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Structural Controls on the Evolution of the Southeastern Brazilian Continental Margin

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The South Atlantic passive margins show considerable variation along strike in terms of both structural style and margin width. Much of this change is thought to be due to variations in basement structure. Previous studies have shown that the influence of pre-existing structures can range from metre-scale local variations in basement fabrics to tens of kilometre-scale lithospheric heterogeneities relating to past deformation events.

The Santos basin (offshore Rio de Janeiro, Brazil) is an increasingly important target for hydrocarbon exploration. The basin is thought to be underlain by thinned continental crust, possibly part of the Neoproterozoic Ribeira mobile belt, whose structures onshore lie parallel or sub-parallel to the continental margin. The formation of structures in the Santos basin and onshore southeastern Brazil has previously been thought to have been controlled by reactivation of these basement structures. Recent discoveries such as the giant Tupi oil field and recently drilled dry wells in the basin (Guaraní, Corcovado-2), highlight the importance of understanding the sub-salt structure in the basin.

A remote sensing- and field-based study of structures formed during Cretaceous and Tertiary rifting events was carried out. We identify two generations of structures: $\sim$120Ma Cretaceous tholeiitic dykes and associated faults; and $\sim$60Ma Tertiary faults, showing silicified breccias associated with further alkaline magmatism. A strong northeast – southwest structural trend is identified from remote sensed imagery. At outcrop scale, sinistral-oblique and normal faults appear to have formed during the Cretaceous and Tertiary, and Cretaceous dykes show sinistral-oblique emplacement kinematics. These datasets are consistent with sinistral transtension during repeated phases of regional east-west extension. Basement fabrics often show strike parallel to the northeast-southwest trend of the brittle structures, but show a wide variation in dip angle.

The identification of Cretaceous faults and fractures has shown for the first time that the early rifting can be studied onshore, as well as offshore. Data from outcrops and remote sensing can be combined with maps of pre- and post-rift structures interpreted from seismic and other geophysical data to provide an integrated onshore-offshore view of the evolution of the Santos basin.

This study also highlights that, whilst we see a consistent trend of the brittle structures on both regional and outcrop scales, the basement fabrics display a great deal more heterogeneity. Where the basement is not oriented parallel to the northeast-southwest regional trend of brittle structures, we do not see an influence on the trend or structural style of the brittle faults. This suggests that whilst the local reactivation of exposed basement fabrics may lead to the development of complex fault systems at sub-seismic scales, the ultimate control on the formation of brittle structures was at a larger scale relating either to the initiation of the South Atlantic and/or to the development of pre-existing fabrics in the upper mantle.