Mesozoic Plate Tectonic Deformation and Basin Development within South America based on Gravity and Aeromagnetic Data

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INTRODUCTION

Gravity and aeromagnetic data for South America are used to image and delineate regional tectonic structures that are associated with plate deformation that developed prior to, and during, the opening of the South Atlantic during Mesozoic to Tertiary times. To investigate and evaluate this deformation, the study uses the gravity signature of the continental/ocean boundary (COB), to compare the relative displacements and mismatches of the continental margins of West Africa and South America.

DATA USED

Since 1988, GETECH has undertaken two major compilation studies in South America, these being the South American Gravity Project (SAGP, 1988-91) and the South American Magnetic Mapping Project (SAMMP, 1993-96). Following the completion of the SAGP study, the resolution of the study products have been improved for Argentina, Brazil (onshore and offshore), Chile and Uruguay by the incorporation of significant volumes of new data and by reducing the grid cell size from 5' to 2' (i.e. from 10 km to 4 km). In the offshore areas, GETECH has reprocessed the satellite gravity data to improve the resolution for areas with poor marine gravity data coverage. Aeromagnetic data compiled in the SAMMP study have also been significantly improved, particularly in Brazil, by the incorporation of the full resolution Petrobrás aeromagnetic data. These studies and subsequent improvements have progressively improved our ability to image regional tectonic structures as well as evaluating the hydrocarbon potential of the sedimentary basins both onshore and offshore.

DEFORMATION OF THE AFRICA PLATE

Although lithospheric plates are often considered to have undergone little to no internal deformation, this is not true on closure inspection. Continental deformation and basin development are recognised phenomena during continental break-up. During the early opening of the South Atlantic Ocean, there is ample evidence of wrench tectonics, of Cretaceous age, generating rift basins that extend from the Gulf of Guinea through Nigeria into west and central Africa. Strike slip fault zones also extend from the Gulf of Guinea through Cameroon, southern Chad, and Central African Republic into Sudan and are associated with major wrench and extensional basin systems (see Figure 1). The cumulative sinistral strike slip fault movement is estimated to be as great as 100 km. Such movement is explained by the differential opening (differences in the location of the poles of rotation and their angular opening) of the Central and South Atlantic basins, where differences in basin opening have been taken up by strike slip movements along the Equatorial Fracture Zone and propagated into Africa as shear/wrench zones before terminating as extensional basins

This deformation has significantly altered the shape of Africa's Atlantic continental margin to the west and south of Nigeria and helps to explain the poor pre-drift fit of Africa with South American. Elsewhere along the African margin there is evidence that fracture zones (or flow lines) have been nucleated by pre-existing basement structures which have also influenced and compartmentalised the continental margin structures. Dickson and Fairhead (this volume), show that the combined use of the horizontal derivative of the Bouguer gravity and the Isostatic residual gravity provide a powerful means of delineating the continental/ocean boundary (COB) along the West African margin between the Niger Delta and the Walvis Ridge and farther south. The West African COB can then be used to evaluate the amount of displacement and mismatch that has occurred along the South American margin.

PLATE RECONSTRUCTIONS

To study continental deformation during and subsequent to plate break-up it is important to have the ability to restore the plates to their paleo-locations at the onset of drift. This has been done using the BG/GETECH specially designed software 'GETplate' using published plate rotation parameters and isochrons. The well defined West African COB is used as a 'goodness of fit' means, to define the location of the South American COB in areas where sedimentation and volcanism have made it less well defined. The West African COB can also help to estimate the amount of deformation the South American margin as undergone since the continental plates separated. It should be noted that many published plate motion vectors for the early opening of the South Atlantic are poorly defined and can introduce error to

the 'goodness of fit'. Better vectors are being developed to resolve this problem.

DEFORMATION OF THE SOUTH AMERICAN PLATE

Deformation of the South American plate has generally been considered to play a less important role in terms of affecting the shape of its continental margin. The possible exceptions to this are probably the Amazon basin and the Parana-Chacos basin deformation zone, with the latter being considered by some authors as being responsible for a significant amount of mismatch of the continental margins in the southern part of the South Atlantic.

The improved resolution of the gravity and aeromagnetic data onshore and over the continental margins permits better assessment of the likely causes for such displacements and mismatches. Quantitative evaluation of these deformation zones and their effect on the shape and mismatch of the continental margins still need to be carried out. From north to south these deformation zones include the Orinoco (1), Takatu (2), Amazon (3), Potiguar (4) and Tucano (5) basins of Venezuela, Guyana and Brazil and the Parana-Chacos (6), Salado (7) and Colorado (8) basin deformation zones of southern Brazil, Uruguay and Argentina (see Figure 1 for numbers and locations).

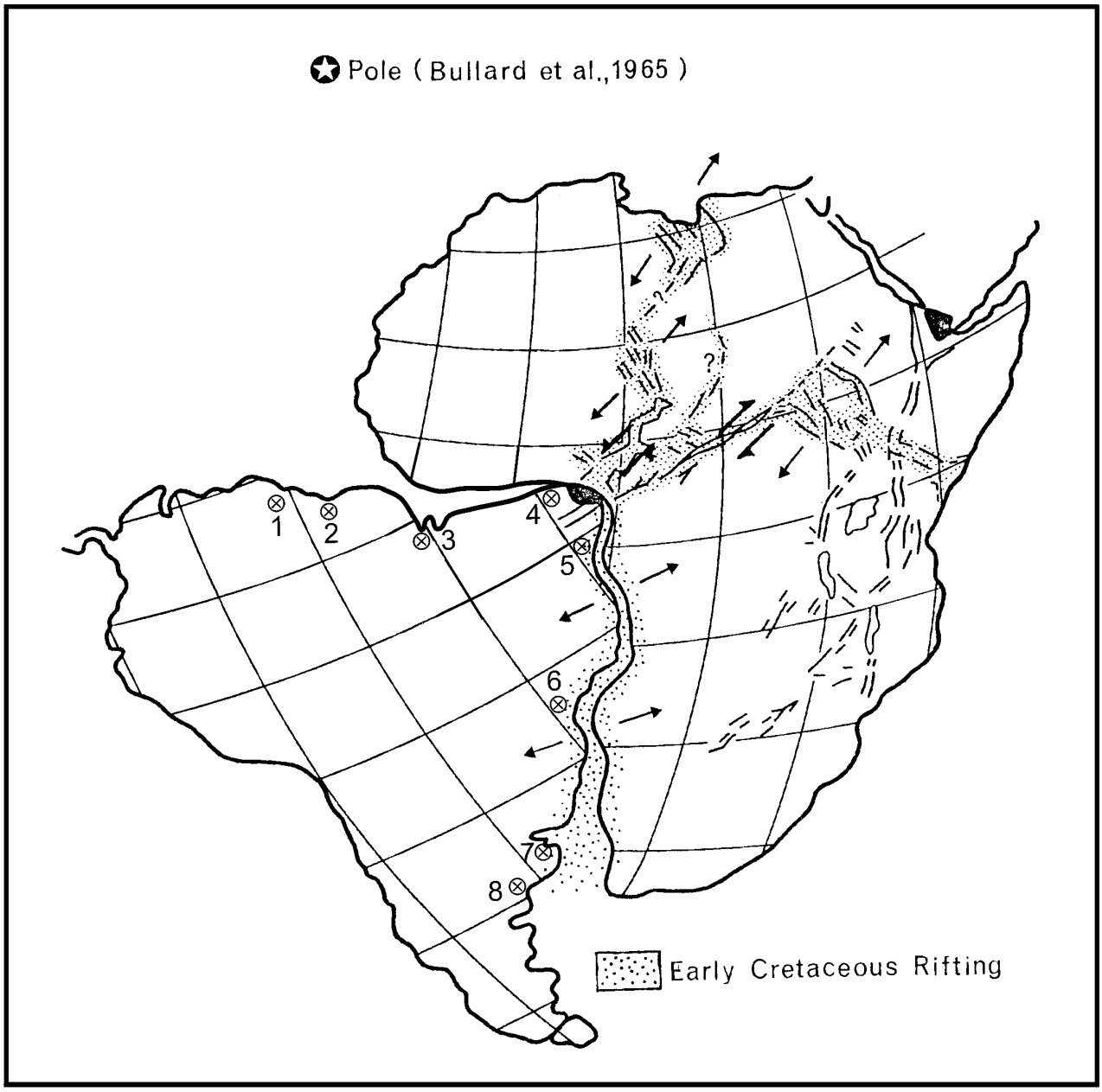

Figure 1. Pre-drift location of Africa and South America showing the major Cretaceous basins of west and central Africa that developed during the early opening of the Central and South Atlantic Ocean basins. On the South American side, the numbered locations (see text) indicate potential sites of plate deformation that will be investigated in the talk. The projection used is a true azimuth and distance plot centered on the Bullard et al. (1965) pole position such that strike slip vectors form small circles about this pole location.