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Short Cruise Report
RV Maria S. MERIAN MSM37.

Las Palmas - Cádiz
22.3.2014 – 21.4.2014
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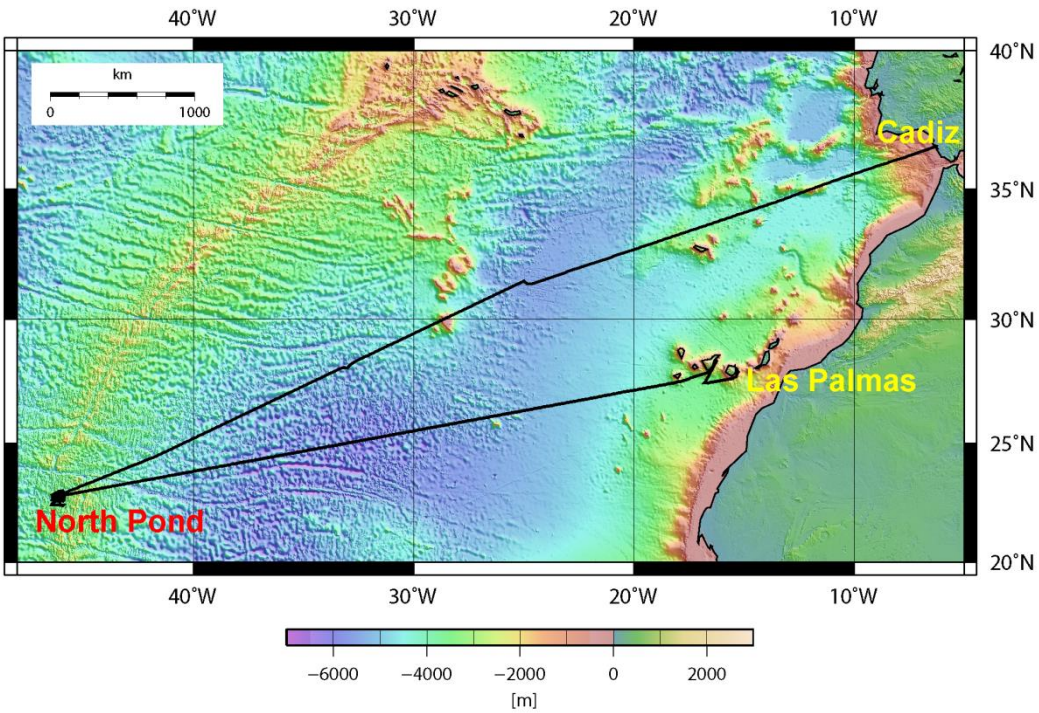
Captain: Björn Maaß



Cruise track of expedition MSM37

Objectives

Basaltic ocean crust covers two-third of Earth's surface, and has been the object of scientific exploration and research for over 40 years of ocean drilling. Scientific seafloor drilling is now at a point where both life sciences and earth sciences are driving exploration and discovery. Microbes were detected in great abundance in all samples recovered from deep marine sediments (e.g., Parkes et al., 1994). A major frontier of deep biosphere research lies in the realm of the ocean crust (sediment and underlying basalt) as a potential biome. One area where progress has been made in microbiological investigations of basalt involves petrographic examination of alteration features, some of which may result from microbial activity (e.g., Fisk et al., 1998) but as yet, robust microbiological and molecular evidence from basaltic rocks recovered from ocean drill holes is scarce.

The North Pond area, a small, well-studied sediment pond on the western flank of the Mid-Atlantic Ridge (MAR; see Fig. 1), is an ideal study site, because it is representative of the vast majority of global ridge flanks, which are areas of extensive heat and fluid flow (~80% of oceanic convective heat loss; e.g., Stein et al., 1994). It is an isolated northeast-trending sediment pond, approximately 8 km x 15 km in aerial extent, and located on the western flank of the MAR at 22º45'N, 46º05'W. The age of basaltic basement is between 7.43 and 8.07 Ma (Melson et al., 1978; Cande and Kent, 1995). Sediment thickness is up to 300 m in the southernmost part of the basin, probably a half-graben, bounded by > 1- km high basement ridges to the east and west. North Pond was the focus of several DSDP, ODP and IODP expeditions culminating in the installation of seafloor observatories (CORKs) at Site U1383 (Holes U1383B and Hole 1383C) and Site U1382, Holes U1382B. MARIA S. MERIAN cruise 20/5 (chief-scientist W. Bach; Bach et al., 2012) in late spring 2012 had the primary objective of conducting operations on subseafloor observatories (CORKs) installed during IODP Leg 336 to examine hydrological-geochemical-microbiological interactions in North Pond. The remotely operated vehicle (ROV) Jason II of the Woods Hole Oceanographic Institution (Woods Hole, USA) was the main operational tool.

The objectives of cruise MSM37 are a follow-up of work started during MSM20/5 and can be summarized as follows:

- inspection of all installed observatories
- recovery of two GeoMICROBE Sleds
- recovery of two Mega-Osmosamplers
- download of pressure data at Site 1382, Hole U1383B and Site 1383, Hole U1383C and U1382A
- pump fluids at Site 1382, Hole U1383B and Site 1383, Hole U1383C and U1382A for microbiological analysis
- collect fluid samples at Site 1382, Hole U1383B and Site 1383, Hole U1383C and U1382A
- install new osmosamplers at Site 1383, Hole U1383C
- map areas in detail which were identified during MSM20/5
- collect rock and sediments samples in these areas
- map temperature anomalies and seafloor discharge sites with a ROV operated temperature probe and sample these sites.

Overall the cruise went extremely well. The Jason team encountered no major technical problem which led to a significant change in work plan or prevented us from reaching our research goals. The Jason team together with the help of the deck crew managed the deployment and recovery of Jason and Medea very well. During dives the navigation of the ship by the mates was flawless which was especially during exploration dives very important and helpful. All planned operations at the CORK sites were completed, the downloaded pressure data are of very high quality and fluid pumping and sampling was successful. The long exploration dives were very revealing as we will have to change our conception of off-axis hydrothermal circulation pattern based on what we found. Our dives were the first off-axis exploratory dives with extensive bottom observations, rock and sediment sampling and temperature gradient measurements.

Narrative

MARIA S. MERIAN departed at 08:20 on March 22. The weather was fair with winds up to force 5 when we left but increased up to force 8 during the day. In the late afternoon one of the seamen hurt his finger so badly that it had to be stitched. The captain decided after consultations with the ship's doctor to drop off the injured person at Tenerife which happened in the early hours of March 23. After that we continued our transit to North Pond with an expected arrival at noon of March 28. Discussions during transit with the Jason team leader and the scientists resulted in an overall plan of mainly day-dives if CORK related work was on the dive plan and on 36h-dives for exploration of specific targets. We decided to focus on CORK-related dives in the first week and on sea floor exploration dives in the second week at North Pond. Jason would be launched right after 8:00 in the morning and recovered just before dark. In case of a 36h-dive we would recover Jason the next day in the evening. Time needed for Jason to descend and ascend to/from the sea floor was estimated to be about 2.5 hours.

The time when Jason was not at the seafloor was used mainly with bathymetric surveys of North Pond and its vicinity. The idea was to benefit from the higher resolution of the EM122 and especially investigate in detail its backscatter and sidescan signals. The hope is that sediment covered areas will be clearly distinguishable from bare rock. Details of the surveys will not be explained in this chapter but in preliminary results.

We arrived at North Pond on March 28 at 11:30. After arrival we dropped a transponder to the seafloor which was intended to be used for a calibration of the Sonardyne USBL system. Due to unknown reasons the anchor separated from the transponder which came up to the surface. A second deployment attempt was successful but the transponder stopped answering after about an hour and could not be released. Therefore we planned to recover the transponder with Jason on one of the dives. Only when the elevator with a different transponder was used, the calibration could be successfully completed in the early morning hours of March 29. By that time the wind had increased to force 6 and in combination with high swell made the deployment of Jason impossible. Therefore, the elevator was released and came up to the surface and was picked up by the ship. A CTD cast in the late morning of March 29 followed. The reason for such a cast was twofold: on one hand, we needed bottom water samples as a reference for the geochemists and microbiologists and on the other hand we needed a sound velocity profile for the swath mapping surveys planned. The CTD was successfully completed in the early afternoon. As the weather had not improved in the meantime we decided to start the planned bathymetric survey. Dive J2-763 on Sunday morning (March 30) revealed a ground fault problem with Medea which became only obvious when both systems were deployed but still at the surface. So everything had to be recovered again. As it was not clear right away how much time would be needed to repair the Medea and as the swell was still quite high, we decided not to dive and continued mapping.

Dive J2-764 (31.3.2014) to IODP Site 1383, Hole U1383B and Hole U1383C (depth 4413m) began with an inspection of the CORK (CORK Lite) at Hole U1383B. The pressure valves were opened for the hydrostatic check of the borehole pressure sensor and left open for a minimum of 30 minutes. The CORK at Hole U1383C and the plugged-in GeoMICROBE Sled and Fast Osmosampler were inspected. Everything looked okay so we could proceed and close the fluid sampling valves and unplug the sampling lines. Also the pressure valves were opened at Hole U1383C for the hydrostatic checks of the three sensors of the different depth horizons of the borehole. Pressure valves at both CORKs were closed afterwards. Fluid sampling at Hole U1383C of the three horizons in Hole U1383C lasted for most of the afternoon. At the end of the dive the upper floats of the GeoMICROBE Sled was cut loose and started its way up to the surface. The Fast Osmosampler was attached to Medea in order to recover it but shortly after it was lifted from oder off the sea floor the weak link at Medea failed due to the high snap load exerted by the Fast Osmosampler. Jason and Medea were on deck at 20:00.

Before Jason was launched we deployed floats (2 balls of syntactic foam) for the recovery of the fallen-off Fast Osmosampler. Dive J2-765 (1.4.2014) was dedicated to pressure data downloads at Holes U1383B and Hole U1383C. Both downloads went without any complications. Fluid sampling at Hole U1383C for about 1 hour was next. The lost transponder was found and released and floatation was attached to the Fast Osmosampler which was also released. Unfortunately the floatation was barely lifting the Fast Osmosampler and it took until the early hours of the next morning until the package was at the surface. Due to an acoustic beacon attached to it we had no problem to locate and recover it.

Dive J2-766 (2.4.2014) was dedicated to fluid sampling at Hole U1383C which lasted for about 5 hours.

After pumping the GeoMICROBE Sled was attached to Medea and retrieved to the surface. Everything made it up to the ship in good shape.

Dive J2-767 (3.4.2014) was the first 36h long exploratory dive. The intention was to investigate three areas west of North Pond in detail where bottom water anomalies and at one place a very high temperature gradient was observed during dives in 2012. We started out with a temperature gradient measurement at the known heat flow site and confirmed that it is still present. In the following visual observations of the sea floor, rock sampling, sediment sampling with push cores and temperature gradient measurements alternated over the entire dive. Watching the bottom water temperature readings of the Jason CTD closely was important as well. The dive ended without major discoveries on April 4 in the evening.

Dive J2-768 (5.4.2014) was dedicated to the other CORK site in North Pond, IODP Site 1382, Hole U1382B which is right next to the old borehole 395A. Before Jason went into the water we deployed floatation to lift up the Fast Osmosampler attached to the CORK at Hole U1383C. This time we used Benthos glass spheres as they have a higher lifting capacity compared to the balls we had on board. The dive started with the inspection of the CORK and opening of the pressure valve for the hydrostatic check. It was closed about 30 minutes later. After that the fluid sampling valves were closed and the sampling lines to GeoMICROBE Sled and the Fast Osmosampler were removed. The next hours were spent on pumping fluids and collecting water samples. At the end of the dive the float was attached to the Fast Osmosampler and the whole package was released. Recovery of the package went very smoothly and happened before Jason came on board again.

Dive J2-769 (6.4.2014) started with a careful inspection and documentation of the reentry cone of Hole 395A. During IODP Expedition 336 (fall 2011) the installation of a CORK in Hole 395A failed due to incorrect documentation of dimensions of the reentry cone. The main part of the downhole installation broke of and is still in the hole. The inspection shows that the pipe is sticking out at the bottom of the reentry cone and maybe fished when attempting to save the hole for future use. After that Jason moved to Hole U1382B for a pressure data download which was completed successfully after about 30 minutes. An osmosampler was hooked up to one of the fluid sampling valves after pumping fluids and collecting samples was completed. At the end of the dive the GeoMICROBE Sled was released and surfaced well before Jason was on deck.

Dive J2-770 (7.4.2014) a 12h exploration dive, devoted to the detailed inspection of a massive dome-shaped feature at the southern end of North Pond. Rock samples collected from the northern part of the dome during MSM20/5 were clearly mantle peridotite, which led to the hypothesis that this feature may be an oceanic core complex. The dive started at the southern edge of the feature where we encountered completely different sediment compared to what we saw and sampled before. It consists of shell fragments with very little added deep-sea clay. Rock and push core sampling was accompanied by temperature gradient measurements. Rocks were basaltic to doleritic and may represent the breakaway zone of an oceanic detachment.

Dive J2-771 (8.4.2014) took place at Site 1383. First three osmosamplers were installed at Hole U1383C and connected to the fluid sampling valves. After that pressure data were downloaded once again at Hole U1383C and Hole U1383B and finally more fluids were pumped and collected. The dive ended with a careful inspection and documentation of both CORKs.

Dive J2-772 (9.4.2014) was planned as 36h exploration dive to complete the observations which were started during dive J2-767. After not finding any indication of a bottom water anomaly in the area where we found one during MSM20/5 we decided to go back to the high heat flow site further east. The transit took about 6 hours. Rock and push core sampling was accompanied by numerous temperature gradient measurements. Jason had to come up earlier than planned due to a problem with the level wind of the Jason winch. At night we did a second CTD cast to get more samples of bottom water.

Dive J2-773 (11.4.2012) was again 36h exploration which continued in the same area as dive J2-772. We decided to investigate one north-south trending ridge in great detail and especially map the temperature anomaly of this ridge with numerous temperature gradient measurements. Push core sampling was concentrated on high heat flow areas. Rock sampling was in part very difficult as no loose samples could be found occasionally. Jason was back on deck at 16:15. A short high resolution bathymetry profile was run across the area of the last two dives. The scientific program ended at 18:15 on April 12.

The transit to Cadiz took 8.5 days, and we arrived there as planned on April 21, 2014 and tied up at 09:00.

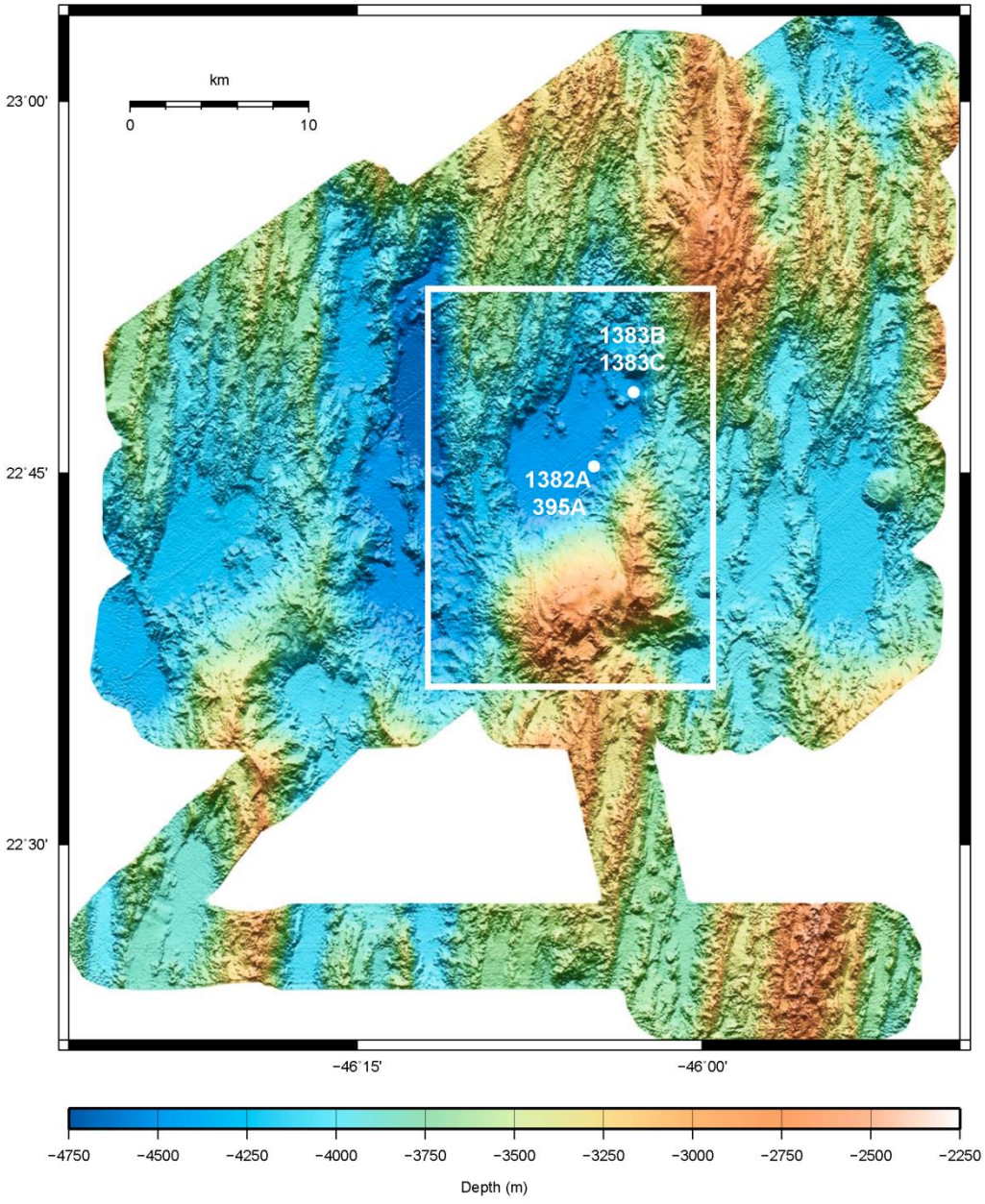


Figure 1. Bathymetry of North Pond and vicinity including the location of ODP/IODP boreholes.

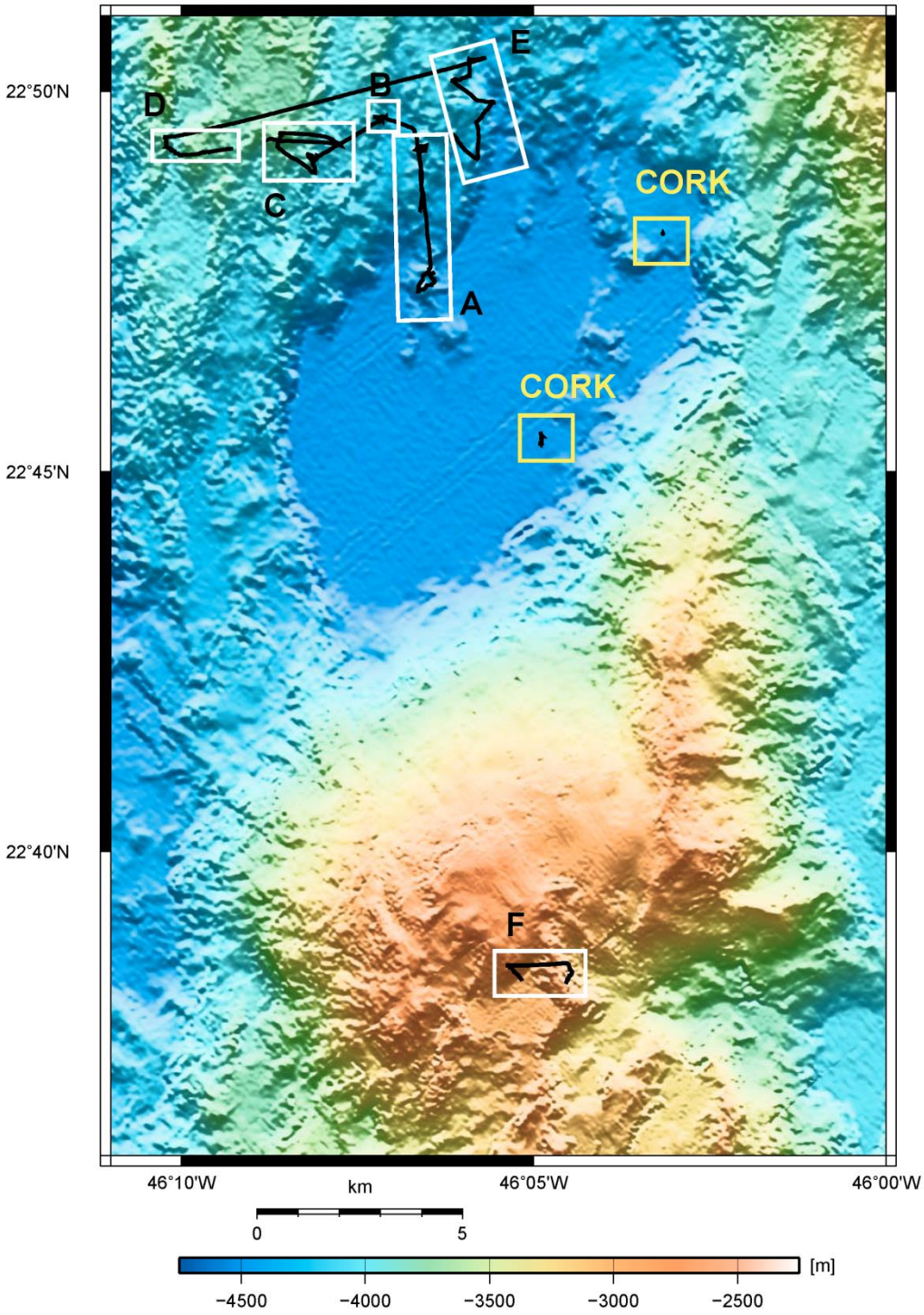


Figure 2. Bathymetry of North Pond with marked areas of detailed seafloor exploration with ROV Jason II. The black lines are dive tracks.

Acknowledgements

The science party thanks the Captain and crew of RV MARIA S. MERIAN for their enthusiastic and friendly support during the entire cruises. Wolfgang Bach, Heiner Villinger, and Norbert Kaul thank the Deutsche Forschungsgemeinschaft for funding of the cruise and the Leitstelle (Univ. Hamburg) for their support. We thank Bernd Heesemann and Götz Ruhland for helping with shipping and container logistics. Funding of the US science party was from NSF through the Center for Dark Energy (Univ. Southern California, Los Angeles, USA).

Science Party

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Kaul, Norbert	geophysics	UHB
Bach, Wolfgang	petrology	UHB
Strack, Anne	student helper/ geophysics	UHB
Gaide, Stefanie	student helper/ bathymetry	UHB
Becker, Keir	geophysicist / leader of dive program	RSMAS
Wheat, Geoff	geochemistry	UAF
Hulme, Sam	geochemistry	UAF
Sturm, Arne	geochemistry	UH
Glazer, Brian	geochemistry	UH
Baquiran, Jean-Paul	microbiology	USC
Carr, Stefanie	microbiology	CSM
Kraft, Beate	microbiology	Harvard
Collasius, Alberto	ROV team leader	WHOI
Verhein, Korey	ROV team	WHOI
Tradd, Benjamin	ROV team	WHOI
Hansen, Scott	ROV team	WHOI
Pelowski, James	ROV team	WHOI
Varnum, Jim	ROV team	WHOI
Agee, Casey	ROV team	WHOI
Kevis-Stirling, Akel	ROV team	WHOI
Popenoe, Hugh	ROV team	WHOI

UHB	University of Bremen, Bremen, German
RSMAS	Rosenstiel School of Marine and Atmospheric Sciences
MBARI	Monterey Bay Aquarium Research Institute, Moss Landing, USA
UH	University of Hawaii at Manoa, Honolulu, USA
USC	University of Southern California, Los Angeles, USA
CSM	Colorado School of Mines, Denver, USA
Harvard	Harvard University, Cambridge, USA
WHOI	Woods Hole Oceanographic Institution, Woods Hole, USA
UAF	University of Alaska Fairbanks, Moss Landing, California, USA

Station list

	Longitude W	Latitude N	Water depth (m)	Date 2014	Start (UTC)	Date 2014	End (UTC)
CTD1	46° 3.67‘	22° 47.32‘	4468	29.03.	11:03	29.03	13:24
Dive J2-764	46° 3.16‘	22° 48.14‘	4416	31.03.	08:09	31.03.	19:49
Dive J2-765	46° 3.16‘	22° 48.25‘	4415	01.04.	08:39	01.04.	19:44
Dive J2-766	46° 3.16‘	22° 48.14‘	4415	02.04.	08:34	02.04.	20:24
Dive J2-767	46° 6.58‘	22° 48.39‘	4366	03.04.	08:29	03.04.	19:52
Dive J2-768	46° 4.89‘	22° 45.47‘	4486	05.04.	08:30	05.04.	19:55
Dive J2-769	46° 4.93‘	22° 45.34‘	4484	06.04.	08:32	06.04.	18:26
Dive J2-770	46° 5.13‘	22° 38.27‘	3013	07.04.	08:30	07.04.	20:13
Dive J2-771	46° 3.15‘	22° 48.14‘	4416	08.04.	08:33	08.04.	20:17
Dive J2-772	46° 9.27‘	22° 49.28‘	3835	09.04.	08:30	10.04.	19:42
CTD2	46° 3.68‘	22° 47.32‘	4462	10.04.	20:27	10.04.	22:43
Dive J2-773	46° 6.63 ‘	22° 49.24‘	4149	11.04.	08:31	12.04.	16:16