

Dorado Outcrop 2014 Expedition

Expedition Report

R/V Atlantis Expedition AT26-24 with the Submersible Alvin

Expedition Information:

Pre-mobilization in San Francisco, CA, October 20, 2014

Mobilization: November 28-29, 2014 - Puntarenas, Costa Rica

Departure: November 30, 2014

Arrival: December 12, 2014 - Puntarenas, Costa Rica

Demobilization: December 13, 2014

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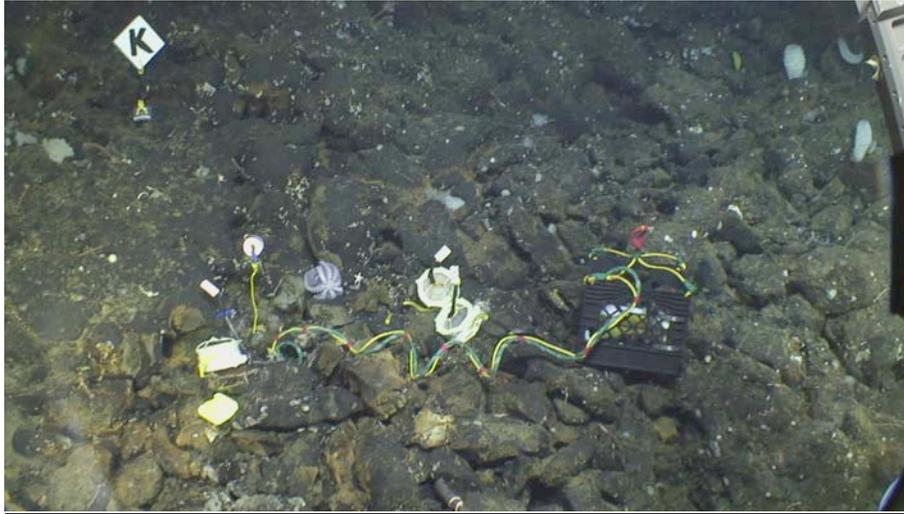
Orcutt (research); and Wankel (research)

Project Co-PIs:

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Preface



Marker K, OsmoSampler, temperature probe, and exposure experiments were deployed in cool (<math><15^{\circ}\text{C}</math>) hydrothermal fluids (December 2013). These and three other sampling and experimental systems were recovered during the December 2014 expedition. In 2014 there were noticeably more octopi in warm fluids vented. Most had eggs and were positioned with their arms away from the rocks. The image below at Marker R (in the Marker K area) shows several of the hundreds of octopi in the area. In one video image of the area we counted 33 octopi. We deployed two OsmoSamplers in 2014, one at Marker R and the other at Marker W, both in the Marker K area.



Dorado Outcrop Expedition 2014

Summary

AT26-24 was the second of two cruises that focused on Dorado Seamount. The first expedition occurred in December 2013 and utilized the remotely operated vehicle (ROV) Jason and the autonomous underwater vehicle (AUV) Sentry. These two assets allowed us to collect bathymetric, backscatter, side-scan, images, magnetometer, and thermal anomaly data. They also provided targets for closer inspection of the seafloor that led to the discovery of warm springs on the seafloor. In 2013 we sampled these springs with the ROV Jason, collected rock and sediment push cores, and made measurements of heat flow. We also deployed temperature loggers, OsmoSamplers, which are continuous fluid sampling devices, and enrichment experiments in several springs to assess the temporal variability in thermal and chemical signatures and to assess the rate of enrichment on particular substrates in this environment. These springs were the focus of the dive program (AT26-24) in December 2014 that utilized the submersible Alvin.

In the first two weeks of December 2014 we completed ten Alvin dives, collected thirteen gravity cores, conducted one CTD hydrocast, and completed four surveys using the hull-mounted bathymetric mapping system. Through these activities we collected hundreds of samples for hydrologic, biogeochemical, and microbial studies, all of which will continue ashore with a spectrum of analytical techniques and modeling efforts.

We learned a great deal about the system and also understand that we need to know more about how the system works. Visual observations of the springs indicated that there are periods when the flow is more/less intense. This was backed by the year-long temperature records and the three-day and four-day records of dissolved oxygen and temperature. While spot measurements of dissolved oxygen confirmed the presence of dissolved oxygen in the spring fluids, discrete (and continuous) measurements clearly define the concentration in spring fluids.

At the beginning of the expedition we assumed that the flow rate was constant with time. That assumption guided several dye experiments to calculate the rate of fluid flow from a single hole or crack. These experiments were modified to account for the variety of flow rates that were observed and the temporal aspect of flow. For example, some springs were non-existent on one dive but vigorous on a dive a week later.

AT26-24 had a more significant sediment operation than the expedition in 2013. Not only did we collect 50 push cores in 2014, but we also collected 13 gravity cores. Work associated with these cores centers on the biogeochemistry of active microbial populations in sediment near and on the outcrop. Here the goal was to get an entire sediment package (rocks on the bottom) so that one can examine interaction with oxic fluids from above and below the sediment package.

We also supported three journalists from TechKnow (Al Jazeera America). They filmed all aspects of an Alvin dive and interviewed many of the people on the ship. They are going to produce three segments on TechKnow. Each segment will be from seven to nine minutes long. One segment will focus on the science that we conducted. Another segment will focus on the new Alvin sphere and 50 years of Alvin operations. The third segment will focus on subsurface

life. We are excited to see it all come together and broadcasted. Also during the dive with one of the journalists, the news office from Al Jazeera America in New York called and interviewed Phil, the primary journalist, while he was in Alvin and on the seafloor. This call was broadcast twice on Al Jazeera's global news network.

During the expedition we completed the following.

Sample and data collections on AT26-24:

- Kilometers of high resolution bathymetric with the hull-mounted system,
- Video and still images of Dorado Outcrop,
- Discrete Fluids from low temperature hydrothermal springs (19 microbial and 35 chemistry),
- Measurements of heat flow (4),
- Measurements of temperature (31),
- Sediment push cores (50),
- Rocks (30),
- Bottom water via Niskin bottles (8) on Alvin and one CTD,
- Discrete dissolved oxygen measurements (26),
- A three-day and a four day record of dissolved oxygen and temperature at two (2) sites,
- Year-long record of temperature at five (5) sites with two sensors at each site,
- Continuous fluid sampling for one year at four (4) sites,
- Year-long enrichment experiments at four (4) sites with three units per site.

Deployments on AT26-24:

- Markers M and W for future reference,
- Seafloor OsmoSampler packages at Markers M and W in the Marker K area (2),

Education, outreach and diversity efforts included

- Participation of under representative groups (8 Females out of 20 in the science party),
- Multi-national participation (US, German, French),
- Twelve (12) people were observers in Alvin for the first time,
- A range of backgrounds and expertise:
 - Graduate students (5)
 - Post-Doctoral Fellows (4)
 - Education and outreach specialists (3)
- Tweeter feed through Al Jazeera America,
- Live interview from the bottom of the ocean on Al Jazerra's global news network,
- Three segments on TechKnow (Al Jazeera America) that will go live in Febuary.

AT26-24 was a group effort, one that could not have been completed without the skilled help from the Atlantis and Alvin crews. They worked to complete our scientific objectives and in doing so they also offered many helpful suggestions to either expedite operations, make operations safer, or to make operations possible. We are indebted to all of their help.

This report is displayed in the following order:

Operational Details: Alvin Dives and Night Program	Page 6
OsmoSampler Recoveries and Deployments	Page 31
Figure 1. Alvin Dive Tracks	Page 34
Figure 2. Individual Alvin Dive Tracks and Sample Locations	Page 35
Figure 3 Sample Locations	Page 36
Figure 4. Jason (2013) and Alvin (2014) dive tracks	Page 37
Figure 5. Sample Locations (2013 and 2014)	Page 38
Table 1. Participants on AT26-24	Page 39
Table 2. Operations at a Glance	Page 40
Table 3. Deployments and Recoveries at a Glance	Page 40
Table 4. Divers and Night Operations	Page 41

Dorado and Costa Rica CORKs 2013: Operational Details

Travel: Most folks arrived and stayed at the Holiday Inn Airport San Jose Costa Rica (\$100/night) or the Hampton Inn and Suites (\$110/night). These hotels have adjoining properties and a free airport shuttle that is shared between the two hotels. The bus arrives every 15 minutes outside of immigration and across the street. Both hotels are quite nice. Travel to Puntarenus is possible via taxi or tourist van. A taxi at the airport costs about \$100 for the one-way trip. A hired van from the front desk at the Holiday inn costs \$250 for 12 people and \$400 for 15 people, stopping for dinner. Some people stayed in Puntarenus at the Alamar (\$90/night).

http://www.costaricanhotels.com/alarmar_apartotel_costa_rica.html

You can use \$US currency everywhere. There was an incident in town and the captain suggested that everyone stay on the main roads and stay together.

Sunday November 30, 2014

We left port shortly after the last launch around 0900. We went directly to Dorado Outcrop, which is about 150 miles away and takes about 14 hours to reach at 11.5 knots. We arrived early in the morning and waited until the 0600 on Monday to begin operations.

Monday December 1, 2014

We started the day at 0600 and deployed an elevator. The elevator had two bioboxes and two large milk crates. The bioboxes were large so that they could hold enrichment experiments and temperature recorders that were deployed in 2013. One side was cut off both milk crates. The milk crates were positioned so that they could hold two of the “regular” sized milk crates that we used to house the OsmoSamplers that were deployed in 2013. Ropes with hooks were added to attach to the recovered OsmoSamplers as a safety.



Images of the elevator and the basket for Alvin Dive 4775.

The primary goal for the dive was to collect good spring fluids, test the use of the funnels, test the funnels with dye and the dye system, deploy two RBR oxygen and temperature systems, and recover OsmoSamplers, enrichment experiments, and temperature loggers. The two dye systems were designed to provide an estimate for the flow rate and the expanse over which the fluids mix and spread. The work focused on the Marker K area and an elevator was deployed about 300 m from the marker at the base of the outcrop. The elevator went down without significant drift.

We located and then moved the elevator to within 20 m of Marker K. All operations were in the Marker K area. Two areas of focus were given additional Markers (M and W) in the Marker K area. Thus the general area is referred to the Marker K area, within which are Markers M and W.

The dive recovered one OsmoSampler, and three exposure experiments, placed two temperature loggers and an OsmoSampler in the elevator, and collected fluids in 10 squeezers. In addition we were able to collect dissolved oxygen data with an Aanderaa optode that was attached to a tee-handle. To calibrate the particular sensor we measure dissolved oxygen in the water column during descent at 500 m intervals and compared the results with data from the hydrocast. Values from our sensor had to be multiplied by 0.91 to equal values from the hydrocast.

The dye in the soap container within the 6-inch funnels did not work as it did in the lab. The soap was a clear glycerin soap that was melted in the microwave. We mixed 0.5 tablets of rhodamine and in 50 ml of water. A tablespoon of this dye was added to the soap and let sit for 40 minutes.

Shavings of the soap were then placed in the capsule. The 35-ml plastic capsule had ~25 holes (9/64). The soap appeared to clog the pours, thus minimizing exchange in with dye (rhodamine) impregnated soap. The dye flow system did not work either. This was a result of a plumbing problem that was fixed before the next dive.

Dive: 4775
Date: 12/1/14
Observers
 : Trevor Fournier/Chris Trebaol

Time (GMT)	Depth (m)	X	Y	Event
16:15		2177	1254	Start video cams/ start logging D=3132m
16:19		2173	1258	located elevator D=3144m
16:33		2182	1300	transit to Marker K, edge of outcrop sheet flow
17:34		2323	1728	Moved elevator to within 20 m of Marker K
17:35		2309	1739	located Marker K
18:12		2331	1749	O2 Probe - sample collection at Green temp logger/Osmo
18:43		2328	1750	Temp probe: 12°C left of red logger
18:47		2329	1750	O2 Probe - sample collection at Red temp logger/OsmoSampler
19:31		2329	1750	deployed RBR O2 probe #2 @ Marker R
19:42		2332	1748	deployed RBR O2 probe #1 @ marker W
19:44		2332	1748	recovered enrichment experiments, blue temp probes and Green OsmoSamplers
19:54		2330	1749	recovered red OsmoSampler and red temp probe
19:56		2330	1749	headed to elevator
19:59		2342	1741	loaded elevator, pillow lava next to elevator
20:15		2342	1741	elevator loaded (2 temp probes (blue and red), 1 OsmoSampler red)
20:16		2342	1741	headed back to marker K to pick up green OsmoSampler
20:24		2329	1739	recovered green OsmoSampler
20:35		2330	1741	deployed meterbar with dye system
20:51		2330	1739	recovered meter bar and dye system, did not work, need more dye (half of a tablet for 3 gallons)
20:56		2333	1739	temp probe: 9.6°C, up hill from marker K/W
21:07		2334	1740	temp probe: 8.5°C further up hill from last reading
21:15				dropped weights

Monday night we conducted the first gravity core and the only CTD hydrocast. The hydrocast was about 1km west of the outcrop and went to within 10s of meters of the seafloor.

Tuesday December 2, 2014

At 0600 there was a decision to cancel the dive because of illness. Most of the Alvin and Atlantis crew and some of the science crew had a 24-hour virus. By afternoon there were enough healthy people to conduct a bathymetric survey and later to conduct one gravity core. It was a slow day.

Wednesday December 3, 2014

We started the day at with Alvin Dive 4776. The goal was to start at Marker A. There we wanted to collect fluids and recover the OsmoSampler, temperature loggers, and enrichment experiments. We also wanted to test the dye experiment. From there they would head to Marker K via several geologic features that we have yet to visited and collect rocks and look for spings at those sites before ending up at the elevator near Marker K. If there were remaining samplers they were to take samples in the Marker K area. The dive was delayed for an hour because of weather.

They descended near Marker A, next to the pinnacle at the NW summit of Dorado. They viewed the steep scarp there and transited to Marker A. There was no visible venting at Marker A. We recovered the 3 exposure experiments, temperature logger, and OsmoSampler. The temperature was not noticeably above ambient temperatures where the deployments were located. We looked all around Marker A for elevated temperatures with no success. At this time, the weather was picking up at the surface and there was a possibility of a short dive. We decided to transit to Marker B in hopes of sampling fluids before the end of the dive. There was no venting at Marker B and temperatures there were also near ambient. There were numerous octopi at Markers A and B, but no venting even when probing under an octopus inside a cavity. We were told at this point that the surface weather had improved, so we proceeded with the plan of exploring along a transit that ended at Marker G. Along this path we observed occasional lobate lava flows, primarily sheet flows and some pillow lavas. When we arrived at the local high on the SW flank below the large collapse feature it appeared to be a large sheet lava flow with a thin sediment drape. We took a rock sample there (RS-1) and continued down slope to another local high near the base of Dorado Outcrop on the way to Marker G. This feature was made of pillow lavas, which were sampled as RS-2 and RS-3. An additional sample of sheet flow lava was taken on the way to Marker G (RS-4). At Marker G there was no visible fluid venting, but temperature probes along a nearly vertical fissure consistently were between 7 and 9°C. There was no place to take fluid samples, but were able to measure reduced oxygen in sediment drape where the temperatures were 9°C. A rock sample (RS-5) was also taken within the fissure. A vertical temperature probe profile was conducted every 5 meters along the fissure until background temperatures were reached. Temperatures seemed to decrease consistently with distance from Marker G, but were elevated within the fissure compared to either side. At the upper end of the fissure a thin (3-cm thick) carbonate sheet was encountered and sampled (RS-6). This layer was sampled by Jason in 2013. The layer is 1-2 m in diameter with rounded edges. Another similar feature was observed ~25 m away on the transit up to the elevator near Marker K. At the elevator, the OsmoSampler (Blue from Marker A) was stored in the crate on the elevator. The temperature logger (Green from Marker A) could not be removed from the Alvin basket. There was ~1 hour of dive time remaining, so we decided to sample the vents near Marker K. A rock sample (RS-7) was taken near these vents as well. Temperature was measured in the vent at

Marker R, which appeared to have more vigorous flow than Marker K. The temperature was 11.7°C at Marker R and oxygen was down to 60. Two biosqueezer samples were taken there with success, and then 4 mixed result chem squeezers. A 5th chem-squeezer was taken successfully. For the final 20 minutes of the dive, the tracer dye was released at Markers R and K and a vent in between them. The dye was very visible and the dispersion of the dye was filmed with the lazer markers on to quantify the distances. The dye was visible in about 5 meters distance from the vent. A background dye release was done slightly away from fluid venting to see the dispersion in the absence of fluid flow. This was the end of the dive due to lack of time. We visually looked out the side windows for additional venting away from these markers, but were unable to see any evidence.



Images of the dye release experiment and making a dissolved oxygen and temperature measurement at the site of the RBR instrument in the Marker K area.

Dive: 4776
Date: 12/3/14
Observers: Samuel Hulme/ Mike Conway

Time (GMT)	Depth (m)	X	Y	Event
15:43		1650	2435	On bottom D=3036
15:49		1650	2435	Niskin; d= 3046
15:57		1650	2435	Marker A; d= 3046
16:00		1650	2435	Placed 3 exposure experiment in the Bio Box
16:15		1650	2435	Temp (TP) at Temp logger; T=2.5
16:20		1650	2435	Recover blue OsmoSampler; Hose detached
16:21		1650	2435	Recover green temp logger
16:22		1650	2435	Recover T-handle for OsmoSampler
16:23		1650	2435	moved 10m E to apparent vents
16:23		1650	2432	No more venting at Marker A
16:34		1653	2429	Temp (TP) near Marker A = 2.4
16:38		1660	2425	heading to Marker B
16:43		1722	2401	At Marker B d=3048
16:49		1725	2401	Temp (TP) temp= 2.0
16:50		1722	2401	heading to elevator

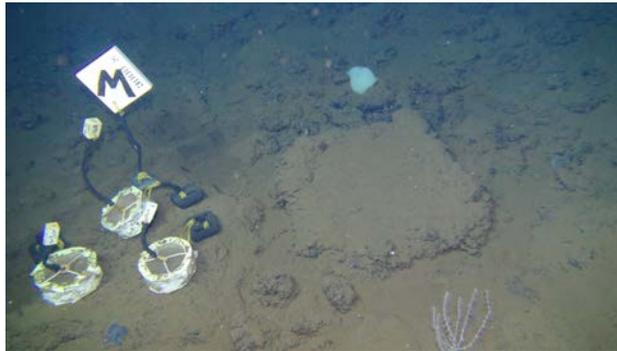
17:15	2005	2009	Rock (RS)1 in back crate near niskin
17:30	1986	1818	Rock (RS) 2 and Rock (RS) 3 pillow lava, with chem squeezers
17:34	2002	1814	going to Marker G
17:43	2150	1738	Rock (RS) 4 sheet flow; on funnels
17:57	2278	1701	Temp (TP) below Marker G temp = 4.0°C
18:02	2279	1704	Temp (TP) below marker; temp= 7.1°C
18:05	2279	1705	Temp (TP) Marker G in seam temp=8.9°C
18:12	2279	1705	oxygen "Marker G"
18:23	2280	1705	Rock (RS) 5 at Marker G with bio squeezers
18:26	2280	1705	Temp (TP) along crack above Marker G = 8.4°C
18:30	2295	1728	Temp (TP) along crack above Marker G = 3.5°C
18:33	2293	1733	Temp (TP) same crack = 3.3°C
18:36	2289	1736	Temp (TP) on carbonate at top of seam 2.0°C
18:37	2289	1738	Rock (RS) 6 carbonate layer; Bio squeezers
18:40	2330	1731	more carbonate layers
18:45	2354	1742	at elevator
18:50	2354	1742	placing blue OsmoSampler in elevator
19:00	2354	1742	note: T logger trapped in basket
19:02	2354	1742	going to Marker K
19:07	2344	1733	Rock (RS) 7 at marker K in bio squeezer
19:14	2342	1737	Temp (TP) at Marker R = 11.7°C
19:16	2342	1737	oxygen probe at Marker R
19:25	2342	1737	bio squeezer 2 Marker R
19:27	2342	1737	bio squeezer 1 Marker R
19:28	2342	1737	chem squeezer 5 Marker R mis-fire
19:33	2342	1737	chem squeezer 6 Marker R partial?
19:34	2342	1737	chem squeezer 8 Marker R mis-fire
19:36	2342	1737	chem squeezer 7 background
19:40	2342	1737	chem squeezer 10 Marker R good
19:40	2342	1737	dye valve open at Marker R
19:50	2345	1734	dye valve open at Marker K
19:54	2345	1734	moving dye to control point
19:58	2344	1735	opening dye between Markers R and K
20:01	2344	1735	end science operations
20:03	2354	1682	dropping weights

We conducted two gravity cores Wednesday night.

Thursday December 4, 2014

We started the day at with Alvin Dive 4777. The goal was to go to Marker H and locate the OsmoSampler and temperature logger and sample flow at the intake or along the wall near Marker C. We would then pick up the enrichment experiments at Marker M. The next operation would be to bring the logger to the elevator and release the elevator. If there were no good sampling site for water we would go back to Marker K and collect fluids there. The last operation was to explore off the southwest portion of the feature. There are some small potential outcrops in this area. Here were would make a measurement of heat flow and collect push cores.

The dive started as planned and we located Marker H however after much driving around we were unable to locate the milk crate within which was the OsmoSampler. They headed to Marker M and recovered the enrichment experiments. They headed to Marker K and collect fluids using the squeezers and a 6-inch funnel to concentrate the fluids before collection. They then proceeded to the southwest portion of the outcrop and explored an area of scouring and potential basaltic highs. Here they collect a heat flow measurement and 6 push cores.



Images of the Alvin basket before the dive and the enrichment experiments at Marker M.

Dive: 4777
Date: 12/4/14
Observers: Beth Orcutt/ Graham Shimmield

Time (GMT)	Depth	X	Y	Event
15:03	3076			bottom
15:04		2606	1534	measurement of bottom water O2
15:09	3081	2606	1534	Fired Niskin in bottom water
15:18	3078	2604	1550	Transiting to Marker H
15:25	3056	2548	1608	At face of cliff below Marker H
15:41	3056	2557	1615	arrival at Marker H no milk crate
15:52	3053	2537	1611	search pattern between M and H for OsmoSampler
16:14	3012	2523	1660	approaching Marker M
16:22	3012	2523	1661	recovered 3 exposure experiments to bio box from M
17:28	3047	2486	1576	aborted search for OsmoSampler- return to Marker H

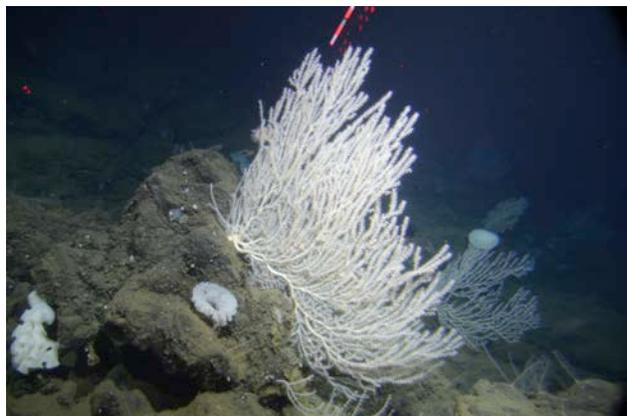
17:36	3056	2557	1624	At Marker H
17:45	3058	2555	1628	At Marker H- no indication of flow
17:45	3058	2555	1628	setting up to do a T probe where sediment is scraped off
17:51	3057	2555	1628	collected 2 rocks; no flow measured
17:52	3060	2555	1624	heading for Marker K
18:07	2897	2324	1739	arrival at Marker K
18:14	2991	2329	1747	RBR Sensor 1 at Marker R appears displaced from the hole
18:32	2991	2329	1747	reposition RBR optode for 2nd reading
18:40	2991	2329	1747	moving funnel into position at Marker K
18:47	2991	2329	1747	squeezers #1-2 and 5-7.
19:00				collected a rock from Marker K
19:04	2998	2319	1752	heading to HF-757-04 site
19:25	3119	2357	1328	arrival at HF-757-04
19:25	3119	2357	1328	first core refused at 10cm
19:29	3120	2343	1338	relocating to 50m due to south to face of feature
19:37	3137	2321	1257	270° heading facing due East of HF-757-05
19:40	3137	2321	1257	Push core PC-12, 9, 1-3, 8
20:01	3137	2319	1250	Heat flow HF-1
20:16	3137	2319	1250	heat flow completed
20:17	3133	2319	1250	Alvin off bottom

We conducted a bathymetric survey at night.

Friday December 5, 2014

We started the day at with Alvin Dive 4778. The goal was to locate the last OsmoSampler and temperature loggers in the area around Markers H and M. After locating the OsmoSampler we would investigate hydrothermal activity just below Marker C. We would then go to the elevator and transfer the temperature logger into the elevator and release the elevator. We would then go to the Marker K area to collect fluids if there were samplers available, recover the RBR loggers, and conduct dye experiments.

We went to Marker H and moved around the west side of the wall to 3050 m depth. There we headed at 32 degrees up slope and located the OsmoSampler. There was no shimmering water coming out of the hole. We stuck the temperature probe in (2.3C) with minimal elevation in temperature. There was no shimmering water to be found. We retrieved the OsmoSampler and temperature logger and drove to Marker C. We scaled the hill below the marker were there were warm temperatures last year. We observed the dark stained areas that were sources of hydrothermal flow last year. There was no shimmering water. We then headed to the elevator, passing by Marker M. At the elevator there was some movement of weights and the temperature logger was placed in one of the bioboxes. The elevator was released and we went to the Marker K area. The flow was substantially diminished. We went to the primary sources with little affect. There was some flow but it was not as vigorous as before. We collected fluids from the funnel and recovered a rock in the biobox. This rock was bathed in hydrothermal fluids. We also took a call from shore and collected several images of large coral.



Images of deep-sea coral and the OsmoSampler intake and monkey fist (for the temperature loggers) that were deployed just downhill of Marker M.

Dive: 4778
Date: 12/5/14
Observers: Geoff Wheat/ Phil Torres

Time (GMT)	Depth	X	Y	Event
15:40	3069	2400	1596	on bottom
15:51	3051	2564	1612	at Marker H moved west ~50m

16:07	3035	2506	1608	near milk crate
16:13	3035	2510	1609	at milk crate no water flowing
16:19				recovered temp loggers
16:22	3035	2510	1609	Temp probe(TP) 2.3°C - 2.0°C
16:23				have wand for osmo
16:27				recovering OsmoSampler
16:32				heading to Marker C
16:53	3026	2566	1656	at Marker C looked around for flow saw several black stained areas that would have had flow last year but didn't have flow this year
16:58	3010	2530	1669	to Marker K and elevator (U Homer #75)
17:02	2984	2336	1744	passed Marker M
17:19	2984	2336	1744	at elevator
17:28	2984	2335	1745	Put temp logger on elevator, adjusted weights on elevator
17:37	2982	2336	1744	elevator off bottom
17:40				moving to Marker K
18:15	2990	2342	1755	recovered O2 probe #1 in quiver
18:17	2990	2342	1755	deployed funnel
18:31				O2 probe on Alvin 75.362 O2; 9.732°C in funnel
18:35				moved next to octopus
				O2 probe on Alvin 89.588 O2; 6.569°C
18:37				moved again
				O2 probe on Alvin 84.599 O2; 8.055°C
18:40				squeezer #1-2, 5, 7, 9 good; heading at 108
19:14	2992	2340	1758	at Marker R
				O2 probe on Alvin 82.58 O2; 8.959°C
19:17				looking for good flow - O2 probe on Alvin 92.3 O2; 7.39°C rising
19:48	2992	2342	1757	funnel
19:51	2992	2342	1757	O2 probe on Alvin 89.85 O2; 7.123°C
19:53				Rock that was in flow was placed in the bio box
19:55				squeezer # 6 and 8 ok
20:02	2992	2341	1756	32 octopus in camera view
20:10				Camera set for deep sea coral, then off bottom

After dinner we conducted a gravity coring operation.

Saturday December 6, 2014

We started the day at with Alvin Dive 4779. This was a PIT dive that focused on examining some of the local geology around the south end of the outcrop. The dive was to start at Marker H and move along the south wall to a “fissure”. The sub would ascent the fissure area and head to the tallest feature on the outcrop. Here they would move around the southern and just eastern faces looking for bedding. The dive would then progress by Marker E on the way to Marker K for more water collection and the redeployment of the two RBR sensors. After water collection they would head back uphill to the summit and collect rocks on both sides of the fissure.

The dive started as planned. They spent much of the dive exploring the various geologic features to determine rock type, strike, and bedform. They made their way to the Marker K area to deploy the two RBR loggers (dissolved oxygen and temperature). They did not have time to do additional mapping after water collection.

Upon recovery of the submarine, the tow-rope got caught in the aft thruster. This thruster was ripped off and sank.



Images of the area around Marker H and the Alvin Basket. There was room for rocks!

Dive: 4779
Date: 12/6/14
Observers: Katie Inderbitzen

Time (GMT)	Depth (m)	X	Y	Event
14:59	3067	2560	1576	on bottom
15:05	3065	2557	1585	heading to Marker H
15:39	3055	2567	1623	at Marker H
15:43				firing niskin
15:47	3053	2566	1625	Rock (RS) 1 from cascading sheet flow -stbd rear of center crate
15:55	3053	2583	1636	Rock (RS) 2 lobe - fwd port long box
16:05				moving to WP1
16:14	3036	2581	1648	Rock (RS) 3 from wall - port rear of center crate

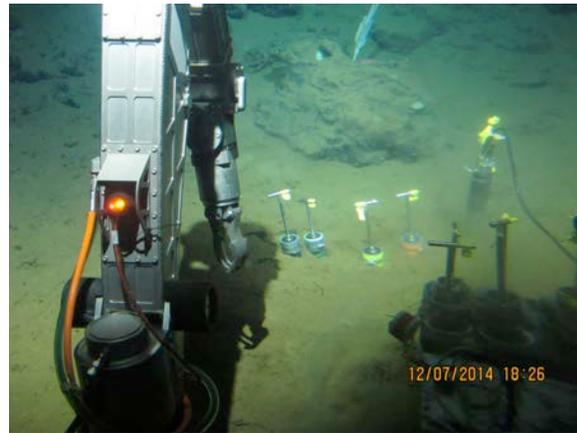
16:32	3024	2594	1701	sheet flow, really hard - Rock RS (4) after long box but broke up
16:46	3024	2594	1701	Rock (RS) 4 part 2 also in aft long box
16:59	3024	2594	1701	moving to top of hump to move over to saddle and wall
17:13	3004	2468	1696	base of wall hummocky pillows
17:16	2993	2444	1703	zig zagging up wall
17:30	2988	2475	1758	notch in wall
17:35	2984	2467	1785	eastern wall edge, moving up 30m and back to west -mappable??
17:48	2981	2457	1738	large angled gutting section trackable? V. high dip
17:56	2951	2418	1764	crack and at top of knob heading to Marker E
18:08	2959	2399	1744	around corner from east Temp probing max ~4°C
18:18	2959	2392	1745	at Marker , going to Marker K
18:24				Rock (RS) 5 stbd fwd center crate
18:26				Rock (RS) 6 port fwd center crate from discolored rock at top of hole
18:35	2990	2343	1753	at Marker K
18:42				Temp probe to right of Marker W ~11.1°C
18:44				deploy funnel
18:53				Temp probe ~8.5°C just inside funnel
18:56				4779bg.txt O2 probe 4779_1 near W
19:03				remove optode
19:05				squeezer #1-2, 5-7
19:17				Grab RBR purple (#1?) place in hole, where samples are from
19:20	2992	2361	1754	at Marker R looking for water too cold (high ~5°C)
19:35				at Marker W
19:39				moving RBR purple to get rest of Squeezers
19:40				replace funnel at marker W temp site still good
19:42				squeezer #3, 4, 9, 10
19:52				redeploy RBR purple #1
20:00				deploying RBR yellow just up from marker R at max T ~7°C on probe
20:03	2992	2350	1755	Rock (RS) 7 back of middle crate just uphill from Marker K

At night we conducted two gravity coring operations.

Sunday December 7, 2014

We started the day with Alvin Dive 4780. The plan was to go to Marker D and recover the temperature logger, then proceed to Marker K to collect fluids if there was a lot of flowing water. After that they were going to descend to the southwest corner of the outcrop where a heat flow measurement was taken in 2013 and collect two sets of gravity cores, one closer than the other. They were then to head towards the chirp line just to the east that runs roughly southeast to northwest. Here they would conduct measurements of heat flow and collect push cores. There were two features of interest, both depressions to the southeast of Dorado Outcrop. The biggest depression is south of the outcrop and west of the chirp line.

The dive was delayed 30 minutes because of weather. Once on the bottom they moved to Marker D and recovered the remaining temperature loggers. We then moved to marker K and they collect fluid samples before going to the southwest corner of the outcrop. They collected two sets of push cores (4 each) and then went to the chirp line. They conducted a heat flow measurement ($\sim 1 \text{ W/m}^2$) and collected another 4 push cores. Because of time they went directly to the first depression. There was a weird “drain-like” feature and some carbonate rich mudstones. They recovered some of the mudstones. They then went further south and west to the large feature, which was “cold”. There was very little time to look around this area.



Images of the basket before launch and one of the push core and heat flow stations.



Images of another coring and heat flow station and the “drain”.

Dive: 4780

Date: 12/7/14

Observers: Rachel Lauer/ Beate

Time (GMT)	Depth (m)	X	Y	Event
15:55	3048	2331	1651	Alvin at bottom heading towards marker D, sheet flow + pillows?
16:08	2988	2335	1703	arrive at marker D
16:13	3004	2332	1712	recover TP in biobox heading towards marker K
16:22	2984	2342	1734	arrive at marker K/W observing some shimmering, mainly where marker W is
16:28	2989	2343	1746	temperature probe max 8.9 move TP a bit 9.4 pull out, potentially warmer
16:35	2989	2342	1741	oxygen optode, at same spot as TP optode not working got it working, try try again
16:44				oxygen optode
16:52				change spot (a couple of cm) O2: 73-92
16:54				place funnel
16:52				squeezer 1 fired
16:54				moving funnel
17:02				move again, better angle for springs
17:03				squeezer 2, did not fire
17:06				squeezer 7 fired
17:08				squeezer 4 fired
17:10				heading to WP1 (WP3)
17:12				good image of shimmering, quite good shimmer
17:37	3064	2518	1447	arrive WP1 (WP3)
17:38				collect RS-1, put to ?
17:40				PC 1 (at slight angle) (orange)
17:42				PC 18 (yellow)
17:43				PC 7 (green)
17:44				PC 10 (green)
17:45				recover PC10
17:46				recover PC 7 recover PC 18
17:49				recover PC 1, whitish clay layer
17:50				head closer to outcrop sed-rock interface
17:59	3055	2497	1561	arrive at 2nd location at push core
18:00				PC 11 (2/3) (green)
18:01				PC 5 valve is twisted, hopefully it all holds (green)

18:02				PC 14 (2/3) (yellow)
18:03				PC 2 (1/2) filled (orange)
18:02				recover push cores heading towards WP2
18:14	3060	2558	1604	arrive at WP2 HF-1 put 2/3 in, but not fired up yet, took it took out to cool off, wait
18:20				parallel to HF, do a push core PC 12 (green)
18:25				PC ?? (green)
18:26				PC 17 (yellow)
18:27				PC 3 (orange), went in almost completely
18:27				HF-1 fired recover push cores
18:29				recover HF probe
18:39				heading towards WP7 (WP4)
19:05	3124	2758	1352	park close to WP7 (in crater)
19:06				move closer to WP7
19:08	3121	2805	1361	move over to interesting hole, white stuff,
19:11	3125	2789	1380	park at white crack (carbonate?)
19:13				HF-2 in sediment; try but hard ground not in deep enough
19:15				try push core, PC 9 (green)
19:16				PC 19 (green) only 1/3, short PC 15 yellow
19:22				PC 23 orange
19:28				trying to get a piece of white stuff (carbonate?)
19:28				RS-2 in bio box
19:29	3125	2789	1380	put marker L
19:35				transit to WP5 (WP11)
19:49	3150	2813	1093	park at WP5 (WP11) Bruce: may be like pieces of broke up carbonate
20:00				HF 3, insert probe, but hard to see how far PC 22 orange, number not visible PC 16 yellow (2nd basket, 2nd right row)
20:08				PC ??, too bad sight, ran out of time
20:11				PC 20 green
20:14				HF-3 pulled out
20:16				going up
20:51				niskin fired midwater (2000m)

At night we conducted our third bathymetric survey of the cruise.

Monday December 8, 2014

We started the day with Alvin Dive 4781. At the end of Dive 4779 we lost the aft thruster. We decided to go in 30 minutes early and use some time to look for the aft thruster. After finding the thruster we would proceed to Marker K to collect fluids and to conduct dye release experiments. We would then move to Marker D to recover the last enrichment experiments, and get another carbonate before heading back to Marker K for more samples and dye release experiments. The idea is to gauge the temporal component of venting. If time they would collect rocks and do a third sampling of the springs.

They started the dive 30 minutes early. The search began about 1 km from Marker K. After 2 hours of searching they started to head towards Marker K and on the way they spotted the thruster. The thruster was picked up and transported to Marker K. they hunted around and found some warm water and collected samples. The dye experiment was not tried because there was a malfunction in one of the connections (for the last two dives this connection, and all others, were epoxied with marine grade epoxy.). They collected fluids then move to Marker D to recover the enrichment experiments and to search for rocks and carbonates. They returned to the Marker K area and began another round of sample collection. The “amount of shimmering seemed less”.

The overlay did not work because there is an issue when cameras are missing. Both bubble cameras were removed prior to the dive for safety reasons. Given the water issues with one of the brow cameras, we only had on science camera and the camera on the starboard manipulator. This caused the archival system to not work in the best interest for science.



Images of the basket and sampling with the squeezers and a funnel. Note that the RBR #1 is just below the funnel.



Images of enrichment experiments at Marker D and the thruster after it was recovered from the sediment and set down while we worked the rest of the day.

Dive: 4781

Date: 12/8/14

Observers: Carly Buchwald/Mike Lee

Time (GMT)	Depth (m)	Lat (deg)	Lat (min)	Long (deg)	long (min)	Event
15:00	3158	9	4.744	87	6.41	at bottom
16:49	3158	9	4.714	87	6.301	abort search for thruster
16:55	3172	9	4.698	87	6.236	Found thruster on way to WP1 (scarp?)
17:32	3158	9	4.829	87	5.875	Fired niskin
17:41	3121	9	4.88	87	5.795	sheet flow
17:50	3036	9	4.926	87	5.755	WP1 did not see any scarp
17:58	2989	9	4.945	87	5.72	arrive Marker W
18:02	2989	9	4.945	87	5.72	temp 10.8°C
18:04	2988	9	4.943	87	5.721	going to set down thruster
18:10	2989	9	4.945	87	5.72	back to marker W
18:12	2989	9	4.945	87	5.72	take temp= 9.4°C
18:13	2989	9	4.945	87	5.72	O2 probe reading
18:17	2989	9	4.945	87	5.72	lots of shimmering
18:21	2829	9	4.945	87	5.72	squeezer fluid samples
18:36	2829	9	4.945	87	5.72	put down dye funnel
	2829	9	4.945	87	5.72	hose is disconnected from funnel put it back
18:38	2991	9	4.946	87	5.721	reposition to new spot Marker R/K
	2991	9	4.946	87	5.721	lots of shimmer
18:40	2991	9	4.946	87	5.721	temp - 10.1°C
	2991	9	4.946	87	5.721	temp- 4.6°C now where probe
18:43	2991	9	4.946	87	5.721	temp- 4.9°C
18:46	2991	9	4.946	87	5.721	reposition closer to R
18:49	2991	9	4.947	87	5.721	temp- 5.9°C
18:56	3003	9	4.924	87	5.725	go to Marker D

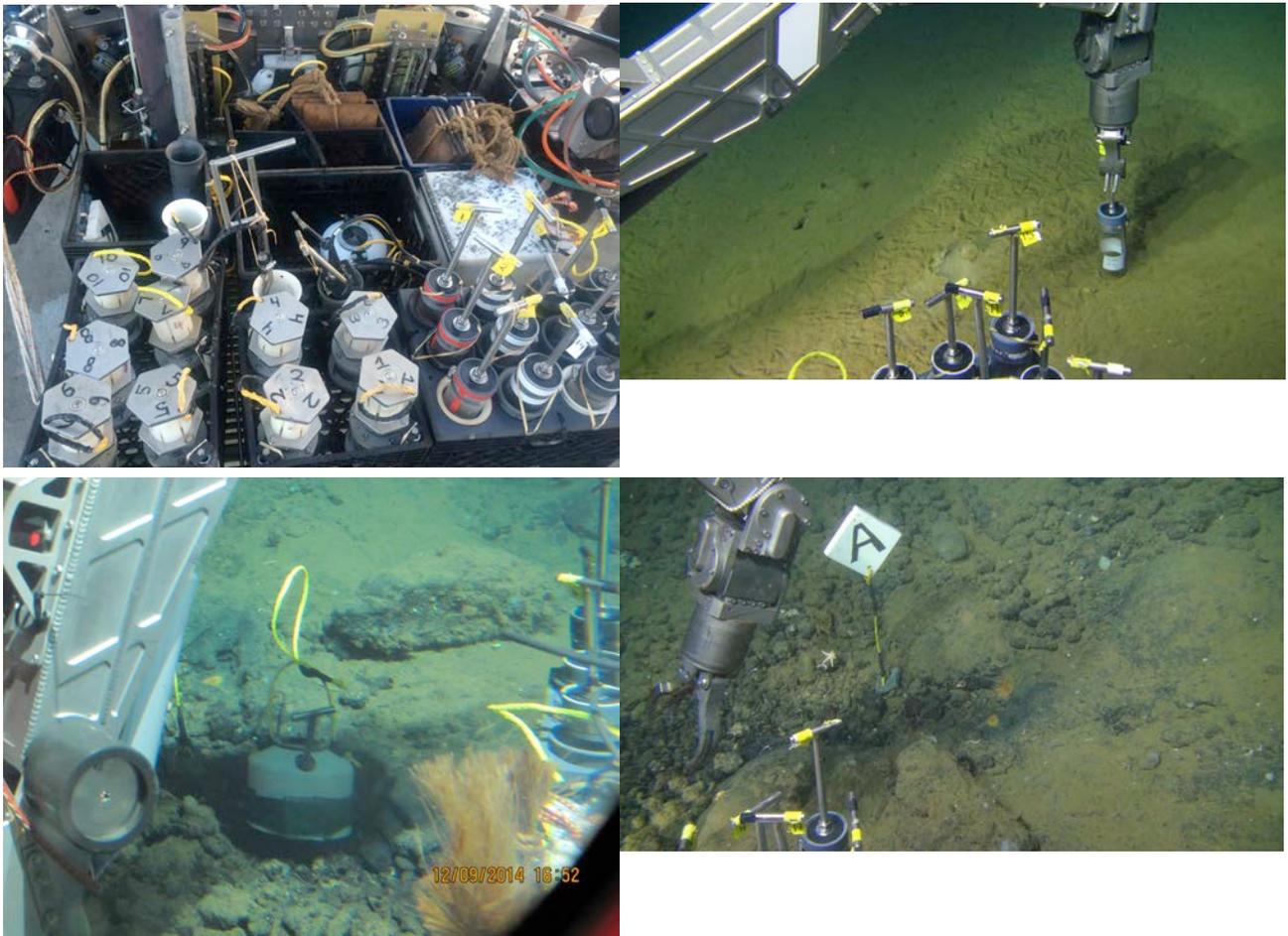
19:01	3005	9	4.922	87	5.721	pick up exposure experiment
19:06	3005	9	4.922	87	5.721	Get a rock, RS-1, in bio squeezers box
19:09	3005	9	4.922	87	5.721	head for carbonate
19:23	3020	9	4.939	87	5.751	go to Marker G
19:24	3021	9	4.939	87	5.75	Get a rock (RS)-2 - 3rd side of dye funnel
	3021	9	4.939	87	5.75	following crack
19:33	3004	9	4.942	87	5.735	find carbonate
19:36	3004	9	4.942	87	5.735	difficulty breaking a piece off
19:47	3009	9	4.94	87	5.742	found a new carbonate spot
	3009	9	4.94	87	5.742	still to hard to grab
19:54	3009	9	4.939	87	5.741	got one! RS-3 with squeezers
20:05	3009	9	4.945	87	5.718	back to Marker K
20:08	3009	9	4.949	87	5.719	funnel down
20:10	2987	9	4.949	87	5.719	temp- 8.4 °C
20:12	2990	9	4.949	87	5.719	O2 measurement
	2990	9	4.949	87	5.719	less shimmering than 1st measurement
20:19	2990	9	4.949	87	5.719	Squeezer samples
20:31	2990	9	4.949	87	5.719	temp 6.9 °C
20:36	2990	9	4.949	87	5.719	Alvin off bottom

After dinner we conducted two gravity-coring operations.

Tuesday December 9, 2014

We started the day with Alvin Dive 4782. The goals were to collect push cores at the site of really high heat flow and push coring operations last year, check on the flow at Marker A, do some geologic mapping and rock collection, and monitor and sample fluids from the Marker K area.

The dive started off as planned. They went and collected 12 push cores from the area. However, they did not see holes or sled marks from last year so they were close, just not on the exact location. They moved to Marker A and saw shimmering water. The temperature was $\sim 10^{\circ}\text{C}$. Oxygen measurements were made and samples were collected. They then proceeded up the pinnacle and collected a rock from the top. They went over the fissure and continued to the north. There were several waypoints for them to collect rocks and to examine the geology, specifically the fault/fissure near the topographic high in the southeast. They made it to the Marker K area and collected fluids.



Images of the basket before the dive, push coring operations, the location the funnel at Marker A, and flow coming from Marker A spring.

Dive: 4782
Date: 12/9/14
Observers: Annie Hartwell/ Maurice Roper

Time (GMT)	Depth (m)	X	Y	Event
14:57	3020.7	1699	2513	reach bottom, issue with starboard camera
15:13	3024.2	1668	2483	issue with camera resolved
15:19				moving to WP 1- depth 3042
15:26	3027	1694	2444	port brow camera not working
15:38	3043.4	1754	2514	Collected 12 push cores top seds brown, deeper seds lighter tan
16:09	3043	1754	2510	moving to marker A
16:19	3032	1657	2423	at marker A, T probe requested slight flow observed by all three of us no octopus on flow ambient 1.6°C Temp 4.6°C
16:26	3039	1645	2420	slight deeper 7.6°C
16:41	3039	1657	2429	optode in progress
16:43	3039	1657	2429	optode disconnect 4782.txt
16:45	3039	1657	2429	new spot- optode 2, 1/2 meter away to south
16:51	3039	1657	2429	optode 2 complete 4782_2.txt
16:55	3039	1657	2429	squeezers
17:11	3039	1640	2443	driving to WP 6
	3039	1640	2443	moving up hill (pinnacle)- starboard camera every 5 sec. snap shot
17:29	3007	1635	2451	attempting to samle pillow at top of pinnacle (WP 4)-- over WP 6 on screen though visably at top of pinnacle
17:34	3008	1633	2450	attempt #3 no sample
17:40	3014	1625	2475	rock (RS)-1, forward squeezer bio box was loose rock has a piece of spong on it
17:42	3014	1622	2469	rock (RS)- 2 w/ squeezer #4
17:52				moving to WP7
18:16	3022	1797	2388	rock (RS)-3, loose rock collected, next to squeezer 5 on starboard side
18:18				moving to WP8
18:36	3016	2101	2087	maybe carbonate sample, attempt 1-4 no sample
	3016	2102	2088	video port of calcium carbonate
18:48				continuing to WP8
18:51	3008	2114	2071	arrive WP8
18:59	3009	2113	2081	rock (RS)-4, stbd 2nd bio box back
19:02				moving to WP9
19:10	2987	2193	1969	arrived WP9, rock(RS)-5 collected stbd aft

				we think it was in situ (rock)
19:15	2986	2193	1968	"nubbins" collected stbd aft rock RS-6
19:17				moving to WP10
19:26				arrived Marker K
19:45				optode, 4782_Mk_K_2
19:47	2990	2336	1741	7.98 highest T at 19:47: not 5 minutes
19:51				squeezer samplers
				data logger repositioned to what looked like highest flow
19:59				moving to WP 12
20:06	2959	2377	1751	rock (RS)-7- after bio box
20:08	2954	2389	1749	rock (RS)-8- center milk crate
20:22		2394	1730	2650m niskin

Tuesday night we conducted two gravity-coring operations.

Wednesday December 11, 2014

We started the day with Alvin Dive 4783. This was a PIT dive. We started the dive at Marker K to recover the RBR oxygen and temperature loggers, collect fluids, and to conduct dye experiments. We will then travel to an area on the west side of the feature (and to the north) where a high heat flow measurement was made. There we would collect a transect of 4 cores in three locations away from the outcrop. Finally we would finish at Marker A and collect fluids and try the dye experiment. The dye experiment has 4 tablets of rhodamine in 3 gallons of water.

The dive went according to plan. Samplers were recovered from Marker K, fluids were collected, and the dye experiment was implemented. They then went to the push coring site and collected 3 sets of 4 cores each. It was difficult to find suitable sediment so close to the outcrop, but they were able to get all of the desired cores. Then they went to Marker A. There was flow and they collected samples. They also did the dye experiment and noticed that the flow was much less at Marker A than at Marker K. The rate at which the dye dispersed confirmed the visual observations from the observers.



Images of the basket before the dive and the dye experiment on the seafloor in the Marker K area.

Dive: 4783
Date: 12/10/14
Observers: Sam Hulme/Lisa Smith

Time (GMT)	Depth (m)	X	Y	Event
15:09	3023	2124	1787	bottom in sight, fire niskin
15:15	3081	2150	1805	on bottom, going to Marker K
15:20	3058	2200	1783	traversing over sheet flows
15:31	3023	2302	1710	Marker G (passing by only)
15:34	3001	2343	1712	Marker D (passing by only)
15:37	2990	2343	1744	Marker K in sight
15:44	2989	2343	1744	RBR purple near Marker W recovered
15:45	2989	2343	1744	Temp Probe (TP) were RBR was deployed 9.6°C
15:50	2989	2343	1744	excavating near Marker W to stimulate flow

15:53	2989	2343	1744	Temp Probe (TP) after excavating 8.6°C
15:55	2989	2343	1744	optode AL4783_MarkerW, 73 O2 10.04°C
16:10	2990	2345	1739	RBR 2-yellow in sandy BBQ pit T=
16:13	2990	2345	1739	Temp Probe (TP) in octo hole near BBQ pit 11.3°C
16:15	2990	2345	1739	oxygen in "octo_hole" 68 O2 10.7°C
16:19	2990	2345	1739	TP not working switch to optode
16:20	2990	2345	1739	cutting video files
16:25	2990	2346	1740	optode in BBQ pit 63 oxy 11.7°C
16:32	2990	2347	1740	deploying funnel in BBQ pit
16:35	2990	2347	1740	optode in BBQ funnel 82 oxy 8.0°C
16:47	2990	2347	1740	Squeezers
17:00	2990	2347	1740	deploying dye tracer funnel
17:12	2990	2347	1740	turn dye on 1 min
17:16	2990	2347	1740	turn dye on 1 min
17:19	2990	2347	1740	turn dye on 1 min
17:30	2990	2347	1740	begin transit to push core site
17:40	2990	2347	1740	video file break
18:06	3035	1778	2287	near waypoint, looking for sediment
18:15	3085	1798	2248	attempting push cores (forward row)
18:26	3085	1798	2248	completed 4 cores (all partial)
18:36	3098	1804	2219	attempting push cores (middle row)
18:45	3098	1804	2219	completed 4 cores (partial, photo taken)
18:50	3100	1820	2206	attempting push cores (back row)
19:00	3100	1821	2206	completed 4 cores (partial, photo taken)
19:05	3095	1816	2200	heading to Marker A
19:06	3095	1816	2200	video camera reset
19:22	3039	1633	2446	at Marker A
19:29	3039	1632	2449	see shimmering, placing a funnel
19:31	3039	1632	2449	optode "Marker_A funnel" 80 O2 7.8°C
19:39	3039	1632	2449	Squeezers
20:00	3040	1632	2449	placing dye tracer funnel
20:07	3040	1632	2449	open dye 1 minute
20:11	3040	1632	2449	open dye 1 minute
20:17	3040	1632	2449	begin ascent

After dinner we completed two gravity-coring operations.

Thursday December 12, 2014

We started the day with Alvin Dive 4784. This was our last dive. The goal was to explore the Marker H, M, and C area to the southwest of the Outcrop. Is there flow out of the hole where the OmoSampler was deployed? Is there flow below the Marker C area? The idea was to look at these areas again and then move to Marker K for more dye experiments and water sampling. If there was time, they would head to the summit to examine the fissure and collect a rock from the other side of the fissure.

They found the hole where the Black OmoSampler was deployed and measured temperature and dissolved oxygen. There was warm (9.5°C) water coming out of the hole. Earlier in the dive series there was no water coming out (~2.3°C). They moved to Marker C and noticed flow, once again, which was not there earlier in the dive series. They went to Marker M to locate the position of the high temperature measurement collected in 2013, but couldn't locate the vent. They then went to the Marker K area to deploy two OmoSamplers, collect fluids, and conduct dye experiments. At the end of the dive they collected rocks from the Marker K area.



Dive: 4784
Date: 12/11/14
Observers: Trevor F./ Laura Z.

Time (GMT)	Depth (m)	X	Y	Event
		in sub		
14:57	3059	2535	1588	at bottom
15:00	3061	2534	1609	trip niskin, shot
15:08	3055	2569	1614	at Marker H
15:17	3035	2500	1628	reached hole to look for flow
15:20	3035	2500	1628	Temp=9.5°C at top of opening
15:26	3034	2503	1630	optode measurement of black osmo hole
15:34	3034	2503	1630	finished optode measurement
15:42	3034	2503	1630	put down funnel
15:46	3034	2503	1630	opened funnel 5s, released dye
15:48	3034	2503	1630	dye experiment again

15:50	3034	2503	1630	temp probe (no go)
15:57	3034	2503	1630	squeezers
16:29	3026	2558	1657	at Marker C
16:46	3026	2559	1656	oxygen measurements
17:11	3011	2523	1657	at Marker M
17:57	2990	2331	1738	at Marker K
18:01	2990	2331	1738	temp at Marker K
18:08	2990	2331	1738	temp after "excavating"
18:12	2990	2329	1739	temp at Marker R
18:16	2990	2329	1739	deploy OsmoSampler at Marker R
18:32	2989	2332	1737	at Marker W
18:33	2989	2332	1737	temp at Marker W
18:40	2989	2332	1737	dye experiment setup
18:45	2989	2332	1737	dye experiment run 1-5
18:53	2989	2332	1737	funnel temp at Marker W
18:56	2989	2332	1737	squeezers
19:06	2989	2332	1737	OsmoSampler at Marker W
19:26	2989	2332	1737	finished setting up OsmoSampler
19:36	2990	2331	1738	dye experiment at Marker W 1-6
19:42	2990	2331	1738	temperature reading from funnel at Marker W
19:49	2990	2331	1738	request permission to surface
19:50	2990	2331	1738	picking up rocks at Marker W

After Alvin was on deck we headed for port. We anchored at 0830 Friday morning, December 12 and off loaded the ship. The science party left the ship by 1400.

OsmoSampler Recoveries

Four OsmoSamplers were recovered. Each of the samplers was deployed on the 2013 Jason/Sentry Expedition. They were deployed for almost a full year. Each sampler also had two temperature loggers at the intakes- only one set was attached to the OmoSampler intake. Upon recovery the OsmoSamplers were cut in 1-m sections and the fluid expelled into micro-centrifuge tubes (1-10) and into a 2 ml glass vial (11-12). These were single pump and single coil samplers.



Image of the Green OsmoSampler at Marker K on Alvin Dive 4775. The fresh water reservoir on the pump was fresh (0 per mil). The pump had 12 membranes.



Image of the Red OsmoSampler in the Marker K area on Alvin Dive 4775. The fresh water reservoir on the pump was 12 per mil. The pump had 12 membranes.



Image of the Blue OsmoSampler in the Marker A on Alvin Dive 4776. The fresh water reservoir on the pump 2 per mil. The pump had 13 membranes.



Image of the Black OsmoSampler in the Marker H-M area on Alvin Dive 4778. The fresh water reservoir on the pump was fresh (0 per mil). The pump had 12 membranes.

OsmoSampler Deployments



Image of the OsmoSampler that was deployed at Marker R (in the Marker K area) on Alvin Dive 4784.

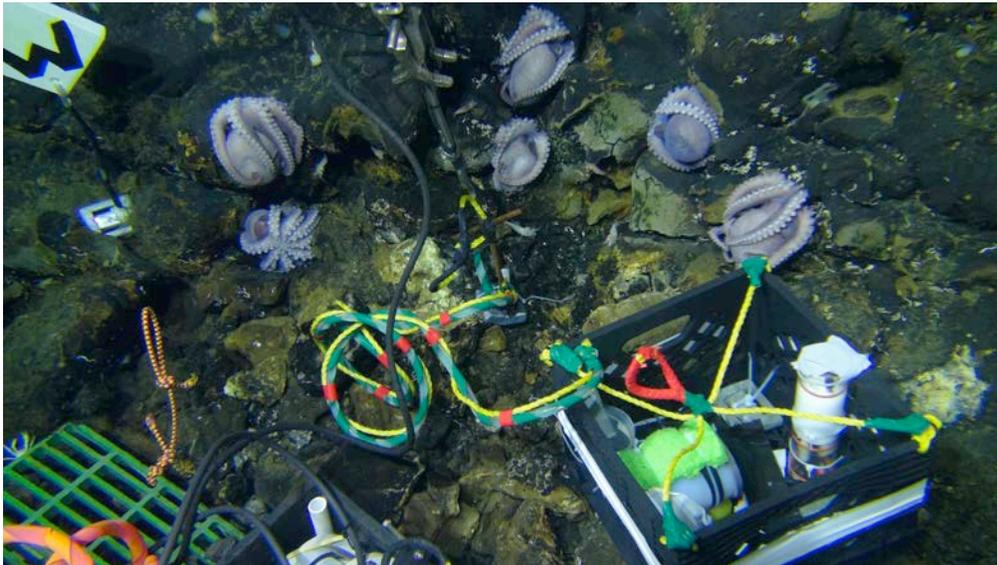


Image of the OsmoSampler that was deployed at Marker W (in the Marker K area) on Alvin Dive 4784.

Figure 1. Bathymetric map of Dorado Outcrop developed from the 2013 Sentry data with Alvin tracks.

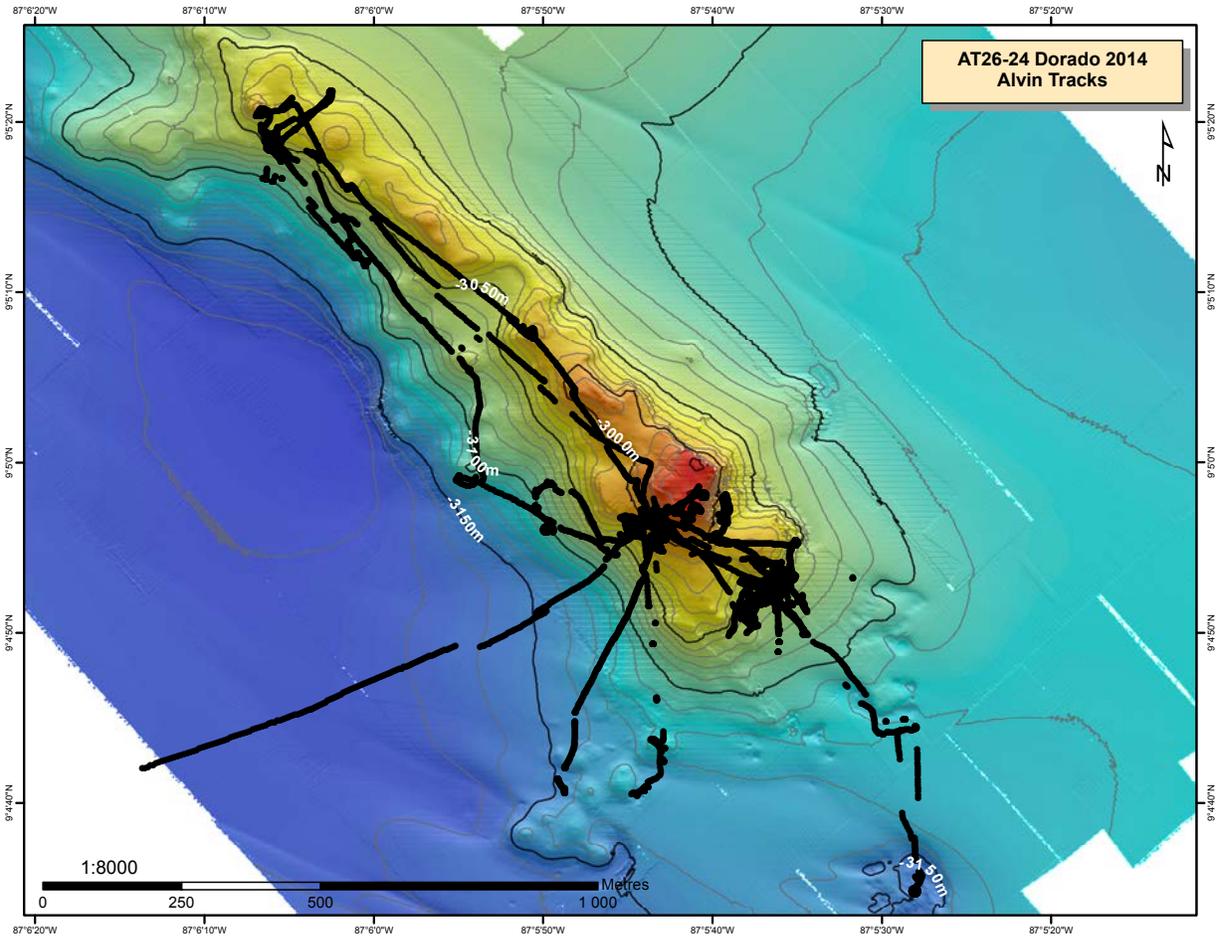


Figure 2. Bathymetric map of Dorado Outcrop developed from the 2013 Sentry data with Alvin tracks delineated for each dive and locations of sample collections in 2014. Not all of the water samples are numbered.

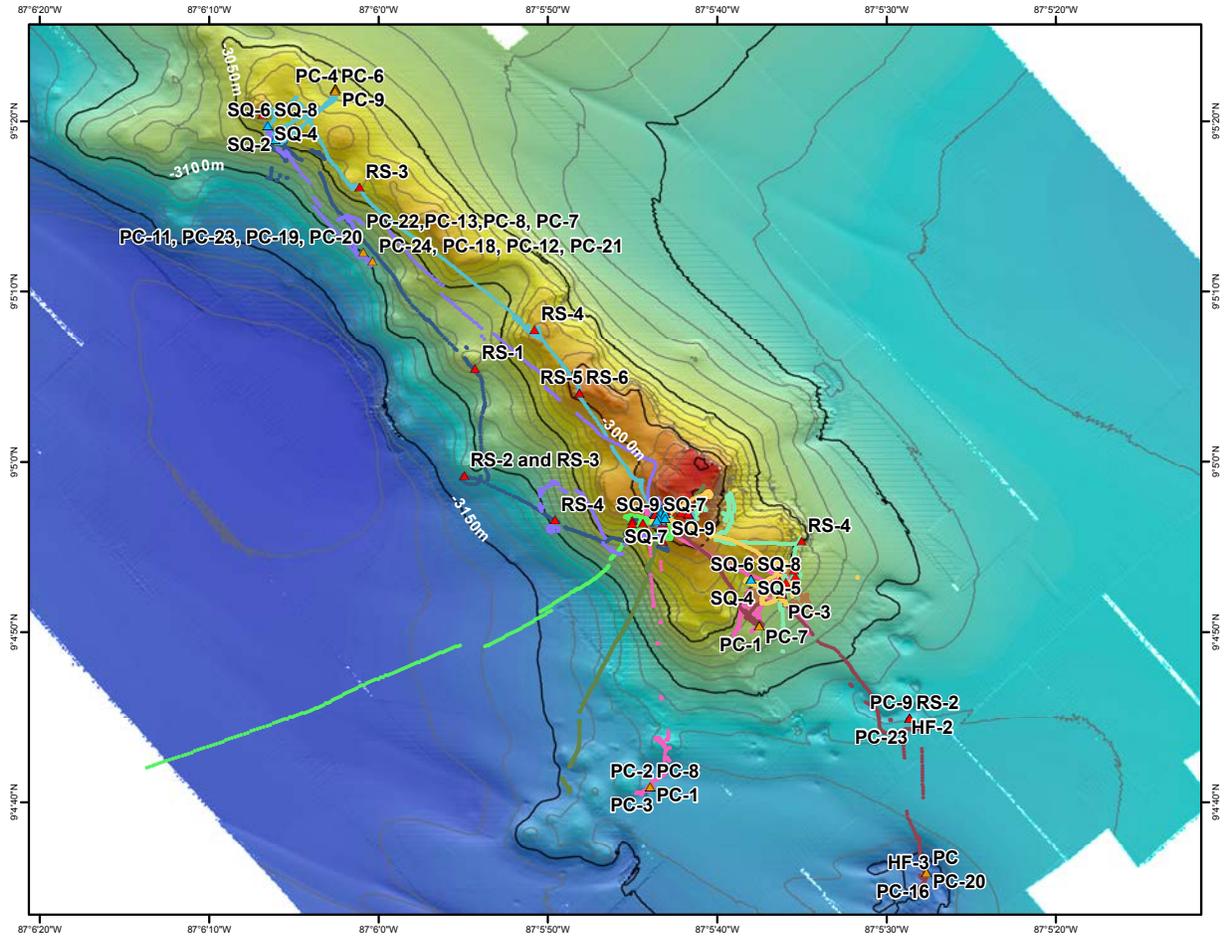


Figure 3. Bathymetric map of Dorado Outcrop developed from the 2013 Sentry data with locations of sample collections in 2014. Not all of the water samples are numbered.

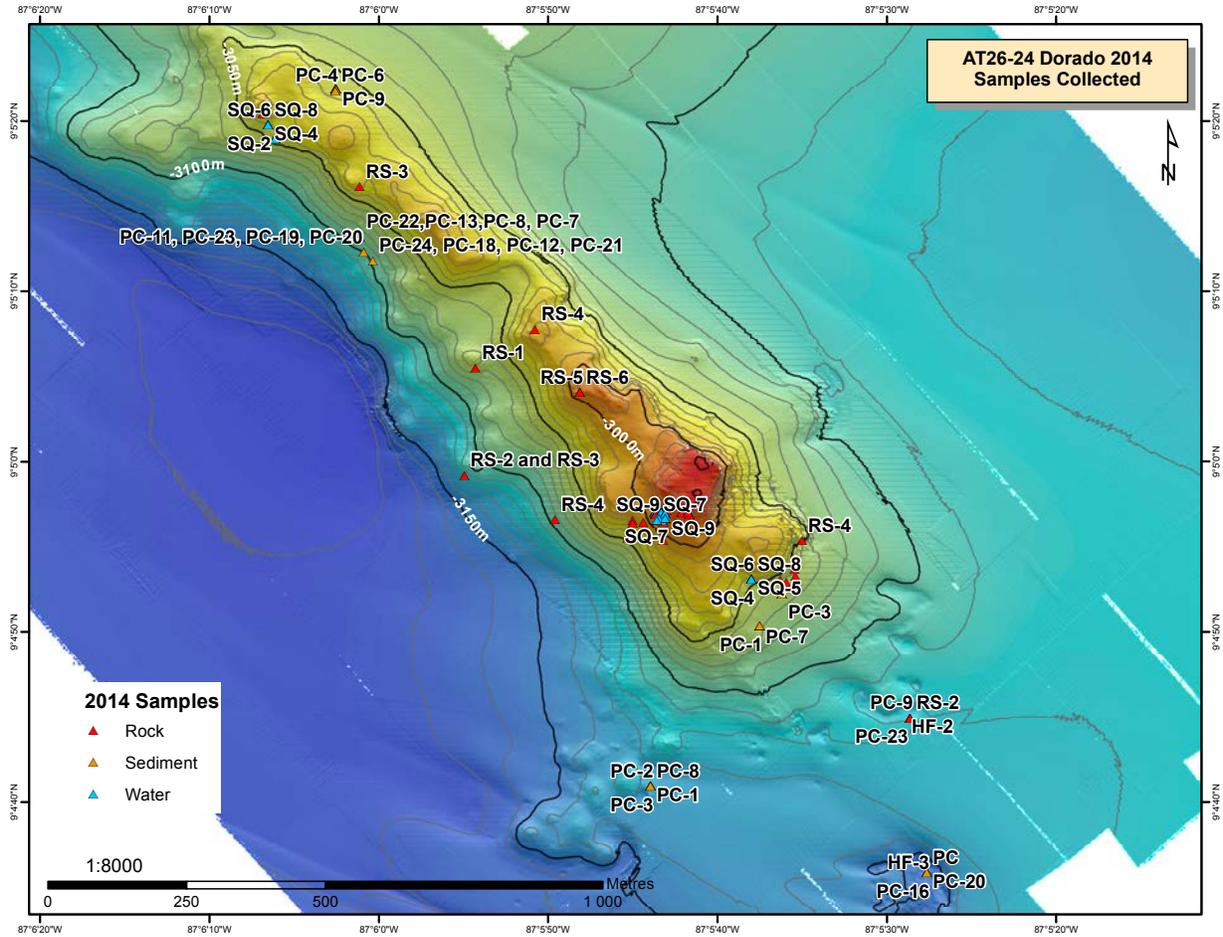


Figure 4. Bathymetric map of Dorado Outcrop developed from the 2013 Sentry data with locations of Jason (2013) and Alvin (2014) dive tracks.

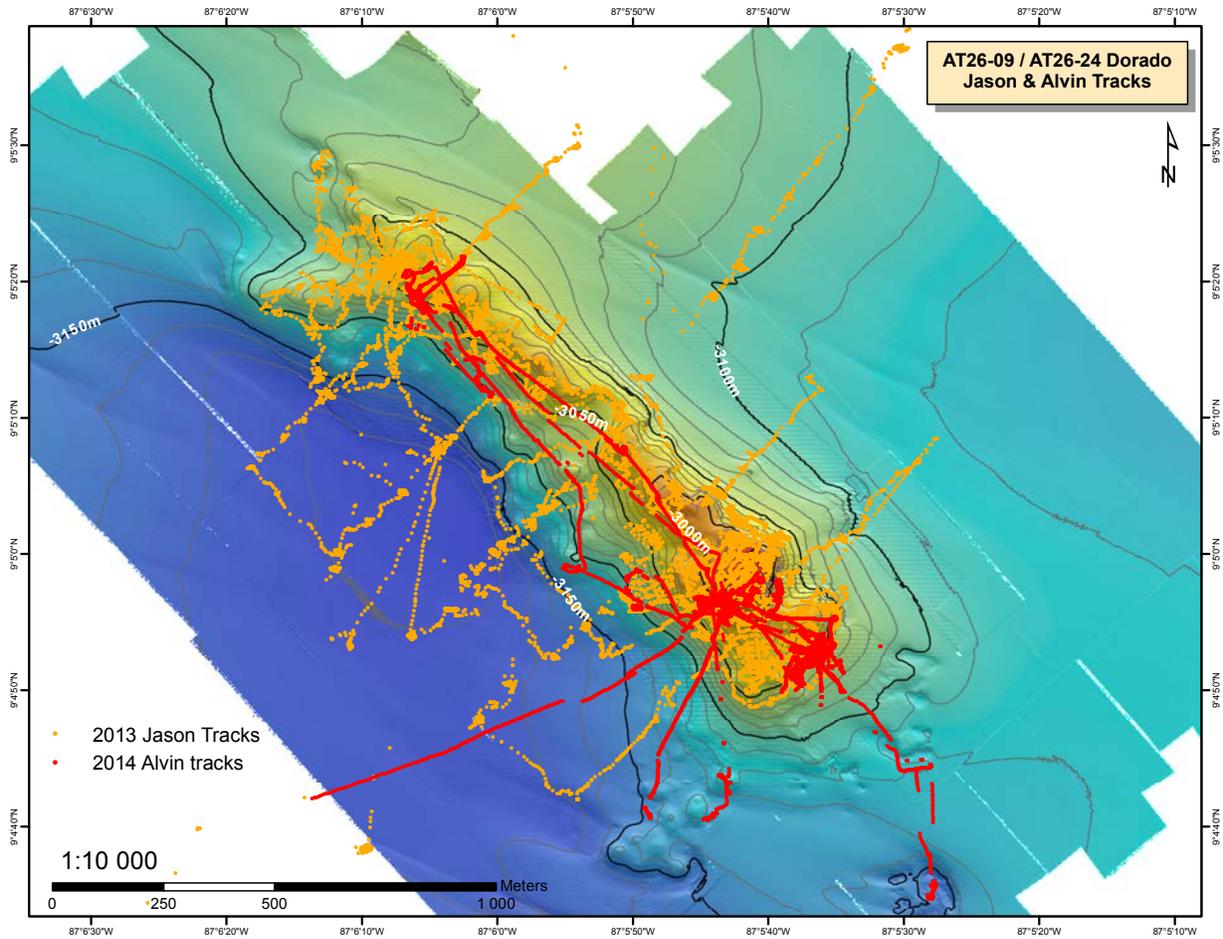


Figure 5. Bathymetric map of Dorado Outcrop developed from the 2013 Sentry data with locations of sample collections in 2013 and 2014. Note that none of the nearly 100 heat flow measurements from 2013 are included in this figure.

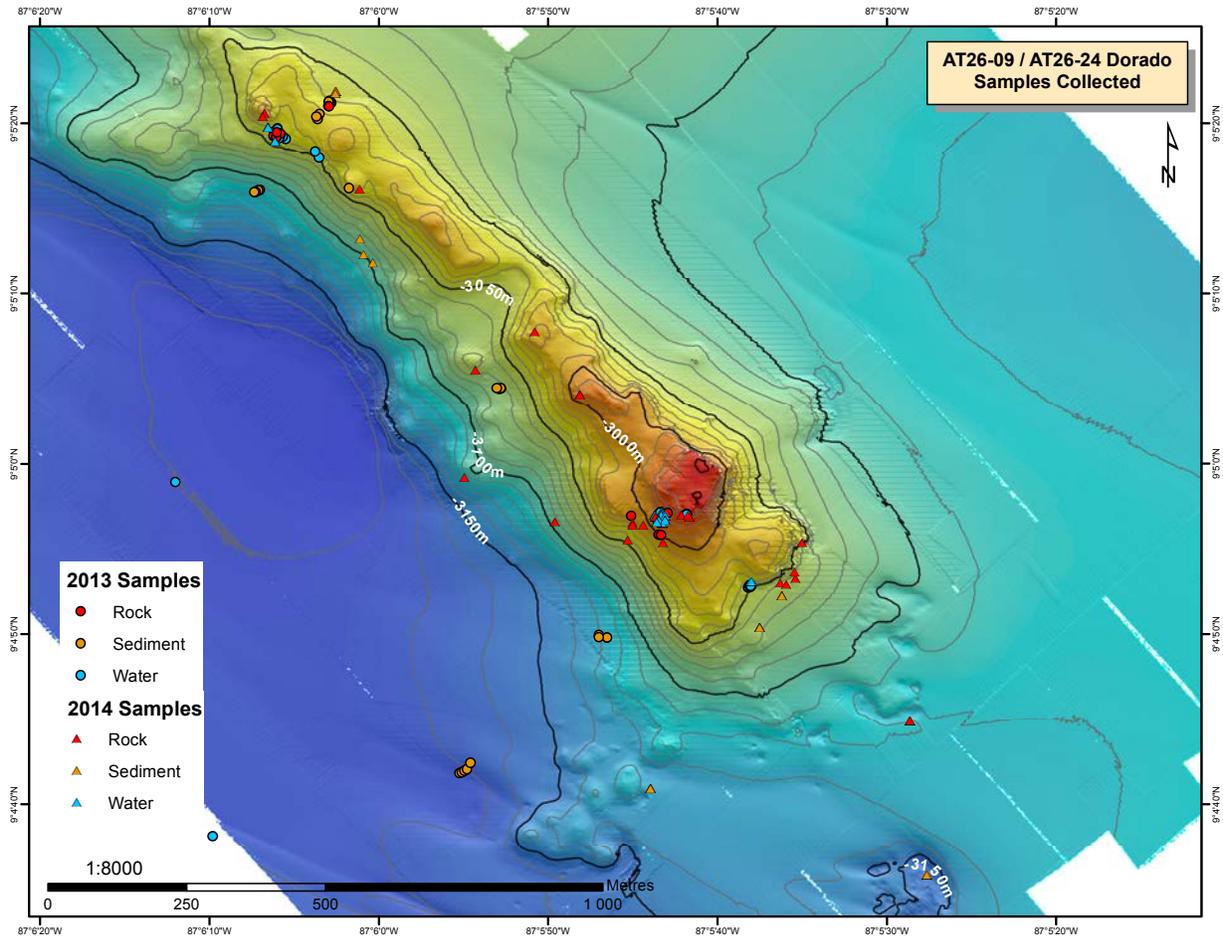


Table 1. Participants on AT26-24.

#	Name		Location	Email	Position	Funding
1	Charles Geoffrey Wheat	M	UAF	wheat@mbari.org	Professor	NSF Funded
2	Trevor Fournier	M	UAF	tfournier@csumb.edu	Grad. Student	
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5	Sam Hulme	M	MLML	samiam0101@gmail.com	Professor	NSF Funded
6	Chris Trebaol	M	MLML	chris.trebaol@gmail.com	Technician	
7	Beth Orcutt	F	Bigelow	borcutt@bigelow.org	Professor	C-DEBI funded
8	Michael Lee	M	USC	leemd@usc.edu	Grad. Student	
9	James McManus	M	Akron	jmcmamus@uakron.edu	Professor	C-DEBI funded
10	Bo Ryan Montanye	M	Akron	Brm63@zips.uakron.edu	Grad. Student	
11	Beate Kraft	F	Harvard	bkraft@fas.harvard.edu	Post Doc	C-DEBI funded
12	Graham Shimmield	M	Bigelow	gshimmield@bigelow.org	Professor	
13	Carla Buchwald	F	WHOI	cbuchwald@whoi.edu	Post Doc	C-DEBI funded
14	Natalie Anna Murray	F	Akron	Nam81@zips.uakron.edu	Grad. Student	
15	Anne Marie Hartwell	F	Akron	ahartwell@uakron.edu	Research Associate	
16	Laura Zinke	F	USC	zinke@usc.edu	Grad. Student	
17	Kelly Butler	M	Aljazeera America	butlersound@mac.com	EPO	
18	Phil Torres	M	Aljazeera America	phillip.juan.torres@gmail.com	EPO	
19	Maurice Roper	M	Aljazeera America	Maurice.roper@gmail.com	EPO	
20	Mike Conway	M	MBARI	comi@mbari.org	Technician	

Table 2. Operations at a glance. Numbers reflect number of operations or samples collected.

Dive number	Squeezers Bio	Squeezers Chem	Optode O2	Temp Probe	Push Cores	Heat Flow	Rocks	Dye
4775	2	5	2	6	0	0	0	Attempted
4776	2	2	2	11	0	0	7	yes
4777	2	3	4	1	6	1	3	---
4778	2	5	6	2	0	0	0	---
4779	4	4	1	2	0	0	7	---
4780	0	3	1	1	20	3	2	---
4781	0	2	2	2	0	0	3	Attempted
4782	2	3	2	3	12	0	8	---
4783	2	2	6	3	12	0	0	yes
4784	3	6			0	0		yes

Table 3. Deployments (-) and recoveries (+) of instruments and the depth that the niskin was tripped.

Dive	Osmo	Temp	Enrichment	RBR	Niskin
4775	1	0	3	-2	none
4776	0	1	3	0	3046 m
4777	0	0	3	0	3081 m
4778	3	3	0	2	none
4779	0	0	0	-2	3055 m
4780	0	1	0	0	2000 m
4781	0	0	3	0	3121 m
4782	0	0	0	0	2650 m
4783	0	0	0	2	3023 m
4784	-2	0	0	0	3061 m

Table 4. Divers and night operations.

	December	Dive #	Port	Starboard	Pilot	Night
Mon	1	4775	Trevor	Chris	Phil	GC 1, CTD 1
Tue	2		Disease cripples crew			Map 1, GC 2
Wed	3	4776	Sam	Mike	Bob	GC 3, GC 4
Thur	4	4777	Beth	Graham	Phil	Map 2
Fri	5	4778	Geoff	Phil	Bruce	GC 5
Sat	6	4779	Katie	Pit	Bob	GC6, GC7
Sun	7	4780	Rachel	Beate	Bruce	Map 3
Mon	8	4781	Carly	Mike Lee	Bob	GC 8, GC9
Tue	9	4782	Annie	Maurice	Phil	GC10, GC 11
Wed	10	4783	Sam	Pit	Bruce	GC 12,GC13
Thur	11	4784	Trevor	Laura	Phil	Map 4