Marine Physical Laboratory

Geostatistical Traverse of EPR Natural Lab

Peter F. Lonsdale

Final Report to the
Office of Naval Research
Grant N00014-92-J-1614
For the Period 06-1-92 - 09-30-93

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University of California, San Diego
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Abstract

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Introduction

Much of the present geologic history of a spreading center can be interpreted from geophysical study of its rise flanks. Years ago it was realized that magnetic lineations and the azimuths of large fracture zones record the history of changing rates and direction of spreading. With the introduction of efficient high resolution survey tools, especially multibeam sonars, it became apparent that the shapes and patterns of medium-scale landforms, especially abyssal hills and volcanoes, contain far more information, especially on the history of rise crest segmentation. Reading the history of creation and extinction of transform and nontransform offsets, ridge propagation and offset migration, and changing patterns of magma supply, and relating this history to changes in external factors such as relative and absolute plate motion, is proving a key to understanding dynamic processes at rise crests. Also, once the geologic history of a rise has

been determined, by collecting critical data on carefully located but widely spaced tracks, a much more detailed prediction of the topography of unsurveyed parts is possible.

Research Objectives

The goal of this project was to use wide-spaced swath mapping sonars, with ancillary magnetic, gravity and seismic data, to establish the geologic history of a spreading center, and then to use that history to make quantitative predictions of the rise flank relief. This project investigated the history of the 9° N East Pacific Rise, and quantifying how that history has affected the medium-scale relief. The fully equipped ship (**Melville** with Sea Beam 2000, seismic profiler, magnetometer, etc.), manned by the P.I. and his associates, made a transit of the EPR between Clipperton and Siqueiros fracture zones, from 10 Ma crust on one flank, across the axis, to 10 Ma crust on the other flank. On the central 30% of this transect the data swath crossed the already surveyed (Sea Beam Mk.1; SeaMarc 2) ONR Natural Laboratory, where the history is well established. The objective was to obtain quantitative comparisons of the relief measured by the different swath mapping tools, and by the MPL Deep Tow multibeam (which collected data from small patches along the transect, earlier in 1992). Beyond the existing crustal-age boundaries of the Natural Laboratory, the data was analyzed for the following purposes:

1. To establish the crustal-age: sediment-thickness relationship for both rise flanks, so as to make additional seismic profiling unnecessary on future cruises.
2. To aid planning for future surveys by establishing at what age (probably about 7 Ma) abyssal hills change azimuth and become highly oblique to the present rise crest. This is a key indicator of how long the EPR crest has maintained its present pattern, and hence an important datum for investigating how the rise evolved to this pattern.
3. To conduct a slope distribution analysis, mainly by student H. Mayer using the statistical techniques of D. Smith and P. Shaw, repeating the analysis we recently did of a Costa Rica traverse. We will be particularly interested in how once -identical crust (accreted at the same time and place on the rise crest) now differs in morphology after moving down the east and west flanks and experiencing the different off- axis tectonic and sedimentary histories of the Pacific and Cocos plates.
4. To do a variogram analysis of the scales of abyssal hill roughness and how they vary with age, using statistical techniques.

Research Results

Bathymetric data of excellent quality was obtained with the new Seabeam 2000 sonar, and was used for objectives 2-4 of the previous paragraph. Seismic profiles and 3.5 KHz profiles are adequate for objective 1. The slope distribution and variogram analyses are consistent with qualitative interpretation of the variations in amplitude, linearity and wavelength of the abyssal hill relief, and these analyses will be published as part of the analysis and interpretation of the much larger data set collected from this region in 1994. The project proved most valuable as a pilot program for this larger study.

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