FINAL REPORT

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Long Range Scientific Objectives

An understanding of crustal generation processes in the South Atlantic, approached with a combined analysis of Sea Beam bathymetric data and sea surface magnetic field data. We are particularly interested in small offset features on the spreading axis, which have a surprisingly large role in altering the normal seafloor fabric and magnetic signature.

Project Objectives

The great clarity of magnetic recording in the oceanic crust of the South Atlantic, compared with the North Atlantic, provides us with an opportunity to guide the development of our models of volcanic and tectonic crustal generation processes. 2-D and 3-D inversions of magnetic data remove the influence of bathymetry and skewness and allow us to create maps of crustal magnetization. We can clearly identify isochron boundaries, construct spreading rate history models, and track the changes in length of transform faults through time. We can also identify zones of enhanced magnetization which may be related to fractionation processes in the axial magma chamber.

Current Status

During early winter 1987, we completed the last of four Seabeam expeditions to the South Atlantic, two focusing on the southern Mid Atlantic Ridge (MAR) from 30°-38°S and two on 25°-28°S, which represent a joint UCSB-URI-Lamont-NRL mapping effort. We have currently completed 2-D analysis of the magnetic data from both areas. 3-D analysis of the southern area has been finalized,

Significant Progress

Ridge crest studies show that ridge morphology is highly dependent upon spreading rate. Spreading rates in the South Atlantic (35-40 mm/yr) are transitional between the fast (>60 mm/yr) and slow extremes (<30 mm/yr) of the spreading rate spectrum. GEBCO maps of the South Atlantic, which represented the best bathymetric maps of the region prior to our surveys, were constructed assuming the morphology of the southern MAR would be much like that established for the well-studied northern MAR. However, our Seabeam data indicate that the morphology of the southern MAR is quite different and furthermore, is transitional between the morphology which characterizes fast vs slow spreading centers. In both of our southern MAR survey areas, we find that the axial rift valley, which is ubiquitous in the North Atlantic, becomes subdued, disappears entirely in places and is replaced by a subtly rifted axial bulge. Also in both areas, the ridge axis is offset by short-offset oblique-trending ridge-axis discontinuities similar to over lapping spreading centers, in addition to classic ridge-perpendicular transforms. These features produce magnetic and bathymetric disruptions in the oceanic crust over areas that are comparable to those associated with large-offset transforms. The evolution and behavior of these small discontinuities has been a special focus of our studies.

Our Seabeam bathymetric and magnetic survey in the 25°-28°S area includes dense coverage of the Moore Transform Fault (Fig. 1) and its off-axis structure, which at present is one such oblique-trending axial discontinuity. From 2-D analysis of the magnetic data we have established the history of this transform within the past ~7 Ma. The morphology of the Moore changes abruptly from a classic ridge-perpendicular valley to a diffuse oblique-trending feature between 2.5 and 1.8 myrs ago. During this time interval, the length of the Moore was decreasing from ~ 20 km to an offset close to its present length of ~ 10 km (Fig. 2). This shortening in offset length is correlated with change in offset length along the Rio Grande Transform, and along the short-offset transforms in the southern area. These results suggest that change in offset on these transforms occurred in response to a regional plate phenomena, perhaps reorientation.

Our spreading rate analysis indicates that full spreading rates north of the Moore were ~ 5 mm/yr faster than south of it during the period of structural transition to a short, oblique-trending discontinuity. The amplitude of 2-D magnetization solutions for this time interval are anomalously large, and could reflect highly magnetized crust. These data, in addition to morphology, all suggest that decrease in the amount of ridge offset at the Moore discontinuity was the result of a sequence of ridge propagation events. Within the southern survey area there is also evidence for ridge propagation events, although the evidence is not as clear as for the northern area.

In the southern survey area, the Sea Beam bathymetric and magnetic data have been gridded at a spacing of 1 km, including the Cox and Meteor transform faults and the ridge-axis discontinuities at 31°20'S and 33°30'S. From 3-D inversions of these gridded data, we have generated maps of crustal magnetization. These magnetization solutions show that high magnetizations are typically associated wi.h the intersection of ridge segments with ridge-axis discontinuities. The amplitude of these magnetization highs appears to be independent of offset length and highs of similar amplitude can be traced along flow lines, in some cases, out to 4 myrs.

An important implication of our studies in the South Atlantic is that the off-axis topography will not be a simple extrapolation of what has been seen in the better studied North Atlantic. Particular attention should be paid to the small, 10-20 km offsets of the ridge axis which seem to produce even larger magnetic and topographic disturbances than some transform faults. We believe that these offsets represent the slow-spreading equivalent of overlapping spreading centers.

Publications

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Welch, S.M., Magnetic analysis of the Mid-Atlantic Ridge from 31^{o}-34^{o}S, (MS thesis, U.C.S.B., 1988).

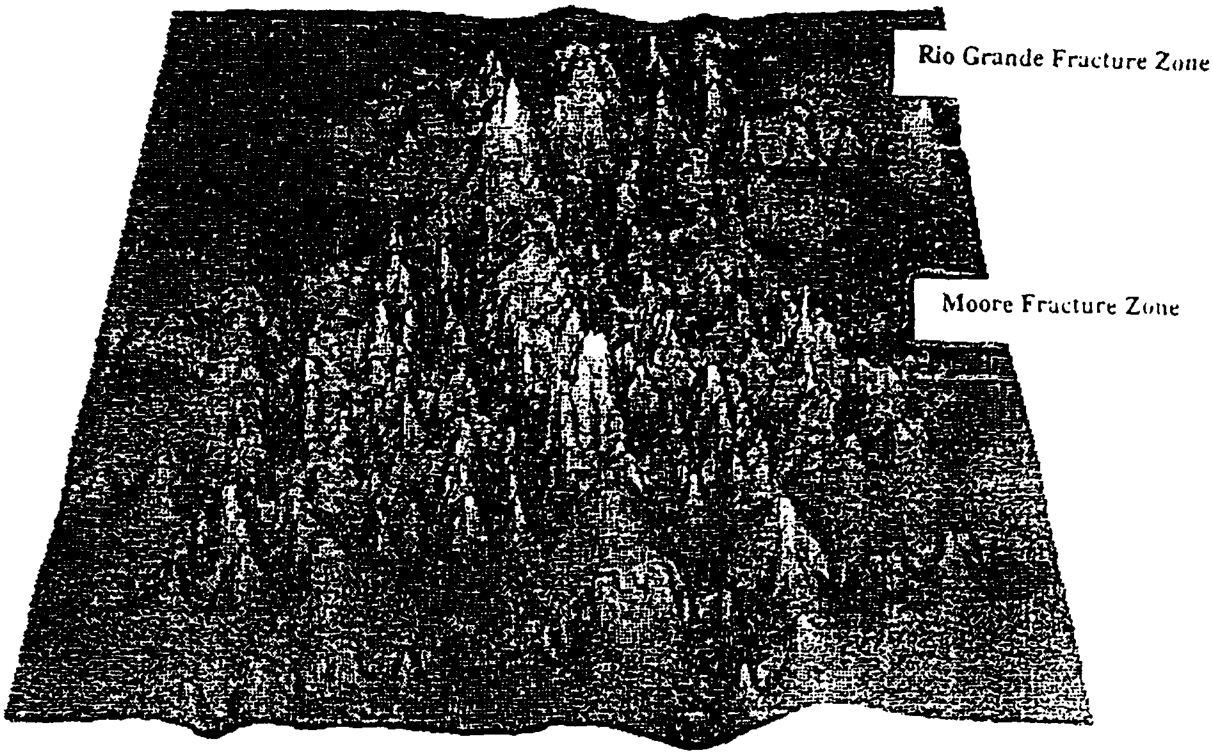

Figure 1. Gridded sea surface magnetic field data for the MAR from 25^{0}-28^{0}S. Note the magnetic field highs located at the ridge-transform intersections. (plotting software developed by R.C. Tyce, U.R.I.)

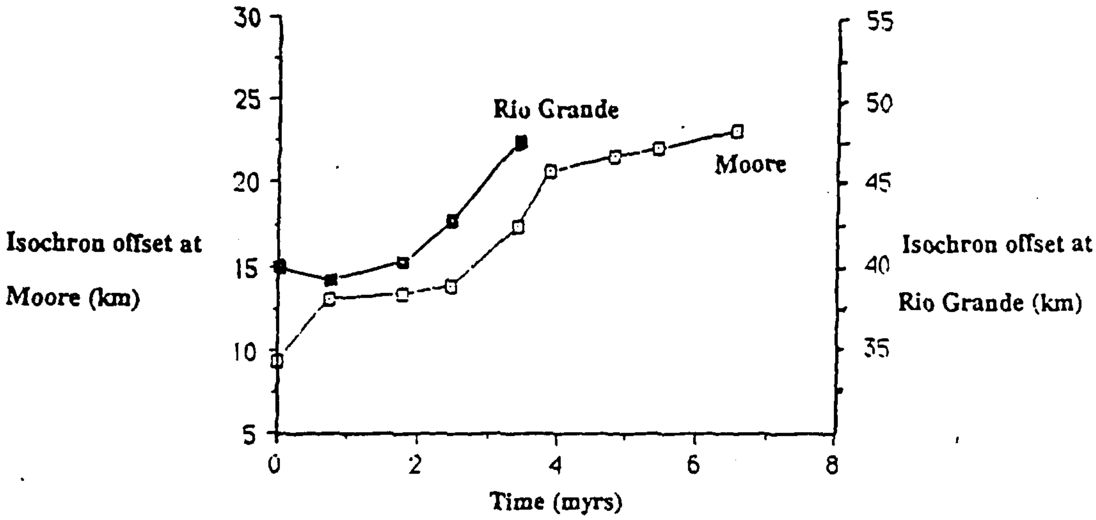

Figure 2. Average offset of isochrons at the Moore and Rio Grande Fracture Zones plotted against time.