Update on the Hydrothermal and Biological Status of the EPR ISS "Bull's-Eye" at 9°50' N

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The EPR ISS bull's-eye site continues to be a very dynamic system. In November 2003 during the FIELD03 expedition on the East Pacific Rise, we completed 6 *Alvin* dives between ~9°49-51' N, from Tube Worm Pillar north to Biovent (Figure 1). The dives were used to

- recover the artificial tube worm aggregation experiments (Fisher Lab),
- resample the high-temperature hydrothermal vent fluids and measure their temperatures (Von Damm Lab),
- recover the HOBO probes left in 2002 and deploy new probes in all of the high-temperature vents as part of ISS baseline data (Von Damm Lab), and
- deploy two replacement transponders at the site for general ISS work.

Each successive sampling trip to EPR shows significant changes from the previous one, irrespective of the exact time interval. The hydrothermal system shows an apparent decreasing (or cessation) of fluid flow toward the southern end of the (BIOGEO) Transect, a continued "hot spot" of activity in the Hole-to-Hell area, and some signs of increased activity to the north. This is evidenced by both the amount and temperature of the fluid flow, and the nature and abundance of the animal communities. Specific examples from the November 2003 cruise of these observations are the cessation of fluid flow at Tube Worm Pillar, the initiation of a new black smoker at Tica, and an expanded areal extent of hydrothermal communities at Tica. We would also describe most of the high-temperature vent fluids as "fizzy," which suggests that the high CO_2 levels observed in these fluids since ~1993-4 continue into 2003.

The following changes were noted in comparison to our most recent cruises at this site (Von Damm, January-February 2002; Fisher, December 2002).

The Tube Worm Pillar (TWP), which previously hosted a black smoker at its top and a lush community of tube worms supported by hydrothermal fluids leaking through the sulfide edifice built on top of a lava pillar, was found to no longer have noticeable fluid flow. Consequently, no live tube worms were noted on the structure, and the empty tubes had sloughed off the lower two-thirds of the structure and were lying on the basalt at the base of the pillar. Without the covering of tube worms, we were able to confirm for the first time our previous hypothesis that most of the 11 m height is sulfide, not basalt.

Moving north from this site, the robust biological community that has been located at BM141/2 for about a decade is now dominated by

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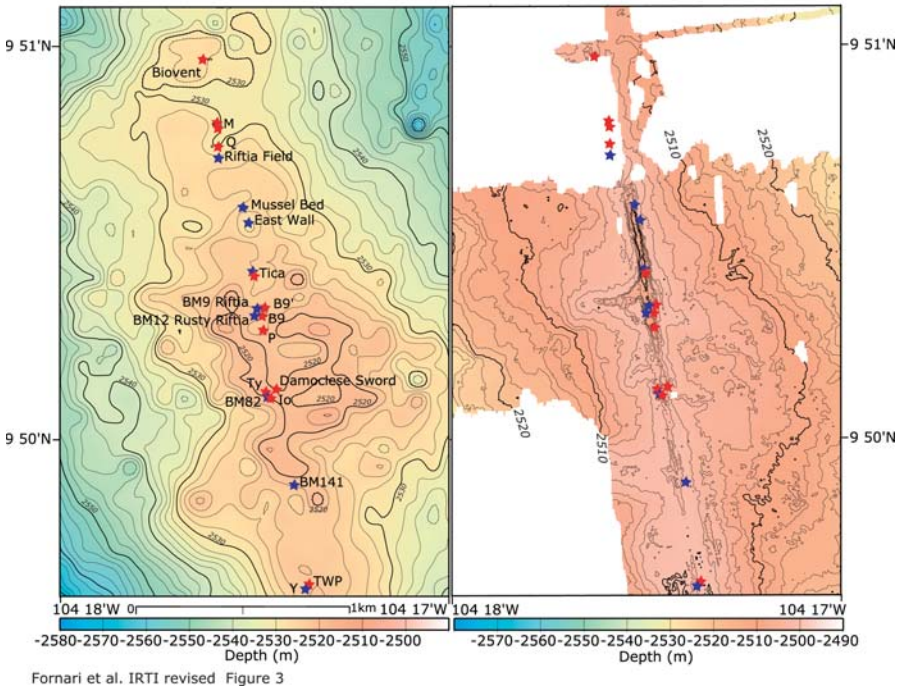

Fig. 1. Left map shows multibeam bathymetry for the EPR ISS bull's eye with high- and low-temperature vents (red and blue stars, respectively) labeled. Right map shows the detailed, 5-m gridded, 675 kHz Imagenex scanning altimetric data collected by ABE. Vertical resolution of the data is 1 m (Fornari et al., 2004). Vent symbols are same as on left map. [Fornari, D. J., M. Tivey, H. Schouten, M. Perfit, et al. In press, 2004. Submarine lava flow emplacement at the East Pacific Rise 9°50' N: Implications for uppermost ocean crust stratigraphy and hydrothermal fluid circulation. In *The Subsurface Biosphere at Mid-Ocean Ridges,* edited by W. Wilcock et al. AGU Geophysical Monograph Series. Washington, DC: American Geophysical Union.]

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mussels. Continuing northward, we revisited BM82, a site of a diffuse flow community that, since ~1997, also hosts two black smokers, Io and Ty. Although mussels dominate, some *Riftia* were observed at this location. Ty and Io remain quite active, although maximum measured fluid temperatures were 333 and 349°C, respectively, which is slightly lower than the values measured in early 2002 (350 and 356°C). Shore-based analysis will be required to discern if the lower temperatures may be a result of mixing within the chimneys. In 2002, fluids from Ty were slightly higher in Cl than seawater, while Io was a vapor; our 2003 shipboard results suggest this remains the case. The HOBO probe left in Ty vent in 2002 was not found.

The Hole-to-Hell area at 9°50' N, the location of the high-temperature P and Bio9 vents, remains extremely active. More than three high-temperature vents remain active at Bio9, and the chimney at P-middle vent has grown significantly since 2002. The HOBO probes deployed in P and P-middle vents in 2002 were recovered, but the one left in Bio9 was not located. Bio9, Bio9' and Bio9" vent fluids had maximum measured temperatures of 384°, 376°, 387°C, respectively, and P and P-middle measured 373° and 371°C (2002 values were 386°, 386°, 377°C for the Bio vents, and 386° and 385°C for the P vents, respectively). This area remains extremely hot, and the Bio9 vents continue to vent fluids with extremely low Cl contents. The P vents also continue to vent low chlorinity fluids compared to seawater. Whether the Cl values have changed since 2002 will require further shore-based laboratory analysis. In general, our impression is that Hole-to-Hell is re-invigorated, with much fluid flow and some *Riftia.* The amount of sulfide that has accumulated in this area since the eruptions in 1991–2, and particularly since ~1995, is notable.

Moving north, the next area of study was Tica. One of the surprises at Tica was the presence of a small black smoker vent. Although the 1–2 m high chimney was very friable, we were able to collect fluid samples from it. A maximum measured temperature of 342°C was recorded. One of the sulfide minerals in the chimney appears to be pyrrhotite, suggesting the fluids are quite reducing, and shipboard results suggest that Tica may be venting the lowest chlorinity fluids collected on this cruise, significantly less than half the seawater value.

Around the small smoker, robust *Riftia* are growing in close proximity to the high-temperature fluids. On the east wall of the Axial Summit Collapse Trough (ASCT) at Tica, the *Riftia pachyptila* individuals were larger and the populations more dense than in December 2002. In addition to this growth, *Bathymodiolus thermophilus* (mussels) have continued to settle among the *Riftia* and on the surrounding basalt. In some places, the mussels are large (> 8 cm) and form dense clumps, but *R. pachyptila* is still the visually dominant species. Aggregations of empty and decaying *R. pachyptila* tubes were present on the floor of the ASC. Tubes were unattached and apparently represent accumulated dead Riftia that have fallen from their original attachment points.

Two other sites that were sampled in December 2001 and December 2002 are Mussel Bed and Riftia Field. This year at Mussel Bed, the overall density and extent of mussels seemed to be decreasing, although there are still pockets of active diffuse flow where the mussel bed is thick and there are bacteria growing on the shells. At Riftia Field, the diffuse flow was still apparent from the presence of shimmering water, but few *Riftia* were still alive at the site. Anemones seemed to be more common at this site than in previous years.

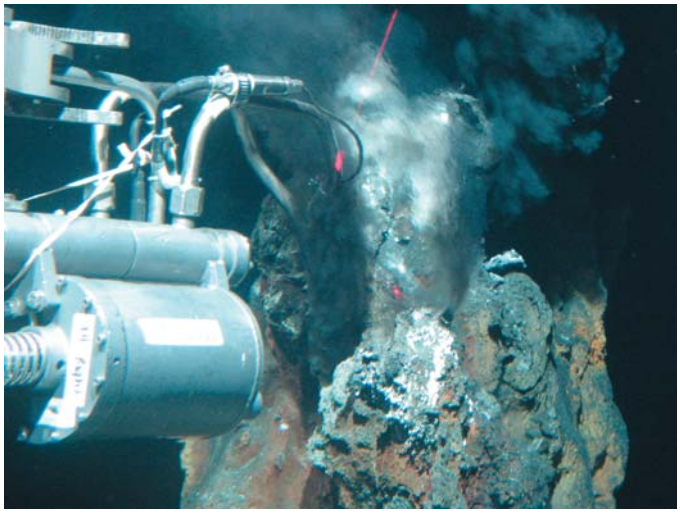

Fig. 2. M vent continues to be vigorously venting fluids, at measured temperatures of up to 366°C at the time of fluid sampling in November 2003. Photo courtesy of K. Von Damm, UNH.

Continuing northward, Q vent, M vent, and Biovent were also sampled. Q and M vent fluids are similar in chlorinity to each other, and about the same as the fluids from the more southerly Ty vent, demonstrating that the Cl-variations are not strictly a geographic trend at the EPR ISS. Unlike the fluids from Q and M vents, the vent fluids sampled from Biovent contain significantly less chloride than seawater. M vent (Figure 2) now hosts a number of smokers (at least 3) and our impression is of a very hydrothermally active area. M vent fluids were measured to be 366°, those from Q were 346°, and 342°C from Biovent, compared to 374°, 344°, and 345°C, respectively, in early 2002. Hence, fluids from Biovent and Q are unchanged in temperature, while those from M may have cooled slightly. The temperature of M vent fluids are basically the same as they were from 1995-1999; the measured value in 2002 was unusually hot. We will need to determine if the chemistry of the fluids has changed significantly to put this apparent temperature change into context. The temperature probe deployed in M vent in 2002 was recovered.

All of the high-temperature vent areas have now been re-instrumented with new recording temperature probes (HOBOs). The plan is to recover these, download their data, and re-deploy them in March 2004. We noted during the November cruise that many of the identifying markers at the high-temperature vents are no longer visible; to remedy this we plan to deploy new markers early in 2004.

Although this is a brief (and preliminary summary), we hope having this quick update of the current status will assist the community in planning their upcoming experiments at this site.