Morphology and Tectonics of the Romanche Transform and its Environs

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Abstract. We describe the results of GLORIA surveys of the Romanche Transform and neighbouring areas of the Equatorial Atlantic Ocean. These surveys have imaged the whole of the Romanche Transform Fault, the eastern end of the Saint Paul Transform, the spreading centre joining them, and the northern part of the spreading centre between Romanche and Chain transforms. They have also imaged representative parts of the off-axis seafloor structure in these areas, and have facilitated preparation of a new bathymetric map, which is presented here. Contrary to previous descriptions of the area, we have found that there is 'normal' spreading fabric (volcano-tectonic lineaments trending NNW–SSE orthogonal to the spreading direction) between these major equatorial fracture zones. This implies that normal seafloor spreading processes have operated there. The Romanche Transform Domain, within which normal spreading fabric is either absent or heavily modified, and transform-related structures predominate, is about 100 km wide. There are multiple transform faults within Saint Paul Fracture Zone, of which we have imaged the active traces of the two southernmost ones. These transforms are joined by short but otherwise normal spreading segments. The Romanche Transform is shorter than previously thought, with a length of 840 km. This is equivalent to an age offset of about 50 Ma. The transform has a complex system of short normal and oblique spreading centres at its eastern intersection, forming an overall oblique section of ridge which may have recently cut off the corner of an earlier, simple, orthogonal ridge-transform intersection. The recent complex system appears to have developed at about 1.5 Ma. An oblique valley is mapped south of the western end of Romanche Transform, and is thought to be the fracture zone trace of an old transform offset between Romanche and Chain transforms. This transform disappeared at about chron 8 (26.9 Ma), as its trace is not seen between 20°W and the spreading centre.

Introduction

The most recent compilation of bathymetric and tectonic charts of the Equatorial Atlantic was made by Gorini (1981). These charts show the active Romanche Fracture Zone as a complex zone of alternating ridges and troughs which is up to 100 km in width. Gorini identified two major E–W transverse valleys, with the longer northern valley inferred as the plate boundary owing to its offset of the Mid-Atlantic Ridge axis by 950 km, and its association with the great majority of earthquake epicentres. The southern valley was traced by Gorini, between about 19°W and 24°W, as a feature slightly oblique to the main valley and interpreted as the old fracture zone trace prior to a change in the direction of the plate motion.

The position of the plate boundary in the less well mapped Saint Paul Fracture Zone has been more uncertain, owing to the numerous ridges and troughs associated with this feature and the scatter of earthquake epicentres located beneath both ridges and troughs. However, it seems likely that there is probably more than one transform valley.

Furthermore, seafloor areas between the Romanche Transform and the inactive limbs of Saint Paul and Chain Fracture zones were identified by Gorini as possessing an unusual fabric of ENE–WSW ridges and valleys, rather than the more usual topographic fabric lineated parallel to the spreading axis.

Following Gorini's work, a GLORIA reconnaissance of the western part of Romanche Transform was undertaken by Belderson et al. (1984), and we subsequently carried out a more complete survey. Together, these more recent results provide...
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Fig. 1. Summary of data coverage used for Plate 1. Heavy line shows tracks of RRS Discovery cruises 96 and 142, which carried GLORIA. Unshaded area is limit of GLORIA coverage. Light lines are tracks of other satellite-navigated cruises.

complete sonar coverage of the whole Romanche Transform Fault viewed from both north and south together with substantial coverage of the spreading segments on both sides, of the easternmost part of Saint Paul Fracture Zone, and of samples of the seafloor fabric in between.

This paper presents GLORIA and bathymetric data for the study area (Figure 1). Our cruise also obtained single-channel seismic reflection data, which have been used in our interpretations but are not illustrated here. Both cruises were navigated by Transit satellite fixes. The combination of the sidescan data with a new bathymetric chart has enabled the main tectonic and morphological features observed in the area to be mapped and analysed, and the position of the plate boundary to be determined with a precision of just a few kilometres. We confirm that the Romanche Trough contains a single active transform fault almost one thousand kilometres long. However, it is slightly shorter than previously thought, since a 50-km-long oblique spreading complex cuts across what was formerly interpreted as an orthogonal ridge-transform intersection at its eastern end. We also confirm the existence, previously suspected but not documented, of at least two transform faults in the Saint Paul Fracture Zone system, and describe the short spreading centre that joins them. We delimit the width of seafloor affected by transform-related tectonics (the “transform domain” of Fox and Gallo, 1984), and show that a broad corridor of normal spreading fabric (i.e. linear fault scarps and volcanic ridges oriented orthogonal to the spreading direction) exists between the Romanche and Saint Paul Fracture zones. Finally, we discuss the implications of our observations for current and past motions of the South America/Africa plate pair.

DATA PRESENTATION

Our data are mainly summarised in Plate 1 and Figure 2. A new bathymetric chart is presented in Plate 1. This utilised all available soundings from the area. Bathymetric contouring was controlled by GLORIA data where available. Figure 2 presents a summary of the main tectonic and volcanic features as inferred from the GLORIA data. In addition, Figures 3–9 show details of both GLORIA and topography over localised parts of the study area.

INTERPRETATION OF GLORIA SONOGRAPHS

On the GLORIA sonographs shown in this paper, areas of high acoustic return are white and areas of low return are black. Varying shades of grey represent levels between these extremes. The principles involved in the interpretation of GLORIA data over mid-ocean ridges have been discussed by e.g. Searle (1981, 1989). The character of the returned sonar signal is governed by three main factors: the direction of insonification, the acoustic roughness of the seabed, and the topography of the seabed and angle of incidence of sound rays (Mitchell, 1991).

Since GLORIA is a sidescanning instrument, features which trend parallel to the sonar’s track will be preferentially highlighted at the expense of features trending in other directions. Because of