Tuesday, September 11 | Theme 2 | 14:00
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The Austral South Atlantic: Early Formation and Crustal Structure of the Orange and Cape Basins

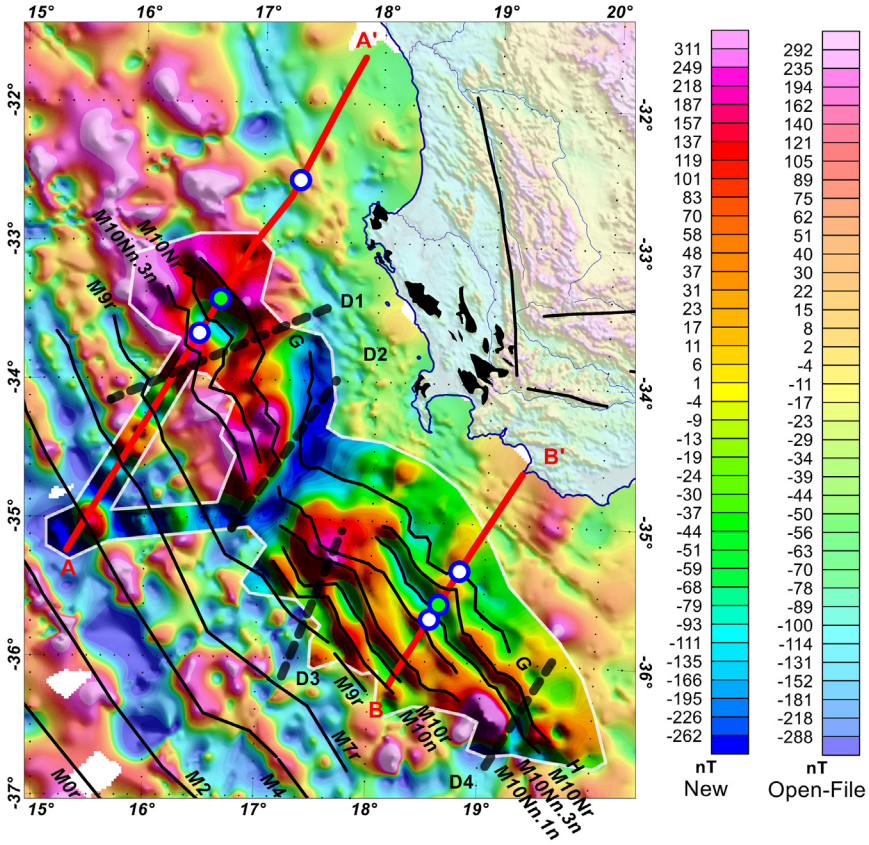


Figure 1. Total magnetic intensity anomalies and African topography (see Hall et al., in press, for additional information). Reprocessed open-file marine magnetic anomalies (Bird Geophysical) are overlain by new, high-resolution magnetic anomalies (Anadarko Petroleum Corporation); Interpreted discontinuities are heavy gray dashed lines (D1 through D4); new high-resolution marine magnetic data survey outline is white; labelled magnetic anomaly correla-tions from this study are black lines. Two-dimensional modeled cross sections are heavy red lines; blue and white circles posted on the model lines correspond to the extents of modeled magmatic underplating, blue and green circles correspond to the modeled boundary between oceanic and continental crust; onshore outcropping basement areas are colored black; the north-south and east-west oriented lines over South Africa trace the Cape Syntaxis.

New high-resolution marine magnetic anomaly data acquired over the southwestern margin of South Africa, integrated with reprocessed open-file marine magnetic anomaly data, displays a pattern of well-defined northwest-southeast striking linear anomalies that can be traced with confidence over distances greater than 150 km (**Figure 1**) (Hall et al., in press). We interpret these anomalies to be M-series seafloor spreading anomalies M9 to M11, suggesting seafloor spreading initiation at about 135 Ma (Late Valanginian / Early Hauterivian). A two-phase spreading rate, from seafloor spreading models (M11 to M0), matches the two-phase spreading rate for M-series anomalies over the conjugate South American margin, offshore Argentina. Importantly, the presence of M11 anomalies over both margins suggests an earlier opening for the austral South Atlantic than previously recognized.

We identify four breaks in the continuity of the linear magnetic anomaly pattern, oriented approximately northwest-southeast, which may be early fracture zones. One such discontinuity, which we have termed the "Cape Lineament" (CL) ("D2" in **Figure 2**), marks a significant change in crustal character and Cretaceous depositional history. Two northwest-southeast striking regional 2D modeled cross sections, integrating wells, seismic reflection, seismic refraction and gravity data, were built northwest and southeast of the CL. Northwest of the CL, the Orange Basin crust is characterized by greater thickness and the presence of seismically-imaged seaward dipping reflectors (SDRs). The modeled cross section through the Orange Basin includes a region of rifted / attenuated continental crust; a wide zone of underplated thin continental crust overlain by SDRs; and another wide zone of thick oceanic crust, associated with smoother seafloor spreading anomalies,

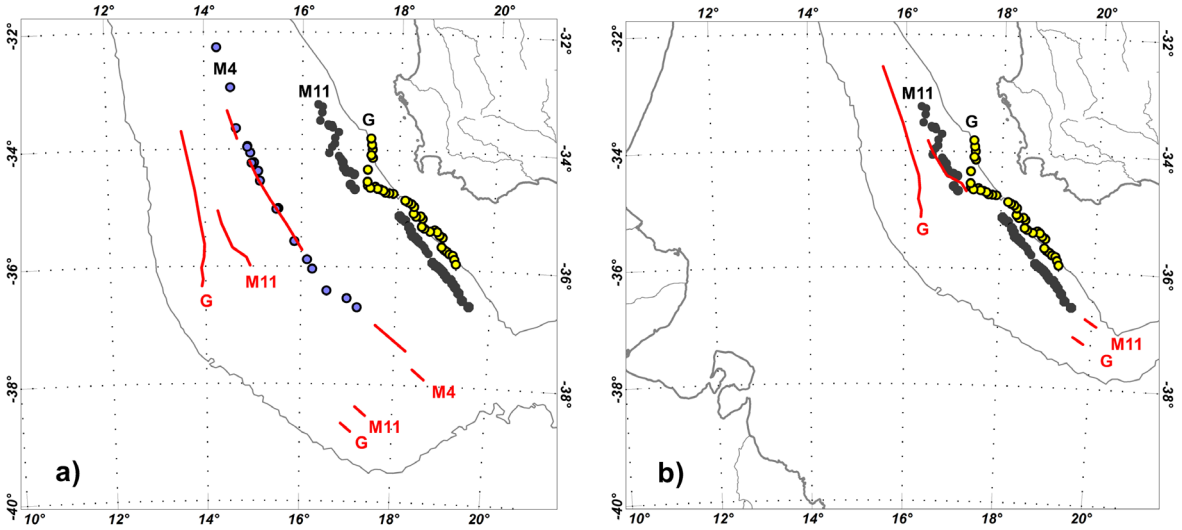


Figure 2. Africa – South America reconstructions of coast lines and 1 km isobaths (see Hall et al., in press, for additional information). a) M4 reconstruction (rotation pole = 45.5°N, 33.0°W, and angle = 54.2°), with our anomaly picks for Africa by blue (M4), black (M11), and yellow ("G") circles; and red for South American magnetochrons and "G" anomaly. B) M11 reconstruction (rotation pole = 38.86°N, 31.46°W, and angle = 56.6°).

that thins progressively to normal oceanic crustal thickness at the seaward edge of the overlying SDRs. However southeast of the CL, the crust has a more "normal" oceanic thickness and SDRs are either absent or more limited in areal extent. The modeled cross section through the Cape Basin indicates a change in crustal character from attenuated continental crust to normal thickness oceanic crust occurring over a much shorter distance, which suggests a diminished influence of magmatic material. Magnetic anomalies over the Cape Basin are better correlated with those predicted by our seafloor spreading model than the anomalies over the Orange Basin.

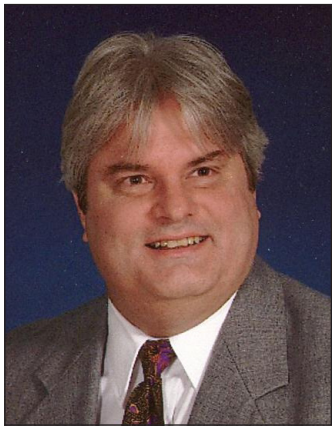
Our reconstructions of the African and South American margins, south of 32°S at M11 and M4 times (i.e., ~135 Ma and ~131 Ma, respectively), successfully overlay magnetochrons of the conjugate margins. In Figure 2 we compare seafloor spreading anomalies M4 and M11, as well as the inboard "G" anomalies over both transitional / continental margins. The new M11 rotation pole (38.86°N, 31.46°W) applies only to the southernmost margins of the Austral segment where the M11 anomalies are observed, because at this time the margins were undergoing non-rigid deformation farther north, including crustal extension and magmatism.

The recognition of initiation of seafloor spreading earlier than previously documented, together with the identification of differing crustal character northwest and southeast of CL, carry important implications for heat flow and the subsidence / depositional history of the margin. ■

Reference

Hall, S. A., Bird, D. E., McLean, D. J., Towle, P. J., Grant, J. V., and Danque, H. A., in press, New constraints on the age of the opening of the South Atlantic basin: Marine and Petroleum Geology.

Biographical Sketch



Dale Bird established Bird Geophysical in 1997, a consultancy focused on interpreting gravity and magnetic data and includes world-wide experience. He earned a PhD in geophysics from the University of Houston (2004) and has since been donating his time on campus (Research Associate Professor) with teaching, collaborating with colleagues, and participating on student research committees. Before these, his experience includes positions with Aerodat, World Geoscience, Marathon Oil Company, Digicon and Aero Service. Dale served honorably in the U.S. Army 1st Military Intelligence Battalion (1976-1979); he is an active member of AAPG, AGU, EAGE, GSA, GSH, HGS, SEG and NESA (National Eagle Scout Association); and he is an avid chess player.

Bird, D. E., Hall, S. A., McLean, D.J., Towle, P.J., Danque, H.A., and Grant, J.V., 2018, **The austral South Atlantic: early formation and crustal structure of the Orange and Cape Basins**: Houston Geological Society – Petroleum Exploration Society of Great Britain, 17th Conference on Africa Exploration & Production, p. 36-38.