Axial 2018 Cruise Report

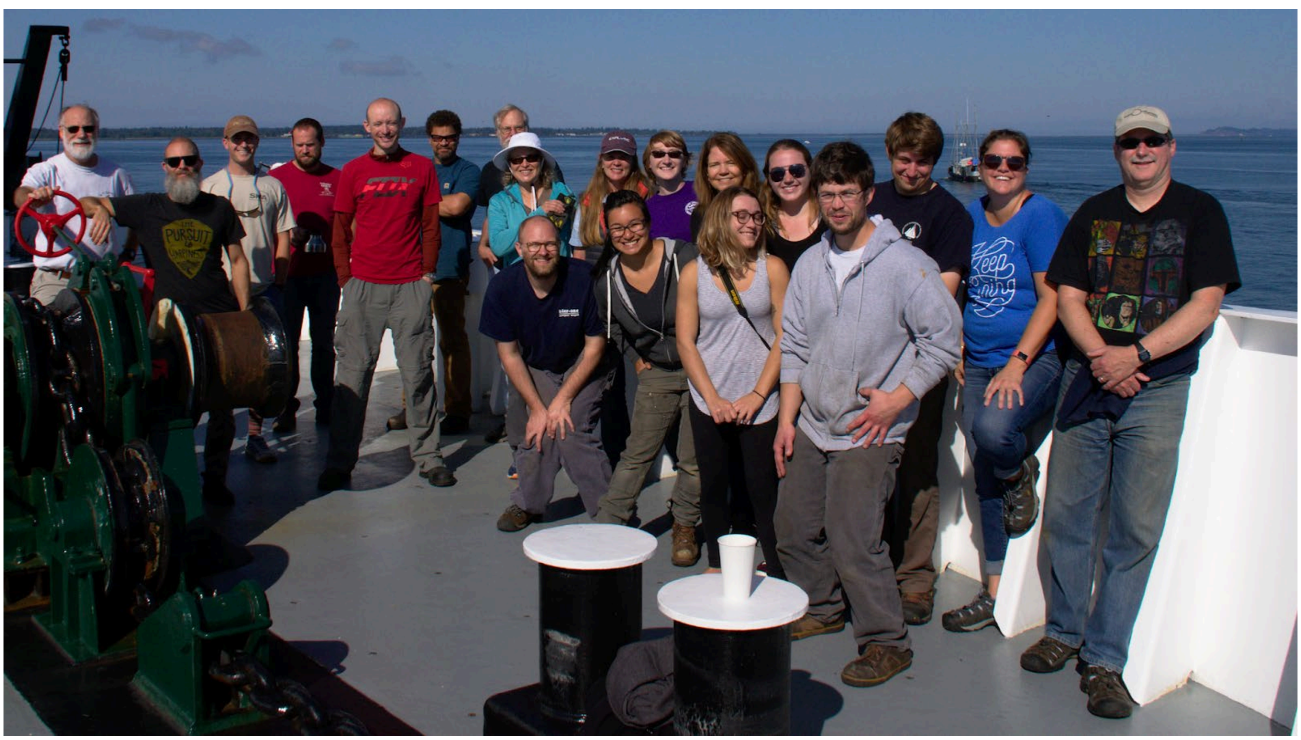
Axial Seamount, Juan de Fuca Ridge

KM-18-13
R/V Kilo Moana

August 18 – 27, 2018

Jason Dives J2-1104 & J2-1105

Chief Scientists: Bill Chadwick/Scott Nooner
R/V Kilo Moana Captain: Charles Martin
JASON Expedition Leader: Tito Collasius
MBARI AUV Expedition Leader: Hans Thomas
Cruise Report prepared by: Andra Bobbitt



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Axial 2018 Expedition Cruise Report

1 - Axial 2018 Cruise Summary

Bill Chadwick, Chief Scientist

Our research expedition to Axial Seamount in August 2018 was another success, thanks to the efforts of everyone on board, including the captain and crew of the *R/V Kilo Moana*, the *Jason* ROV team, the MBARI Mapping AUV team, and the rest of the science party. After three days of marginal weather, during which we could not dive, we complete two long (~ 50 hr) *Jason* ROV dives, and two long (~22 hr) MBARI Mapping AUV dives. In addition, we recovered, turned-around and re-deployed five instrumental moorings (4 BPRs and 1 OBH) that had been out collecting data since last year. We also conducted seven CTD casts, and collected EM122 multibeam sonar data. In short, we accomplished all our highest priority work, despite the challenging weather.

The two *Jason* ROV dives (J2-1104 & J2-1105) were mainly devoted to making pressure measurements at an array of seafloor benchmarks to measure how much the volcano had re-inflated since our last survey last year. We found the center of the caldera has risen 40 cm in the last two years, and 1.61 m since the end of the 2015 eruption. That means the volcano has recovered nearly 2/3 of the deflation that occurred during the last eruption in the last 3 ¼ years. That means the next eruption is still probably not due before 2020 or 2021, depending on how the inflation rate varies between now and then. We'll be keeping an eye on it through the real-time data from the OOI Cabled Observatory, and will be attempting to forecast the next eruption as it gets closer.

During the *Jason* ROV dives we also opportunistically sampled hydrothermal vent fluids for chemical analysis, and turned around long-term temperature recorders at selected vent sites. At the beginning of Jason dive J2-1105, we also visited a group of 5 sulfide chimneys about 1 km SE of the International District Vent Field, that were discovered in last year's Sentry AUV high-resolution bathymetry. We discovered that they were all extinct, with no evidence of any active venting, and it was an unusual sight to see them completely covered by non-vent filter feeding fauna. We called this area Redwood Grove since the chimneys reminded us of big majestic trees, and the chimneys were close enough to each other that you could barely see the others from each one in the dark gloom.

The two MBARI Mapping AUV dives were made to resurvey previously run multibeam sonar lines to document volcanic ground deformation as depth changes between this year's survey and ones in previous years. This is done to complement the pressure measurements that we make on the seafloor. The AUV resurveys have lower resolution for detected depth change, but we can make them quickly over a much larger area than is practical to cover with the pressure measurements. This year's AUV surveys included the crisscrossing lines inside the caldera, radial lines extending outside the caldera like an asterisk, and two sets of circumferential ovals at different distances outside the caldera. This data on the surface displacements at Axial Seamount will help us model the subsurface magma storage and supply system.

As always, we are grateful to the National Science Foundation and NOAA for supporting this research, and we appreciate the support from the University of Hawaii, the captain and crew of *R/V Kilo Moana*, the Woods Hole Oceanographic Institution, the National Deep Submergence Facility, and the *Jason* ROV and MBARI Mapping AUV teams.

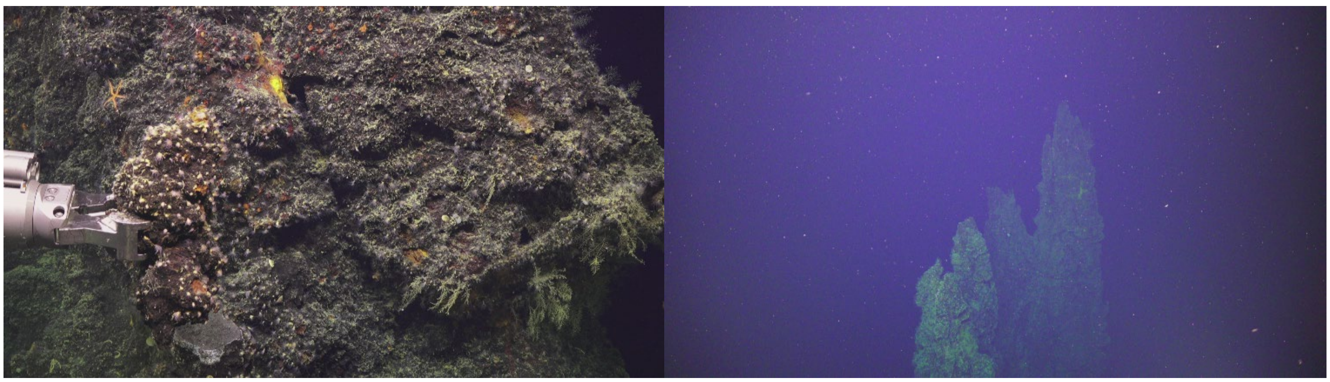
2 – Science Participants

Name	Affiliation	Expertise
Bill Chadwick	Oregon State U.	Geology
Scott Nooner	U. N. Carolina, Wilmington	Geology
Will Hefner	U. N. Carolina, Wilmington	Geology
Audra Sawyer	U. N. Carolina, Wilmington	Geology
Andra Bobbitt	Oregon State U.	Data management
Teresa Atwill	Newport High School	Teacher at sea
Chris Holm	Oregon State U.	Mooring tech.
Morgan Haldeman	Oregon State U.	Geology
Matt Cook	Scripps	Geophysics
Haley Cabaniss	Univ. of Illinois	Geophysics
Kevin Roe	U. Washington	Fluid chemistry
Hans Thomas	MBARI AUV group	MBARI Expedition Leader
Dave Caress	MBARI AUV group	AUV
Erik Trauschke	MBARI AUV group	AUV
Emery Nolasco	MBARI AUV group	AUV
Jenny Paduan	MBARI AUV group	AUV
Tito Collasius	ROV Jason group	Jason Expedition Leader
Chris Lathan	ROV Jason group	ROV
Jim Varnum	ROV Jason group	ROV
Christina Haskens	ROV Jason group	ROV
Jim Convery	ROV Jason group	ROV
Korey Verhein	ROV Jason group	ROV
Jim Pelowski	ROV Jason group	ROV
Andrew Billings	ROV Jason group	ROV
Victor Nakicki	ROV Jason group	ROV
Molly Curran	ROV Jason group	ROV

3 – Operations Log

Pacific Time (-7 GMT)	Date/Time GMT	Event
18-Aug 0800	18-Aug 1500	Departed Astoria, OR
0957	1657	Started logging multibeam and WCD data.
1144	2211	Stopped WCD data logging; EM122 multibeam continued.
19-Aug 0740	19-Aug 1440	Stopped EM122 logging. On station at Axial Seamount.
0854	1554	BPR-North mooring released from seafloor.
0916	1615	Mooring on surface.
1008	1708	**BPR-North recovered**. Mooring on deck.
1048	1748	BPR-Center mooring released from seafloor.
1300	2000	**BPR-Center recovered**. Mooring on deck.
1323	2023	OBH-Center mooring released from seafloor.
1350	2050	Mooring on surface.
1424	2124	**OBH-Center recovered**. OBH on deck.
1451	2151	BPR-West mooring released from seafloor.
1508	2208	Mooring on surface.
1534	2234	**BPR-West recovered**. Mooring on deck.
1611	2311	BPR-South 2 mooring released from seafloor.
1623	2328	Mooring on surface.
1653	2353	**BPR-South 2 recovered**. Mooring on deck.
2029	20-Aug 0329	**V18A-01 CTD** cast in water at International District.
2211	0511	CTD on deck.
2246	0546	**V18A-02** CTD cast in water at Vixen Vent.
20-Aug 0019	0719	CTD on deck.
0112	0812	**V18A-03** CTD cast in water at ASHES/Inferno Vent.
0322	1022	CTD on deck.
0408	1108	**V18A-04** CTD cast in water at CASM Vent field
0542	1242	CTD on deck.
0645	1345	**V18A-05** CTD cast in water at "New Chimney" site (failed to log data)
0813	1513	CTD on deck.
0932	1632	**V18A-06** CTD in water at second "New Chimney" site
1056	1756	CTD on deck.
1154	1854	**V18A-07** CTD in water for background cast.
1345	2045	CTD on deck.
1545	2245	**OBH mooring deployed** 45 57.4963'N 130 0.2509'W
1811	21-Aug 0111	**BPR South mooring deployed** 45 54.9348'N 129 59.6164'W
1826	0126	Begin EM122 Multibeam survey
21-Aug 0552	1252	End EM122 Multibeam survey-continuing to log/ping en route to Dive site
0600	1300	Stopped EM122 logging. On station at Axial Seamount. Weather not good.
0912	1612	**BPR North mooring deployed** 45 58.4203'N 130 1.1737'W
1012	1712	**BPR Center mooring deployed** 45 57.5116'N 130 0.6747'W
1237	1937	**J2-1104 Dive** begins at Axial Seamount
1622	22-Aug 2322	J2-1104 Jason off bottom 200m to prepare for AUV launch
1705	23-Aug 0005	**MBARI AUV Dive 20180822m1** launched
1933	0233	AUV Dive problems: brought to surface, INS reset, sent down again **Dive 20180822m2**
2000	0300	J2-1104 resumes
22-Aug 1605	2305	J2-1104 aborted to recover MBARI AUV
1656	2356	Jason out of water

Pacific Time (-7 GMT)	Date/Time GMT	Event
1921	24-Aug 0221	MBARI AUV recovered on deck
23-Aug 2040	0340	**J2-1105 Dive** begins
24-Aug 1327	2027	**MBARI AUV 20180824m2** begins
25-Aug 0925	25-Aug 1625	J2-1105 Last pressure measurement completed @AX-307 for this expedition
1040	1740	Jason on deck
1252	1952	MBARI AUV on deck
1447	2147	**BPR West mooring deployed**
26-Aug 0240	26-Aug 0940	Begin EM122 Multibeam survey
0601	1301	Ship headed for Astoria while continuing EM122 logging.
1945	27-Aug 0245	Began WCD survey with EM122
0310	1010	End EM122 and WCD survey
27-Aug 0930	1630	Arrived in Astoria



Views of Redwood Grove chimneys east of Axial's caldera.

4 – Discipline Summaries

4.1 Geology/Geophysics

4.1.1 Pressure Measurements to Monitor Volcanic Deformation at Axial Seamount

Bill Chadwick, Scott Nooner, and Matt Cook

We have made ROV-based campaign-style pressure measurements with a “mobile pressure recorder” (MPR) on seafloor benchmarks at Axial Seamount since 2000 to monitor vertical movements of the seafloor due to volcanic inflation and deflation caused by magma movements beneath the volcano. In addition, we have deployed various kinds of continuously-recording bottom pressure recorders (BPRs) throughout the caldera. There are 3 kinds of BPRs: (1) Some BPRs are autonomous moorings that record for 1-3 years at a time (4 of these were turned around in 2018). (2) Four others are BPR/Tilt instruments that are connected to the OOI Cabled Array. (3) In addition, we use “mini-BPRs” that are deployed and recovered by ROV on some of the MPR benchmarks (we recovered 4 of these and deployed 5 in 2018). The aim is to have both campaign-style and continuous pressure measurements at all of our pressure monitoring sites (the array of 10 seafloor benchmarks). Where the MPR measurements are co-located with a BPR, then the MPR data can determine the instrumental drift of the BPR, so the BPR data can be corrected. The 2017-2018 time interval was the first time we have been able to constrain the drift rates of the BPRs at all of the seafloor benchmarks, except one, AX-308, which did not have a nearby BPR. This section summarizes this year’s MPR & BPR operations and results.

MPR measurements

The MPR measurements provide a precise depth for each benchmark *relative* to the reference site AX-105 (South Pillow Mound), which is located ~10 km south of the center of the caldera. Note however, that a new Self Calibrating Pressure Recorder (SCPR) was deployed on the OOI Cabled Array this year at the center of the caldera, and once its operation is shown to be reliable, this could be used as a reference in future years. This year, MPR pressure measurements were made at the benchmarks during *Jason* dives J2-1104 and J2-1105. We had intended to conduct the measurements during a single dive, but dive J2-1104 had to be ended early in order to recover the MBARI AUV after its first dive.

This year ROV *Jason* was operating in two-body mode (with *Medea*) on *R/V Kilo Moana*. This meant that *Jason* could transit between sites at a speed of up to 1 knot, instead of being limited to 0.5 knots, as it did when in single-body mode last year. This made the pressure dives a bit more time-efficient. On dive J2-1104, we made two full transects of all the benchmarks, starting at AX-308, going to AX-105, and ending after fluid sampling at ASHES and the 3rd repeat measurement at AX-106 (all others had two, and AX-105 had one). On dive J2-1105, we started at the newly discovered chimneys ~1 km SE of International District, then proceeded to AX-310, northward to AX-303, AX-309, and AX-302, then back southward visiting all the east-side benchmarks to AX-105, and the back northward again to AX-104, AX-308, AX-106, and finally AX-307 where the dive ended. Between the 2 dives, benchmarks AX-106, AX-309, AX-303, AX-310, and AX-104 got 4 repeats, AX-308, AX-307, and AX-302 got 3 repeats, and AX-101 and AX-105 got only 2.

At the first benchmark (AX-308), we attempted to sweep off the upper surface of the benchmark with a brush, so that ash from a future eruption could be identified and sampled unambiguously, but we quickly realized this was a bad idea, because the manipulator arm would move the benchmarks if we weren’t careful. Also, the bottom currents since the 2015 eruption have now effectively removed any 2015 ash that was deposited, making cleaning them unnecessary. Therefore, we did not attempt any additional brushing on other benchmarks. As in previous years, each measurement was made by placing the MPR on top of a benchmark and recording for 20 minutes. Data were recorded on a laptop PC in the *Jason* control room. The two Paros pressure gauges that we have used in the past (s/n 43535 and 62201) were used in the MPR again this year. We conducted some fluid sampling during both pressure dives (using Major and Gastight sampling bottles this year instead of The Beast). The MPR pressure data were converted to depth then corrected for ocean tides using data collected by the Mini-BPR #04, which was recovered at AX-105 on the 2nd pressure dive, and predicted tides after that. Instrument drift was calculated during the survey and was removed. The uncertainty in the pressure measurements was determined by the scatter of repeated measurements at each benchmark and was ± 1.3 cm this year. The 2017-2018 MPR results show uplift (inflation) at all stations relative to AX-105.

Cement Benchmark Locations

AXIAL CEMENT BENCHMARK NAMES	LAT	LON	Depth	LAT DEG	LAT MIN	LON DEG	LON MIN
AX-101 Caldera Center	45.95520	-130.00987	1532	45	57.312	-130	0.592
AX-104 Bag City	45.91617	-129.98950	1534	45	54.970	-129	59.370
AX-105 Pillow Mound	45.86317	-130.00376	1718	45	51.790	-130	0.225
AX-106 Ashes	45.93445	-130.01160	1542	45	56.067	-130	0.696
AX-302 Trevi	45.94642	-129.98378	1522	45	56.785	-129	59.027
AX-303 Marker 33 site	45.93346	-129.98225	1516	45	56.008	-129	58.935
AX-307 Magnesia West	45.94535	-130.00906	1544	45	56.721	-130	0.544
AX-308 BPR-South1	45.93160	-129.99880	1533	45	55.896	-129	59.928
AX-309 RSN-PN	45.93835	-129.97208	1527	45	56.301	-129	58.325
AX-310 Intern. District	45.92580	-129.97787	1531	45	55.548	-129	58.672

Depth changes from July 2017 to August 2018 at MPR benchmarks. Uncertainty is ±1.3 cm.

BENCHMARK NAME	Depth change (cm)
AX-101 Caldera Center	34.3
AX-104 Bag City	13.4
AX-105 Pillow Mound	0.0
AX-106 Ashes	20.0
AX-302 Trevi	17.2
AX-303 Marker 33 site	17.5
AX-307 Magnesia West	30.7
AX-308 South1	21.8
AX-309 RSN-PN	11.4
AX-310 Intern. District	17.7

OOI Cabled Array BPR drift

The results from the MPR survey allow us to constrain the drift rate of the OOI Cabled Array bottom pressure/tilt instruments (BOTPTs). This is the second time we have been able to do this since the original three BOTPT instruments were powered up in September 2014 (although only for the first time for the fourth

BOTPT instrument that was deployed at ASHES in August 2017). Last year, the 2015-2017 MPR data showed that the drift at all of the OOI-BPRs was less than 1 cm/yr, which we considered “essentially zero”, considering the errors. This year, comparison with the 2017-2018 MPR results suggests small positive drift rates between 3-7 cm/yr (see table below). However, these calculations have their own uncertainty, because they require picking start and end depths from the BPR time-series, which is overprinted with tidal residuals and oceanographic effects. The fact that the calculated drift for all 4 OOI BPRs has moved in the same direction since last year, suggests that the apparent drift may be largely due to the non-geophysical signal in the BPR data. This source of error has more influence on these calculations because of the shorter time period between MPR surveys this year (2017-2018). Presumably, the longer time period of the previous MPR survey (2015-2017), should provide a more accurate determination of the OOI-BPR drift, just because the oceanographic effects will have less influence. Thus, for now, we still conclude (as we did last year) that no drift corrections should to be made to the OOI NANO-BPR data from the BOTPT instruments on the cabled observatory inside the summit caldera. Our next MPR survey in 2020 will provide another 2-year survey interval with which to calculate the drift rates on the OOI-BPRs. Another, even better test of drift will be to compare the OOI-BPR data over the next year or two with the new self-calibrating pressure recorded (SCPR) that is now on the Cabled Array at the caldera center.

OOI cabled BPR Drift Rates Determined by Comparing with MPR Surveys

Name	Location	Nearest MPR benchmark	Drift rate 2017-2018 (cm/yr)	Drift rate 2015-2017 (cm/yr)
BOTPT-A301-MJ03F	Central Caldera	AX-101	+3.376	-0.682
BOTPT-A302-MJ03E	Eastern Caldera	AX-309	+6.935	-0.839
BOTPT-A303-MJ03D	Intern. District	AX-310	+3.011	-0.892
BOTPT-A304-MJ03B	ASHES	AX-106	+2.099	N/A

Autonomous BPR moorings

We recovered the four autonomous BPR moorings in August 2018 (West, North, Center, and South2) that were deployed in July 2017 and they all had recorded data successfully. All the moored BPRs are built by NOAA/PMEL and record pressure every 15 seconds in psi, which is converted to depth by multiplying by 0.670 m/psi. Below, is a first-look summary of the data from each autonomous BPR mooring.

Data from BPR-Center looks "normal" for the first half of the record (showing ~7 cm of inflation, before drift correction), but then there is an abrupt ~10 cm offset downward in the middle of the record, which must be due instrument instability (since the nearby OOI-BPR does not show this). Also, the record after this offset is relatively flat and does not show continued inflation like the OOI-BPR does, so the instrument apparently remained unstable for the rest of the deployment. So, this record is a bit of a bust (at least the 2nd half of it), but it's really just a back-up for the OOI-BPR at the caldera center (or they are back-ups for each other), so this is no major loss. This is the first time we've seen moored BPR instability like this, but obviously there is some luck involved when free-falling instruments from the surface. The drift rate in the table below is calculated from the first half of the record only.

Data from BPR-North looks good throughout, although it had a bit of a long equilibration. The overall record shows inflation of ~30 cm (not drift-corrected), mostly before June 2018, when inflation slowed for a month or two, which we saw in the OOI instruments. This is a good record, but we don't know the drift. Data from BPR-South2 is also a good record, and has a similar trend with time compared with BPR-North and OOI-MJ03F. It shows ~12 cm of uplift (before drift correction). Data from BPR-West is unusual because it shows steady apparent deflation the whole year, amounting to ~40 cm! This is the first record from up on the western rim of the caldera, which probably has heavy sediment. The apparent deflation could be due to site instability - perhaps the instrument was slowly settling into the sediment all year? Or else the drift rate could be relatively high and positive, but unfortunately we have no way to constrain it. The main purpose of the BPR-North and BPR-West instruments is to have two additional continuously recording measurement sites in useful locations to catch the next eruption, so even if this record is ambiguous over the 2017-2018 time period, it may still be useful to have this instrument out there during the next eruption, because the eruption will occur over a short time-interval, so we can ignore drift.

By comparing the BPR-Center and BPR-South2 data with the 2017-2018 MPR survey at benchmarks AX-101 (Center) and AX-104 (South-2), we can determine the drift rate of these two BPRs. How those rates compare with previous years' data is shown in the following table.

Autonomous Moored BPR Drift Rates Determined by Comparing with MPR Surveys

Name	S/N	Dynamic range (psi)	Drift rate 2017-2018 (cm/yr)	Drift rate 2015-2017 (cm/yr)	Drift rate 2013-2015 (cm/yr)	Drift rate 2011-2013 (cm/yr)
BPR-Center	103402	10,000	-18.060	-15.365	-20.101	-8.576
BPR-South2	125320	3,000	-1.278	-3.514	-5.048	n/a

This shows that (1) the same BPR deployed in the same location has a different drift rate from deployment to deployment, and (2) BPRs with larger dynamic ranges tend to have larger drift rates. Note, we cannot constrain the drift of the BPR-West and BPR-North instruments, because there is no MPR benchmark nearby. All four BPRs were turned-around at sea and redeployed in close to the same locations.

BPR Mooring Deployment Locations in 2018 (all acoustically surveyed)

Name	Lat Deg	Lat Min	Lon Deg	Lon Min	Lat	Lon	Depth
BPR-Center	45	57.460	-130	00.679	45.95766	-130.01131	1532
BPR-South2	45	54.910	-129	59.600	45.91516	-129.99333	1537
BPR-West	45	57.016	-130	02.174	45.95027	-130.03623	1448
BPR-North	45	58.388	-130	01.177	45.97313	-130.01962	1581

Mini-BPRs (TG11s)

During *Jason* dives J2-1104 and J2-1105 this year, we recovered 4 mini-BPRs that were deployed on MPR benchmarks in 2017 (see table below). These 4 mini-BPRs were built at Scripps and are owned by Glenn Sasagawa and Scott Nooner. They were deployed with small tripods on their undersides to make them stable and ~5 pounds heavy in water. All recorded for the entire period.

MINI-BPRs RECOVERED in 2018

BENCHMARK NAME	Mini-BPR	Paros S/N	Paros model	Range (psi)	Drift rate (cm/yr)
AX-303 Marker 33 site	#02	137987	43K	3000	+52.469
AX-105 Pillow Mound	#04	137988	43K	3000	+22.813

AX-302 Trevi	#05	137989	43K	3000	+10.768
AX-307 Magnesia West	#10	137990	43K	3000	+47.724

Just like last year, the drift rates of the mini-BPRs are high and variable. However, the drift rates I calculated for the mini-BPRs above are LINEAR. That is, I just eyeballed the starting depth and ending depth and compared it to the depth change determined by the MPR survey. However, it is pretty clear that the drift experienced by the mini-BPRs is exponential at the beginning and then (probably) linear after some time period. So the linear drift correction I have calculated is probably not the best approximation of the drift behavior. Mini-BPR #05 had one bad-data record in the raw data at 07/21/2018 05:33:20 (which was replaced by the mean of the preceding and following records). There is also an offset of about 45 cm (up) mid-way in the record for MiniBPR #04 from about 11/25/2017 to 12/11/2017. It is not just one single offset, but a series of offsets and time periods with unrealistically high changes. It is not clear what the source of these offsets was. For now, we have removed the 45 cm offset from the later 2/3 of the record (by eye), and calculated a drift rate from the artificially offset time-series, but it should be considered just a best guess.

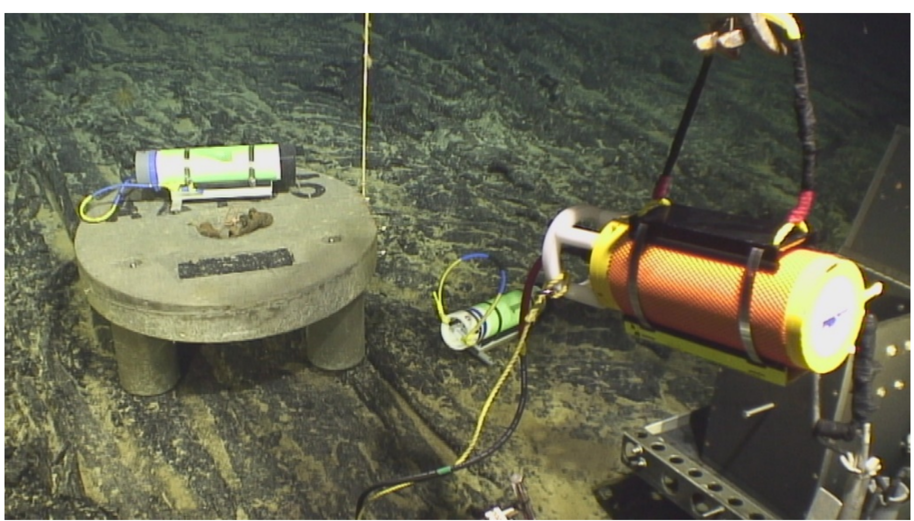
The Mini-BPRs report pressures in kPa every 100 seconds (1 min 40 sec). The pressure was converted from kPa to psi using 1kPa = 0.14503773800722 psi and then to depth in meters using 1 psi = 0.670 meters. All the non-cabled BPR data this year were de-tided by subtracting predicted tides provided by Rick Thomson at the Institute of Ocean Sciences in Sydney, BC, based on the first year of OOI BPR data from instrument BOTPT-A301-MJ03F on the OOI Cabled Array (located at 45.954850° -130.008753°, at the Central Caldera). In other words, he used real data to calculate the tidal constituents for Axial, which provides better predicted-tides than the generic tide-prediction program SPOTL, which we used for this purpose before 2017.

In order to have 5 Mini-BPRs to deploy in 2018, we turned around one of the units that were recovered (Mini-BPR #10), and deployed it on the second pressure dive (we only came out with 4 units instead of 5). Mini-BPR units 08, 09, 12, 10, and 13 were deployed in 2018 at the benchmarks listed in the following table:

MINI-BPRs DEPLOYED in 2018

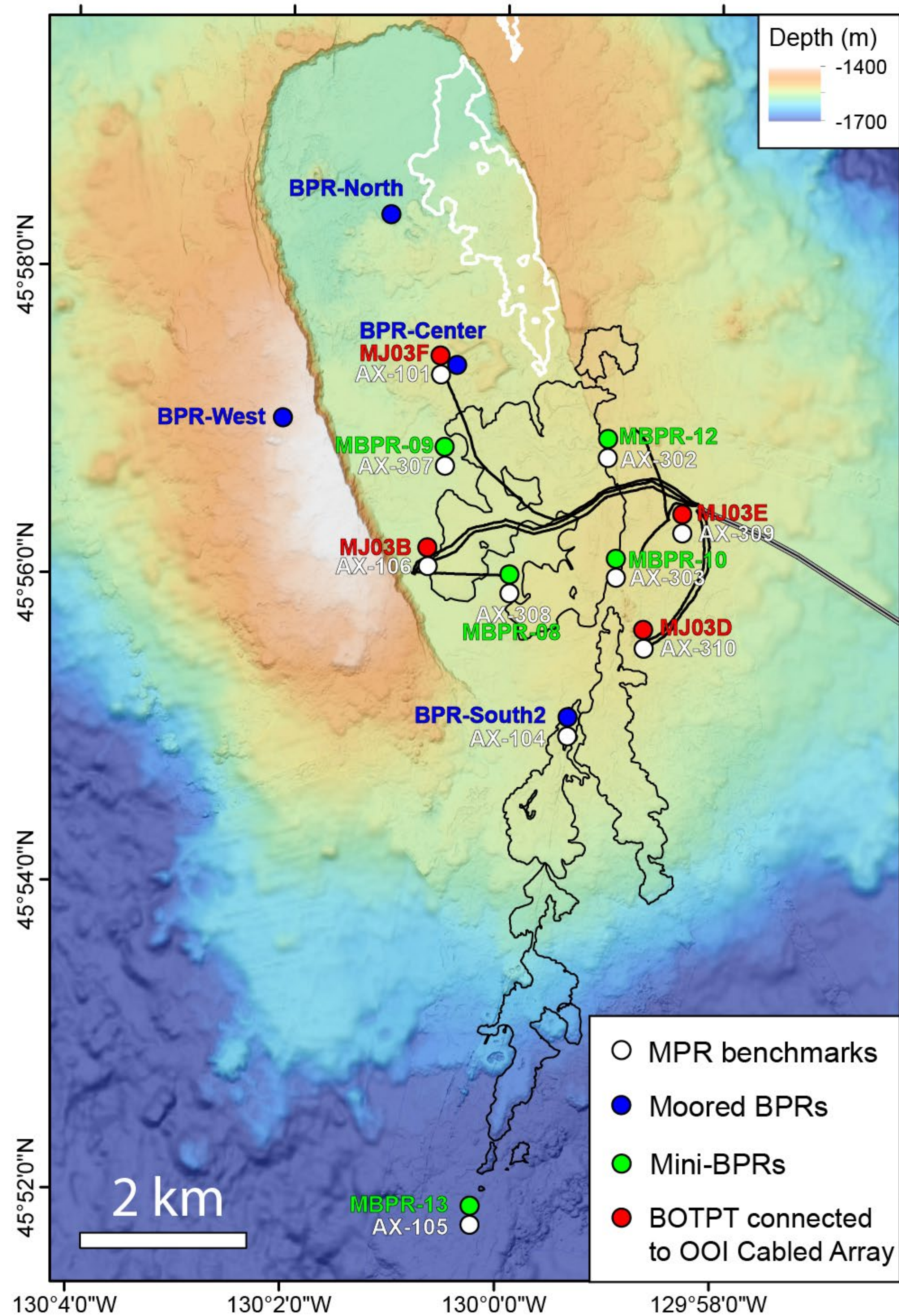
BENCHMARK NAME	Mini-BPR	Paros S/N	Paros model	Range (psi)
AX-308	#08	127329	43K	3000
AX-307 Magnesia West	#09	127331	43K	3000
AX-302 Trevi	#12	132673	46K	6000
AX-303 Marker 33 site	#10	137990	43K	3000
AX-105 Pillow Mound	#13	132674	46K	6000

We plan to recover these in summer of 2020 and replace them with the other 5 Mini-BPRs. The 5 Mini-BPRs that are NOT currently deployed are the following units: 02, 04, 05, 06, 07. This is the first time ALL the MPR benchmarks have a BPR either on the benchmark or nearby (either a mini-BPR, and OOI-BPR, or an autonomous BPR mooring). See figure below.



Overall Results of the Pressure Measurements

The data from the 2018 MPR survey and the BPRs that were recovered show that by mid-August 2018 Axial Seamount had re-inflated about 63% of the total amount of deflation that occurred during the 2015 eruption (1.61 m of post-eruption re-inflation compared to 2.54 m of co-eruption deflation). The rate of re-inflation since the 2015 eruption has been variable, with periods of more rapid inflation separated by periods of slower inflation, or even short-lived deflation (such as from mid-June to early July 2018). Extrapolating the average long-term rate of inflation (40-50 cm/yr), it appears Axial will not be ready to erupt again until mid-2020 to mid-2021. We will attempt to make a more specific forecast of the timing of the next eruption as the time nears, using the real-time BPR data from the OOI Cabled Array (https://www.pmel.noaa.gov/eoi/rsn/). The spatial distribution of re-inflation is consistent with the source geometry derived from modeling of our previous MPR surveys – that is, a prolate spheroid (cigar-or-football shape) that is located at a depth of about 3.8 km beneath the eastern wall of the caldera near AX-302 (Trevi) and oriented with the long-axis nearly vertical but steeply dipping to the WNW. Complementary bathymetric re-surveys with the MBARI Mapping AUV for measuring volcanic deformation over a larger area are described in the next section.



Map showing MPR benchmarks and co-located BPRs (after the 2018 cruise).

4.1.2 - Rock Collections

Morgan Haldeman and Jenny Paduan

J-1105-GEO-01

- Massive polymetallic sulfide from “Redwood Grove” chimney field
- Sample was from the new chimney field that was discovered in AUV *Sentry* bathymetry data from 2017. All chimneys observed were inactive. They were uniformly wide for nearly their entire heights, which inspired the name “Redwood Grove”. They had been built directly on a lightly sedimented, hackly lava flow beyond which were pillow lavas.
- Sample was of an old orifice protruding from ~6 m up from the base of the southern-most chimney, which was 22 m high according to the ROV’s altimeter. It was broken from the chimney, and remained intact until contact with the ROV porch.
- Collected at 1553 m depth
  - 45° 55.207502 N, -129° 57.795632 (W)
  - 05:21:53 on 2018/08/24
  - Placed on porch between boxes of fluid samplers
- Broke into two large pieces 18x18x15 cm and 19x19x9 cm plus a few smaller pieces
- The interior is uniformly gray crystalline polymetallic sulfide. The lower piece retains the hollow pipe of the orifice, which is clogged by the top. No chalcopyrite or sparkly crystals are apparent. The exterior has some brown alteration.
- The exterior was populated with small pink anemones, which have been removed.
- The sample will be chemically analyzed by ActLabs and a piece sent to John Jamieson for age dating.

J-1105-GEO-09

- Small pillow bud from 2011 Bag City lava flow
- Collected at ~1531 m, approx. 4m NW of AX104 benchmark
    - 45.91619 N, -129.989535 W
    - Collected around 23:14:22 UTC, 2018/08/24
    - Placed in port bio box
- 7 x 4 x 3.25 inches (LxWxH)

- Radial swelling from interior
- Glass rim 0.4 cm thick, very vitreous, oily rainbow sheen
- Raised, lobate glass texture
- Newly exposed surface displays outwardly radiating vesicles
    - Vesicle chains ~0.5 cm long
    - Vesicles generally ≤ 1 mm in diameter
    - Vesicle chains may connect to create larger voids
    - Aphanitic lithics
- Minor oxidation (orange) around the outer edges of the exposed surface
    - Deepest section ~2 cm depth
    - Appears to be mostly surficial and confined to exposed surfaces
    - Minor oxidation also present in chipped glass
- Plagioclase crystal present in exposed surface and in glass, < 0.5% of mass
    - Glass – up to 0.6 cm length, single prism
    - Lithic – up to 0.4 cm diameter, radiating lathes
- Glass chipping off very easily in shards and chips
    - Translucent pieces displaying typical brown glass coloration expected of basalt


J-1105-GEO-09
Office DEPOT

J-1105-GEO-12

- Collected from surface sheet flow adjacent to AX105 benchmark
- Collected at ~1715m depth
    - 45.863154 N, -130.003826 W
    - Collected around 05:11:23 UTC, 2018/08/25
    - Placed in gastight box on port side of basket
- 10.9 x 9.9 x 4.9 cm (LxWxH)

- Picked up from a surface sheet flow. Pahoehoe rope structures visible, but more angular than ropy
    - Aphanitic lithics
- Matte quench rind overlaying glass beneath
- Cooling rings visible in small corner of sample
- One plagioclase crystal visible, ~0.3 cm long lathe
- No evident vesicles, but two larger voids (1 cm x 1 cm and 1.3 cm x 1 cm) may have formed from volatile exsolution
    - Evenly smoothed
    - Ovoid to spherical
- Glass rim depth / thickness difficult to determine in hand sample, but estimated at ~ 0.3 cm thick

J-1105-GEO-13

- Collected from surface sheet flow adjacent to AX105 benchmark
- Collected at ~1715m depth
    - 45.863154 N, -130.003826 W
    - Collected around 05:14:23 UTC, 2018/08/25
    - Placed in gastight box on port side of basket
- 18.2 x 10 x 4.3 cm (LxWxH)

Note: Sample broke into 3 pieces when dropped into basket: GEO-13-01, GEO-13-02, GEO-13-03

GEO-13-01:

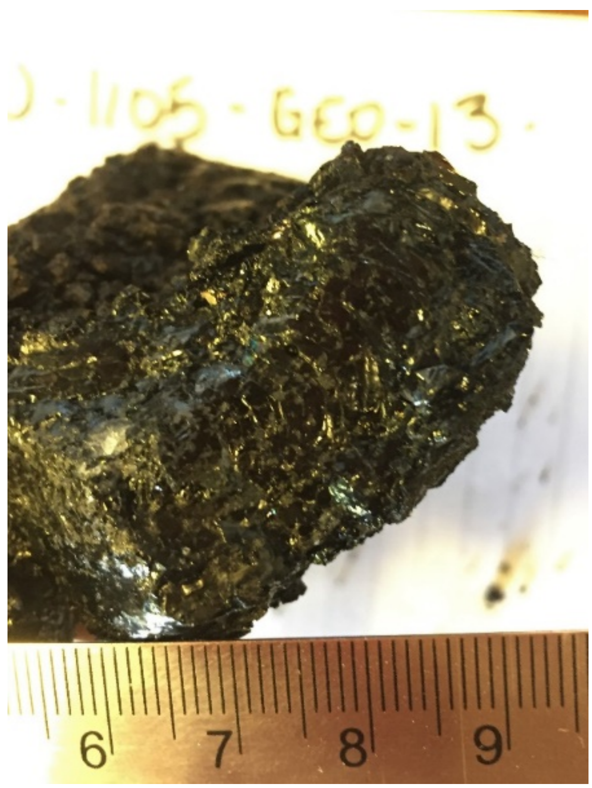
- LxWxH – 8.9 x 10 x 4.3 cm
- Has elongated, ovoid void in the center with a length diameter of 1.2 cm and a width diameter of 0.4 cm
- Multiple plagioclase crystals, < 1% of mass
    - Largest is prism, 0.55 x 0.35 cm
- Cooling rings in glass
- Visible transition between glass and more lithic materials, ~ 0.6 cm from rim
    - Lithic is aphanitic
- Few vesicles visible on either glassy or exposed surfaces
    - Largest is 1 mm in diameter
- Surface (glassy rind) is cracked and split in quench / cooling textures

GEO-13-02:

- LxWxH – 7.7 x 6.8 x 5 cm
- Similar to 13-01 in textures, still contains cooling rings in glass
- Transition between glass and lithics occurs ~ 0.6 cm from rim
  - Lithic material aphanitic, black
- No visible vesicles
- Cracked / split rind displaying quench / cooling textures
- 2 prominently visible plagioclase crystals on exposed break surface
  - Both ~ 0.4 cm long and ~ 0.35 cm wide

GEO-13-03:

- LxWxH – 4.9 x 3.6 x 3 cm
- Similar to previous two samples
  - Cooling ring still prominent
  - Glass rind ~ 0.6 cm thick from rim to transition
  - No visible vesicles
- Only one visible plagioclase crystal, spherical, ~ 1 mm in diameter
- More prominently lithic due to increased surface exposure, possibly due to the breaking during collection
- Lithic is aphanitic



J-1105-GEO-14

- Collected from surface pahoehoe / pillow lava flow from 2011 Bag City
    - Approx. 5 m from benchmark AX104
- Collected at ~1530m depth
    - 45° 54.96582 N, -129° 59.36880 W
    - Collected around 09:58:38 UTC, 2018/08/25
    - Placed in Majors box on starboard side of basket
- 17.7 x 11.4 x 8.9 cm (LxWxH)

Note: Sample broke into two pieces when dropped into the box: GEO-14-01, GEO-14-02

GEO-14-01:

- LxWxH – 12.6 x 6.4 x 8.3 cm
- Thick glass rind ~ 0.5 cm thick
    - Black, glossy, vitreous, easily breakable
- Lithic/glass transition easily distinguished in some places, less so in others
- Appears that the break point between sibling samples may have started as a pre-existing crack, as an oxidation outline is present
- Vesicle chains present, up to 0.6 cm in length
    - Individual vesicles ≤ 1.5 mm, most less than 0.5 mm
    - Larger ovoid / spherical void also present, ~ 0.6 cm in diameter, with a smaller companion ~ 0.25 cm in diameter
- Exposed surface of lithic retains oily sheen
    - Aphanitic, black

- One distinguishable plagioclase crystal present, ~ 1.5 mm in diameter
- Vesicle barrier present ~ 1.2 cm from rim/edge
    - 0.9 cm thick at its thickest point
    - Barrier extends along circumference of sample
    - Secondary barrier also present in center of sample
        - 1.6 cm of lithic material separates the two vesicle barriers

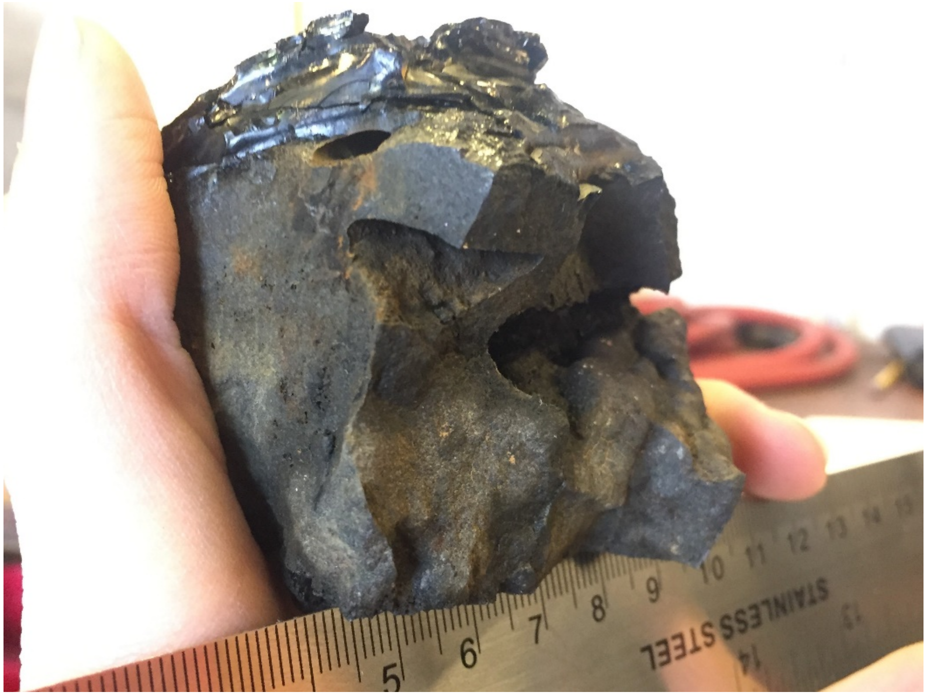
GEO-14-02:

- LxWxH – 10.2 x 10.8 x 8.9 cm
- Very thick glass rind, up to 1.4 cm thick
    - Black, glossy, vitreous
    - Matte quench coloration partially obscures glossy areas of rind
- Thick, sheened lithic and interior exposed surface
    - Aphanitic
- Minor vesicle chains present, < 0.4 cm in length
    - Largest visible vesicle is ~ 2 mm in diameter
    - Combined vesicles may create a void ~ 3 mm in diameter
- Small ring of surface oxidation on exposed surface, possible indication of an exposed crack / weakness between 14-01 and 14-02 prior to collection
- No visible plagioclase crystals

J-1105-GEO-15

- Collected from surface pahoehoe / pillow lava flow from 2011 Bag City
  - Approx. 5 m from benchmark AX104
- Collected at ~1529m depth
  - 45° 54.96750 N, -129° 59.36874 W
  - Collected around 10:12:38 UTC, 2018/08/25
  - Placed in Majors box on starboard side of basket
- 11.4 x 7.3 x 6.6 cm (LxWxH)

- Glass rind ~ 1.3 cm thick at thickest point
  - Matte glass, quenched, makes up ~80 % of rind
  - 20% of rind is glassy, black, vitreous, somewhat laminated
- Lithic exposed surface
  - Aphanitic, oily
- Minor vesicle groups forming near-bubble chains up to 0.5 cm long
- Largest vesicles ~ 2 mm in diameter
  - Small layer of horizontal vesicles ~ 0.8 cm below the glass/lithic transition
  - ≤ 0.4 cm wide
- Three stacked, horizontal voids
  - First – 0.5 cm wide, 0.2 cm high
  - Second – 1.9 cm wide, 0.7 cm high
  - Third – 5.2 cm wide, 0.9 cm high
- Minor surface oxidation
- One plagioclase crystal ~ 0.35 cm in diameter


STAINLESS STEEL

4.2 Fluid Sampling
Kevin Roe

Fluid samples were obtained from select high-temperature vents using bottles and not the PMEL EOI HFS sampler this year. The first sample attempted was using the Red major bottle #22 at Virgin Vent but the ram on the bottle was too long to be triggered by Jason's starboard arm. The sample was completed using another major (white).

dive	date	time	latitude	longitude	heading	altitude	depth	Comments	Virtual Van #
J2-1104	2018/08/23	20:24:32	45.93366	-130.01324	149	0.79	1540.7	SAMPLE: J1104-Major-01 at **Virgin Vent**. Tmax=245.5degC. White Major bottle 6C. Tail had good flow.	4948
J2-1104	2018/08/23	21:42:10	45.93357	-130.01373	255	4.04	1537.8	SAMPLE: J1104-Major-03 at **Inferno Vent**. Taken from top of chimney at large black smoker excavated for good flow. Tmax=302degC. Yellow bottle 20.	5181
J2-1105	2018/08/24	08:24:36	45.92654	-129.97953	239	15.04	1502.6	SAMPLE: J1105-Major-03 at **El Guapo**. At upper part of the vent where active pieces were exploding off. Major bottle #2. Tmax=330degC.	6168
J2-1105	2018/08/24	08:30:38	45.92654	-129.97953	240	15.04	1502.6	SAMPLE: J1105-Major-04 at **El Guapo**. Major bottle #1. Good flow deflection and sample. Same location at El Guapo. Tmax=330degC.	6187
J2-1105	2018/08/24	09:19:44	45.92638	-129.97904	215	1.76	1519.0	SAMPLE: J1105-Major-07 at **Diva Vent**. Anhydrite chimney knocked over prior to sampling for better flow. Red major bottle. Tmax=301degC.	6329
J2-1105	2018/08/24	23:50:45	45.91736	-129.99299	226	1.3	1531.1	SAMPLE: J1105-Major-10 at **Vixen**. Green bottle at Vixen with Tmax 321degC. Excavated venting orifice to get better flow.	8365

4.3 Gas Sampling

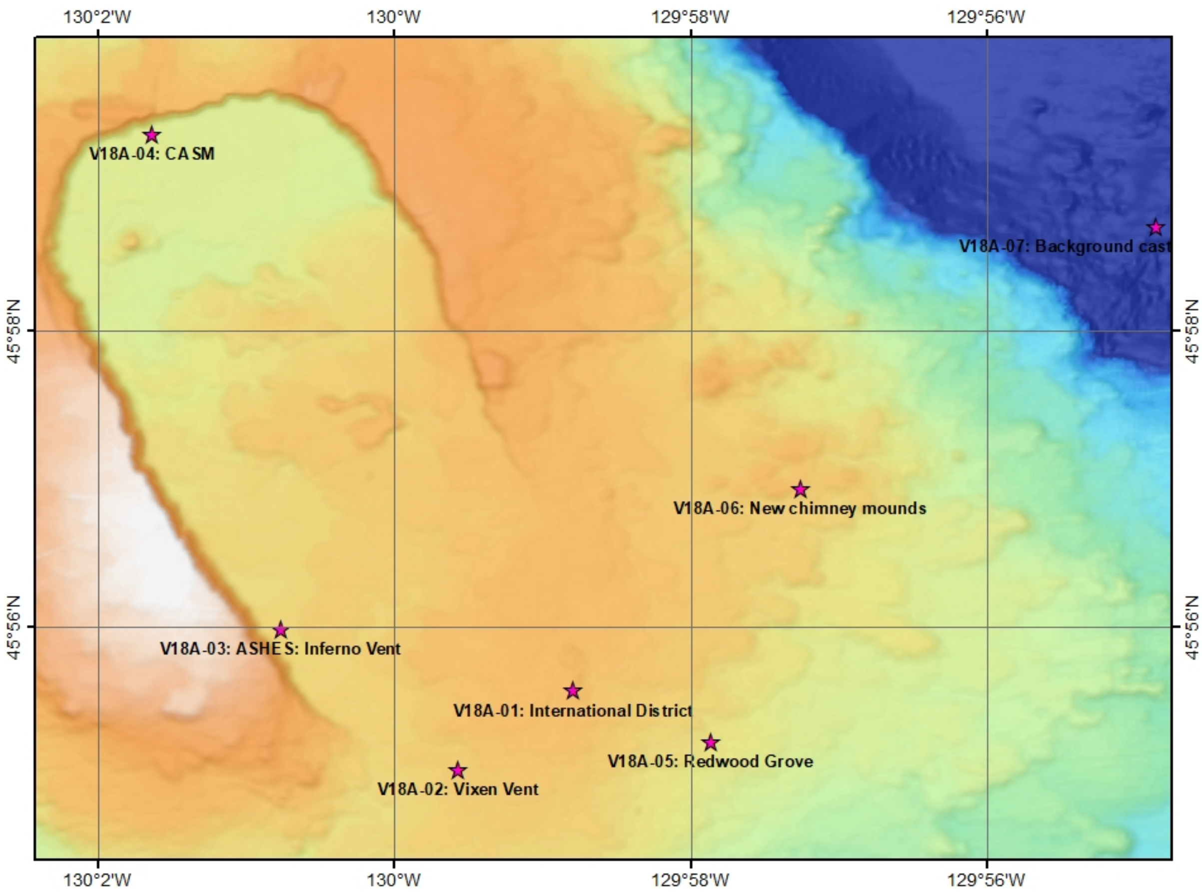
Gas samples were collected with titanium gas-tight bottles at select, high-temperature vents. Several of the gas samples failed to trigger (were empty when brought to the lab) and speculation is that bottles were not tight in the grip. The tape had been removed during pre-dive checks as it was too thick. During sampling it appeared the bottles had been triggered however movement of the o-ring movement did not occur.

dive	date	time	latitude	longitude	heading	altitude	depth	Comments	vv
J2-1104	2018/08/23	20:31:21	45.93366	-130.01324	149	0.8	1540.6	SAMPLE: J1104-GTB-02 at Virgin Vent. Tmax=245.5degC. Green bottle 2. GTB shifted forward slightly when triggered. Same place as J1104-Major-01.	4968
J2-1104	2018/08/23	21:50:12	45.93357	-130.01373	254	4.1	1537.8	SAMPLE: J1104-GTB-04 at Inferno Vent. Same location as J1104-Major-03. Tmax=302degC. Yellow/green GTB #12. (FAILED)	5205
J2-1105	2018/08/24	08:44:23	45.92654	-129.97953	239	15.0	1502.6	SAMPLE: J1105-GTB-05 at El Guapo. White bottle #17. Same location as majors. Tmax=330degC. (FAILED)	6227
J2-1105	2018/08/24	08:51:53	45.92654	-129.97953	240	15.0	1502.5	SAMPLE: J1105-GTB-06 at El Guapo. Same location as previous samples. Tmax=330degC. Red bottle #9.	6248
J2-1105	2018/08/24	09:27:52	45.92638	-129.97904	215	1.9	1518.9	SAMPLE: J1105-GTB-08 at Diva. Tmax=301degC. Same location as majors. Purple GTB bottle #11. (FAILED)	6356
J2-1105	2018/08/24	23:56:52	45.91736	-129.99299	226	1.3	1531.0	SAMPLE: J1105-GTB-11 at Vixen in the flow but not the sediment. Fired. Same location as the major sample with 321degC Tmax. Yellow GTB bottle #6.	8383

4.4 CTD Operations

2018 CTD casts were conducted consecutively while weather prevented ROV and AUV dives. Unfortunately, we discovered after the cruise that no data were logged for the 5th CTD cast (V18A-05) due to operator error.

CTD	latitude	longitude	depth	Site	Data File	20-Aug Time utc
V18A-01	45.92623	-129.97982	1500	International District	KM1812_cast1.hex	0329
V18A-02	45.91737	-129.99273	1510	Vixen Vent	KM1813_cast2.hex	0546
V18A-03	45.93314	-130.01271	1520	ASHES: Inferno Vent	KM1813_cast3.hex	0812
V18A-04	45.98872	-130.02713	1573	CASM	KM1813_cast4.hex	1108
V18A-05	45.92047	-129.96430	1558	Redwood Grove	KM1813_cast5.hex (failed to log data)	1345
V18A-06	45.94888	-129.95427	1535	New chimney mounds	KM1813_cast6.hex	1628
V18A-07	45.97836	-129.91438	1500	Background cast	KM1813_cast7.hex	1854



4.5 Axial Moorings

Chris Holm, Oregon State University

Objectives:

Recover 4 Bottom Pressure Recorders (BPRs) (BPR South, BPR Central, BPR West, BPR North)

Recover 1 Ocean Bottom Hydrophone (OBH)

Service and replace BPR and OBH Mooring Hardware

Service 4 BPR Instruments

Deploy 4 BPR Moorings and one OBH

Acoustic survey of mooring locations (if time permits)

OBH and BPR Recoveries

Day 1 on site the weather was determined to be unworkable for ROV or AUV operations so the decision was made to use the time to recover all moorings. Combined seas were 7-10ft with 25 to 30knt NW winds with gusts to 35knts. The ship was instructed to set up 1-2km from the mooring location and hold station with dynamic positioning, the enable code was sent to confirm good communications with the acoustic release, after a successful response was returned the release code was sent and mooring release was confirmed by ranging on the acoustic release. The transducer was held over the stern mid-ship which on the Kilo Moana is open due to the catamaran design. The transducer was lowered until the first strip of white tape was close to the air sear interface. All releases had good communications and were released without issue. It was necessary to listen using the headphones on a few to hear all the return pings as the deck box did not pick up every ping. After release it took about 20 minutes on average before the glass balls where spotted off the bow.

All moorings were recovered on 8/19/2018 using the capstan fairlead to the A-frame using turning blocks. The Capstan line was brought over to the port rail near the stern and fixed with a snap hook rated to 1500lbs and fixed to the end of a 24’ carbon fiber pole fabricated by OSU OOI. Two grappling hooks were also at the ready as the ship brought the glass balls down the port side. BPR North was recovered first using a grapple and ships stainless steel carabineer (rated to 1000lbs) on a pole. The carabineer was fouled with the grapple and side loaded upon lifting the first set of glass balls leaving it badly bent and at risk of failing at any time. A 3T Crosby snap hook on a stopper line (3/8” Spectra) was hooked in just below the first set of balls on the pear link and the line was made fast on a cleat before the glass balls were lowered to the deck. The carabineer was replaced with a ½” shackle and was hooked in to the pear link and the capstan was used to lift each section on board before stopping off and lowering to the deck. The last section of wire rope was brought over the wide mouth mooring block rigged to the a-frame.

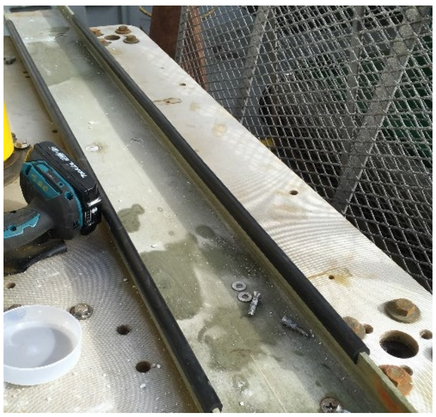
The OBH mooring was next followed by BPR Center, BPR west, and BPR South. For these moorings the 24’ pole and heavier snap hook was used and while grappling was attempted on each mooring the hook on a pole was the first successful connection on all but BPR Center. All mooring recoveries went smoothly after initial hook up was made and the mooring was towed out to stern before bringing onboard. No contact with the ship on any BPR or OBH instrument platforms was witnessed on recovery, BPR Center’s glass balls did come into contact with the ship’s hull during the “drive by” operation.

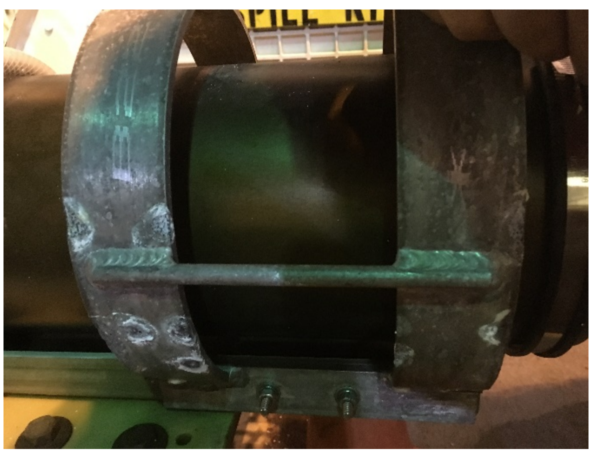
Mooring Refurbishment and Deployment

The weather for 8/20/2018 was similar to 8/19/2018 grounding ROV and AUV operations, which made a quick turnaround of the moorings advantageous. The OBH and BPR south were deployed on 8/20/18 PDT.

OBH Mooring

The OBH mooring was turned around first because it required the least amount of work to refurbish. The acoustic release was swapped with SN 54540, and OBH-6 was replaced with OBH-7. The rubber bicycle tubing was replaced with rubber edging from McMaster-Carr which was brought for the Mini BPR instruments. The aluminum guards on each end were removed and the stainless steel ¼-20 flat head screws were wrapped with electrical tape in order to attempt to isolate the SS from the aluminum as the guards were pretty badly corroded. In addition, some of the bike tubing was repurposed to use under the flat washers again to attempt isolation from the aluminum.






The best set of glass balls was selected from the group of recovered mooring gear for deployment of the OBH. The chain sections attached to the glass balls were not replaced, however all other chain, wire rope, line, and shackle connections were replaced with new equipment. All shackles were greased with Aquashield and hand tightened, cotter pins were installed and taped where they were near mooring line sections. Cotter pins were double checked before deployment and the acoustic release was tested prior to deployment. For deployment a slip line was attached to the pear link just below the first set of glass balls and another was attached to the pear link just below the last set of glass balls. The Balls were pushed off the deck by hand and lowered to the water using the slip line. Each set was then moved forward and subsequently pushed off continuing to slip the line off of a cleat. When clearing the first slip line, the line wrapped around the pipe attaching the first set of glass balls and took a bit of holding tension while it bounced in the waves before it let loose. The second slip line was cleared once the anchor was lifted with the capstan line using a brailer release provided by the ship.

This line was cleared without issue. The anchor was lowered to the water line and the release was tripped at 8/20/2018 22:45 UTC. This mooring is upright and the release was disabled.

BPR South

BPR South's acoustic release was replaced with SN 35256 which was tested on deck before deployment. The BPR appears to have recorded reasonable data for the entire deployment. During refurbishment it received new desiccant, o-rings, band clamps, and battery. The card was reformatted. All proof of life tests were passed and the data appeared to be stable. This mooring received reused glass balls and the chain sections were not replaced, however decent looking sections were selected from all the availble glass balls on board. The shackles, line, wire rope, and intermediate chain sections were all replaced. The BPR platform was also replaced on this mooring with a new one as the old table leg hardware showed signs of crevice corrosion on the stainless steel bolts. The U-Bolts were also replaced with grade 2 Titanium bolts and hardware provided. Care should be taken to have extra Titanium nuts and washers available for this mooring on future turns, as stainless hardware should not be used on the Titanium U-Bolts**.** All shackes were greased with Aquashield, hand tightened and cotter pinned, shackles near line sections were taped with electrical tape, leaving obvious pull tabs at the end of the tape. The mooring and cotter pins were doubled checked against the mooring diagram before deployment. On this deployment the set of three glass balls were set on deck in the wrong order anchor side balls outboard and flag side balls inboard, which required some reshuffling while releasing the slip line, this ordering was missed during the pre-deployment mooring check. The slip line set up was the same as in the OBH deployment, the first slip line also fouled on this deployment in a similar way to the OBH however wrapped well enough to require that the line was cut loose, leaving ~5m of line attached to the top float set. The rest of the deployment continued without issue and the anchor was released at 08/21/2018 01:11:15 UTC. This Mooring is upright and the release was disabled.

BPR North

BPR North's acoustic release was replaced with SN 54542 which was tested on deck before deployment. The BPR appears to have recorded reasonable data for the entire deployment. During refurbishment it received new desiccant, o-rings, band clamps, and battery. The card was reformatted. All proof of life tests were passed and the data appeared to be stable. This mooring was deployed with a new set of glass balls, chain, shackles, line, and wire rope. All shackes were greased with Aquashield, hand tightened and cotter pinned, shackles near line sections were taped with electrical tape, leaving obvious pull tabs at the end of the tape. The mooring and cotter pins were doubled checked against the mooring diagram before deployment. For this deployment we used the same slip line configuration as the previous two with similar results. The first slip line fouled around the first set of glass balls, luckily this one like the OBH only had one wrap and eventually came off. The second slip line released with no issues. While we were fighting with the first slip line the second line came tight and a set of glass balls held over the transom was flexed with audible sounds of cracking plastic. Once the slip line was free, we lowered the set off the transom, no visible signs of damage were observed and we continued the deployment. The BPR north anchor was released at 08/21/2018 16:12:57. This mooring's release needed the power turned up to 9 and receive gate 9, it also indicated it was horizontal not vertical and returns were weak. This release was disabled.

BPR Center

BPR Center's acoustic release was replaced with SN 33135. The BPR appears to have recorded reasonable data for the entire deployment. During refurbishment it received new desiccant, o-rings, band clamps, and battery. The card was reformatted. All proof of life tests were passed and the data appeared to be stable. This mooring was deployed with a new set of glass balls, chain, shackles, line, and wire rope. All shackes were greased with Aquashield, hand tightened and cotter pinned, shackles near line sections were taped with electrical tape, leaving obvious pull tabs at the end of the tape. The mooring and cotter pins were doubled checked against the mooring diagram before deployment. In addition all release codes were confirmed to be correct and the release was operational. On this deployment we finally learned from previous errors and only used a slip line in the pear link immediately below all of the glass balls. This meant the first set was allowed to drop, however the mooring line was used to control the decent. This went smoothly, and the second line was cleared without issue. This deployment went smoothly and the anchor was deployed at 08/21/2018 17:12:29. This mooring was upright and the releas was disabled.

BPR West

BPR west's acoustic release was replaced with SN 54673. The BPR appears to have recorded reasonable data for the entire deployment. During refurbishment it received new desiccant, o-rings, band clamps, and battery. The card was reformatted. All proof of life tests were passed and the data appeared to be stable. All release codes were confirmed and the release was tested. This mooring was deployed with an old set of glass balls, however there was time to swap both sections of chain that secured the glass balls with exception of the steel pipe in which no replacement was available. The steel pipe appeared to be in reasonable condition as the best availabe was selected from the remaining sets. The BPR platform was also replaced due to obvious crevice corrosion on the old table legs. The U-bolts were swapped on this platform as they appeared to be in reasonable condition therefore these U-bolts are 316 Stainess Steel. The shackles, line, wire rope, and intermediate chain sections were all replaced. All shackes were greased with Aquashield, hand tightened and cotter pinned, shackles near line sections were taped with electrical tape, leaving obvious pull tabs at the end of the tape. The mooring and cotter pins were doubled checked against the mooring diagram before deployment. On this deployment only one slip line was used on the pear link immediadly below the last set of glass balls and again the yalex moring line was used to control the decent of the first set of balls to the water. As with the other moorings a Brailer release provided by the ship and secured to the pear link immediately above the acoustic release was used to overboard the anchor and instrument platform and the anchor was released at 08/25/2018 14:47 UTC. This mooring is upright and the release was disabled.

Figure 4.6-1 Preparing the mooring for deployment (Morgan, Trevor, Chris and Matt)

Table 4.5-1: Recoveries

Instrument	Date (UTC)	Time (UTC)	Depth (m)	Latitude	Longitude	Comments
BPR-South-2	8/19/2018	23:53	1530	45.917787	-129.992868	time/location when instrument on deck
BPR-Center	8/19/2018	20:00	1530	45.944233	-130.016377	time/location when instrument on deck
BPR-West	8/19/2018	22:34	1418	45.911162	-129.990887	time/location when instrument on deck
BPR-North	8/19/2018	17:08	1578	45.971125	-130.020872	time/location when instrument on deck
OBH_Center	8/19/2018	21:24	1558	45.958567	-130.007243	time/location when instrument on deck

Table 4.5-2: Deployments

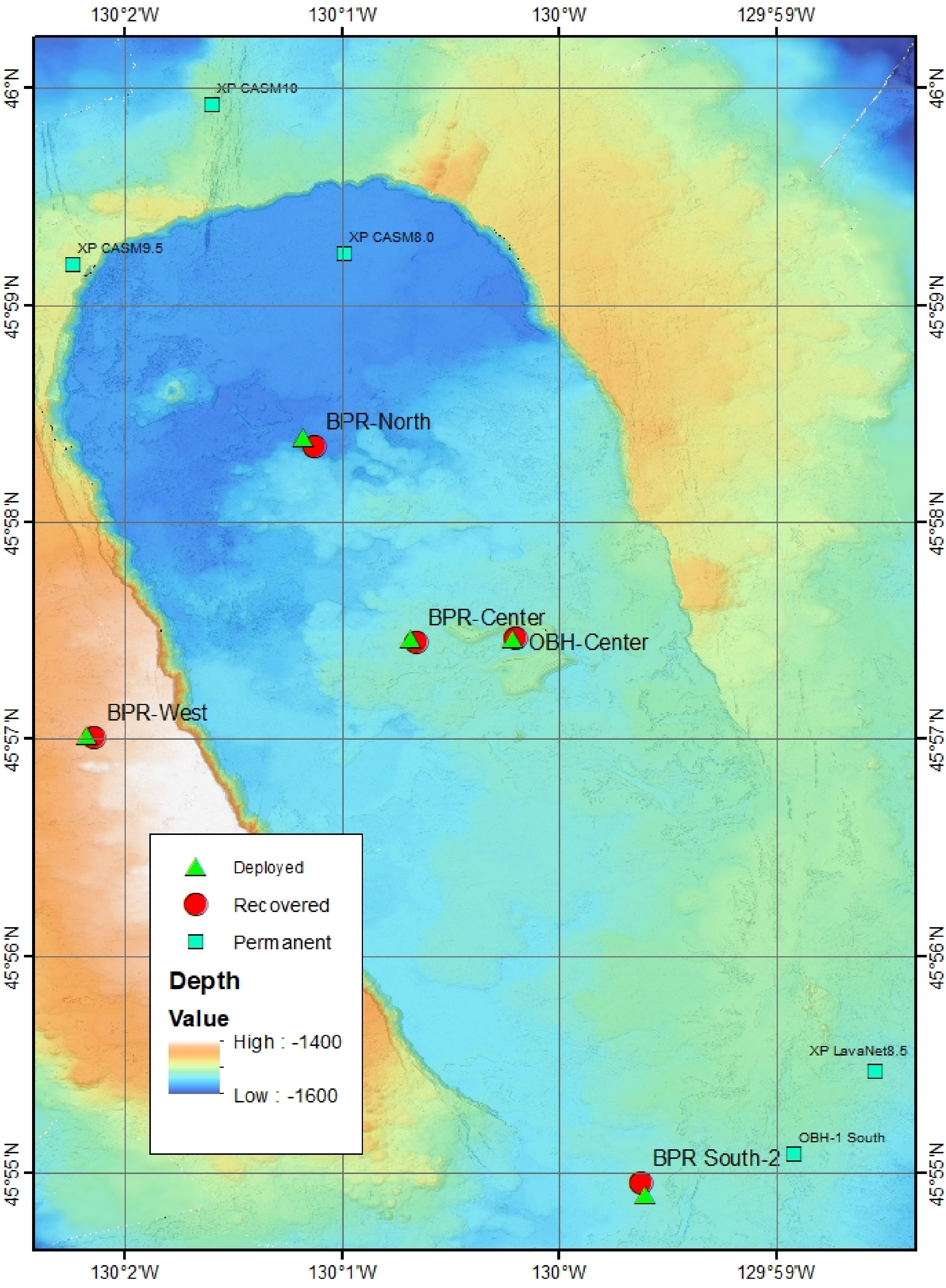
Instrument	Date (UTC)	Time (UTC)[1]	Depth (m)	Latitude[2]	Longitude[2]	Latitude[3]	Longitude[3]
BPR-South-2	8/21/2018	1:11:15	1537	45.915628	-129.993493	45.91516	-129.993333
BPR-Center	8/21/2018	17:12:29	1532	45.958578	-130.011127	45.957663	-130.011305
BPR-North	8/21/2018	16:12:57	1581	45.973843	-130.019435	45.973130	-130.019618
BPR-West	8/25/2018	21:47	1448	45.950393	-130.03683	45.950268	-130.036227
OBH	8/20/2018	22:45:00	1525	45.958245	-130.00408	45.957661	-130.003481

1) Time of Anchor release
2) Location from Ships log at time of Release
3) Surveyed Location

Table 4.5-3: Acoustic Release Codes

Instrument	Release S/N	Enable	Disable	Release	Comments
BPR-South-2	35256	107020	107045	126345	
BPR-Center	33135	321657	321674	335177	
BPR-North	54542	270107	270124	247370	Indicated it was Horizontal!
BPR-West	54673	271766	272014	250301	
OBH	54540	270013	270030	247336	

KM18-13 Moorings Deployed and Recovered



4.6 Mapping

4.7.1 EM122 multibeam data collected on 2 expeditions to Axial: KM1812 and KM1813

Susan G. Merle

Throughout expeditions KM1812 and KM1813 multibeam seafloor data were collected during transits and when the ROV could not dive due to weather. Surveys at Axial included an extensive survey of the south rift zone, and re-survey of the caldera and north rift zone. Water column data (wcd) were collected concurrently with seafloor bathymetry and backscatter on the Cascadia margin. No water column data were collected on the Juan de Fuca plate (Figure 4.7.1-1).

KM1812: 5601 km^2 seafloor coverage. Chief scientist Meg Tivey.
Lines 0000 through 0015 - only seafloor bathymetry and backscatter logged.
Lines 0015 through 0058 - wcd also collected on the Cascadia margin.
Regarding the wcd on KM1812: The students on board the *Kilo Moana* monitored the wcd collection and were instructed to change the log file whenever they saw a methane flare in the wcd display. That is not a proper practice as it breaks the flare data into 2 separate files, and also creates a lot more files than would be logged if one had just allowed the log files to change automatically every hour, as is the usual practice.

KM1813: 8354 km^2 seafloor coverage. Co-Chief scientists Scott Nooner and Bill Chadwick.
Lines 0000_20180818_165655 through 0030_20180827_101041 – seafloor bathymetry and backscatter logged.
Lines 0000_20180818_165655 through 0001_20180818_184410 – wcd logged on the margin during transit.
Lines 0016_0827_024445 – 0030_20180827_101041 – wcd logged on the margin during transit.

At the present time the wcd on the margin have not been analyzed. The seafloor data will need additional processing, although it will be impossible to get rid of some of the persistent artifacts in the data. Those include “washboard” swath edges, possibly due to a bad calibration number entered into the data acquisition software, or the need to re-calibrate the EM122 system on the *Kilo Moana*. The washboard edges effect is worse in areas of flat seafloor, but persisted throughout the surveys. Another artifact that is present throughout are 2 particular areas of bad beams either side of nadir (Figure 4.7.1-2). The data will be processed and made available to the community at National Centers for Environmental Information (NCEI) and Marine Geoscience Data System (MGDS).

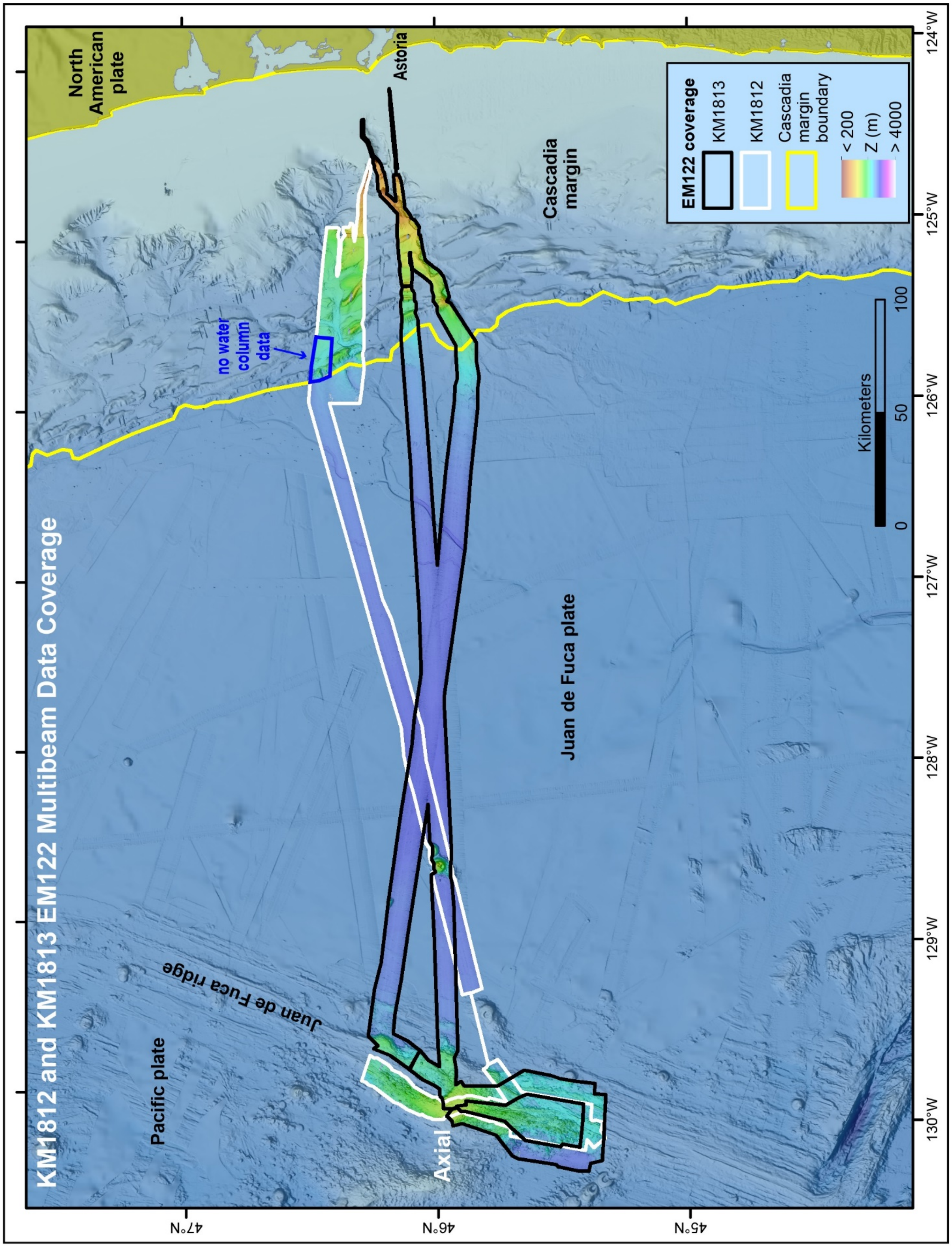


Figure 4.6.1-2 KM1812 and KM1813 EM133 data coverage.

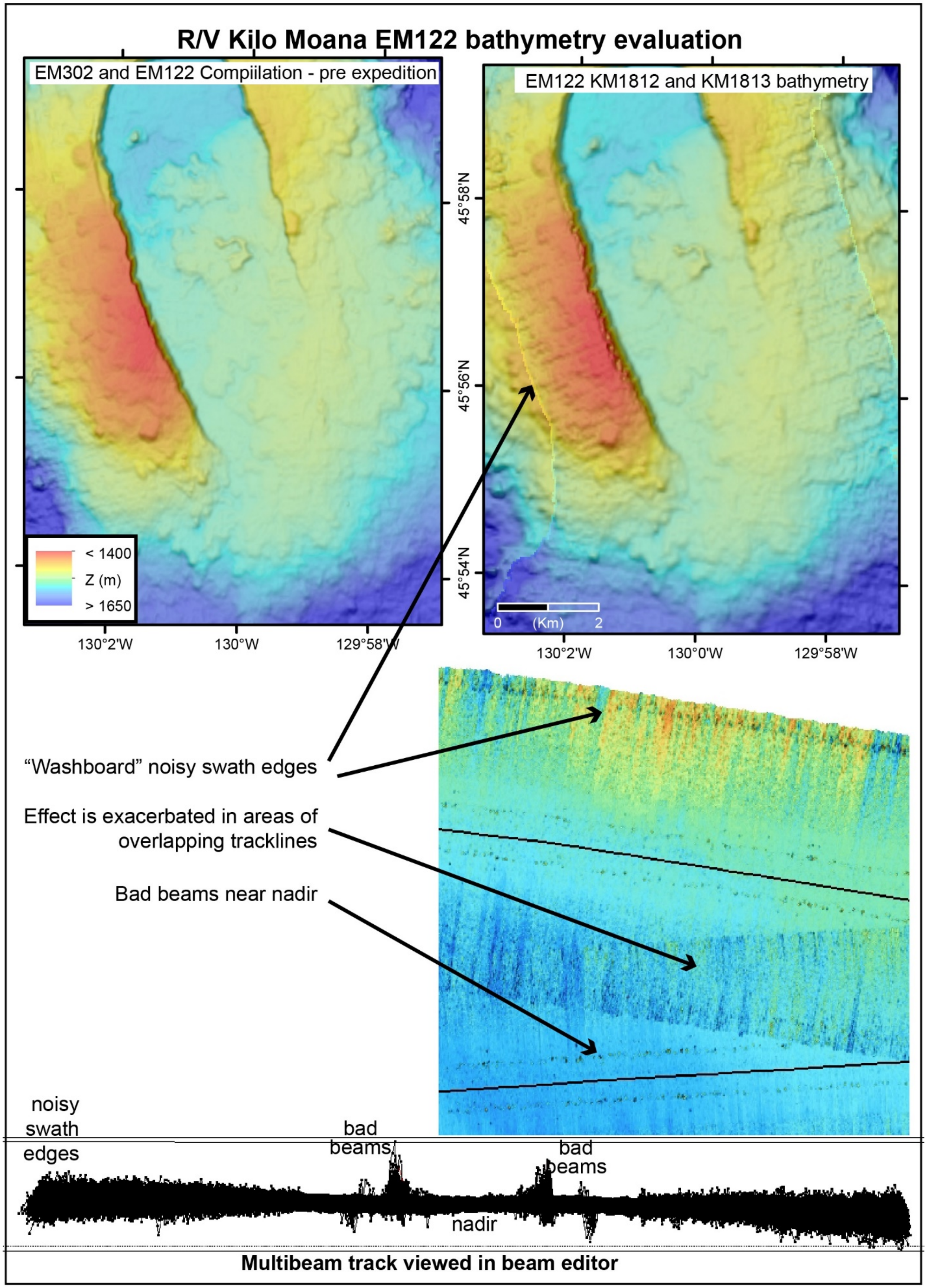


Figure 4.6.1-3 Bathymetry comparison.

4.6.2 Seafloor Mapping Using an MBARI Mapping AUV

David W. Caress, Jenny B. Paduan, Hans Thomas, Erik Trauschke, Emery Nolasco

4.6.2-1. Introduction

During KM1813 we deployed one of the Dorado class AUVs designed, built, and operated by MBARI to obtain 1-m- scale bathymetry and backscatter seafloor maps and chirp subbottom profiles. The purpose of these AUV surveys was to repeat a pattern of sparse survey lines extending across a 20-km N-S and 10-km E-W region that is centered on the Axial Seamount caldera. By comparing the 1-m resolution bathymetry with previous and future surveys, we will measure the vertical deformation of Axial Seamount due to subsurface processes. The caldera center BPR site has uplifted more than 1 m since the last eruption in 2015; this uplift results from the re-inflation of the subsurface magma reservoir. The repeated AUV surveys are being used to augment and expand the seafloor pressure measurement based deformation monitoring at Axial Seamount. The pressure data are higher vertical resolution (+- 1 cm) and are continuous in time, but are only being made at 10 benchmarks in the caldera and south rift zone. The AUV measurements of vertical depth change have a lower resolution of +-20 cm, but can be made over a much larger area and are spatially continuous along survey tracklines. Thus, the two techniques are complementary.

Due to weather limitations precluding AUV recoveries while ROV *Jason* was diving, we were limited to two AUV mission opportunities during KM1813. Both surveys were successful, and the combined 175 km survey track covers all but one outer line of the planned repeat survey pattern (Figure 1). This continues a time series begun with MBARI Mapping AUV surveys in 2011, 2014, and 2016 and AUV *Sentry* in 2015 and 2017. Multibeam bathymetry, 110 kHz sidescan, and 1-6 kHz subbottom data were collected. For the first time, a PMEL MAPR was installed in the MBARI AUV; MAPR data were successfully collected during the second mission only.

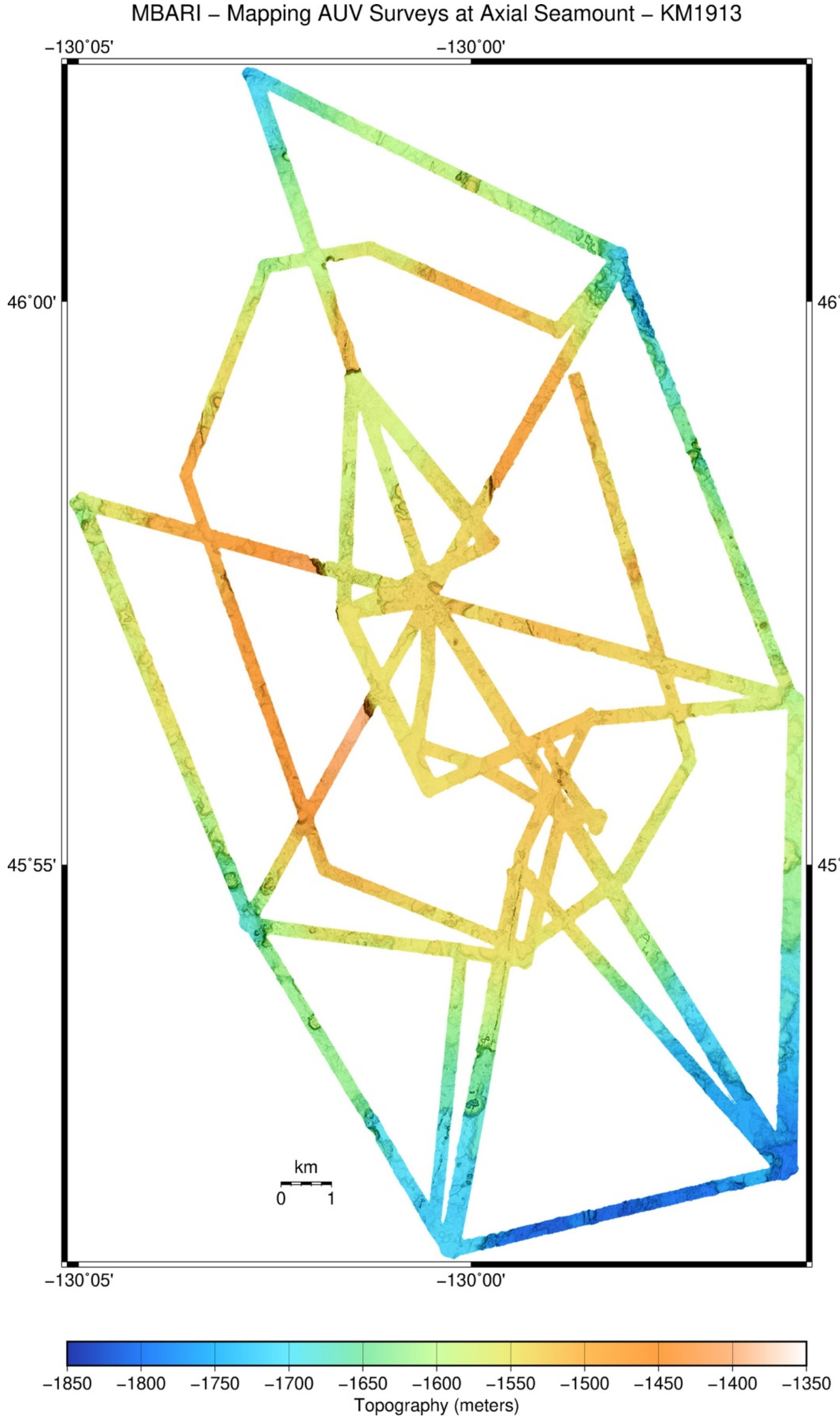


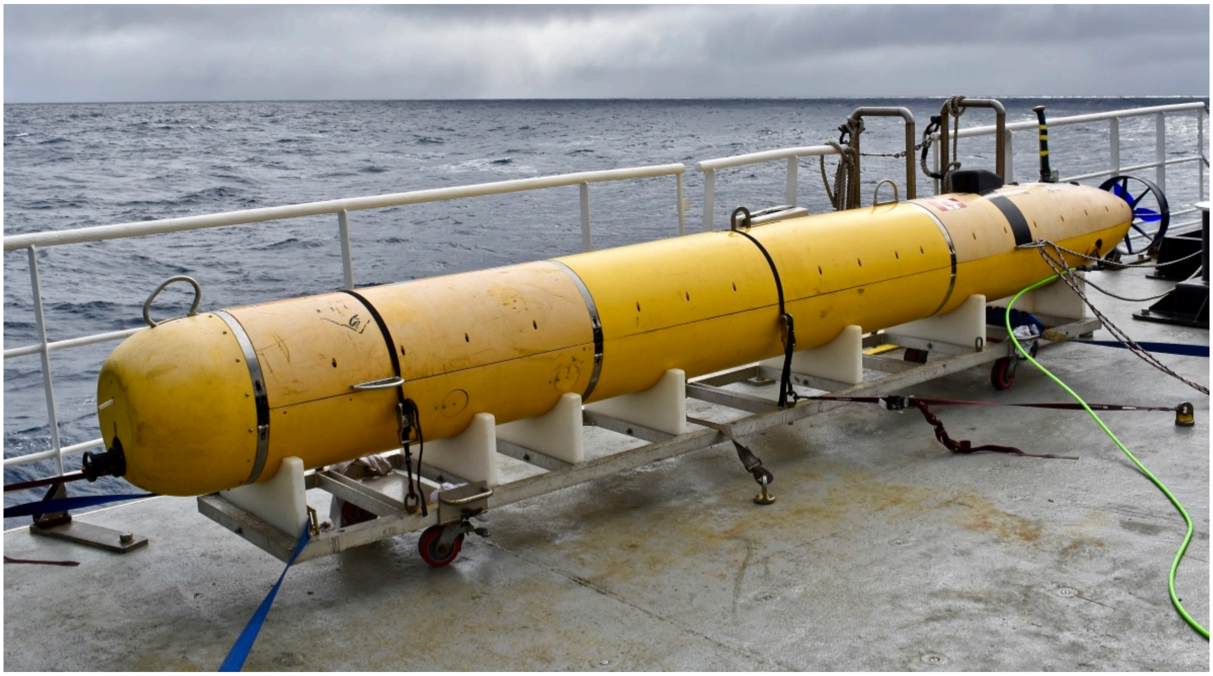
Figure 4.6.2-1. Coverage of the Axial Seamount summit by two Mapping AUV surveys during KM1813. These lines repeat coverage obtained in prior years using both MBARI Mapping AUVs and AUV *Sentry*.

Overview of MBARI Mapping AUVs

The MBARI mapping AUVs are 0.53 m diameter, torpedo-shaped, Dorado class autonomous underwater vehicles equipped with 400 kHz multibeam sonar, 110 and 410 kHz sidescan sonars, and a 1-6 kHz subbottom profiler (Figure 2). All components of the vehicles are rated to 6,000 m depth. Using precise navigation and attitude data from a laser-ring-gyro based inertial navigation system (INS) integrated with a Doppler velocity log (DVL) sonar, MBARI Mapping AUVs can image the deep-ocean seafloor and shallow subsurface structure with much greater resolution than is possible with sonars operated from surface vessels. Typical survey operations use a vehicle speed of 1.5 m per second (3 knots) and an altitude of 50 m to achieve about 1 m horizontal and 10 cm vertical resolution. Mission durations are up to 20 hours, allowing survey tracklines as long as 100 km. Battery recharge and data download between missions requires about 5 hours. The MBARI Dorado AUVs are maintained and operated by the AUV Group within the Division of Marine Operations. Since 2006, some 255 successful surveys have been conducted using the Mapping AUVs, including the two achieved during this expedition. MBARI Mapping AUVs have been operated on several non-MBARI vessels, include *R/V Thomas Thompson*, *R/V Atlantis*, *CCGS Sir Wilfrid Laurier*, *Ocean Researcher 1*, *Ocean Researcher 5*, the icebreaker *Araon,* and now the *R/V Kilo Moana*.

Although the vehicle fielded during KM1813 has been in operation for over a decade, many key systems have been upgraded or replaced as the available mapping and navigation technology has improved. The systems integrated with the Mapping AUV on this expedition include:

- Multibeam sonar: Reson 7125-AUV 400 kHz
- Sidescan sonar: Edgetech FSAU 110 kHz chirp sidescan
- Subbottom sonar: Edgetech FSAU 1-6 kHz subbottom profiler
- CTD: SeaBird Electronics SBE49 Fastcat CTD
- Doppler Velocity Log (DVL): 300 kHz Teledyne-RDI Workhorse Navigator DVL
- Inertial Navigation System (INS): Kearfott SeaDevil w/300 kHz DVL
- Pressure Sensor: Paroscientific 8CB4000 4000-m rated Intelligent Depth Sensor
- Ultra Short Baseline tracking beacon: Sonardyne AvTrak 6G
- Acoustic Modem: Teledyne-Benthos 3G LF Acoustic Modem, directional transducer
- Batteries: Two MBARI-design 5 kWhr battery spheres using lithium ion battery packs from Inspired Energy.
- MAPR: Eh sensor, nephelometer, temperature and pressure sensors, provided by PMEL.



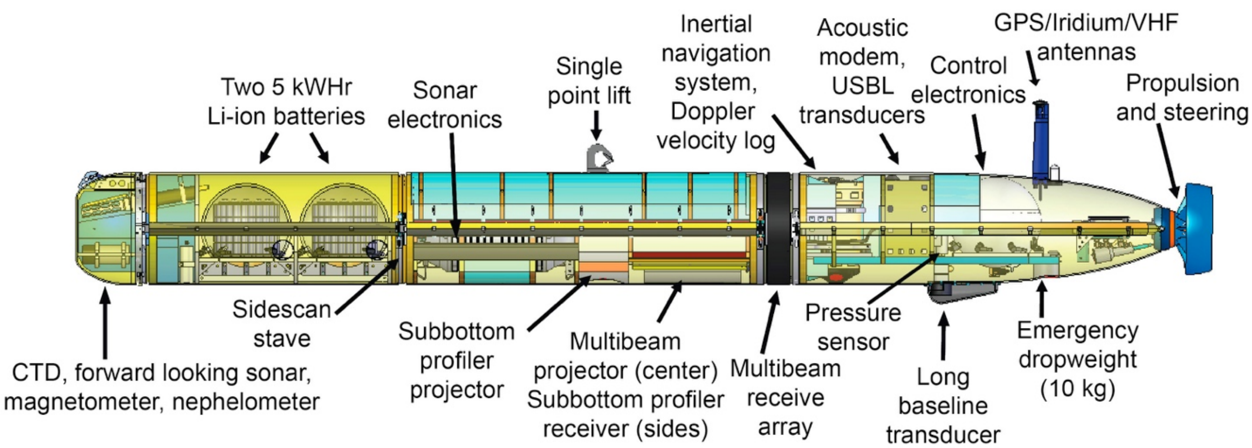


Figure 4.6.2-2: (Top) MBARI Mapping AUV secured on the R/V *Kilo Moana* aft deck during KM1813. The AUV was charged and maintained on the fantail. The AUV was launched from the stern using the ship's port crane, and recovered using the ship's stern A-frame. (Bottom) CAD drawing showing system level layout of the AUV internals.

MBARI Mapping AUV Mission 20180822m2

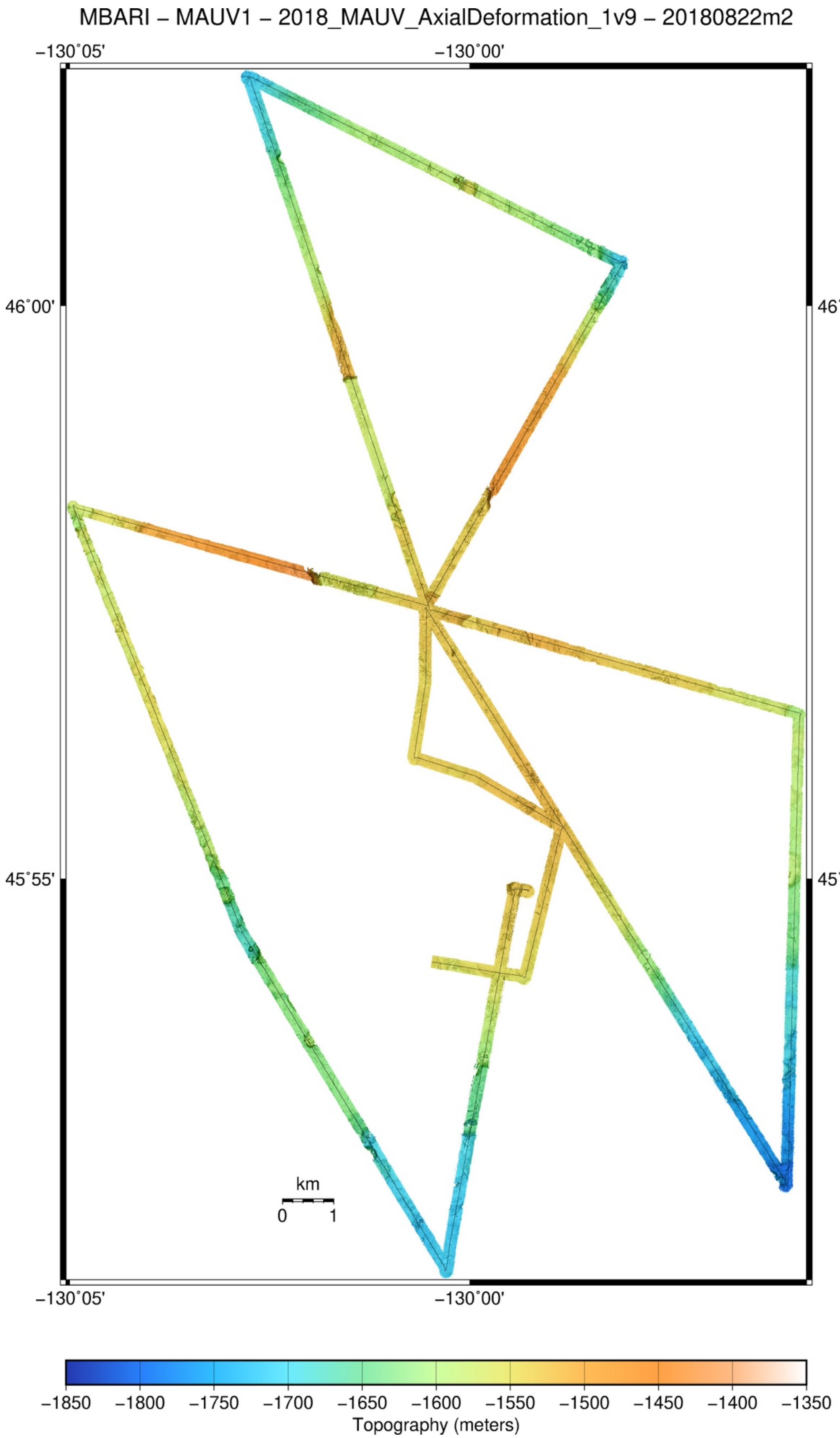
Navigation Totals:
Total Time: 16.0466 hours
Total Track Length: 83.2036 km
Average Speed: 5.1851 km/hr (2.8028 knots)

Start of Data:
Time: 08 23 2018 03:33:14.880000 JD235 (2018-08-23T03:33:14.880000)
Lon: -129.991013499 Lat: 45.915338393 Depth: 1528.7899 meters
Speed: 3.7058 km/hr (2.0031 knots) Heading: 170.3770 degrees
Sonar Depth: 1435.2000 m Sonar Altitude: 93.5900 m

End of Data:
Time: 08 23 2018 19:36:02.575999 JD235 (2018-08-23T19:36:02.575999)
Lon: -130.007880155 Lat: 45.904510962 Depth: 1545.0441 meters
Speed: 5.5081 km/hr (2.9773 knots) Heading: 279.9493 degrees
Sonar Depth: 1493.8965 m Sonar Altitude: 50.8988 m

Limits:
Minimum Longitude: -130.084048156 Maximum Longitude: -129.929441503
Minimum Latitude: 45.858422083 Maximum Latitude: 46.034585990
Minimum Sonar Depth: 1369.3589 Maximum Sonar Depth: 1744.8722
Minimum Altitude: 37.6349 Maximum Altitude: 167.6900
Minimum Depth: 1419.5920 Maximum Depth: 1805.8867
Minimum Amplitude: -16.2697 Maximum Amplitude: 85.9055
Minimum Sidescan: 0.0000 Maximum Sidescan: 2652.7832

Data Totals:
Number of Records: 180496
Bathymetry Data (512 beams):
  Number of Beams: 92413952
  Number of Good Beams: 67771589 73.33%
  Number of Zero Beams: 8889741 9.62%
  Number of Flagged Beams: 15752622 17.05%
Amplitude Data (512 beams):
  Number of Beams: 92413952
  Number of Good Beams: 67771589 73.33%
  Number of Zero Beams: 8889741 9.62%
  Number of Flagged Beams: 15752622 17.05%
Sidescan Data (2048 pixels):
  Number of Pixels: 369655808
  Number of Good Pixels: 82522667 22.32%
  Number of Zero Pixels: 0 0.00%
  Number of Flagged Pixels:287133141 77.68%



MBARI – MAUV1 – 2018_MAUV_AxialDeformation_1v9 – 20180822m2
−130˚05'
−130˚00'
46˚00'
45˚55'
km
0
1
−1850
−1800
−1750
−1700
−1650
−1600
−1550
−1500
−1450
−1400
−1350
Topography (meters)

MBARI Mapping AUV Mission 20180824m1

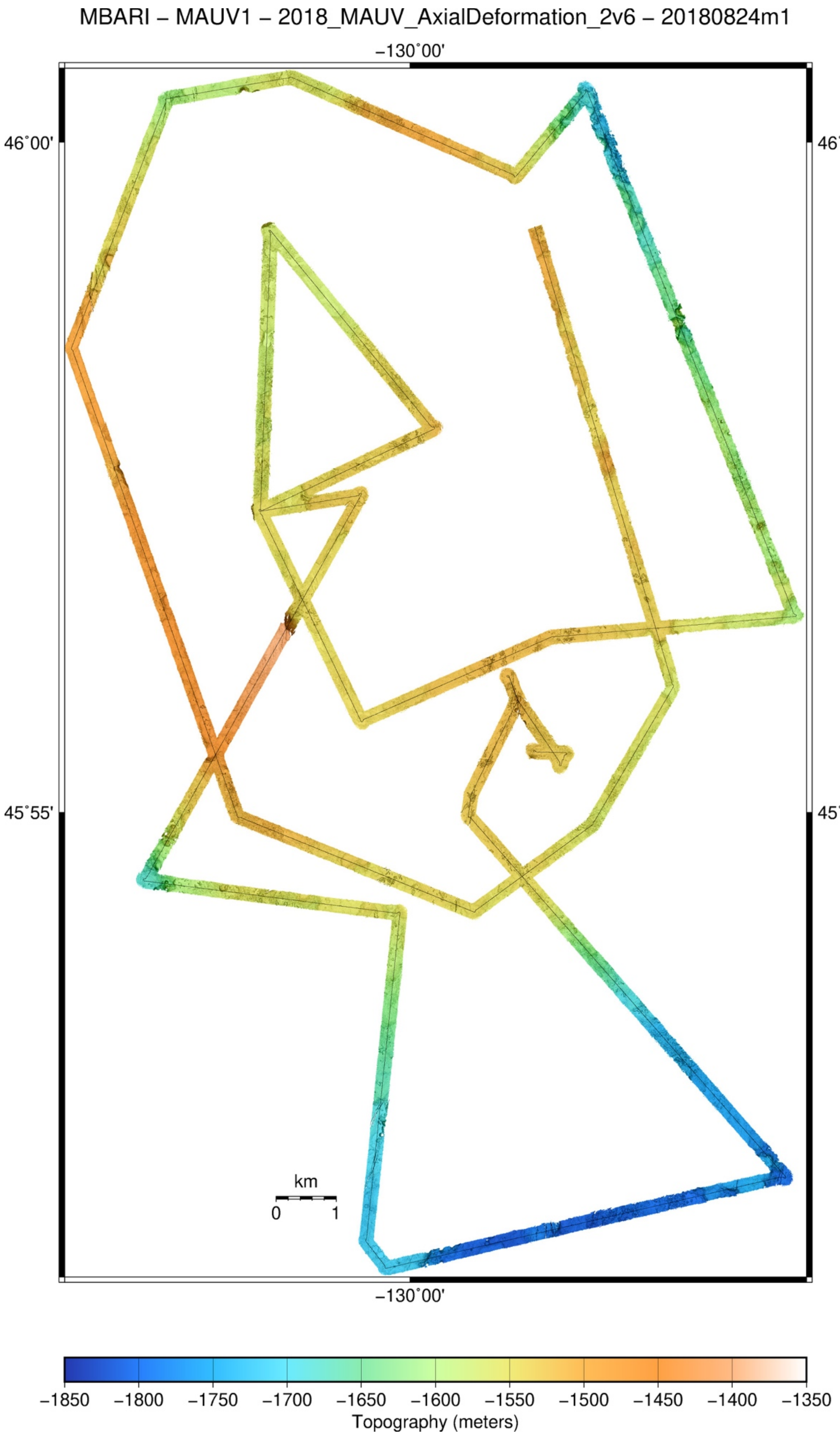
Navigation Totals:
Total Time: 18.1327 hours
Total Track Length: 92.2415 km
Average Speed: 5.0870 km/hr (2.7497 knots)

Start of Data:
Time: 08 24 2018 21:34:18.311000 JD236 (2018-08-24T21:34:18.311000)
Lon: -129.978205603 Lat: 45.923911661 Depth: 1527.3563 meters
Speed: 3.0714 km/hr (1.6602 knots) Heading: 323.2249 degrees
Sonar Depth: 1458.4463 m Sonar Altitude: 68.9100 m

End of Data:
Time: 08 25 2018 15:42:15.931999 JD237 (2018-08-25T15:42:15.931999)
Lon: -129.978158583 Lat: 45.989327572 Depth: 1513.2450 meters
Speed: 4.5136 km/hr (2.4398 knots) Heading: 341.8739 degrees
Sonar Depth: 1456.7244 m Sonar Altitude: 56.5100 m

Limits:
Minimum Longitude: -130.061939577 Maximum Longitude: -129.929597092
Minimum Latitude: 45.858387213 Maximum Latitude: 46.009061948
Minimum Sonar Depth: 1345.7491 Maximum Sonar Depth: 1769.1981
Minimum Altitude: 31.2347 Maximum Altitude: 111.9728
Minimum Depth: 1394.4458 Maximum Depth: 1838.0260
Minimum Amplitude: -17.5562 Maximum Amplitude: 91.0086
Minimum Sidescan: -262.5909 Maximum Sidescan: inf

Data Totals:
Number of Records: 203929
Bathymetry Data (512 beams):
  Number of Beams: 104411648
  Number of Good Beams: 76625550 73.39%
  Number of Zero Beams: 9772421 9.36%
  Number of Flagged Beams: 18013677 17.25%
Amplitude Data (512 beams):
  Number of Beams: 104411648
  Number of Good Beams: 76625550 73.39%
  Number of Zero Beams: 9772421 9.36%
  Number of Flagged Beams: 18013677 17.25%
Sidescan Data (2048 pixels):
  Number of Pixels: 417646592
  Number of Good Pixels: 93237397 22.32%
  Number of Zero Pixels: 0 0.00%
  Number of Flagged Pixels:324409195 77.68%


MBARI – MAUV1 – 2018_MAUV_AxialDeformation_2v6 – 20180824m1
−130˚00'
46˚00'
45˚55'
km
0
1
−1850
−1800
−1750
−1700
−1650
−1600
−1550
−1500
−1450
−1400
−1350
Topography (meters)

4.7 MAPR deployments
Bill Chadwick

Sharon Walker at PMEL sent two MAPR instruments (Miniature Autonomous Plume Recorders) for use on the cruise. MAPRs have temperature and depth sensors, as well as an ORP sensor (oxidation reduction potential) and a nephelometer.

MAPR #63 was used on the CTD for 7 casts in a row and had fresh batteries to start. However, when the data were downloaded, the Excel file did not include all the CTD casts - it ended abruptly in the middle of the 3rd of the 7 casts, apparently because LOGIC battery voltage on that MAPR had discharged faster than normal. That MAPR will be checked after the cruise.

MAPR #62 was placed on the MBARI AUV for its first dive, and it recorded data successfully, but those data were never downloaded (due to operator error), and then were overwritten and lost during the second dive of the MBARI AUV. Fortunately, those data were successfully downloaded after the 2nd MBARI AUV dive. Sharon Walker processed the MAPR data.

4.8 Hydrothermal Vent Temperature Recorders
Bill Chadwick

During the Jason ROV dives, we recovered HOBO-style high-temperature probes (aka MISO) at Castle, Diva, Trevi, and Vixen hydrothermal vents (all anhydrite chimneys). A HOBO probe was recovered at Virgin vent in July 2018 by UW colleagues during an OOI operations & maintenance cruise. Unfortunately, the probe at Vixen died, so no useful data were recorded there. Low-temperature MTR recorders were recovered from Anemone and Marker 33 Vents.

The following temperature probes were deployed in 2017 and recovered in 2018:

Vent name	Probe ID	Dive deployed	Dive recovered
Castle	MISO 153	J2-965	J2-1105
Diva	HOBO 130	J2-965	J2-1105
Virgin	HOBO 129	J2-966	J2-1074
Vixen	HOBO 151	J2-967	J2-1105
Trevi	HOBO 104	J2-967	J2-1105
Anemone	MTR 3197	J2-966	J2-1104
Marker-33 Vent	MTR 3048	J2-967	J2-1105

From these new data we have updated long-term plots of these temperature data at each vent. In each plot, there are trends in the maximum recorded temperature, but the excursions to lower temperature should be ignored, because they are largely due to the probes falling out of the vents. The two colors in parts of the plots are when probes with two independent sensors were used.

Observations:

• The Castle and Vixen records are 2001-2018 and 2001-2017, respectively. Castle shows rising temperature leading up to the 2011 eruption, and perhaps the 2015 eruption, but the record is pretty incomplete since 2011 (it's difficult to keep the probe in the vent there). The Vixen record has a moderate rise in temperature from 2001-2013 and has been declining since then. There is an apparent steep decline from 2015-2017 but it could be due to the probe being on the edge of the fluid flow.

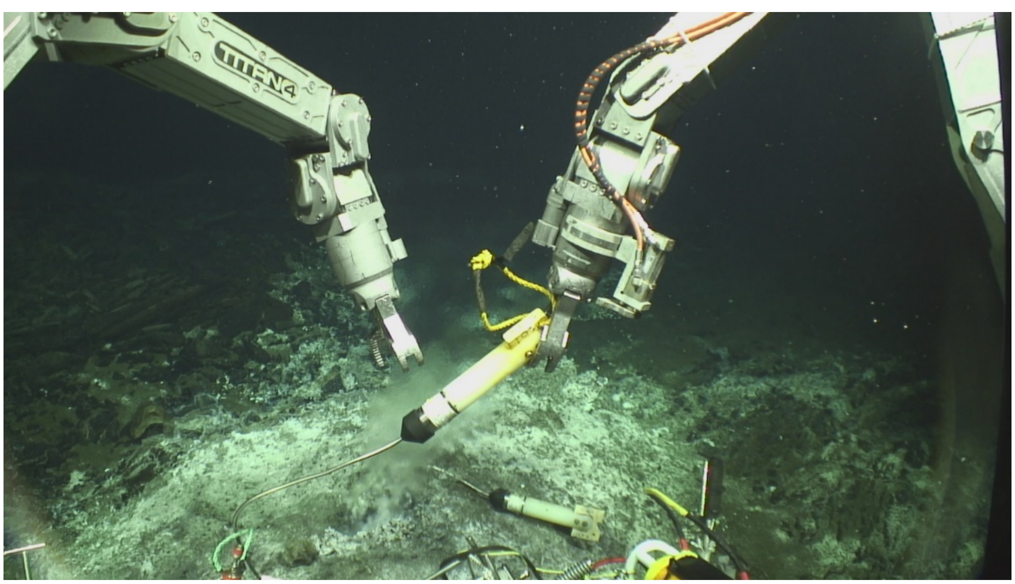
• The Diva and Trevi plots are both from 2010-2018. Diva was one of two probes showing a sudden temperature decrease during the 2011 eruption (the other was Casper; Vixen shows a small co-eruption decrease in 2015). Temperature at Diva rose before both the 2011 and 2015 eruptions and was lower afterward. At Trevi, temperature increased from 2011-2013 and has been declining since then.

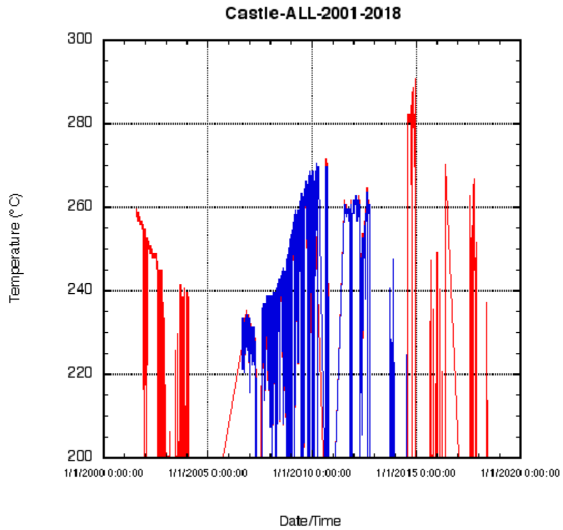
• The long-term plot from Virgin (1998-2018) shows a declining temperature since the 1998 eruption, but the record is not very complete.

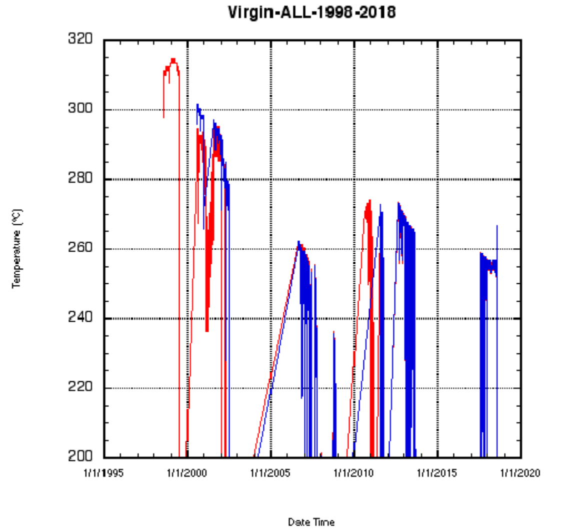
We currently have HOBO probes in the following vents: Castle, Diva, Vixen, and Trevi. A UW probe is in Virgin vent.

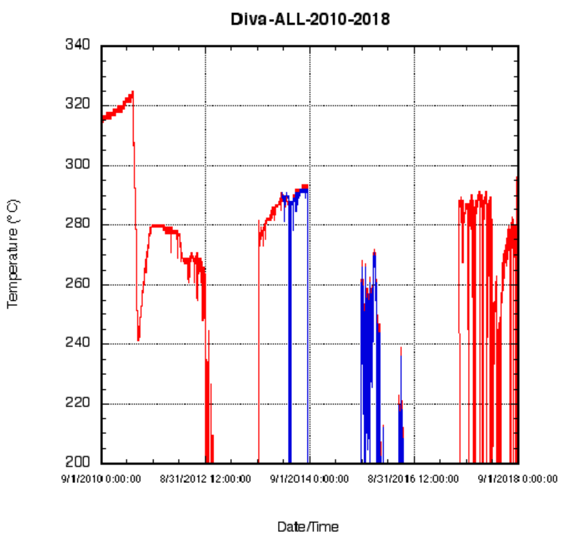
The following temperature probes were deployed in 2018:

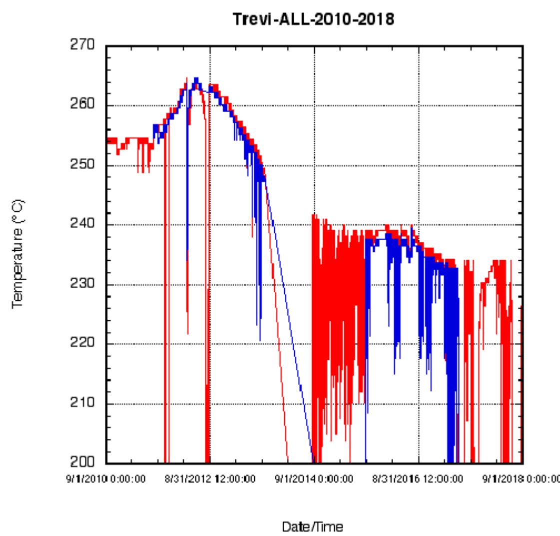
Vent name	**Probe ID**	**Dive Deployed**
Castle	MISO 129	J2-1105
Diva	MISO 102	J2-1105
Vixen	MISO 101	J2-1105
Trevi	MISO 103	J2-1105
Anemone	MTR 3052	J2-1104
Marker-33 Vent	MTR 3028	J2-1105

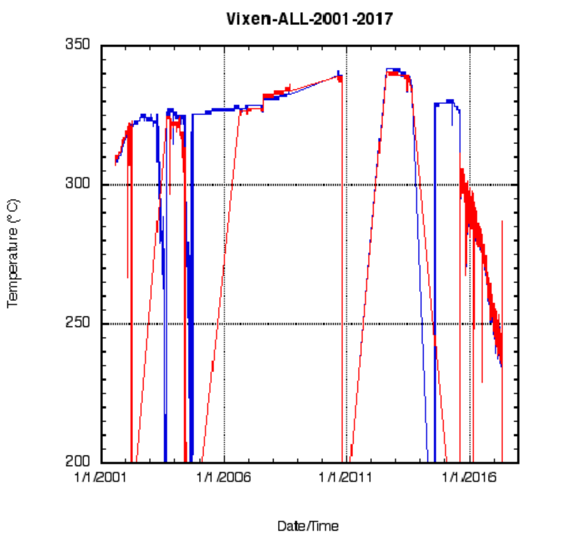


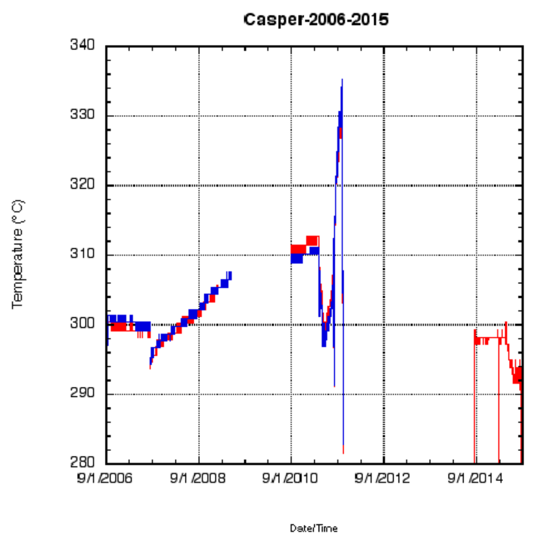

Castle-ALL-2001-2018
Temperature (°C)
Date/Time


Virgin-ALL-1998-2018
Temperature (°C)
Date Time


Diva-ALL-2010-2018
Temperature (°C)
Date/Time


Trevi-ALL-2010-2018
Temperature (°C)
Date/Time


Vixen-ALL-2001-2017
Temperature (°C)
Date/Time


Casper-2006-2015
Temperature (°C)
Date/Time

4.9 Outreach and Education

Bill Chadwick, Teresa Atwill, Andra Bobbitt

As in previous years, we maintained an on-line Cruise Blog for outreach and education at the following URL:

http://axial2018.blogspot.com

Teresa Atwill (Lincoln County School District) was our teacher-at-sea this year and wrote all the entries on the cruise blog. The blog entries were posted almost daily (10 posts in total). The blogs describe the science teams and the research conducted onboard the ship, with background information to help readers better understand the geologic setting and significance of our research at Axial Seamount. Images and videos were embedded in the blogs to help illustrate the operations, the people, the submersible vehicles we were using, and life on board the *R/V Kilo Moana.*

List of Blog posts:

- Introduction to 2018's Expedition
- Navigation, Is Where It's At
- Kilauea Volcano versus Axial Seamount
- Finding the Right Ship
- In the Water! At Last!
- It's an AUV! Not a Torpedo
- Accurate and Precise
- The Dive Plan!
- Our Next Gen Scientists
- Summary of the 2018 Expedition

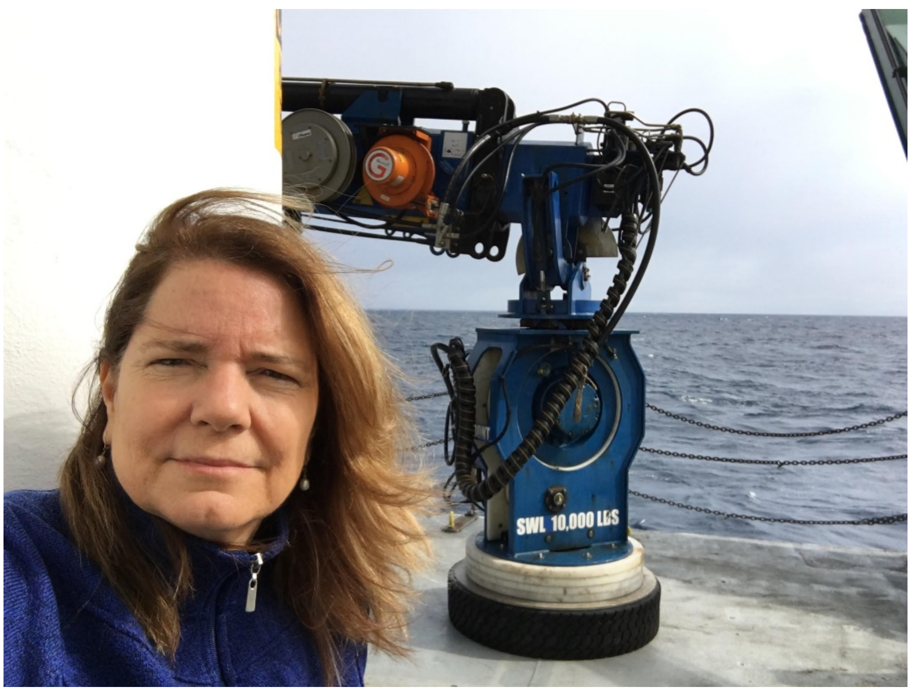


Figure 4.9-4 Teacher-at-sea Teresa Atwill.

5.0 JASON Imagery and Video

Bill Chadwick

The science camera on Jason this year was a new Sulis 4K video camera, so the video highlights are in higher resolution than before, and there was a new frame grabber integrated with the new camera. The video quality was very good, but we also noticed that the light sensitivity and the maximum zoom capability were a bit less that was possible with the previous mini-Zeus camera.

Automated H264 Continuous HD Video Recordings

Three 1080i camera streams (brow camera, pilot camera, science camera) were recorded to hard drive-based video files. Raw videos are MPEG Transport Stream (.ts) files compressed (output rate was 13 Mbps) using the H.264 codec. Image resolution is 1920x1080 pixels. These are playable using open source video players such as VLC. Filenames include camera name and start timestamp. Automated clip duration was set at 15 minutes. In addition to the video files, metadata broadcast in real-time on the Jason network was captured to subtitle files (.srt format), which can produce a line of text overlain on the video (time, lat, long, heading, depth). These components were merged into a Matroska container file (.mkv). Components are provided in subdirectories.

The following is a listing of the number of H264 files and the total file size

Dive	Number of H264 .mkv files	Total file size
J2-1104	659	731.3 Gb
J2-1105	446	509.9 Gb
Total	1105	1.241 Tb

4K High-Definition video highlights

Highlight video was recorded to hard disk at a higher quality format than the H264 recordings. This year for the first time, the highlight recordings were recorded in 4K (3840 x 2160 pixels) using the Apple ProRes422 family of codecs at a data rate of 563 Mbit/s, making them considerably larger than in previous years. The video files are renamed after each dive so that they indicate lowering ID, start time, and stop time. A summary listing of the highlight video clips are included in the table below. The recordings include time code that is synchronized to the same time reference as the other logging computers in the Jason system.

Dive	Number of .mov files	Total file size
J2-1104	49	659.2 Gb
J2-1105	48	701.9 Gb
Total	97	1.361 Tb

HD video frame grabs

With the new Sulis 4K camera, frame grabs can be captured at two different resolutions in two different ways. Frame grabs that are captured by the video loggers during a dive are recorded in HD resolution (1920x1080 pixels, from two of the many cameras on Jason simultaneously). The choice of the two camera is selectable, but usually included the Science Camera and another. These are saved as cam1 and cam2*.tif files (1920 x 1080 pixels) that are typically 6.2 Mb in size. File names include date and time.

Dive	Number of HD frame grabs	Total file size
J2-1104	2625	16.3 Gb
J2-1105	2057	12.8 Gb
Total	4682	29.1 Gb

4K video frame grabs

The 4K frame grabs from the Sulis camera have replaced the previous Super Scorpio digital still camera. These are captured using a button on the control box at the Watch Leader station in the Jason control van. Each image takes some time to process, so there is a limit to how many images you can capture in a short amount of time. The images are saved as sulis*.jpg files (5968 x 3352 pixels) with date and time in the file name. The files are 3-10 Mb in size. The 4K images are beautifully crisp.

Dive	Number of 4K frame grabs	Total file size
J2-1104	160	762.8 Mb
J2-1105	156	785.4 Mb
Total	316	1.548 Gb

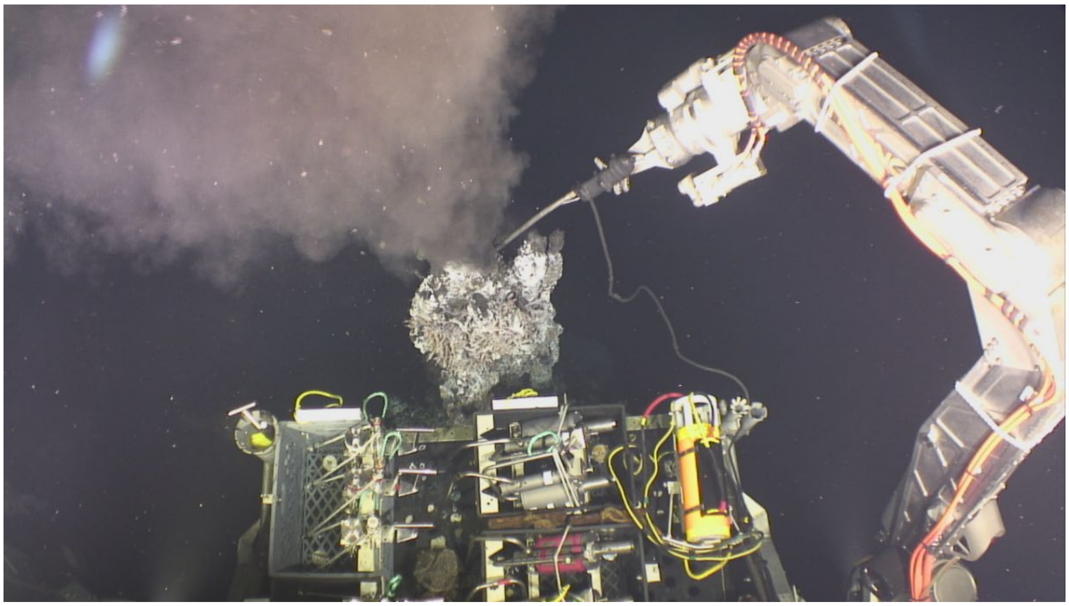


Figure 5-1 HD frame grab set to Brow camera: cam2_20180824081332.tif.

Figure 5-2 HD Frame grab at same time as above set to Science camera: cam1_20180824081332.tif.

6.0 JASON

6.1 Dive Statistics

JASON - Lowering Summaries (All Times GMT)

Lowering Id	Start/Launch	Start Ops	End Ops	End/On Deck	Bottom (Hrs:Mns:Secs)	Lowering (Hrs:Mns:Secs)
J2-1104	2018/08/21 19:37	2018/08/21 20:40	2018/08/23 22:24	2018/08/24 00:11	49:43	52:33
J2-1105	2018/08/24 03:40	2018/08/24 04:42	2018/08/25 16:30	2018/08/25 17:39	35:47	37:59

On Bottom			Off Bottom			Max Depth During Dive
(DecDegs)	(DecDegs)	(mtrs)	(DecDegs)	(DecDegs)	(mtrs)	
45.93138	-129.99881	1517	45.93255	-130.01324	1362	1717
45.92001	-129.96287	1551	45.94536	-130.00912	1537	1717

6.2 Dive Goals and Summaries

J2-1104:

DEPLOYMENT LOCATION: Benchmark AX-308

45° 55.896', -129° 59.928', Z=1533 m

Main goals: Make pressure measurements at array of seafloor benchmarks. Planned 3 transects of the benchmarks but dive cut short after 3rd visit to AX-106. Collected fluid samples at ASHES Vent Field at end of dive.

BASKET for this dive:	Also
4 Major sampler bottles	Jason high-temp probe
4 Gastight sampler bottles	2 markers (243, 290)
MPR instrument (electrically connected)	Benchmark cleaner brushes
2 HOBOS (101 & 103)	

Port Swing Arm	Starboard Swing Arm
2 mini-BPRs & 1 MTR (3028)	2 mini-BPRs & 1 MTR (3052)

TASKS:

1) Make pressure measurements at seafloor benchmarks (3 transects). Deploy all 4 Mini-BPRs on seafloor on 1st loop. Recover Mini-BPRs on 2nd or 3rd loop.

Benchmark	**Deploy**	**Recover**
AX-308 ->	Mini-BPR-08 (1st loop)	None
AX-106 (ASHES) ->	None	None
AX-307 ->	Mini-BPR-09 (1st loop)	Mini-BPR-10 (1st or 2nd)
AX-101 (Center) ->	None	None
AX-302 (Trevi) ->	Mini-BPR-12 (1st loop)	Mini-BPR-05 (1st or 2nd)
AX-309 ->	None	None
AX-303 (M33 vent) ->	None (next dive)	Mini-BPR-02 (2nd loop)
AX-310 (Int. Dist.) ->	None	None
AX-104 (Bag City) ->	None	None
AX-105 (S. Pillow Mound) ->	Mini-BPR-13 (1st loop)	Mini-BPR-04

2) After 3rd visit to AX-106 transited to ASHES Vent Field

- ASHES: Virgin Vent: temp-probe then 1 Major, 1 Gastight (Left HOBO at vent in place).
- ASHES: Inferno vent: temp-probe then 1 Major, 1 Gastight
- ASHES: Recovered MTR 3197 at Anemone diffuse vent. Deployed MTR-3052.

J2-1105:

DEPLOYMENT LOCATION: New Chimneys
45° 55.192', -129° 57.748', Z=1560 m

Main goals: Explore new chimneys, finish pressure measurements at array of seafloor benchmarks. Collect opportunistic fluid samples & temp probes.

<u>BASKET for this dive:</u>
4 Major sampler bottles
4 Gastight sampler bottles
MPR instrument (electrically connected)
2 HOBOS (101 & 103)

<u>Also</u>
Jason high-temp probe
2 markers (205, 218)
Cleaner brushes

<u>Port Swing Arm</u>
1 Mini-BPR-10 & 1 MTR (3028)

<u>Starboard Swing Arm</u>
2 HOBOs (102, 129)

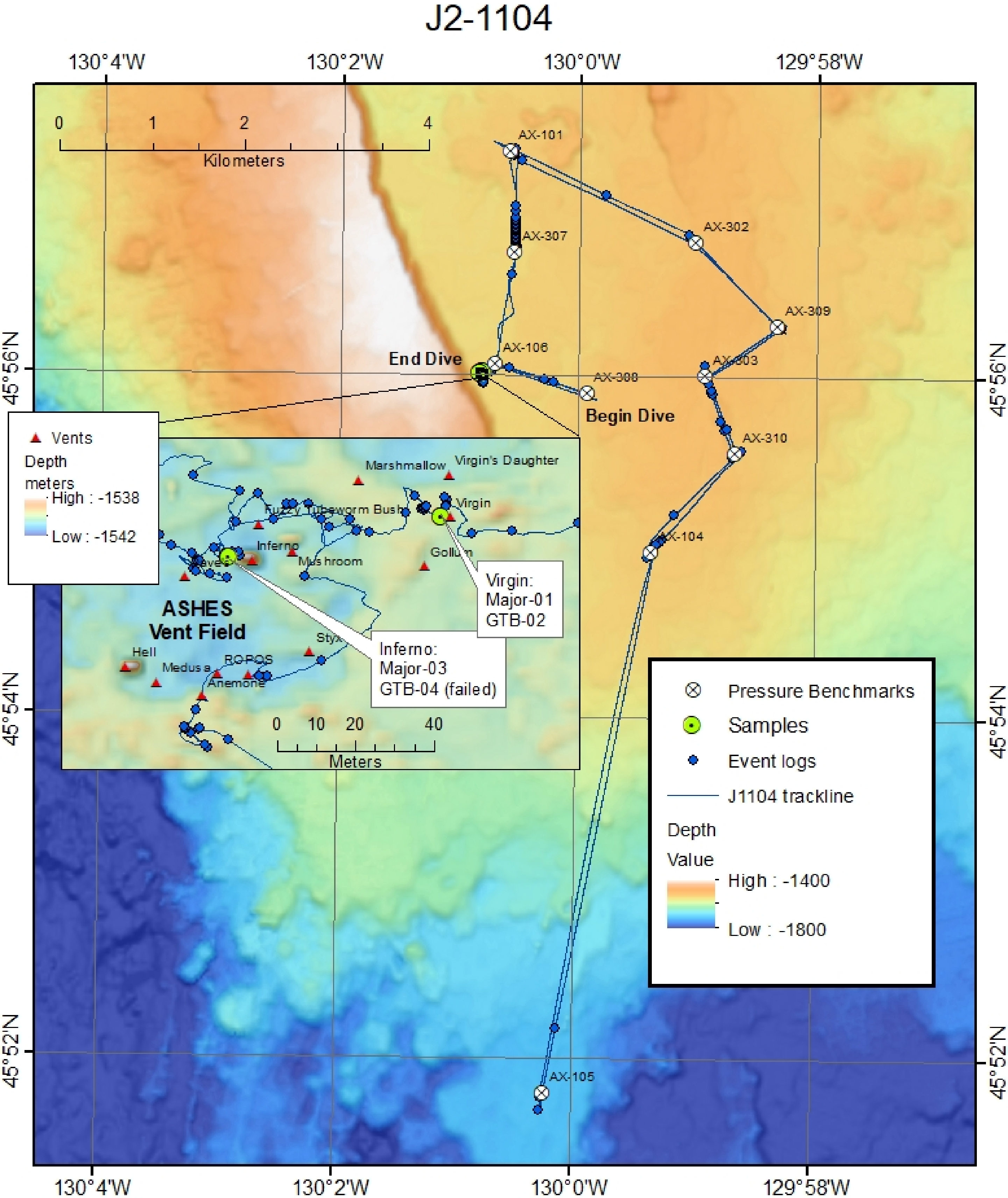
<u>TASKS:</u>
1) Explore New Chimney area. Took one rock sample from Redwood Grove.

2) Make pressure measurements at seafloor benchmarks. Deploy Mini-BPR-10 @ first visit to AX-303 (Marker 33 Vent). Later, recover Mini-BPR-04 from AX-105 (South Pillow Mound) during only visit there.

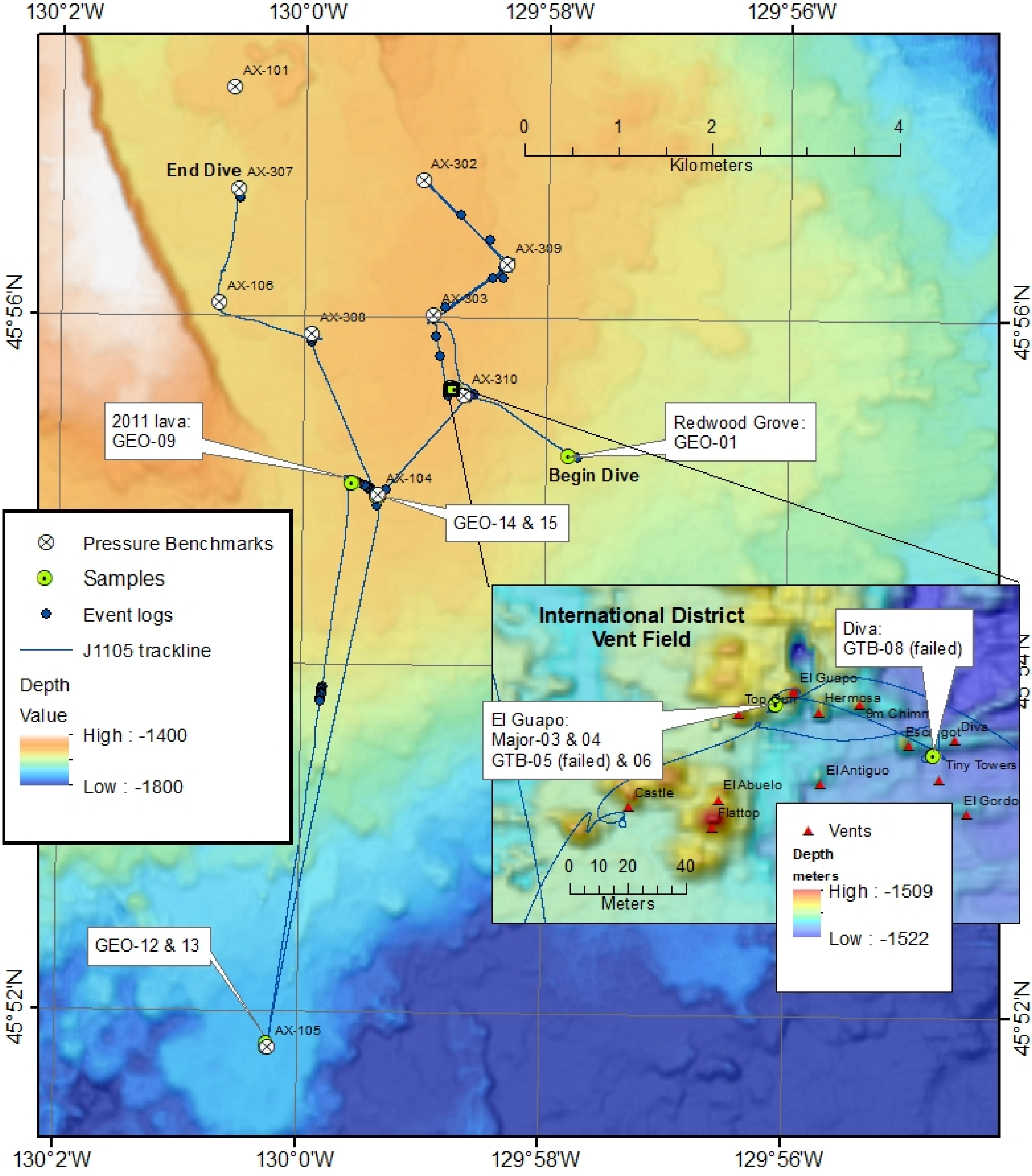
3) FLUID SAMPLING & TEMPERATURE SENSORS:
• International District:
  El Guapo (at top): temp-probe then 2 Majors, 2 Gastights
  Diva: temp-probe then 1 Major, 1 Gastight; swap HOBO 130 with HOBO-102.
  Castle: swap HOBO 153 for HOBO-129.
• M33 vent: swap MTR 3048 in vent with MTR 3028 from left swing arm box
• Trevi: recover HOBO 104, temp-probe then 1 Major, 1 Gastight, deploy HOBO-103.
• Vixen vent: recover HOBO 151, temp-probe, 1 Major, 1 Gastight, deploy HOBO-101.

4) Deployed new marker, Mkr-243 at AX-101.
5) Took rock samples in 2011 lava near AX-104 and miscellaneous rock samples at AX-105 and again at AX-104.

6.3 Jason Dive Maps



J2-1105



130°2'W
130°0'W
129°58'W
129°56'W
45°56'N
45°52'N
AX-101
End Dive AX-307
AX-302
AX-309
AX-106
AX-303
AX-308
AX-310
0 1 2 4
Kilometers
2011 lava:
GEO-09
Redwood Grove:
GEO-01
Begin Dive
AX-104
GEO-14 & 15
Pressure Benchmarks
Samples
Event logs
J1105 trackline
Depth
Value
High : -1400
Low : -1800
International District
Vent Field
Diva:
GTB-08 (failed)
El Guapo
Hermosa
9m Chimn
Diva
Tiny Towers
El Guapo:
Major-03 & 04
GTB-05 (failed) & 06
El Antiguo
El Abuelo
Castle
Flattop
El Gordo
0 10 20 40
Meters
Vents
Depth
meters
High : -1509
Low : -1522
GEO-12 & 13
AX-105

6.4 Jason Navigation

6.4.1 Offsets

Navigation positions for 2018 Jason dives were very good. The pressure benchmarks locations are ideal to use as baseline positions from year to year. Table 6.4-1 lists offsets from Jason RENAV positions for each benchmark visit. A few additional offsets are listed for ASHES and International District sites. The offsets were generally less than 10 meters and in most cases within 5 meters of the benchmark which is within visual range detection by Jason's pilots and cameras. The exception is the position of AX-309 which had a total offset of 15 meters.

Offsets for benchmarks were measured from the 25-m bathymetry grid compiled of EM302 and EM122 data by Susan Merle prior this expedition. Offsets at ASHES and International District sampling locations used 2017 MBARI AUV bathymetry grids which were shifted to match historical vent locations. The ASHES grid (axauvd1m) was shifted 13.2 X and -5.3 Y (meters). International District was shifted 10.5X -5.6Y meters (axauvc1m). For sampling in those areas, the shifted grids were used as Jason underlay maps during the dive and the offsets listed in Table 6.4-1 were from these grids.

The Redwood Grove offset was measured from a new MBARI AUV bathymetry grid provided as a geotiff. The chimneys were relatively easy to find due to their morphology (tall and skinny relative to the flat lavas surrounding them) on Jason's scanning sonar.

Dive	location	Total offset (m)	E-W offset	N-S offset	Notes
J1104	AX-308	8	7E	1.5S	1st visit
J1104	AX-106	4	3E	2S	1st visit
	AX-307	5.3	4.9W	1.3S	
	AX-101	4.2	4.2W		
	AX-302	1.3		1.3S	
	AX-309	15	3.5E	15N	
	AX-303	5.3	2.7E	5.2S	
	AX-310	1		1S	
	AX-104	5.8	5.8E		
	AX-105	2.6	0.7W	2.5S	
	Inferno	3.6	3.6W		Using the shifted 2017 bathymetry for ASHES (c-grid)
	Virgin	1.6	1.6W		
J1105	Castle	4	2W	3.5S	Sampling: Using shifted 2017 bathy for Int'l (d-grid)
	El Guapo	5.8	4.3W	3.7S	
	Diva	5.8	3.2W	4.5S	
	Vixen	4.6	2.7W	3.2N	
	Redwood Grove	31	11E	28S	Offset with geotiff from MBARI (noted in nav 30m north)

*Both dives had bad nav until bottom doppler reset
J1105 had some bad nav while sampling at Trevi 14:56:09; 14:57:28-15:28:15; 17:38:36 (kept logs and edited in a new stationary position).

6.4.2 Navigational Markers

Navigational markers were deployed on each dive to assist future site visits to these locations. On J2-1104 at AX-101 pressure benchmark, Mkr-243 was placed to the north of the site for better approach visibility. The old benchmark flag was not as visible compared to the newer marker design. Mkr-218 was placed at Vixen Vent on dive J2-1105 to quickly distinguish it from Casper on first approaches.

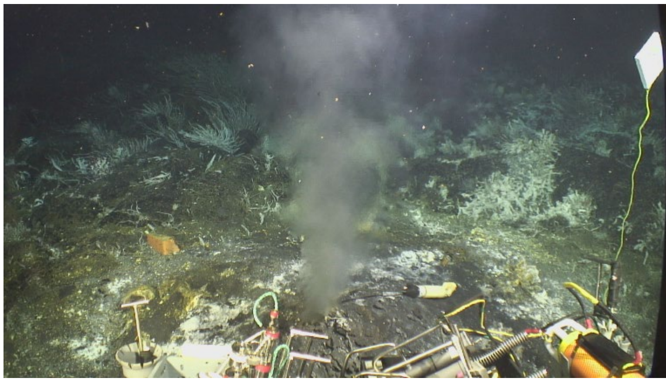
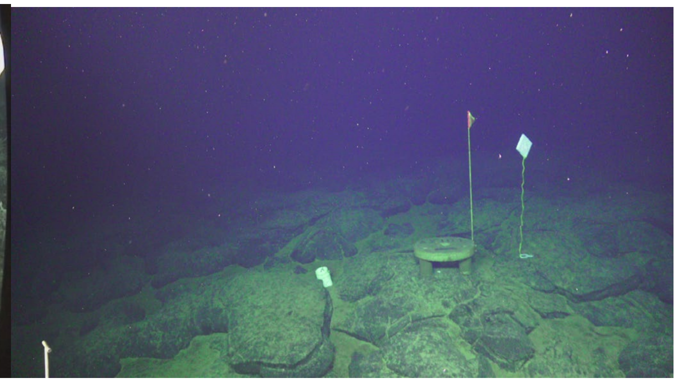



Figure 6.4.2-1 (left) Mkr-218 Vixen Vent with HOBO in place. Figure 6.4.2-2 (right) Mkr-243 at AX-101 (tephra bucket to left).

Table 6.4.2-1 Marker Deployments

Dive	date	time	latitude	longitude	Head	Alt	depth	Comments	Virtual Van #
J2-1104	8/23	12:43:49	45.95520	-130.00991	237	0.8	1528.9	**DEPLOY: Mkr-243.** DEPLOY marker Mkr-243 at AX-101. To the right of the benchmark landing at this heading.	3899
J2-1105	8/25	00:14:05	45.91736	-129.99299	226	1.4	1531.0	**DEPLOY: Mkr-218 at Vixen** to the right of the samples out of way. Marker anchor in line with HOBO orientation away from the vent.	8439

6.5 Jason Samples

Jason samples were collected on each dive and numbered sequentially as collected. Samples are named by dive, type and their collection number: Dive-type-Number, J1105-GEO-01 for example. The type in the name indicates the primary purpose of the sample and the description will indicate if there were subsamples of different types (such as rock collected that had biology on it). The time and date are GMT, not local times. Position information was evaluated after the dive to determine the best position within the cluster of fixes while stationary. The VV field is the Virtual Van record ID at the time the sample was being collected. Sample metadata is submitted to SESAR (System for Earth Sample Registration) at www.geosamples.org.

dive	date	time	latitude	longitude	Gyro	altitude	depth	Comments	type	vv
J2-1104	2018/08/23	20:24:32	45.93366	-130.01324	149	0.8	1540.7	SAMPLE: J1104-Major-01 at Virgin Vent. Tmax=245.5degC. White Major bottle 6C. Tail had good flow.	fluid	4948
J2-1104	2018/08/23	20:31:21	45.93366	-130.01324	149	0.8	1540.6	SAMPLE: J1104-GTB-02 at Virgin Vent. Tmax=245.5degC. Green bottle 2. GTB shifted forward slightly when triggered. Same place as J1104-Major-01.	gas	4968
J2-1104	2018/08/23	21:42:10	45.93357	-130.01373	255	4.0	1537.8	SAMPLE: J1104-Major-03 at Inferno Vent. Taken from top of chimney at large black smoker excavated for good flow. Tmax=302 degC. Yellow bottle 20.	fluid	5181
J2-1104	2018/08/23	21:50:12	45.93357	-130.01373	254	4.1	1537.8	SAMPLE: J1104-GTB-04 at Inferno Vent. Same location as J1104-Major-03. Tmax=302degC. Yellow/green GTB #12.	gas	5205
J2-1105	2018/08/24	05:24:41	45.92012	-129.96326	20	6.7	1553.2	SAMPLE: J1105-geo-01. GEO-01 sample from 6 meters up on the southernmost chimney located 45.920121 -129.963264. (Nav offset is 30m to south from bathymetry map). At Redwood Grove chimney field.	geo	5739
J2-1105	2018/08/24	08:24:36	45.92654	-129.97953	239	15.0	1502.6	SAMPLE: J1105-Major-03 Sample Major at El Guapo. At upper part of the vent where active pieces were exploding off. Major bottle #2. Tmax=330degC.	fluid	6168
J2-1105	2018/08/24	08:30:38	45.92654	-129.97953	240	15.0	1502.6	SAMPLE: J1105-Major-04 at El Guapo. Major bottle #1. Good flow deflection and sample. Same location at El Guapo. Tmax=330degC.	fluid	6187
J2-1105	2018/08/24	08:44:23	45.92654	-129.97953	239	15.0	1502.6	SAMPLE: J1105-GTB-05 at El Guapo. White bottle #17. Same location as majors. Tmax=330degC.	gas	6227
J2-1105	2018/08/24	08:51:53	45.92654	-129.97953	240	15.0	1502.5	SAMPLE: J1105-GTB-06 at El Guapo. Same location as previous samples. Tmax=330degC. Red bottle #9.	gas	6248

dive	date	time	latitude	longitude	Gyro	altitude	depth	Comments	type	vv
J2-1105	2018/08/24	09:19:44	45.92638	-129.97904	215	1.8	1519.0	SAMPLE: J1105-Major-07 at Diva Vent. Anhydrite chimney knocked over prior to sampling for better flow. Red major bottle. Tmax=301degC.	fluid	6329
J2-1105	2018/08/24	09:27:52	45.92638	-129.97904	215	1.9	1518.9	SAMPLE: J1105-GTB-08 at Diva. Tmax=301degC. Same location as majors. Purple GTB bottle #11.	gas	6356
J2-1105	2018/08/24	23:14:22	45.91618	-129.98952	332	0.8	1530.7	SAMPLE: J1105-Geo-09 Pillow bud of 2011 lava near Bag City. Location 45.9167197 -129.989535. Heading is 332 and depth is 1530m. Sample taken below the ridge that AX-104 sits on in the 2011 flow. Placed in port biobox.	geo	8258
J2-1105	2018/08/24	23:50:45	45.91736	-129.99299	226	1.3	1531.1	SAMPLE: J1105-Major-10 at Vixen. Green bottle at Vixen with Tmax 321degC. Excavated venting orifice to get better flow.	fluid	8365
J2-1105	2018/08/24	23:56:52	45.91736	-129.99299	226	1.3	1531.0	SAMPLE: J1105-GTB-11 at Vixen in the flow but not the sediment. Fired. Same location as the major sample with 321degC Tmax. Yellow GTB bottle #6.	gas	8383
J2-1105	2018/08/25	05:11:04	45.86310	-130.00384	337	0.9	1716.8	SAMPLE: J1105-GEO-12 Sample of lava flow adjacent to AX-105 45.863154 -130.003826.	geo	9064
J2-1105	2018/08/25	05:14:42	45.86349	-130.00377	337	0.9	1716.8	SAMPLE: J1105-GEO-13 from same location as GEO-12.	geo	9072
J2-1105	2018/08/25	09:59:58	45.91610	-129.98948	42	1.6	1530.2	SAMPLE: J1105-GEO-14: Near Bag City (AX-104) Lat: 45.916163 Long: -129.989527 Depth: 1528.9 m. Sample was placed in the starboard-side forward crate with the major samplers. Sample crumpled when placed in box. Downslope of Bag City/AX-104 ~5m from benchmark.	geo	9666
J2-1105	2018/08/25	10:12:46	45.91612	-129.98949	43	1.7	1530.1	Sample: J1105-GEO-15 was collected by Morgan and is placed at the top of the starboard-side forward crate on top of sample J1105-GEO-14 which was collected by Haley. Downslope of Bag City/AX-104 ~5m from benchmark.	geo	9693

6.6 Jason Dive Logs

This version of the cruise report does not include the dive logs (an additional 54 pages). The complete version which includes logs is available online at the Marine Geoscience Data System (MGDS):

www.marine-geo.org.

Additionally both the complete and this short version are available on the NOAA PMEL Earth-Ocean Interactions website at:

https://www.pmel.noaa.gov/eoi/axial_site.html.