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Structural and stratigraphic development of a volcanic rifted passive margin, Campos and Santos basins, SE Brazil

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We describe the structural and stratigraphic development of the Atlantic margin of SE Brazil, including volcanic rocks. Our analysis is based on published literature, Bouguer-corrected gravity, regional reflection seismic profiles, and well data.

From published literature, the margin initiated as a rift system in Neocomian times. In the Santos and Campos basins, the rift architecture was strongly influenced by pre-existing fabric and structures of Late Proterozoic (Brasiliano) age. The Atlantic margin inherited an ENE-WSW orientation, so that rifting was oblique to the margin. During the initial stages of rifting, large quantities of basaltic magma erupted, forming the Paraná-Etendeka large igneous province. The cause of this volcanic activity was probably the Tristão da Cunha hotspot.

More recently available data help to define the architecture of the rifted margin. Our results have implications for the risks associated with distribution, maturation, and migration of hydrocarbons within the prolific Early Cretaceous lacustrine petroleum system of the Campos and Santos basins. On a regional gravity map, a near-shore belt of positive anomalies correlates with a broad Moho uplift in the footwall of Neocomian extensional faults. Farther offshore, a second belt of positive anomalies correlates with a pre-salt ridge of eroded basement anticlines, which are covered by thin Aptian evaporites. We interpret this ridge as a failed spreading center. An intervening belt of negative anomalies coincides with the main rift basin. All three belts show apparent offsets across linear zones, trending WNW-ESE, which we interpret as transfer zones. The vergence of half-rifts tends to change across transfer zones, compartmentalizing the rifted margin into sub-basins. At the eastern limit of continental crust, transfer zones become aligned with ocean-ridge transform faults, which trend E-W across the South Atlantic.

Although most authors have considered the margin of SE Brazil to be purely passive, we document Late Cretaceous and Cenozoic reactivation of older structures, attributing it to the combined effects of far-field stresses and hot-spot activity. Our conclusions are based on current seismicity, digital topography, fission-track ages, gravity data, regional reflection seismic profiles, and well data. Our results have important implications for risk factors associated with deep-water exploration plays, especially the prolific Early Cretaceous lacustrine petroleum system of the Campos and Santos basins.

Onshore, widespread crustal seismicity indicates a current transpressional stress regime. The Moho is 37 to 42 km deep, and neotectonic fault-block tilting has resulted in mountain ranges up to 2700 m high and extensive river capture. Based on fission-track data, the mountains were exhumed in Cretaceous and Eocene times. A series of Tertiary continental pull-apart basins, developed during Palaeogene right-lateral transtension, have become inverted during Neogene right-lateral

transpression. Alkaline intrusions of Late Cretaceous to Palaeogene age, attributable to the Trindade hotspot, were emplaced along reactivated Neocomian strike-slip faults and transfer zones.

Offshore, current seismicity is widespread across the continental margin. The locus of clastic fan deposition shifted during Late Cretaceous and Tertiary times, because of onshore block faulting and drainage reorganization. Cretaceous sediments were folded, tilted, eroded and unconformably onlapped above an inferred Neocomian Moho uplift, to produce an accentuated nearshore hinge-line. Neocomian transfer zones reactivated during ongoing sedimentation. They were accompanied by abundant volcanism and resulted in deep-seated folds. In the Campos area, uplift of a coastal salient led to redeposition of Eocene turbidites. In general, regional tilting resulted in thin-skinned deformation above Aptian salt.