APPENDIX IV

Haymond/McDonald Cruise Highlights

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Subject: Cruise Plan

HAYMON/MACDONALD CRUISE PLAN SUMMARY

We primary propose is to survey the narrow axial zone of the ultrafast-spreading EPR at 17*18'-42'S using the fiber-optic ARGO II near-bottom optical/acoustic system and the AMS-120 sonar system. Our purpose is to test the hypothesis (based on ARGO data from EPR 9-10*N) that along-strike thermal gradients set up by the segmented pattern of magma supply to fast-spreading MOR's exert primary control on the distribution and types of hydrothermal vents and vent biota, as well as on variations in fine-scale volcanotectonic characteristics along the axial zone. On the 4th order scale at EPR 9-10N, this magmatic control of hydrothermal discharge is manifested by the concentration of high-temperature vents along eruptive fissures. EPR 17*18'-42'S is a superb area for further investigation of relationships between magmatic processes and other axial processes. Along a segment of ridge only 45 kms long, seismic data show that the axial magma chamber (AMC) changes along strike from a flat-topped body at relatively constant depth to a peaked cupola ("spike") that intrudes to within 0.8 km of the seafloor at 17*27'S. This represents the most extreme along-srike variations in thermal gradients that we know of on the MOR, and contrasts with the flat-topped AMC at EPR 9-10N. The survey we propose is designed (and will be interpreted) within the context of seismic reflection/refraction data, SeaMARC II and MR1 imaging, SeaBeam bathymetry, gravity and magnetic data, submersible observations, and extensive petrologic/geochemical data that exist already for the proposed study area and adjacent ridge flanks. These data show that this apparently unsegmented portion of the EPR is actually partitioned into at least six 4th-order segments (our proposed survey may reveal more), and that the axial zone exhibits along-strike changes in morphology and some extreme along-strike changes in axial lava compositions. Ridge morphology and some visual observations indicate recent eruptive activity in part of the proposed survey area. Beyond testing ideas about coupled magmatic/hydrothermal segmentation along the MOR, we will also observe how hydrothermal and other axial zone processes are affected by ultrafast spreading rates and extreme along-strike thermal/magmatic gradients. We will determine the nature of the axial troughs found along portions of the axial zone in the proposed study area (axial summit caldera or graben?) and investigate the development of these important axial features. To this end, we will carry out a secondary Argo survey of a hydrothermally-active portion of the axial summit graben on the segment south of the main survey area (at approx. 18.5S. Finally, we will provide a baseline survey of the fine-scale segmentation and distribution of vents and biota along a ridge segment destined for future seismic andsubmersible studies.

We propose to carry out a 36 day cruise that consists of: 2 days of AMS-120 surveying, 19 days of ARGO-II surveying; 2 days for ARGO II maintenance checks (required every three days, with a turnaround time of 6 hours); 2 days for deployment/surveying/ recovery of acoustic transponders used in navigation; and 11 days of transit (from Tahiti to the survey area, and then to Easter Island).

We are not proposing any ship time for additional dredge sampling of basalts or hydrothermal deposits (beyond that of Sinton et al., 1991) because the length of the cruise would be prohibitively long. SeaMARC II records indicate that the axial zone is relatively narrow (<400 m) throughout the survey area. To achieve sufficient density of coverage, we plan to drive fourteen 45 km-long, axis-parallel lines through the axial zone with line spacings of 10-30 m. This will provide us with 100% saturation coverage where the axial zone is <100 m wide, ranging down to a minimum coverage of 45% where the axial zone widens to 400 m. [For the 83-km long ARGO survey at EPR 9-10*N, we achieved a maximum of 80%

coverage where the axis was narrowly defined by an ASC <200 m wide, and 40% coverage for the southern third of the survey area where the location of the ridge axis was less well-defined by the structure of the axial zone].

Accurate navigation is absolutely necessary to achieve the close line spacings required for our proposed survey and to determine the relative locations of fine-scale features with respect to each other. For the proposed survey we will follow the procedures that we established for our 1989 ARGO I survey to attain a navigational precision of +5 m throughout the survey area. At the outset of the survey we will lay out a line of 11 bottom-moored acoustic transponders spaced 1 km west (or east) of the ridge axis and ~5 km apart. These will be surveyed in using GPS navigation and accurate depths at the drop points. Navigation of the ARGO II vehicle can then be acquired by ranging off successive pairs of transponder as the vehicle travels along strike.

For the proposed program, Haymon will be chief scientist at sea, and Macdonald will be co-chief scientist. The PI's will share responsibility for data acquisition and analysis. ARGO II watches require 5 people. DSOG provides 2 people per watch and the science party must supply 3 per watch. One of the watchstanders is designated as a datalogger. This person watches the real-time video and logs observations digitally in real time. In this way we can manage the huge visual dataset. The datalogger files are subsequently edited by going back to the tapes to review and verify the logged observations. By this means the classification of features is standardized and erroneous data are deleted from the files. The end product is a set of digitized and categorized GIS/ArcInfo files that can be plotted in any combination (for example, black smokers and fissures; vent communities and Age 1 lavas; etc.). This is a very powerful approach to data management that has worked beautifully for the EPR 9-10N ARGO I dataset.

Dan Scheirer has been separately funded by NSF to carry out an ancillary study of magnetics measured with a magnetometer mounted on the Argo, and to analyze high resolution bathymetry collected with a Mesotech sonar that will also be incorporated on to the Argo sled.

We will also collect CTD and transmissometer data using instruments mounted on the Argo sled and on the towing cable.