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South Atlantic Margins Basin Analysis (SAMBA): The Brazilian Margin or SAMBA, Brazilian Style

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INTRODUCTION

The South Atlantic Margins Basin Analysis (SAMBA) study is a multi-phase study to investigate the West African and Brazilian continental margins. It ranges in time across six epochs and in scale from continental to basinal using multiple sets of geophysical and geological data to evaluate the hydrocarbon potential of these conjugate margins. This paper reviews some of the data sets and methods employed and describes results of the regional overview based on special plate-tectonic reconstructions. It concludes with references to the basin scale work offshore Brazil. The results include various criteria important to hydrocarbon exploration such as the continent/ocean boundary, basin limits and controlling lineations. An additional advantage of the project was the placement of interpretation features versus well-defined grid locations and carefully detailed projection parameters. Consequently, new data could readily be added as available.

SAMBA PHASE 1: SCOPE

SAMBA Phase 1 concentrated on defining the regional distribution of the offshore basins and determining the limits of the thinned continental crust (continental/ocean boundary, COB). Much good work has been done historically from magnetic, gravity and deep seismic profiles. However, the only truly regional geophysical data coverage of both onshore and offshore is gravity as compiled by GETECH. The four contributing data sets were two major continental gravity compilations on- and near- shore, reprocessed satellite gravity over the continental margins and Sandwell public domain satellite data in the deep ocean. The resulting grid was sampled every 2' (about 4km) over the entire project area of the South Atlantic Ocean and adjacent continents of Africa and South America.

The free air gravity data when combined with proprietary bathymetry data for the margins was used to generate the Horizontal Derivative of Bouguer gravity (HDB) and the Isostatic residual gravity (ISO). These and several other derivative/anomaly map types together with Euler deconvolution results provided a powerful means for identifying and mapping the structural elements of the continental margin, the location of recent sedimentation and the COB.

WEST AFRICAN MARGIN

The ISO maps clearly demonstrated the geometry and location of recent fan sedimentation as significant positive anomalies caused as denser sediments replaced water with insufficient time for the crust to reach isostatic equilibrium. The fans showed a northerly offset from their sedimentary sources due to South Atlantic ocean's anti-clockwise current circulation. The HDB maps (Figure 1) showed two distinct domains: one full of high amplitude lineaments interpreted as continental and another, quiet zone, of oceanic crust. The dividing line was sharp and well defined from the Walvis Ridge to the Niger Delta. One domain was hot (with high amplitudes), dissected and full of linear features corresponding to the continental syn-rift fabric. The seaward domain was cool and undisturbed, especially in the magnetically quiet area of Cretaceous oceanic crust. Lineaments in the continental crust revealed a syn-rift pattern of half-graben development. Discontinuities in the syn-rift features correlated with known oceanic transforms such as the Fang and N'Komi Fractures. In addition to their paleo control on reservoir distribution, these fractures remained important for their association with fluid migration paths.

Euler Deconvolution results from the Bouguer gravity (EDB) for the West African margin were analyzed in depth slices of 0-4, 4-8, 8-10;10-15 and >15km, using a structural index of 0.5. Solutions for each depth range were displayed in different colours to permit analysis of stacked features. These EDB colour-coded depth slices permitted the identification of the shape and nature of tectonic features in intuitive ways. Shallow sources reflected known tectonic and basin structures while the deeper solutions helped delineate, on a regional basis, limits of the thinned continental crust (COB). The demarcation of the COB off West African was remarkably clear in this analysis. It was then used in the reconstructions to redefine the Brazilian margin which had been over-printed by major volcanic episodes causing a much more complex gravity signature.

PLATE RECONSTRUCTIONS

Instead of using the old style 'wire-frame' computer-based reconstructions, this study restored full present day gravity grids for the South American and African plates to their paleo-positions using known plate rotation parameters and isochrons. Five time periods between 55Ma (Figure 1) and 120Ma were chosen for reconstruction using GETplate software licenced from BG/GETECH. Data preparation only required removal from the gravity field of the third through tenth order harmonics (normal gravity just has harmonics to second order removed). This correction enabled relocation of the present day gravity grid to different time periods without experiencing major data busts at the paleo-reconstructive margin (i.e. paleo-ridge axis).

The reconstructions provided real exploration leverage in two ways. Firstly they provided a framework to extrapolate data from known to unknown areas (especially in the South Atlantic syn-rift basins) which increased the understanding of data already in hand. Secondly they provided the regional ranking basis for targeting high-potential oil concession blocks.

BRAZILIAN MARGIN

From a confident interpretation on the West African side, it was possible to extend these observations to the Brazilian margin. Since segments of the two continents fit at break-up, a clear definition of one passive margin dictated the shape of the other. The HDB fit of the conjugate margins indicated the necessity for the Brazilian COB to move seaward from previously published limits of the syn-rift Campos and Espirito Santo Basins, enlarging the area of inferred lacustrine source potential. The COB was not defined in this study solely from the HDB map on the Brazilian margin, partly due to masking by Tertiary to Recent sedimentation. This masking effect was clearly observed over the Amazon Cone where the signature of the drift age sequence was demonstrated on the Isostatic residual gravity. The thick pile of younger sediments diminished the HDB response of the underlying syn-rift section. Multiple map products including ISO, EDB and various filters were again used to image the COB and the syn-rift and post-rift sections. Extensive volcanism along the Brazilian margin caused masking of a different sort. Again, the necessary fit to the West African margin helped determine the limits of the continental crust in these obscured areas.

SAMBA PHASE 2

For the Brazilian margin, this Phase built on the results of Phase 1 by interpreting the available higher resolution marine gravity and aeromagnetic data over the margin at more detailed scales. The Brazilian margin was subdivided into a series of four multi-basin regions and within one region, into three single basin segments. Within each region and segment the interpretation delineated structures (lineament mapping), mapped areas of volcanism, halokinetics and fan deposition and made inferences on the segment's hydrocarbon potential. Broad-ranging examples from the literature were used as bases for general calibration of the work.

Examples of the results from this detail phase will be shown.

REFERENCES

1) *Dickson and Fairhead, AAPG-Rio, 1998*

2) *Dickson, Fryklund and Green, AAPG-Rio, 1998*

3) *Dickson, Offshore, May 1999, in press.*

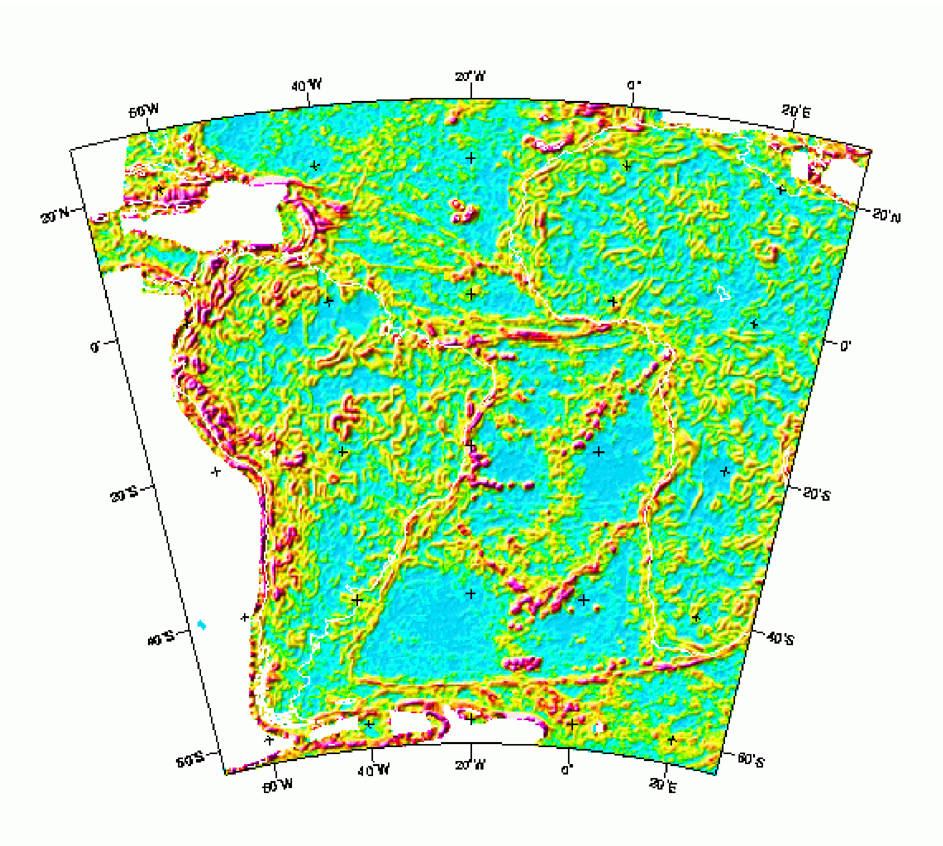

Figure 1 Caption: Horizontal Derivative of Gravity (HDB) display of the entire region with plates restored to 55Ma using GETplate.