R2K Letter of Intent for 15 Feb. 2005 Target Date

Collaborative Research: Hydroacoustic Monitoring and Analysis of Tectono-Volcanic Earthquakes within the Lau Basin Integrated Study Site

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Intellectual Merit:

The RIDGE 2000 (R2K) program seeks to understand the complex linkages that facilitate the flow of energy and material from the mantle into the overlying oceans. As earthquakes represent first-order perturbations to the ridge system, which can be used to track a number of important lithospheric processes, obtaining a record of their spatial and temporal history is essential to the success of this program. We propose two long-term deployments of seven autonomous underwater hydrophones to monitor seismicity within the R2K Program's Lau Basin Integrated Study (IS) Site. The 2.5-yr longevity of the hydrophones provides for great flexibility in the timing of turn-around and recovery operations. This will significantly minimize ship time requirements/costs and is expected to result in the collection of 3-5 years of continuous data in total.

The hydrophone array will take advantage of the more efficient propagation of sound in the oceans, relative to the solid Earth, allowing us to detect and locate seismically generated T-waves associated with shallow-hypocenter events along the Eastern Lau Spreading Center (ELSC). Our analysis of these small-to-intermediate size (> ~2.5 m_b) earthquakes will focus on the inter-relationship between seismicity and the many other tectonic, volcanic, hydrothermal and biological processes being studied within the Lau Basin. To facilitate community involvement, a catalog of T-wave epicenters will be made available to the R2K and ocean science communities as the hydrophone data are processed. Our main goal, however, will be to utilize the hydroacoustic waveform data and T-wave derived earthquake information to:

A. *Examine the temporal and spatial pattern of earthquake production along the ELSC:* Integration with previously funded mapping and sampling studies will allow us to develop a comprehensive seismo-tectonic model of the ELSC and examine how very pronounced along-axis changes in spreading rate, morphology and magma supply correlate with the distribution and character of seismicity. The regional context provided by the T-wave data will allow us to constrain the nature and extent of the active plate boundary zone and the style and mechanics of magmatic/eruptive processes along the ELSC.

B. *Constrain the nature of volcano-tectonic perturbations within the ELSC-system*: As Lau research transitions from reconnaissance to long-term monitoring focused at a bull's eye location, the detection of small (>2.5 m_b) earthquakes will be critical in tracking physical perturbations to the hydrothermal system. The system's sensitivity and the mechanics of its disturbance will be constrained using epicentral information and numerical models that estimate the amplitude of static and dynamic strains associated with local-to-regional earthquakes. Quantitative information on the timing, location and scale of magmatic and tectonic events is fundamental for interpreting changes in hydrothermal flow, chemistry and biology. The spatio-temporal nature of the system's response cannot be defined without such observations.

In addition, *we will expand the use of our moorings to accommodate tidal pressure and acoustic current meters* at the closest two hydrophones to the bull's eye site. Continuous pressure data will be used to evaluate the influence of tidal forces on vent flow and temperature, as well as temporal occurrence of small magnitude earthquakes. Current-meter data will be integrated with an ongoing floater experiment that is aimed at understanding the physical oceanography of the basin, providing important constraints for interpreting water column measurements and understanding the dispersal of hydrothermal biota.

Broader Impacts:

Because the array will record a variety of natural and man-made noises, the broader impacts of this monitoring effort will be significant, and the data will facilitate a wide-range of studies beyond the scope of this proposal. Examples include the use of seismic body-wave arrivals to constrain the velocity

structure of the solid earth and the use of T-waveforms to constrain and improve theoretical models of T-wave generation and propagation. Cetacean vocalizations recorded in the basin will allow estimates of the distribution and migration pattern of large baleen whales for a region where little previous information exists. Hydroacoustic data also can be used to estimate sound intensity levels and will help to monitor anthropogenic noise sources within the basin. Educational aspects of this project include the development of a K-12 curriculum module where students build and deploy their own hydrophone, the maintenance of interactive cruise websites and online educational resources. Two undergraduate interns also will participate in the analysis of these data.