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Tectonic Architecture of the Equatorial Atlantic Margin: Insights from the Central Segment of Brazilian Counterpart

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The sedimentary basins of the Brazilian Equatorial Margin (BEM) are considered a key frontier for petroleum exploration. The BEM is characterized by transform tectonics, featuring oblique and divergent brittle structures occurring on the Foz do Amazonas, Pará-Maranhão, Barreirinhas, Ceará, and Potiguar basins. This tectonic pattern is also recognized in the West African marginal basins (Ghana, Ivory Coast, and Liberia), including those of Cote d'Ivoire and Ghana. The central sector of the BEM, where the divergent segments of the Pará-Maranhão Basin meet the transform segment of the Barreirinhas Basin. To better understand the tectonic framework, a comprehensive dataset, including seismic data, in addition to well data (gamma-ray, density, sonic profiles, checkshots, and biostratigraphy), was analyzed across 80,000 km². These data, reinterpreted considering modern understanding of the BEM evolution, provided insights into the structural and stratigraphic characteristics of the margin. The basins were classified based on the obliquity of their segments relative to the rift extension direction. This obliquity, defined by the angle between the transform faults and segment direction, was used to delineate four distinct crustal domains: the continental thinning domain, the hyper-extended continental domain, the mantle exhumation domain, and the oceanic domain. Each domain reflects different geological processes contributing to crustal evolution. The Pará-Maranhão divergent segment, which connects with the Barreirinhas transform segment, is oriented NW-SE with a 53° obliquity. This segment has a wider continental thinning domain due to its higher obliquity. The sequence of crustal thinning progresses from continental to oceanic, marked by normal faults, horsts, and grabens, indicating tectonic extension. The sedimentation in this region is mainly controlled by thermal and tectonic subsidence, with distinct rift (syn-rift), post-rift, and continental shelf sequences. Fault blocks rotate, creating listric faults and rollover systems that affect sedimentation. In contrast, the West Barreirinhas segment, which is aligned with the Romanche Fracture Zone, has a 0° obliquity. This transform margin features a narrow continental crust neck, with differential subsidence and steep post-rift slopes. Listric faults and large negative flower structures are characteristic of this segment. Overall, the variation in obliquity across the margin segments significantly influences the width of the crustal thinning domain, with higher obliquities resulting in wider thinning zones. The presence of thinned continental crust and exhumed mantle in the deep-water region, prior to the first occurrence of oceanic crust, is similar to the analysis of the African conjugate margin, which is associated with a hydrocarbon system based on Upper Cretaceous turbiditic sandstone reservoirs. The same potential reservoirs are also found in the Brazilian counterpart.