High-resolution marine magnetic anomaly data across the margin would delineate structures controlling lithospheric formation and rift localization

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Proposed sites: (1) Carolina/Avalon terrane boundary and ECMA offshore New Jersey; (2) Alleghenian suture and ECMA offshore Georgia

Forthcoming data: high-resolution, near-source, three-component, marine magnetic anomaly data

Onshore, magnetic anomaly data from airborne surveys clearly delineate geologic terranes along the entire length of the eastern North American margin (Figure 1). Similar magnetic data have been collected offshore, but deep water and thick sediments suppress short-wavelengths, making it difficult to map the continuation of these features across the shoreline or identify new boundaries offshore. High-resolution marine magnetic anomaly data can be collected from a variety of near-bottom instrument platforms, enabling detailed offshore mapping of sutures, dikes, sills, and small plutons—structures that played a key role in the formation of the east coast margin.

The eastern North American margin was formed by a series of accretion and rifting events throughout the Paleozoic and Mesozoic, leaving behind distinct terranes separated by sutures, each with different lithologies and patterns of faulting and magmatism (e.g., Sheridan et al., 1993). Understanding the role this fabric played during periods of accretion, extension, and magmatism along the east coast margin can address at least two critical questions: 1) What is the role of preexisting structures in the evolution of continental margins in general? 2) How does the lithospheric architecture observed along the eastern North American margin influence lithospheric stability?

The lack of resolution in offshore magnetic data, as well as the paucity of near-bottom data, prevents us from better understanding how sutures and other inherited structures influenced localization of the Atlantic rift margin and the associated continent/ocean transition (COT). Two example locations of where better magnetic data would be especially illuminating are offshore of Georgia and New Jersey. In Georgia, the Alleghanian Suture separates the Carolina and Brunswick Terranes from African crust and appears to mark the axis of a major abandoned rift basin, the South Georgia Rift (Hatcher, 1989). Offshore, existing magnetic data appears to show that the Alleghanian Suture turns north at the westward extension of the Blake Fracture Zone, eventually merging with the East Coast Magnetic Anomaly (ECMA), a feature spatially correlated with the voluminous, rift-related magmas of the East Coast Margin Igneous Province and the Atlantic COT (e.g., Holbrook and Kelemen, 1993). Further north and offshore of New Jersey, the ECMA/COT turns abruptly to the east-northeast at what appears to be the boundary between the Carolina and Avalon Terranes. The relative geometry of these sutures and the ECMA/COT suggests that Paleozoic sutures may have exerted control over the localization of rifting of the Atlantic (e.g., Rankin, 1994). In both offshore regions, the exact geometry of the sutures is difficult to determine on existing, low-resolution magnetic data. Near-bottom/near-source, magnetic observations made at sea would enable high-resolution mapping of these sutures and other magnetic features, informing our understanding of east coast margin evolution.

A variety of near-bottom magnetic platforms exist, and they can be operated from a range of vessels, making the collection of high-resolution magnetic data a feasible and valuable addition to larger marine expeditions. For example, magnetometers mounted on a deep-towed sled (e.g., the Woods Hole Oceanographic Institution's TowCam) could be used to rapidly (tow-speed of ~10 kts) collect high-resolution, three-component vector magnetic anomaly data before or after seismic operations on the R/V *Langseth*. If Autonomous Underwater Vehicles (AUV) (e.g., AUV Sentry of the National Deep Submergence Facility) are being used to explore a region in detail, vector magnetometers can be mounted alongside side-scan and/or chirp-sonars. Such a configuration makes it possible to simultaneously obtain high-resolution bathymetric data, revealing the morphology of seafloor features such as fault scarps, slumps, pockmarks, and submarine channels, and near-source, three-component magnetic anomaly data, both with accurate navigation. Furthermore, high-resolution, multi-channel seismic data could be collected during periods of AUV battery charging using a portable MCS system (e.g., the Scripps portable seismic system). The variety and portability of these magnetic platforms make it possible to efficiently obtain high-resolution magnetic data along with other geophysical observations, providing a comprehensive, detailed picture of the potential offshore extension of sutures, the ECMA, and other yet-unresolved structural features.

References

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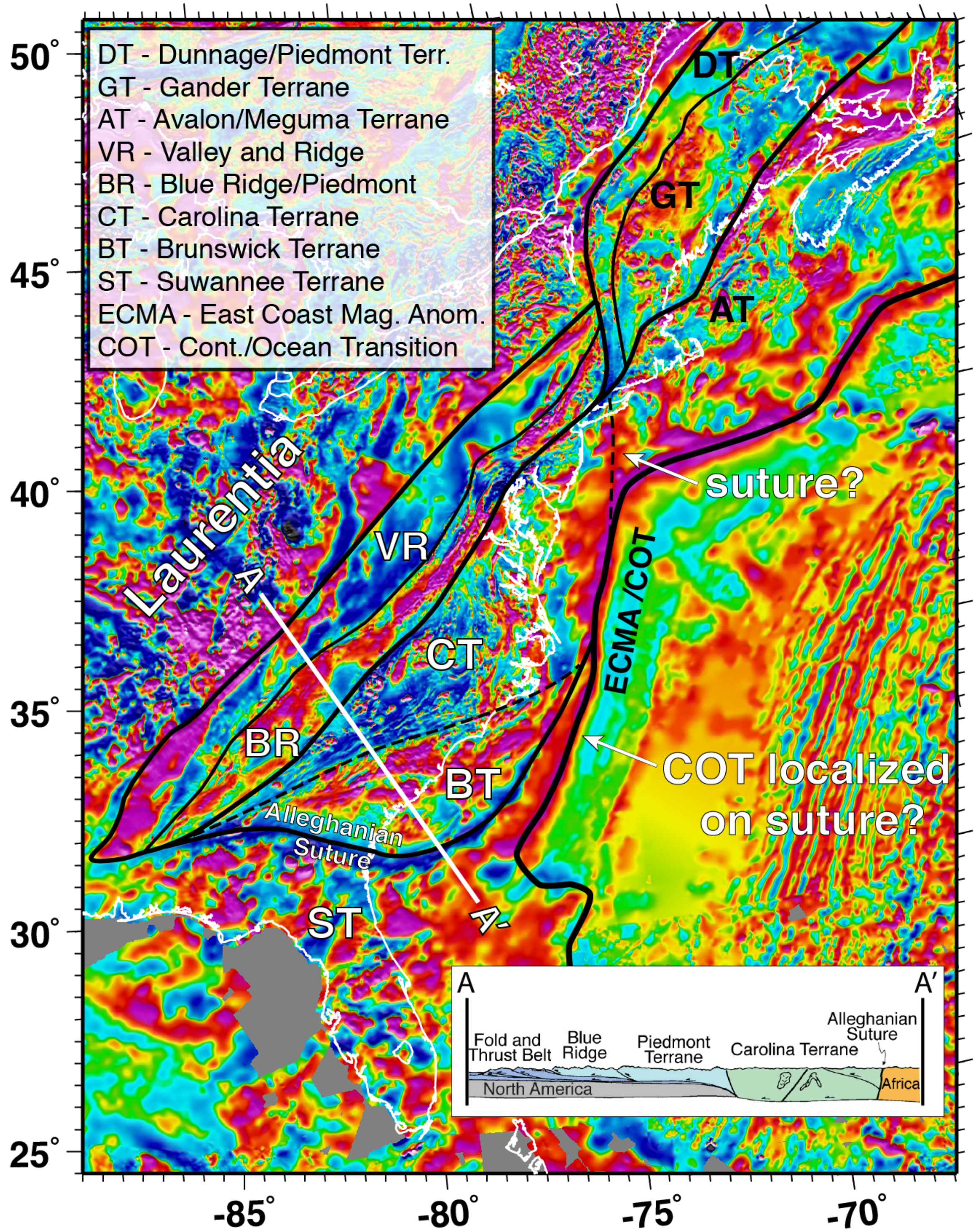

Figure 1. Magnetic anomaly data from airborne surveys over the eastern North American margin. Onshore, the series of accreted terranes (black lines) are precisely delineated by the magnetic data. Offshore, poor data resolution, a result of attenuation by deep water and thick sediments, makes mapping structures difficult. Inset cross-section is from Hatcher (1989).