Summary of High- and Low-T Time-Series Vent Fluid Temperature Experiments - East Pacific Rise Vents 9° 49'-51'N

EXTREME-1 Cruise - May, 1999
R/V ATLANTIS 03-34

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Abstract

In May, 1999, time-series temperature data from seven self-recording HOBO temperature probes deployed in seven high-temperature vents, and 23 low-temperature Vemco probes deployed in eight diffuse flow communities on the East Pacific Rise (EPR) crest in the 9° 49'-51'N area were recovered using Alvin. Preliminary, shipboard results indicate that between 1997 and 1999: (1) high-temperature vents within the BioTransect generally increased in temperature- Bio9Prime vent and Bio9 vent fluids increased ~7°C, and P vent increased 12°C; (2) high-temperature vents outside (north) of the BioTransect either experienced a decrease (e.g. BioVent decreased 4°C), or remained relatively constant (e.g. M Vent). Several temperature "events" are present in the data. Probably the most significant one is a temperature increase recorded in fluids from Bio9Prime and Bio9 vents from Nov. 28 to Dec. 17, 1997. Data show that a ~6°C to 10°C increase over a 4 to 5 day period occurred at these vents, and was followed by a relatively slow decline over weeks to a few months, and then a return to the pre-drop temperature. Fluid temperatures at P vent were variable during this period, in contrast to the relatively stability of fluid temperature for the rest of this deployment period. Detection of the Nov-Dec, 1997 temperature increase was also experienced by Vemco probes deployed within the Bio9 Riftia community, a low-temperature diffuse-flow Riftia tube worm-dominated community adjacent to the Bio9 and Bio9Prime vents. The onset of the temperature increase at the low-T diffuse flow site corresponds to the increase at the adjacent high-T vents. One other important geological event recorded by the HOBO probes occurred on February 6, 1998 between 1830-1900 hours local time. During that time the Bio9 chimney collapsed. Subsequent burial of the Bio9 Riftia Vemco array at the Bio9 Riftia area in the sulfide rubble, may have played a important role (despite the presence of elevated temperatures) in the demise of this once thriving Riftia community. Small variations in temperature (less than 3°C) within sites of diffuse vent flow, unoccupied by vent organisms at the northern end of the BioTransect (Bio9 and Bio12), contrast greatly with the large temporal variability (rapid 5°C to 20°C shifts) associated with tube worm and mussel-dominated communities in more southerly areas of the BioTransect. Spatial variability between individual Vemco probes separated by less than 0.5 meters within several developing communities in the BioTransect revealed temperature profiles that are frequently out of phase with each other. This may reflect the observed increase in spatial heterogeneity within vent organism microhabitats dominated by developing mussel populations within the tube worm communities. In many cases, both mobile and sessile fauna were living

interstitially within or attached to the probe arrays. Animals recovered from individual arrays were preserved and catalogued, and attached microbial constituents scraped for community analyses. At the end of the May 1999 Alvin dive program (EXTREME-1 Cruise), we successfully deployed 8 HOBO loggers at 8 high-T vents and 35 lowT Vemco Miniloggers in 9 arrays (including 4 vertical “stick” arrays with 5 probes banded at fixed distances) within 5 diffuse flow communities for long-term temperature monitoring. The deployed probes are schedule to be recovered in Spring 2000 on an Alvin diving cruise to the EPR crest. Analysis of existing data, including spectral analysis and tidal analysis is ongoing.

Time-Series Temperature Experiments - East Pacific Rise Vents 9° 49'-51'N
Preliminary Cruise Data Summary - D.J. Fornari & T.M. Shank
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Background

HOBO and Vemco temperature probes

Time-series temperature records for high-T and low-T diffuse vent sites in the axial trough of the East Pacific Rise (EPR) in the region 9° 49'-51'N have been collected since 1993 [Fornari et al., 1998a,b; Shank et al., 1997; 1998; Von Damm et al., 1995; 1997, submitted]. The instruments used to collect these data were developed by D. Fornari in collaboration with several commercial vendors (Onset Computer for HOBOs, and Vemco, Ltd. for the Miniloggers; Deep Sea Power and Light manufactures the titanium housings for both instruments) [Fornari et al., 1994; 1996]. HOBO Sealoggers are deployed at high-T vents (initial low-T measurements were made with HOBOs up to 1995), and since 1995, Vemco Miniloggers have been used at the low-T diffuse flow sites. The HOBO probes deployed in Nov. 1997 were programmed to record temperature every 30 minutes, and the Vemco probes every 15 minutes.

Calibration

High-T HOBO probes have been calibrated generally at 300°C, 350°C and 400°C using an IEEE calibrated oven, or an oven coupled to a IEEE calibrated platinum RTD digital thermometer. In some cases, especially post deployment, we find that there are probes with ~7-10°C (normally probe reads lower than oven temp.) variations at the calibration temperatures. We believe this is principally due to our inability to insert the probe tip fully into the oven block after it has been bent and dinged by the Alvin manipulators on deployment/recovery, or by encrustations while embedded in the chimney wall. In general, the HOBO temperatures agree very well with Alvin hi-T probe measurements made in the same orifices, after a correction for the assumed cold junction is applied. High-T HOBO data have a resolution of 1°C.

For the Vemco probes, we do not have a calibrated oven block suitable for calibration so we use the manufacturer's calibration curves and normally immerse the probes in an ice bath and let them equilibrate and then bring them to room temperature. We have noted that values for ambient seafloor water temperatures recorded by the Vemco Miniloggers agree very well with the Alvin low-T and window temperature measurements recorded during each dive. Low-T Vemco data have a resolution of 0.1°C.

Deployment/Recovery

High-T HOBO probes are deployed by the Alvin pilots in open vent orifices that have been sampled for fluids and corresponding sulfide. In nearly all cases a high-T Alvin probe temperature measurement is recorded. While we have tried to deploy probes in the same chimney orifice over the multi-year time series, consideration is given to whether the eventual position of the probe may be compromised by the evolving chimney structure and venting fluids. We have frequently found that within a few days to a week, the HOBO probes have been cemented into the chimney wall by growth of several centimeters to 0.5 m of sulfide, and that the bottom ~10 cm of the probe tip is well inside the orifice where it is bathed by the venting fluids. The platinum RTD temperature sensor of the HOBOs is located within a centimeter of the end of each probe.

During this cruise, we successfully deployed 8 HOBO loggers at 8 high-T vents (Figures 1 and 2). We expect to recover them on an Alvin/Atlanits cruise to be scheduled for the Spring of 2000.

Low-T Vemco Miniloggers were deployed within a variety of diffuse flow biological communities using spatial references to bottom markers which were deployed in 1992 and 1993. Typically, Vemco arrays consist of two to five, ~15cm-long probes banded together (like sticks of dynamite) with the result that the probe tips are ~2.5 cm apart (Figure 3). This configuration permits both replicate data as well as our ability to discern temporal variations in temperature changes over very small spatial scales. Miniloggers deployed in 1997 were deployed in pairs, except for one "Stick" array deployed near the 3A Marker at the 141 tube worm community [Shank et al., 1998].

We successfully redeployed 35 Miniloggers in 9 arrays during this cruise, each recording every 10 minutes for a 454 day recording period; we expect to recover them on an Alvin cruise to be scheduled for the Spring, 2000 time period. We banded 3 Miniloggers together for all sites except the Marker 141 site. At the Marker 141 site, where we also have repeatedly deployed time-lapse video and 35mm camera systems, we fabricated 4 vertical "stick" arrays consisting of ~1m long, 0.5cm" diameter Extren fiberglass rods with 5 probes banded at fixed distances. The Miniloggers on the "Sticks" were configured with 2 pairs of probes with their tips separated by 23 cm, and the 5th probe 23 cm above the 2nd set. The "Sticks" were deployed vertically, in a nearly linear N-S array across the now mussel-dominated Marker 141 community over a ~2m area, within the field of view of both time-lapse camera systems (Figure 4). Separation between each stick is ~0.5-1.0m.

Instrument Problems and Unrecoverable Probes

Over the six years that we have been deploying temperature loggers at the EPR vents several of them have not been able to be recovered. The past cruise was no exception in regards to the high-T HOBOs. One logger was completely destroyed by hot venting fluids at Q vent, and one HOBO was lost because it became embedded into IO vent (Figure 1), which had dramatically increased in venting activity, height (was ~2m and is now ~9m tall), and girth (was ~1m wide and is now >2m diameter) since Nov. 1997. We presume that the HOBO is now incorporated into the IO chimney structure on the NW side of the vent.

We also experienced low battery power in 4 of the recovered HOBO probes which caused the recordings to stop in Sept. 1998. The lithium batteries in these loggers were supposed to last for 5 years, however, it is evident that long-term exposure to low temperatures at the ocean floor decreased the battery capacity. We rebatteried all loggers prior to their redeployment on this leg, and will now routinely change batteries after each recovery to avoid this problem.

All the low-T Vemco Miniloggers deployed in 1997 were recovered from the diffuse flow sites, although some were completely buried in the tube worm and mussel communities and were only visible due to the orange reflective tape or the yellow polypro line used as the marker for each array.

1995-1999 Time-Series Temperature Recordings - Preliminary Results

Data were recovered on this cruise from 7 high-T vents and 8 low-T diffuse flow sites shown in Figure 1 and Tables 1-3. Table 4 provides a compilation of high-T Alvin temperature probe data which compares vent fluid temperatures in Nov. 1997 and May 1999. Figures 5-7 provide overall high-T records for the HOBO probes for 1997-1999 deployments, compiled data for 1995-1999, and some detailed plots of interesting variations. Figures 8-9 show selected plots for low-T Vemco data from the Bio9 Riftia diffuse flow vent area. Below are brief discussions of the time-series data for the past two deployments of temperature loggers from 1995 to 1999.

High-T HOBO Data 1995-1999

BioVent is the northernmost high-T vent in our study area (located near 9° 51’N on the western rim of the axial trough, Figure 1), and based on towed camera and Alvin dives is the only high-T vent on the EPR crest between ~9° 51’N and 9° 55’N. In 1995, HOBO data indicate BioVent fluids were 352°C. In 1997, BioVent fluid temperatures were 343°-345°C. At the end of the recording period in Sept. 1998, BioVent fluid temperatures had decreased to 341°C.

M Vent is the next vent south of Biovent and is located on the eastern wall of the axial trough at 9° 50.8’N (Figure 1). In 1995, M vent fluid temperature based on HOBO data was 358°-360°C (Alvin high-T probe measured 365°C- uncorrected). The time-series fluid temperature record for this vent is extraordinary in that we see no variations greater than a few degrees, or within the 1°C resolution of the HOBO probe. Uncorrected, Alvin high-T probe temperature for M vent in May 1999 was also 365°C. For 4 years, M vent fluid temperature recorded at 30 min intervals by the HOBO probes has been nearly constant at ~358°-360°C. This stability is in marked contrast to the fluid temperature records for high-T vents south of M, in the BioTransect area (Figures 5 and 6).

Three high-T vents are located near the northern limit of the BioTransect area- Bio9Prime, Bio9, and P vents (Figure 1). The general character and setting of these vents has been discussed by Fornari et al. [1998] and Shank et al., [1998]. Bio9Prime and Bio9 vents are located within a few meters of each other along the primary eruptive fissure for the 1991 eruption [Haymon et al., 1993; Fornari et al., 1998]. The only other high-T vents within the northern Transect region are at P vent which is located ~50 m south of Bio9 vent.

In March 1995, the HOBO record for Bio9 vent showed an abrupt temperature increase that has been correlated to a microseismic swarm [Sohn et al., 1998; Fornari et al., 1998b] which resulted from fracturing in the lower crust presumably induced by the evolving hydrothermal fluid circulation pattern and the resulting thermal stresses in lower crustal rocks. One of the important findings of this work has been the identification of the 4-day residence time of hydrothermal fluids in the upflow limb of a circulation system below the Bio9 vent. Since early 1995, fluid temperatures at Bio9Prime and Bio9 vents increased from ~365°C to 372°C in Nov. 1997 (Figure 5).

There are five noteworthy, preliminary observations which we can make regarding the time-series temperature records for Bio9, Bio9Prime and P vents in the 1995 to 1999 time period. They are:

1) a temperature event that was recorded at all three vents in the time period Nov. 28 to Dec. 17, 1997 (Figure 5 and 7);
2) an increase in P vent temperature of ~12°C between Nov. 1997 and May 1999 (Figure 5);
3) a general increase in Bio9Prime and Bio9 fluid temperatures of ~7°C between Nov. 1997 and May 1999 (Figure 5); and
4) several discrete periods (lasting a few days at most) where the Bio9Prime vent fluid temperature dropped 3°-7°C, and took several weeks to a few months to recover to the pre-drop temperature (Figures 5 and 7). These types of variations were not observed in the fluid temperature record for the adjacent Bio9 vent during the same periods.

5) collapse of the Bio9 chimney on Feb. 6, 1998, expulsion of the probe from the vent orifice and burial in the sulfide rubble which also impacted the Bio9 riftia community just west of the vent (also instrumented with a Vemco array) (Figures 5, 8 and 9).

On Nov. 28, 1997, 1800 local time, the fluid temperature at Bio9Prime and Bio9 vents increased ~6°C over a 4 day period (Figures 5 and 7). Following this event, Bio9 fluid temperature remained steady at 370°C until Feb. 6, 1998 at 1830 hours, whereupon the chimney apparently collapsed. Bio9Prime fluid temperature then abruptly decreased to 348°C over 5 days until Dec. 8, 1997, at which point it rose steadily for 6 days and plateaued at 355°C. As shown in Figure 8, Bio9Prime fluid temperature continued to increase, especially over the period Aug. 10 to Sept. 17, 1998. In May 1999, HOBO data indicate the fluid temperature at Bio9Prime was 372°C. Uncorrected Alvin high-T probe reading for this vent was 375°C. During the Bio9Prime and Bio9 event, P vent fluids remained largely at 373°C except for several abrupt periods of decreased temperature on Nov. 29 (3°C), Dec. 8 (10°C), Dec. 10 (6°C) and Dec. 15 (3°C). Notably, the Dec. 8 decrease at P vent is nearly simultaneous with the start of the increase in Bio9Prime fluid temperature. Overall, the fluids at Bio9Prime and Bio9 vents have increased 7° to 10°C over the approximately 42 month time period between Nov. 1995 and May 1999. We have noted discrete periods of abrupt temperature decrease in the Bio9Prime fluid temperature history, especially during the 1995-1997 recording period where approximately 5 short-lived temperature decreases of 6°-13°C occurred over a 3-7 day period (Figure 5). Temperatures gradually increased over several weeks to a month back to pre-drop levels and continued to increase as noted above.

Fluid temperatures at P vent increased gradually by ~5°C over the 1995-1997 recording period, and were measured at 370°-372°C in Nov. 1997. P vent temperature remained very steady at 370°-372°C until Sept. 1998 when the logger stopped recording because of low battery power (Figure 5). Uncorrected Alvin high-T probe measurements made during the EXTREME-1 cruise in May 1999 were between 374°C and 377°C (Table 4), indicating that over the approximately 42 month time period between Nov. 1995 and May 1999, P vent fluid temperature increased ~10°-12°C.

As noted above, based on the HOBO temperature record, we can pinpoint the time (to within a 1/2 hr) when the Bio9 chimney fell over (Figures 5 and 7). It occurred sometime between the measurements taken on Feb. 6, 1998 at 1830 and 1900 hrs. local. We are unsure what caused this event, however, we have confirmed with the various deep diving submersible operators that no submersible was working in the area at the time. We have requested information from C. Fox (NOAA-PMEL) whether his autonomous hydrophone array detected any t-phase events on the EPR in the 9° 50'N area for the time period when Bio9 chimney fell.

There are three other high-T vents in the BioTransect, TY and IO vents are located ~250 m south of P vent, near the Marker 82 diffuse flow community (Figure 1). The third vent is located at the top of Tube Worm Pillar (TWP), a large lava pillar (~10 m tall) at the southern end of the BioTransect [Shank et al., 1998] which hosts a large vestimentiferan community that has colonized its sides and top (Figure 1). As mentioned above, the probe at IO vent was destroyed by the vent. In 1997 when IO first became active, it comprised a 1-2m tall, ~1m diameter stump of active diffuse flow and hotter (~>100°C) venting. When visited in May, 1999, IO consisted of a ~9m tall, ~2m diameter edifice which was vigorously venting hot, diffuse fluid over it's entire surface area, and had 348°C fluids venting from orifices at the top of the structure, including some orifices that had classic "beehive" sulfide caps.

TY vent is located ~10 m north of IO vent and in Nov. 1997 it was venting fluid at 352°C. The HOBO probe at TY vent recorded data from Nov. 1997 to Sept. 1998 after which recording stopped due to low battery power (Figures 2 and 5). During the recording period, TY showed a dramatic decrease in temperature (~10°C) which also coincided with the onset of the Bio9Prime and Bio9 temperature event in late Nov. 1997. Fluid temperatures at TY vent continued to decrease until Jan 1, 1998 and then began a slow, steady rise. Uncorrected Alvin high-T probe measurements in May, 1999 at TY vent show the temperature was 352°C.

High-T HOBO data will be further analyzed and cross-correlated post cruise with other datasets, especially the vent fluid chemistry data being analyzed by K. Von Damm (UNH) and M. Lilley (UW), and vent sulfide mineral analyses being done by R. Haymon (UCSB). We also plan to integrate the time series temperature data with modeling studies of hydrothermal vents at fast-spreading ridge crests.

Low-T Vemco Minilogger Data 1997-1999

During this cruise, data were recovered from 23 Vemco probes deployed within 8 low-temperature vent communities shown in Figure 1 and Tables 2 and 4. The greater than 1.2 million data points (over 50,000 data points per probe) precludes the presentation of even a modest portion of the data here. However, examples of the types of temperature records recovered from the northern BioTransect diffuse flow community near Biomarker 9 are shown in Figures 8 and 9. These data from the Bio9 Riftia site also serve to illustrate correlations between lowT and highT vent temperature history seen in the Nov-Dec., 1997 temperature event at the Bio9 and Bio9Prime vents.

There are several noteworthy, preliminary observations which we can make regarding the time-series records for the low-temperature vents collected between 1997 and 1999. They are:

1) Detection of a prominant increase in temperature within the Bio9 Riftia area (Figures 1, 8 and 9) beginning on November 28, 1997, that directly corresponds to the event documented in the adjacent high-T vents- Bio9 and Bio9Prime (as described above).
2) Small variations in temperature (less than 3°C) within sites of diffuse vent flow unoccupied by vent organisms at the northern end of the BioTransect (Bio9 and Bio12), contrast greatly with the large temporal variability (rapid 5°C to 20°C shifts) associated with tube worm and mussel-dominated communities in more southerly areas of the BioTransect.
3) Collapse of the Bio9 chimney on Feb. 6, 1998, and subsequent burial of the Vemco array at the Bio9 Riftia area in the sulfide rubble, may have also played a important role (despite the presence of elevated temperatures) in the elimination of this Riftia community that was observed thriving in November, 1997.
4) Spatial variability between individual probes separated by less than 0.5 meters within several developing communities revealed temperature profiles that are frequently out of phase with each other. We believe this reflects the increased spatial heterogeneity in microhabitats increasingly dominated by both mussels and tube worms.
5) In many cases, both mobile and sessile fauna were attached either to the probe housings, polypro line or found living in the small cavities created by the tape and tie-wrap material used to hold the probes together (Figure 3). The animals were sorted and preserved for later study. All probes were also scraped for microbial community analysis.

Table 3 . Low-T Vemco Minilogger Arrays recovered during Extreme I (May 1999). Each of these venting areas was created during the 1991 volcanic eruptions in the BioTransect region [Haymon et al., 1993; Rubin et al., 1994]. See Figure 1 for locations.

Vent Community ID	Housing ID	Logger ID	Temperature Range and Variability
Biomarker 9 Riftia tube worms	251	2898	30.7°Cmax; steady for 1 yr then to 24C; increase Nov 28th
	250	1112	29.8°Cmax; steady for 1 yr then to 24C; increase Nov 28th
	245	2894	29.8°Cmax; steady for 1 yr then to 24C; increase Nov 28th
Biomarker 12 Riftia tube worms	257	4364	3°C steady down to 2°C; low variability
	248	2896	4°C steady down to 3°C; low variability
Biomarker 141 B Riftia tube worms	205	1107	3°C steady up to 7°C; moderate variability
	256	2876	2°C fluctuates up to 12°C; moderate variability
Biomarker 141A Riftia tube worms	230	2904	3°C fluctuates up to 14°C; moderate variability
	261	2883	3°C fluctuates up to 15°C; moderate variability
	215	2875	3°C fluctuates up to 15°C; moderate variability
Biomarker 82 B Riftia tube worms	203	1116	4°C fluctuates up to 16°C; high variability
	225	1129	4°C fluctuates up to 19°C; high variability
	235	2884	4°C fluctuates up to 18°C; high variability
Biomarker 82 A Riftia tube worms	222	1127	4°C fluctuates up to 19°C; high variability
	201	1114	3°C fluctuates up to 18°C; high variability
	254	1118	3°C fluctuates up to 18°C; high variability
Biomarker 141 Stick Array	213	1123	bottom; fluctuates up to 16°C; moderate variability
	219	1108	middle; fluctuates up to 9°C; moderate variability
	216	1106	top; 2°C fluctuates up to 3°C; moderate variability
Biomarker 141C Array	227	2890	fluctuates up to 12°C; moderate variability
	107	2880	fluctuates up to 14°C; moderate variability

Coupling High-Temperature and Low-Temperature Data for the Nov. 28, 1997 Event

The Bio9 Riftia community is situated one meter west and roughly inbetween the Bio9 and Bio9Prime high-T vents (Figure 1). This site was a thriving, Riftia-dominated community from 1993 to 1997 (Figure 10). In November, 1997, the Bio9 Riftia community contained over 700 individuals of Riftia bathed in strong shimmering fluids near 29°C, as measured by Alvin's low-T probe. Based on the Vemco Minilogger data recently collected on the EXTREME-1 cruise, on the morning of November 28th, after a week of steady stable temperatures near 29°C, a sharp decline of almost 2°C over a 4 hour period was followed by a steady 1.5 °C increase in temperature that occured over a 2-day period (Figures 8 and 9). This was followed by a week-long steady decline that only varied slightly until July 10th, when another increase in temperature occurred that was similar in magnitude to the one 8 months earlier. The Nov. 28, 1997 temperature event recorded at the high-T Bio9 and Bio9Prime vents is also observed in the data for the low-T Bio9 Riftia community. The later event, in July of 1998, was not evident in the high-temperature records. Five months earlier, on Feb. 6, 1998, the Bio9 vent sulfide structure collapsed into the primary fissure and on top of the area occupied by the Bio9 Riftia. Despite intensive imaging and searching for the remains of the Bio9 Riftia community, only a few (<~10) Riftia and no other vent-endemic megafuana were observed in this locality. Worm tubes, that are often observed in a state of decay years after the death of individual worms, were no longer present.

Bio82 Community and Bio141 Community

The Biomarker 82 community, the largest low-temperature community within the BioTransect (370 meters south of the Bio9 Riftia), and the Biomarker 141 (930 meters south of Bio9 Riftia) community have become increasingly dominated by mussels since November, 1995 (Figure 1). The 24 records from Biomarker 82, and the 28 records from the Biomarker 141 community collected between 1993 and 1997, revealed that temperatures within these habitats frequently fluctuates between 5°C and 29°C. These records reveal dramatic and rapid variability, on the order of 13°C changes in less than 2 seconds, and show strong tidal (12.5 hr) periodicities. These records have also frequently shown an ~3 month periodicity that resembles a bell -shaped curve over this time period. The 6 Vemco probe records within the Biomarker 82 Riftia between 1997-1999 were very similar in their frequency and variability to past records as described above. However, the Biomarker 141 records show a marked decrease in variability (largest temperature shifts no greater than 3 °C). These records suggest several possible causal processes. It is possible that the increase in density of colonizing mussels onto the Riftia tube worms fundamentally alters the flux and temperature behavior of the diffuse fluid flow, whereby mussels serve to dampen and insulate fluid flow to essentially eliminate rapid temperature shifts within these microhabitats at the Marker 141 community (and not at the Biomarker 82 community where proximal mussel colonization is relatively low). It is also possible that the flux of diffuse fluid flow has decreased over time at Biomarker 141, however, we note that the tube worm community is as robust as ever and that diffuse flow from the primary fissure is still vigorous. We find more support for the former hypothesis given that the temperature at the beginning of the 1997 deployments are similar in magnitude and variability as at the end of the deployment. Interestingly, the quarterly periodicity and bell- curve is present in many of the Biomarker 141 temperature records despite the lack of short-term variability. Comparisons of records from the Bio9 Riftia, where presumably very few megafauna were present following the collapse of the Bio9 Vent, and the Biomarker 82 and 141 temperature records reveal that the small variation in temperature (less than 3°C) within diffuse vent flow unoccupied by vent organisms (including the Bio12), stands in marked contrast with the large temporal variability (rapid 5°C to 20°C) shifts associated with tube worm and mussel-dominated communities at Biomarker 82 and 141. These records from areas devoid of vent organisms may serve to demonstrate the modifying effects organisms have on the thermal behavior of their microhabitats. Detailed spectral, tidal and covariance analyses of each of the 23 recovered temperature records during this cruise will be conducted post-cruise to quantitatively charaterize these effects.

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