INTRODUCTION

A poorly understood aspect of sea-floor spreading and continental drift involves the tectonic processes active during the earliest rifting history and separation of the continents. The identification of the boundary between oceanic and continental basement is required for any precise predrift reconstruction. No satisfactory criterion exists today for precisely determining continental reconstructions. Bullard et al. (1965) used selected isobaths for mathematically determining and evaluating the best geometric fits and others have used different criteria. Even though these fits appear visually satisfying at a large scale, many gaps and overlaps are present (Fig. 1).

Talwani and Eldholm (1973) have demonstrated that the boundary between oceanic and continental basement is not necessarily associated with constant bathymetric contours. They have shown that the margin off Norway includes a subsided block of continental materials which they can identify by seismic results together with the gravity and magnetic anomalies associated with its edges. They also describe the structures and geophysical signatures for the margin of South Africa on either side of the Agulhas Fracture Zone. They have noted the existence of magnetic quiet zones on these margins and cite evidence to suggest that the quiet zones are situated on continental basement. Furthermore, the gravity anomalies indicate that dense rocks are located beneath the shelf edge, marking a hinge line for the subsidence of the continental slope and rise. Numerous geological and geophysical lineaments are noted bordering the continental margin of the northwest Atlantic Ocean. These include:

1. A subsurface ridge defined by seismic compressional velocities and located near the seaward edge of the continental shelf (Drake et al., 1959).

2. A continuous free-air gravity high located near the shelf break (Emery et al., 1970; Rabinowitz, 1973).

3. A nearly continuous high-amplitude magnetic anomaly, called the east coast magnetic anomaly, which is located, in places, as far seaward as the continental rise and, in places, as far landward as the coastline (Taylor et al., 1968).

4. A magnetic quiet zone that is situated seaward of the east coast magnetic anomaly (Heirtzler and Hayes, 1967).

The data on the western North Atlantic margin show similarities with the data observed bordering Norway and South Africa, thus it will be concluded that the concepts of Talwani and Eldholm (1972, 1973) are applicable to the continental margin of the northwest Atlantic Ocean, and that this model may provide a working hypothesis for the study of the early rifting history of other passive continental margins.

MAGNETIC ANOMALIES

Perhaps the two most prominent characteristics of the magnetic field bordering the continental margin of eastern North America are the presence of a magnetic quiet (or smooth) zone and a nearly linear high-amplitude magnetic anomaly called the east coast magnetic “slope” anomaly (Fig. 2).

Fig. 1. Four reconstructions of the North Atlantic Ocean: (1) Bullard et al., (1965): a mathematical least-squares fit of the 500-fm isobath; (2) LePichon and Fox (1971): fracture ridges interpreted as defining the flow lines of early motion are predicted on either side of the ocean, with large mismatch noted on the presumed Canary Island-Kelvin Seamount fracture zone; (3) Drake et al., (1968): matching the magnetic rough-smooth zone boundaries; (4) Dewey et al. (1973): similar to that of Bullard et al. (1965) south of the South Atlas Fault, with northern part of Morocco shifted to the east.
Magnetic Quiet Zone

King et al. (1961) first recognized a distinct quiet (or smooth) zone in the western North Atlantic Ocean bordered on the west by the east coast magnetic slope anomaly and on the east by the disturbed zone. Heirtzler and Hayes (1967) recognized a similar zone in the eastern North Atlantic Ocean. The smooth zones are characterized, in general, by anomaly amplitudes of ±20 to 50 gammas in contrast to typical values of ±100 to 300 gammas in the disturbed zone (Fig. 3). In the western North Atlantic Ocean, the smooth zone is observed at least from near the Grand Banks to the West Indies; in the eastern North Atlantic the smooth zone is observed at least from the Sierra Leone Rise to about Gibraltar (Heirtzler and Hayes, 1967).

At the eastern border of the smooth zone in the western North Atlantic a sequence of anomalies (Keathley sequence) have been identified by Heirtzler and Hayes (1967), Anderson et al. (1969), and Vogt et al. (1970a). This sequence has been identified bordering the quiet zone in the eastern North Atlantic by Vogt et al. (1969) and Rona et al. (1970). Recently, Larson and Pitman (1972) have correlated the Keathley sequence in the western North Atlantic with presumed Mesozoic lineations in the Pacific and established a working model of Mesozoic geomagnetic chronology.

The magnetic, gravity, and topographic data along the ship's tracks of Figure 2 have been projected normal to the coastline and are illustrated in Figures 3-5. The profiles are all aligned with respect to anomaly E. The continuity of anomaly E in the region between 32 and 34°N (south of profile 1, Fig. 3) and between about 34 and 36°N (between profiles 2 and 3, Fig. 2) is further substantiated by detailed magnetic surveys of Vogt et al. (1971) and Einwich (1972). This anomaly has an amplitude of generally less than 100 gammas compared to anomalies greater than 300 gammas in the disturbed zone farther seaward.

A number of important observations are noted from Figures 3-5:
1. In general, the magnetic field is much more subdued in the quiet zone landward of anomaly E than seaward of it (Fig. 3). Hence anomaly E separates the quiet zone into what will be termed a landward inner quiet zone and a seaward outer quiet zone.

Fig. 2. Locations of ships' tracks where geophysical data are available and that are projected and shown in Figures 3-5. Some other tracks where data are available but which are not projected are shown also. The intersection of the bold curved line with the ships' tracks are the points along which the projections are aligned.