

Letters of Intent: Endeavour
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Acoustic panoramas of diffuse and focused hydrothermal flow and associated fluxes at major vent clusters in the Main Endeavour Field

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Introduction

Plumes that discharge from black smoker-type vents and associated diffuse flow that discharges from broad areas of the seafloor are major agents of dispersal of heat, chemicals and biological material transferred from the lithosphere into the ocean. Conventional methods study these two types of hydrothermal flow separately because they require different types of measurements. The acoustic imaging and processing methods that we are developing are amenable to use in a panoramic mode that visualizes plumes and diffuse flow together within a vent cluster or field in addition to the standard focused mode to visualize an individual black smoker or to map a patch of diffuse flow. In our work so far we have applied our methods to study individual plumes or to map areas of diffuse flow. Panoramic imaging is the next step, drawing on all our methods to derive a coherent view of the distribution and behavior of plume and diffuse flow together.

Proposal

We propose to apply our methods to a panoramic data set to derive a unified view of the distribution and physical behavior of both plumes and diffuse flow and to coordinate this information with in situ measurements of temperature and flow rates to determine volume and heat fluxes within an area imaged. Questions that we are addressing based on the coordination of acoustic images of a given area with in situ measurements include: 1) What is the areal partitioning between black smoker and diffuse flow; 2) What is the partitioning in terms of volume and heat fluxes; 3) How do these flows couple into the surrounding ocean under prevailing current and tidal regimes.

Methods

We will apply the processing and analytical methods we have developed to our existing panoramic acoustic images of four natural clusters of vents within the Main Endeavour Field (MEF) that we recorded during our VIP (Vent Imaging Pacific) 2000 cruise as part of the summer 2000 Endeavour Observatory experiments. These vent clusters comprise Grotto, S & M, Bastille-Easter Island group, and Salut. Processing and analytical methods comprise scalar and vector measurements of 3D reconstructions of black smoker plumes and 2D mapping of the distribution of diffuse flow using our AST (Acoustic Scintillation Thermography) method. Our application of these methods to vent clusters in the MEF will comprise: 1) scalar measurements of the size and shape of the major buoyant plumes; 2) vector measurements of the vertical flow rates within major plumes using the coherent Doppler method where applicable; 3) examination of the plume boundaries and calculation of entrainment coefficients to determine mixing processes at the interface with the surrounding ocean; 4) mapping of areas of diffuse flow within a vent cluster; 5) draping of diffuse flow and focused flow over bathymetry for a unified image of the distribution of these flow regimes; 6) Calculation of fluxes combining our acoustic information on area, volume and flow rates with concurrent in situ measurements by other investigators of flow rates, temperature, currents, and a tidal model.

Relevance to R2K ISS

Our proposal addresses question 3.1 of the Endeavour ISS plan that asks, “What are the complex linkages that govern the transformation, accumulation, transport, and export of mass and energy in the Main Endeavour Field and what are the magnitudes of the associated heat and material fluxes?”

Opportunities for Collaboration and Integration

The proposed work involves integration of in situ measurements by other Endeavour Observatory investigators with our acoustic imagery and analysis to derive fluxes for the vent clusters imaged. In determining mixing, entrainment, and dispersal processes up to the plume boundaries it interfaces with those other ISS proposals (Johnson et al.; Kim et al. ISS pre-proposals) that examine dispersal of heat, particles, and biological material beyond those boundaries into the surrounding ocean.