Mid-Cayman Spreading Centre Hydrothermal Vents Located: Cruise RRS James Cook 44, March-April 2010

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In March and April this year scientists from the National Oceanography Centre (NOC), and the Universities of Southampton, Durham, North Carolina and Texas located, imaged and sampled two vent sites on the Mid-Cayman Rise, in the Caribbean Sea. The NOC cruise, aboard the RRS *James Cook,* was led by Doug Connelly with Jon Copley, Bramley Murton, Paul Tyler and Kate Stansfield. It was part of a collaborative programme with Chris German from Woods Hole Oceanographic Institution and Cindy Van Dover from Duke University Marine Lab and followed an earlier cruise aboard the RV *Cape Hatteras* during October 2009. That earlier cruise, as reported in InterRidge News last year, discovered plumes in three locations indicating the potential presence of both high and low temperature venting on the sea floor. The results from that survey were also published this year in Proceedings of the National Academy of Sciences (German *et al.*, 2010).

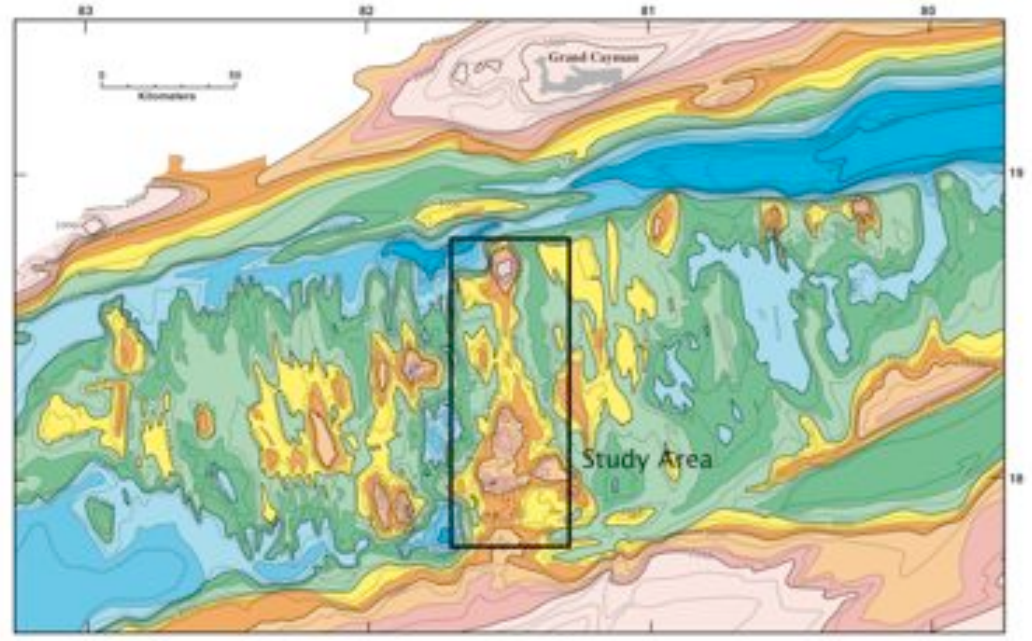

Figure 1: Bathymetry of the Cayman Trough with the study area (black rectangle) showing the crest of the ultra-slow spreading Mid-Cayman Rise.

Our cruise (JC44) started with a high resolution multibeam survey (Simrad EM120 bathymetry with 50m resolution) and TOBI survey (30kHz deep-towed sidescan sonar with 3m resolution) of the entire Mid-Cayman Rise. We followed this with a plume survey using CTD casts and fine scale mapping using the new AUV, *Autosub 6000*. The target areas were initially based on the earlier RV *Cape Hatteras* plume data but were quickly modified following the results from our new surveys.

Carrying a CTD (with light scattering sensors), an Eh sensor (for proximal plume location), and a Simrad EM2000 multibeam sonar for high resolution bathymetric and acoustic mapping, *Autosub 6000*proved extremely efficient at locating the seabed sources of the plumes. Operating down to 5000m, the AUV was able to make 24 hour dives at altitudes as low as 5m and at speeds of 4kts covering large areas in great detail. These AUV surveys produced overwhelming evidence for the presence of two separate vent sites on the floor of the Mid-Cayman Rise, which is an outstanding scientific and engineering success for the *Autosub 6000* on its first scientific mission.

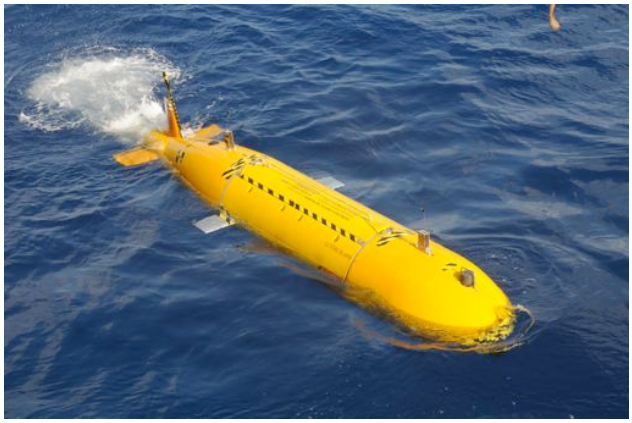

Figure 2: NOC's new AUV *Autosub 6000* being recovered aboard the RRS *James Cook* after its first science mission where it successfully located a 5000m-deep source of hydrothermal venting on the Mid-Cayman Rise.

Also on its first scientific mission was NOC's new, cost-effective, remotely operated tethered vehicle (ROTV) *HyBIS* commissioned from the UK company Hydro-Lek, (www.hydro-lek.co.uk). Using this 6000m-rated, manoeuvrable vehicle allowed us to explore the two sites and take reconnaissance samples of plume particulates, vent fluids, vent fauna, microbiota and mineral deposits. Using an HD camera on the veheicle, we were able to video the worlds deepest vent site, at 4960m, in exceptional clarity revealing abundant chimney structures of polymetalic sulphides from which dense clouds of particulate-rich fluid were gushing. We have named this ultra-deep vent site *Beebe* (in memory of William Beebe, the first person to observe deep sea life *in situ*).

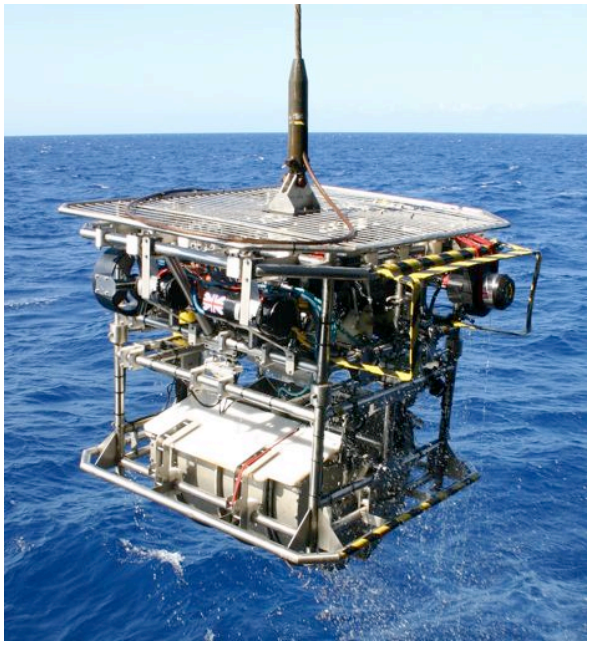

Figure 3: The *HyBIS* ROTV being deployed from the RRS *James Cook*.

The second vent site was found at shallower depths and also revealed actively venting sulphide chimneys with an abundance of vent life. Our scientific team have named this site *Von Damm* (in honour of Karen Von Damm, who passed away in 2008 after making a uniquely valuable contribution to our understanding of hydrothermal processes).

We also investigated a third area of the spreading centre where the previous RV *Cape Hatteras* survey detected LSS signals and elevated concentrations of dissolved Fe and Mn in a single CTD profile (German et al., 2010). Despite occupying 27 km of new CTD tow-yo survey lines, 130 km of closely spaced *Autosub 6000* survey lines, and 12

hours of seafloor exploration by *HyBIS,* no further evidence was found for any seafloor hydrothermal venting.

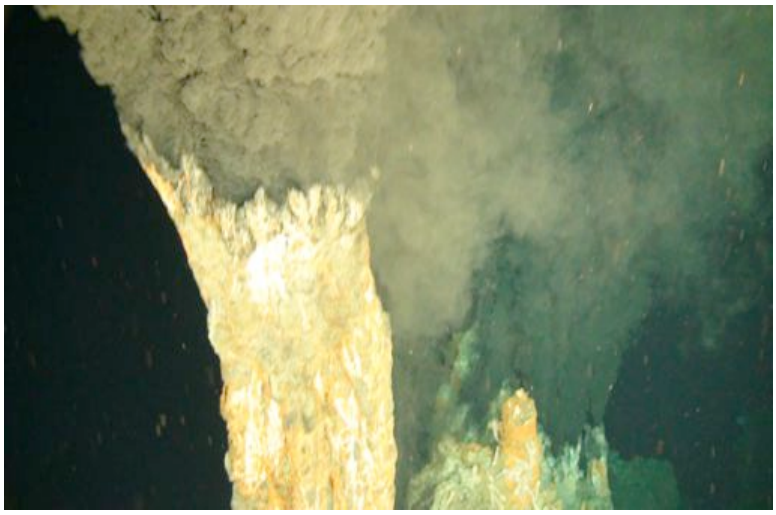

Figure 4: Sulphide chimneys and black vent fluids at the ~5000m deep vent site, Mid-Cayman Rise (photo from the *HyBIS* ROTV).

The combination of using both an AUV and ROTV together proved exceptionally powerful as a method for locating and investigating new hydrothermal sites. We were impressed by the capabilities and versatility of both NOC's new vehicles. This novel approach to searching for hydrothermal vents is becoming established as the preferred mode of operation and is likely to become commonplace in the future. The success of the Cayman work is also testimony to the benefits of close collaboration; the initial plume survey by our US partners followed by our AUV/ROTV survey exemplifies the spirit of InterRidge by being able to achieve far more together than separately.

We would like to thank the captain, officers and crew, and the UK's National Marine Facilities' engineers, on the RRS James Cook cruise JC44 for their enthusiasm and professionalism throughout this exciting and demanding cruise.

The James Cook will be returning to the two vent sites in early 2012, with the UK ROV *ISIS*, for a more thorough mapping and sampling programme.

References: C. R. German, A. Bowen, M. L. Coleman, D. L. Honig, J. A. Huber, M. V. Jakuba, J. C. Kinsey, M. D. Kurz, S. Leroy, J. M. McDermott, B. Mercier de Lépinay, K. Nakamura, J. S. Seewald, J. L. Smith, S. P. Sylva, C. L. Van Dover, L. L. Whitcomb, and D. R. Yoerger. Diverse styles of submarine venting on the ultraslow spreading Mid-Cayman Rise PNAS 2010 107 (32) 14020-14025