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Tectonic controls on the location of incised valleys/submarine canyons during the last 89 my, Bahia Sul Basin, Brazil

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Abstract

The Bahia Sul Basin originated during the Late Mesozoic opening of the South Atlantic. The initial break-up was dominated by rift generation, with numerous small basins filled by terrestrial sediments and bounded by normal faults. This rift sequence of alluvial and fluvial deposits gave way to the initial drift phase during the Aptian when marginal marine evaporite deposits, followed by Albian-Turonian shallow marine deposits were laid down. The rift and initial drift stratigraphy includes (from oldest to youngest):

1. Jurassic alluvial and fluvial deposits (Dom Joao Stage)
2. Thick Lower Cretaceous lacustine deposits (Rio da Serra Stage)
3. Aptian evaporite deposits (Alagoas Stage)
4. Albian-Turonian shallow-marine carbonates

Near the end of the Turonian, the rate of sea-floor spreading increased rapidly. As a result of this change in spreading rate, the top of the Turonian is marked on seismic and in well-logs by a large regional unconformity, followed by a flooding surface and the deposition of marine sands and shales of the Espirito Santo Group. This regional unconformity cuts into the underlying rift section, and is interpreted as the 89 my Sequence Boundary. Relief on this sequence boundary is considerable, and reveals a series of incisions, which run from west to east into the newly opened South Atlantic. The locations of these incisions probably follow the underlying basement grain and focused subsequent deposition. Deposition after the 89 my Sequence Boundary is characterized as a succession of incising sequence boundaries, and each sequence's deposits can be characterized by the deposition of lowstand, transgressive and highstand sediments in response to relative sea-level changes on the Bahia Sul passive margin. During each lowstand, sediments bypassed the shelf through the incised valleys and submarine canyons, and were deposited in the basin as submarine channel fill and deep-sea fans, generally followed by a shale-prone lowstand wedge. During the subsequent transgressive/highstand cycles, the incised valleys were filled with sediment, which diminished, or totally obscured, the lowstand shelfal relief.

Incisions on the successive sequence boundaries have steadfastly maintained their relative geographic location since the 89 my Sequence Boundary. These incisions are coincident with present day submarine canyons, and line up with the major rivers on the continental margins of Brazil and Gabon (West Africa). This coincidence of geographic location of the valleys/canyons suggests a strong tectonic control throughout the basin's drift phase.

Tectonic control for such a long period of time is likely related to crustal structure. The break up of the South Atlantic occurred as the propagation of a series of predominantly N-S, but also E-W rifts, which followed Proterozoic structural features on the craton. The continuation of these rifts into the continental crust is well documented both on the African Continent (i.e. Benue Trough) and on the Brazilian craton (Reconcavo basin). To a much lesser extent, the break-up fabric is evidenced on the Bahia Sul margin by the alignment of mid-oceanic transforms with present day submarine canyons. The strain related to the mid-oceanic transforms must be manifested in the continental crust of the Bahia Sul margin, as a series of weak zones where the rivers and canyons tended to develop. Crustal tectonic control on the location of these shelfal canyons seems to continue into the craton, causing the major rivers to follow nearly straight courses toward the ocean, in areas of low relief where more sinuous rivers would be expected. Similar alignment and tectonic control on major rivers is observed on the conjugate African margin. For example, the Ogooue River in Gabon is located in a low area that is formed on the eastern end of the South Atlantic Ascension Fracture Zone. The Ogooue River, and its predecessors, has been depositing sediments into the Ogooue Basin during at least the last 89 ma, similar to our observations in the Bahia Sul margin. All of these observations support the conclusion that the initial break-up fabric has dominated both the structural and the depositional evolution of the Bahia Sul margin throughout its entire history.