Deep Ocean Exploration Institute - Final Project Report

Biogeochemical Fluxes, Interactions and Biogeochemical Fluxes at 9°N East Pacific Rise: Multi-disciplinary

Chris German, Geology & Geophysics
Olivier Rouxel, Marine Chemistry & Geochemistry
Katrina Edwards, Marine Chemistry & Geochemistry
Lauren Mullineaux, Biology

What were the primary questions you were trying to address with this research? (Or, if more appropriate, was there a hypothesis or theory that you were trying to prove or disprove?)

Our project sought to investigate how the output from a "black smoker" hot spring might change, through time, after a seafloor volcanic eruption. We already knew, from other scientists work, that the composition of the fluids exiting a vent right after a volcanic eruption, are different from those collected one, two or ten years after the eruption. But what we didn't know was how MUCH material came out at different stages.

What have you discovered or learned that you didn't know before you started this work?

We have shown that sediment traps (inverted cones that collect material sinking to the seafloor) can be used to monitor changes in the fall-out of minerals from hydrothermal plumes and, hence, changes in the chemical activity of a vent, through time. This is new. Also, the very first samples we collected showed that what we thought was a purely chemical/mineralogical problem may be quite biological: even samples collected closest to the vents contain complex organic compounds.

What is the significance of your findings for others working in this field of inquiry and for the broader scientific community?

One of the strangest discoveries is that vent-flux seems too "pulse" on ~monthly time-scales for the first 1-2 years post-eruption. Our next goal is to verify this and investigate whether our work, up in the ocean, can tell us about how the "plumbing" of the vent-site is changing due to magma movement or seismic activity beneath the seabed. We may have stumbled into a completely new way of understanding what is happening out of side, "underground".

What is the significance of this research for society?

Our work has shown that maybe 25% of all the iron (Fe) in the world's ocean might come from hydrothermal vents and that, even at the outset, it might be intrinsically associated with organic carbon. Since we already know that Fe plays an important role in the global carbon cycle in the upper ocean, this project has inspired a new line of research to investigate whether hydrothermal systems might help regulate the global carbon cycle: if it plays an important role in the oceans then it might, surprisingly, also have an impact on the overlying atmosphere!

What were the most unusual or unexpected results and opportunities in this investigation?

This project simply set out to investigate the impact of venting, following a volcanic eruption, on the chemistry of the nearby ocean and local sediments. We didn't expect to be learning new things, potentially, about sub-seafloor geology OR about the global Carbon cycle!
What were the greatest challenges and difficulties?

The single biggest challenge was to get the project started. This work had hardly been attempted in the world's oceans before – and certainly not by WHOI geochemists. So getting the sediment traps prepared and out to sea at short notice was a definite "result" – we were happy to have such great support from our biological colleagues who havehelped us every step of the way.

When and where was this investigation conducted? (For instance, did you conduct new field research, or was this a new analysis of existing data?)

Our sediment traps were deployed on the East Pacific Rise at the vent/eruption site at 9°50'N from May 2006 until June 2006 then from June 2006 until November 2006 and from November 2006 until November 2007 – approximately 2 years post-eruption. Our first results are based on what we measured from samples collected in May-June 2006 and what we were subsequently funded by NSF's Ridge 2000 project to continue measuring in our July-November 2006 samples. We are now applying back to Ridge 2000 to continue analyses of the Nov 2006-Nov 2007 sample suite and to merge our geochemical measurements with wider physical studies.

What are your next steps?

As well as our new NSF project proposal, we have also established a new SCOR/InterRidge Working Group to investigate the role of deep-sea hydrothermal systems in regulating the global ocean carbon budget, to be co-Chaired by Nadine le Bris (IFREMER, France) and Chris German (WHOI).

Have you published findings or web pages related to this research? Please provide a citation, reprint, and web link (when available).

Our first paper was published in Nature Geoscience in January 2009:-

B.M.Toner, S.C.Fakra, S.J.Manganini, C.M.Santelli, M.A.Marcus, J.W.Moffett, O.Rouxel, C.R.German & K.J.Edwards. Preservation of iron (II) by carbon-rich matrices in a hydrothermal plume. Nature Geosciences, doi: 10.1038/NGEO433, 2009.

Please provide photographs, illustrations, tables/charts, and web links that can help illustrate your research.

Fig.1 = Photo of Sediment Trap being prepared for deployment on the East Pacific Rise

Fig.2 = Schematic of sediment trap, on the seafloor, underlying the rising and spreading hydrothermal plume.

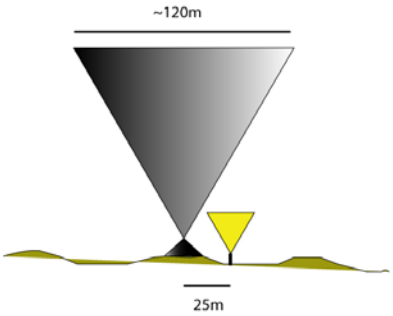

Fig.3 = Time-series of “pulses” of hydrothermal plume fall-out collected in a sediment trap at an East Pacific Rise hydrothermal vent.