deg)	Station Longitude (min)	Station Longitude (hemi)	Station Latitude (decimal degrees)	Station Longitude (decimal degrees)	Station Depth from Inversion (m)	Station Depth at Inverted Coords from Multibeam (m)
J48	S85	11/23/2011	22:47	47	7.8237	N	130	39.0794	W	47.130395	-130.651323	2946	2973

J48 Surveyed on Recovery Leg

Table 3. CTD Locations and Depths

CTD Number	Station Name	Deployment Date (UTC)	Deployment Time (UTC)	CTD Station Latitude (deg)	CTD Station Latitude (min)	CTD Station Latitude (hemi)	CTD Station Longitude (deg)	CTD Station Longitude (min)	CTD Station Longitude (hemi)	CTD Station Latitude (decimal degrees)	CTD Station Longitude (decimal degrees)	CTD Max Depth (m)	Filename
001	J48	05/17/2012	10:34	47	7.884	N	130	39.172	W	47.13141	-130.65287	1002	Cast_001_binned.cnv

Table 4. Station Location Shifts Relative to Pre-Cruise Plans

Site Name	Planned Deployment Site Latitude (decimal degrees)	Planned Deployment Site Longitude (decimal degrees)	Water Depth at Planned Deployment Site (m)	Station Latitude (decimal degrees)	Station Longitude (decimal degrees)	Station Depth from Inversion (m)	Station Depth at Inverted Coords from Multibeam (m)	Distance Shift (km)	Direction Shift (deg. east of north)
J48	47.00570	-130.55730	2913	47.130395	-130.651323	2946	2973	15.6	333

J48 Surveyed on Recovery Leg (OC1205A)

Table 5. All WHOI OBS Year-1 Station Locations and Deployment History

Site Number	OBS I.D.	Drop Date (UTC)	Drop Time (UTC)	Station Latitude (deg)	Station Latitude (min)	Station Latitude (hemi)	Station Longitude (deg)	Station Longitude (min)	Station Longitude (hemi)	Station Latitude (decimal degrees)	Station Longitude (decimal degrees)	Station Depth from Inversion (m)	Station Depth at Inverted Coords from Multibeam (m)	Recovery Date (UTC)	Recovery Time (UTC)	Duration (days)
G03A	S87	11/17/2011	16:30	40	3.546	N	126	9.7517	W	40.059100	-126.162528	4058	4113	05/13/2012	20:37	178.2
G30A	S88	11/18/2011	12:29	41	57.3008	N	128	19.1573	W	41.955013	-128.319288	3115	3124	05/14/2012	12:32	178.0
J06A	S81	11/19/2011	01:14	43	15.0891	N	128	48.0613	W	43.251485	-128.801022	3224	3224	05/14/2012	22:20	177.9
J23A	S80	11/21/2011	05:57	44	50.6412	N	129	40.9497	W	44.844020	-129.682495	2649	2655	05/15/2012	09:21	176.1
J28A	S84	11/16/2011	07:58	45	3.8155	N	127	9.3823	W	45.063592	-127.156372	2859	2867	05/16/2012	04:56	181.9
J29A	T102	11/20/2011	15:53	45	10.5429	N	128	0.5016	W	45.175715	-128.008360	2827	2849	05/15/2012	23:45	177.3
J30A	T106	11/20/2011	21:50	45	25.4509	N	128	54.4167	W	45.424182	-128.906945	2791	2824	05/15/2012	18:53	176.9
J31A	T105	11/21/2011	16:29	45	33.185	N	129	40.3638	W	45.553083	-129.672730	2624	2657	05/15/2012	14:35	175.9
J37A	T109	11/29/2011	00:08	45	51.8509	N	127	59.1166	W	45.864182	-127.985277	2857	2862	05/16/2012	15:05	169.6
J38A	T114	11/23/2011	04:55	46	2.3717	N	128	51.1865	W	46.039528	-128.853108	2733	2734	05/16/2012	19:43	175.6
J39A	T101	11/22/2011	23:00	46	10.5623	N	129	38.6449	W	46.176038	-129.644082	2653	2659	05/17/2012	00:09	176.0
J45A	T111	11/28/2011	18:09	46	31.2515	N	127	54.2927	W	46.520858	-127.904878	2750	2757	05/18/2012	02:49	171.4
J46A	S86	11/23/2011	10:35	46	39.8347	N	128	47.3006	W	46.663912	-128.788343	2741	2744	05/17/2012	22:04	176.5
J47A	T108	11/23/2011	16:12	46	50.5963	N	129	42.8088	W	46.843272	-129.713480	2679	2685	05/17/2012	16:41	176.0
J48A	S85	11/23/2011	22:47	47	7.8237	N	130	39.0794	W	47.130395	-130.651323	2946	2973	05/17/2012	10:15	175.5
J52A	T107	11/28/2011	11:49	46	59.517	N	127	0.9516	W	46.991950	-127.015860	2614	2613	05/18/2012	08:40	171.9
J53A	S82	11/28/2011	05:23	47	9.8524	N	127	55.3279	W	47.164207	-127.922132	2691	2686	05/18/2012	14:34	172.4
J54A	T115	11/27/2011	23:31	47	20.1501	N	128	48.6948	W	47.335835	-128.811580	2636	2662	05/18/2012	19:19	172.8
J55A	T112	11/24/2011	04:38	47	31.8279	N	129	42.4542	W	47.530465	-129.707570	2756	2800	05/18/2012	23:59	176.8
J61A	T113	11/27/2011	17:19:43	47	52.3485	N	128	11.8294	W	47.872475	-128.197157	2647	2644	05/20/2012	03:36	174.4
J63A	S83	11/25/2011	13:04	48	12.3884	N	130	0.1971	W	48.206473	-130.003285	2847	2882	05/19/2012	05:44	175.7
J67A	T104	11/26/2011	17:05	48	8.9975	N	127	5.054	W	48.149958	-127.084233	2580	2612	05/19/2012	21:35	175.2
J68A	S89	11/26/2011	00:05	48	28.8602	N	127	49.7502	W	48.481003	-127.829170	2554	2590	05/19/2012	16:31	175.7

Table 6. Keck OBS Rise Rates

Site Number	OBS I.D.	OBS Type	Station Depth from Inversion (m)	Rise Rate (m/min)
J23	S80	Keck	2649	33
J06	S81	Keck	3224	32
J53	S82	Keck	2691	32
J63	S83	Keck	2847	31
J28	S84	Keck	2859	35
J48	S85	Keck	2980	34
J46	S86	Keck	2741	32
G03	S87	Keck	4058	31
G30	S88	Keck	3115	32
J68	S89	Keck	2554	31
			mean	32
			std	1.3

Table 7. ARRA OBS Rise Rates

Site Number	OBS I.D.	OBS Type	Station Depth from Inversion (m)	Rise Rate (m/min)
J39A	T101	ARRA	2653	51
J29A	T102	ARRA	2827	45
J67A	T104	ARRA	2580	44
J31A	T105	ARRA	2624	46
J30A	T106	ARRA	2791	50
J52A	T107	ARRA	2614	46
J47A	T108	ARRA	2679	49
J37A	T109	ARRA	2857	49
J45A	T111	ARRA	2750	49
J55A	T112	ARRA	2756	50
J61A	T113	ARRA	2647	49
J38A	T114	ARRA	2733	45
J54A	T115	ARRA	2636	49
			mean	48
			std	2.3

Table 8. Keck OBS Clock Performance (Seascan)

CIET Year1; Keck OBS Clock-Corrections Table

Site Name	WHOI OBS I.D.	Total Seascan Drift (s) (Seascan-GPS) (Computed)	Deployment Duration (decimal days UTC) (Computed)	Seascan Drift Rate (Computed)	Drift per Day (ms) (Computed)	Absolute Value of Drift per Day (ms) (Computed)
J23A	S80	0.222001500	176.17	1.458514E-08	1.26	1.26
J06A	S81	0.305228880	177.90	1.985808E-08	1.72	1.72
J53A	S82	0.291365500	172.43	1.955696E-08	1.69	1.69
J63A	S83	0.292398500	175.76	1.925473E-08	1.66	1.66
J28A	S84	0.012776700	181.91	8.129421E-10	0.07	0.07
J48A	S85	0.091847500	175.54	6.055992E-09	0.52	0.52
J46A	S86	0.115127200	176.54	7.547784E-09	0.65	0.65
G03A	S87	-0.054269100	178.20	-3.524679E-09	-0.30	0.30
G30A	S88	0.032129030	-187.96	-1.978468E-09	-0.17	0.17
J68A	S89	0.167446600	175.72	1.102914E-08	0.95	0.95
					mean drift per day (ms)	0.90
					std	0.65
					median drift per day (ms)	0.80
					90th percentile	1.72

Table 9. ARRA OBS Clock Performance (CSAC)

CIET Year1; ARRA OBS Clock-Corrections Table

Site Name	WHOI OBS I.D.	Total CSAC Drift (s) (CSAC-GPS) (Computed)	Deployment Duration (decimal days UTC) (Computed)	CSAC Drift Rate (Computed)	Drift per Day (ms) (Computed)	Absolute Value of Drift per Day (ms) (Computed)
J39A	T101	-0.018920800	176.11	-1.243481E-09	-0.107	0.107
J29A	T102	-0.000753000	177.38	-4.913315E-11	-0.004	0.004
J67A	T104	-0.005563300	175.22	-3.674731E-10	-0.032	0.032
J31A	T105	0.001073500	175.97	7.060930E-11	0.006	0.006
J30A	T106	-0.017883700	176.92	-1.169928E-09	-0.101	0.101
J52A	T107	-0.000347900	171.92	-2.342142E-11	-0.002	0.002
J47A	T108	-0.053879500	176.07	-3.541708E-09	-0.306	0.306
J37A	T109	0.001574700	169.67	1.074208E-10	0.009	0.009
J45A	T111	0.001635500	171.40	1.104413E-10	0.010	0.010
J55A	T112	-0.003611300	176.86	-2.363358E-10	-0.020	0.020
J61A	T113	-0.039706000	174.48	-2.633883E-09	-0.228	0.228
J38A	T114	-0.003883100	175.66	-2.558527E-10	-0.022	0.022
J54A	T115	-0.023330600	172.87	-1.562023E-09	-0.135	0.135

mean drift per day (ms)	0.076
std	0.097
median drift per day (ms)	0.022
90th percentile	0.275

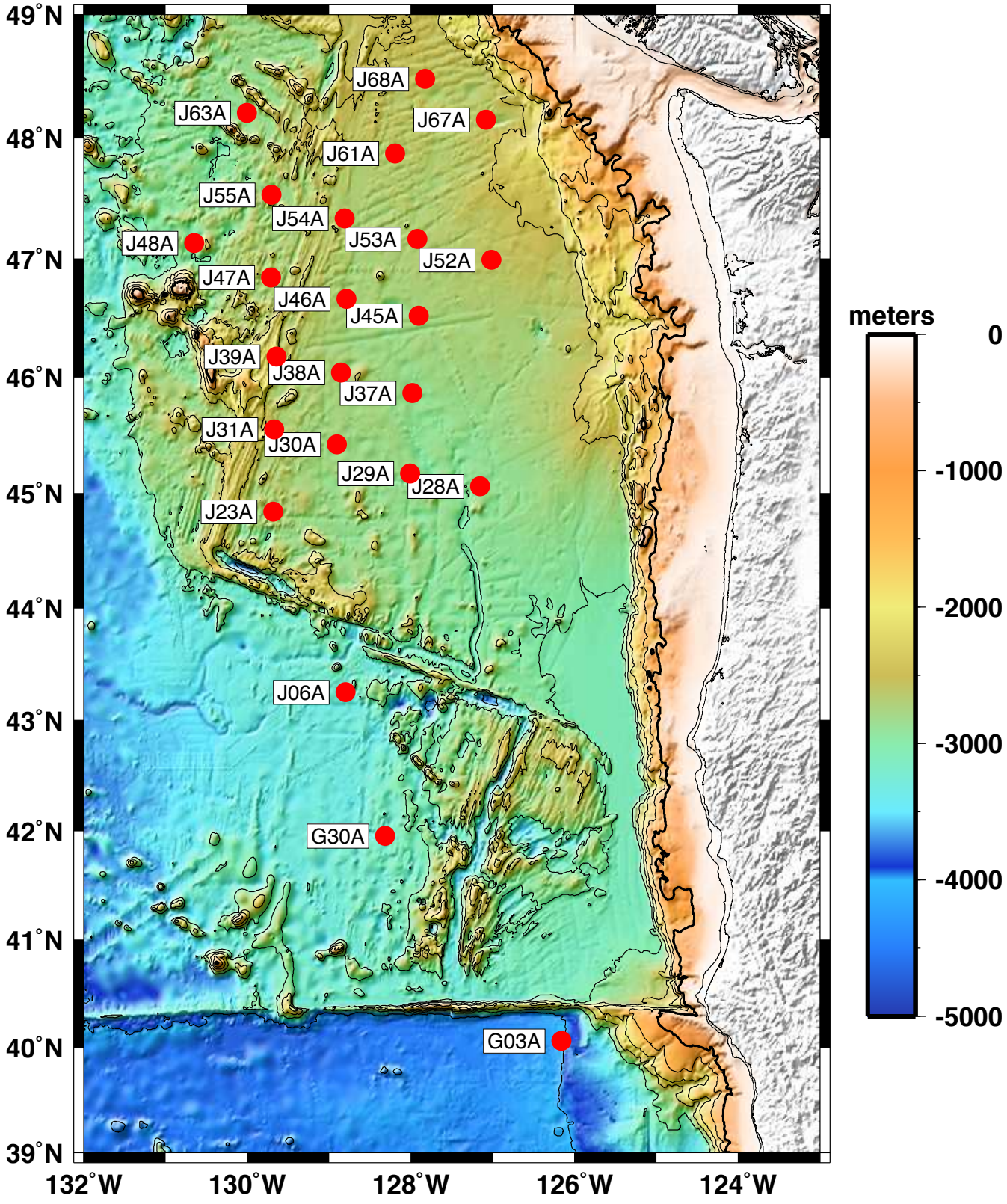

Figure 2. Locations of the OBS recovered on cruise OC1205A of the R.V. Oceanus are shown as labeled red circles superimposed on satellite-derived bathymetry.

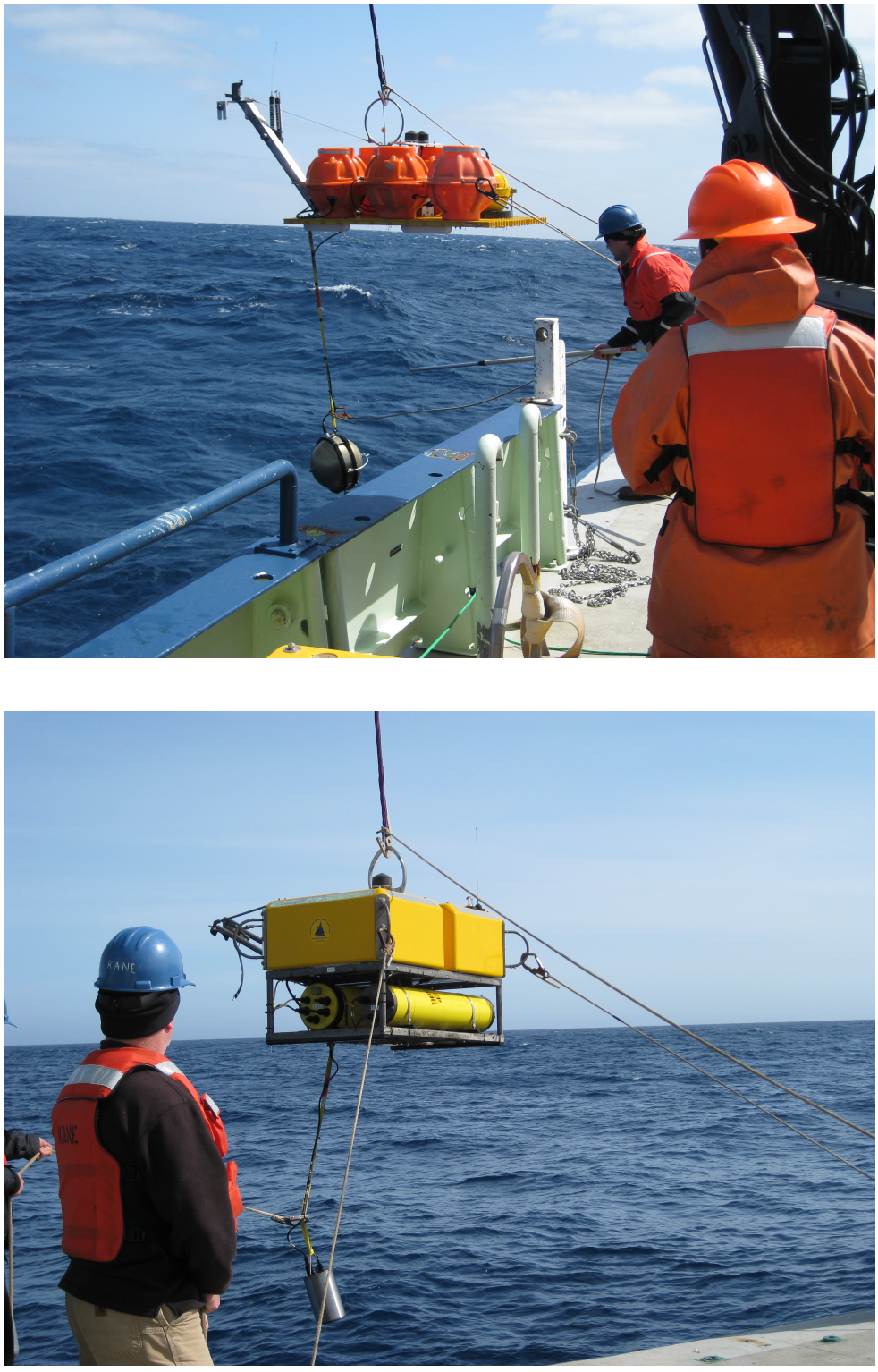

Figure 3. Recovery of a WHOI Keck OBS (top) and a WHOI ARRA OBS (bottom). Tag lines are attached to the OBS frame and to the seismometer pressure housing.

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