Letters of Intent: Endeavour
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Corridors of Productivity: Flux and Dispersion of Organic-Carbon Through a Mid-Ocean Ridge Hydrothermal Plume System

James Cowen (Department of Oceanography, University of Hawaii, 1000 Pope Rd, Honolulu, HI 96822; jcowen@soest.hawaii.edu;), Richard Thomson (IOS, 9860 West Saanich Rd., Sidney, B.C., V8L4B2; thomsonr@dfo-mfo.gc.ca), Stuart Wakeham (Skidaway Institution of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411; stuart@skio.peachnet.edu), David Kadko (RSMAS, University of Miami, 4600 Rickenbacker Causeway, Miami, Fl 33149; dkadko@rsmas.miami.edu), Tim Shank (Department of Biology, WHOI, Woods Hole, MA 02543; tshank@whoi.edu)

Although hydrothermal plumes are major contributors to the redistribution of geothermally-derived heat and chemical mass and to larval dispersion, most mechanisms contributing to these processes remain poorly constrained. Little is known about potential linkages, rates of transfer, or specific modes of transport between plumes and the overlying ocean. A highly significant case in point is the dispersion of hydrothermally-derived organic-carbon downstream of hydrothermal sources and within the overlying ocean waters. Studies have documented a substantial production of organic carbon in hydrothermal environments. The major sources have been identified as: combined subseafloor microbial and abiotic processes; vent field microbial and macrofauna production; chemosynthetic production in situ within hydrothermal plumes (utilizing H2, CH4, NH3, and possibly sulfur and iron), and background oceanic organic carbon entrained into hydrothermal systems. However, the production and especially export and dispersion of this organic carbon is poorly quantified.

We propose a field study of the dispersion of organic carbon via the current driven hydrothermal plumes over the Endeavour Segment of the Juan de Fuca Ridge. We will study the current velocity within and over the axial valley of the Endeavour Segment using both Eulerian and Lagrangian methods. We will examine the effects of both ridge topography and entrainment processes (e.g., during the buoyant phase of hydrothermal plume formation) on tide- and wind-forced currents. In conjunction with the Eulerian (moored current meters) we will also deploy particle traps to monitor the correspondence between temporal changes in the vertical flux of organic carbon and current velocities vectored back to known hydrothermal vent fields. Moorings will be equipped with temperature and light scattering sensors to monitor the intensity or periodic absence of a plume signal at mooring locations. Placement of our moorings, current meters and particle traps will be guided by recent current meter data (R. Thomson, unpublished manuscript) suggesting that flow within the axial valley of Endeavour Segment is a two layered structure with inward flow to the valley within the deep layer (to 75 mab), with a southerly flow in the overlying layer. Lagrangian floats will be deployed over vent fields several times per year to capture the actual drift pattern of parcels of hydrothermal plumes in complement to the moored current meters.

We will also conduct detailed 3 dimensional surveys of the water column using CTD-light sensors-rosette (Niskin bottles) tow-yo casts throughout of the axial valley, as well as outside of the ridges. Vertical CTD-light sensor-rosette and in situ pump casts will be used to provide detailed sampling for key chemical and biochemical parameters diagnostic as tracers of hydrothermal origins and of diagnostic in situ biogeochemical processes that are indicative of lateral advection of hydrothermally-produced mateial.

Furthermore, we will take advantage of the simultaneous measurement of current velocities and particle flux collections to conduct a preliminary study of larval dispersion at Endeavour. Although most species of hydrothermal vent macrofauna appear to use planktonic larval stages, which are subject to the same physical dispersion forces as are other plume constituents, little is known about the mechanisms of release, transport, and settlement of larvae. We will combine dispersion models resulting from current

measurements with population genetics data on larvae collected in the particle traps and adults from Endeavour's vent fields.

PROPOSED WORK:

Current velocity:

Eulerian: multiple conventional CM and ADCPs moored on- and off-axis. Moorings will be configured with minimum vertical profiles and deployment sites will be situated so as to minimize conflicts with expected submersible operations at the IS Site.
Lagrangian drifter floats: a series of drifter float releases within and above the Endeavour axial valley.

Mass flux:

Vertical particle flux: ascending/descending particle traps. Constituents that will be particularly targeted will include: Organic carbon, lipid biomarkers, trace elements (e.g., Mn, Fe, Al, Ti, Cu, Zn, S, Ca, Si. REEs etc.), larvae.
Physical Hydrothermal signals: temperature and light scattering sensors.

Water column/hydrothermal plume inventory:

A pattern of CTD tow-yos will be performed along the axial valley and the off-axis flanks of the ridge crests during each of a least two cruises. A series of vertical CTD-rosette bottle and in situ pump casts will be made to provide detailed vertical sampling of the water column for dissolved and particulate parameters (e.g., Particulate organic carbon concentrations and stable carbon isotopes; Particulate nitrogen concentrations and stable nitrogen isotopes; Methane concentrations and stable carbon isotope; Particle size distribution (LISST-Deep); lipid biomarkers and their stable isotopes).
Source material for Organic-Carbon in hydrothermal plumes: Proposals by other investigators will model the relative and absolute contributions to heat and mass flux from diffuse versus high temperature focused flow at Endeavour Segment vent fields. As part of our project, we will collect samples of near-field plume samples, as well as of diffuse and focused vent fluid samples for analyses as 'source' samples.

Field work:

We propose to deploy moorings in spring/summer of 2004 and recover them in summer/fall of 2005. The intense water column surveys will be performed during both deployment and recovery cruises. We will also request several (3 dives) submersible dives to collect the diffuse and focused vent fluid samples for organic carbon concentrations and characterization. The submersible dives can best be ancillary to another dive cruise.