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A geophysical view of the Southeastern Brazilian margin at Santos Basin: Insights into rifting evolution

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ABSTRACT

This study investigates the rifting structures of Santos Basin at the Southeastern Brazilian margin, based on an integrated geophysical approach. Our aim is to constrain the crustal basement topography of central and northern Santos basin, the presence of magmatism and the role of inherited structures in space and time through the rifting processes. We present a new high resolution aeromagnetic dataset, which in correlation with gravity anomalies enables us to interpret the tectonic trends and crustal basement structures. We calculated the magnetic basement depth for the central and northern Santos Basin using power spectrum analysis. The obtained depths range between 2 and 9 kms, and are comparable with results from previous works. From our integrated study, three margin domains could be identified, which display distinct rifting structures and are characterized by important lateral variation along the margin. The proximal domain displays trends and magnetic basement blocks NE–SW oriented, i.e., parallel to inherited onshore crustal basement with an inflexion to E–W oriented trends; the necking domain is characterized by oblique magnetic basement highs and lows (E–W and NW–SE) and a structural trend change. The trends and magnetic basement highs are bounded by NW–SE negative anomalies, interpreted as transfer zones. Oceanwards at the distal domain, the lineaments and transfer zones show a progressive structural inflexion to ENE and E–W, sub-parallel to adjacent South Atlantic Fracture Zones. The observed crustal basement architecture and segmentation suggest the reactivation of pre-rift structures at the proximal margin and the obliquity of rifting relative to them. From the proximal domain oceanwards the structural pattern may reflect the passage from a "continental type" domain, where lithospheric inheritance controls the deformation, to a distal margin where this influence diminishes and "new" structural trends are formed. We propose that northern Santos Basin show evidences of an intensely deformed zone, where rift evolved under oblique extension, similar to that observed at transform margin segments.

1. Introduction

The Santos basin at the southeastern Brazilian margin (Fig. 1) has been intensely studied in the last decades, and represents at present one of the main targets of the world oil industry. The tectono-magmatic history of the basin is highly complex, encompassing three phases of magmatism, both mafic and alkaline (Almeida et al., 1996; Mizusaki et al., 1998; Moreira et al., 2007), that affected the margin and were accompanied by intense tectonic activity since the pre-rift stage (Ponte and Asmus, 1976; Macedo, 1989; Almeida et al., 1996; Zalán and Oliveira, 2005). The salt sequence, which is widely distributed throughout the basin, reaches more than 2000 m thickness and the distal part lies in present-day ultra-deep waters. These characteristics built a tectonic setting which challenges researchers and industry's technologies still nowadays. Despite all the studies and high quality data acquisition in the last decades, the basin architecture is not completely understood and the oceanward boundary of the ocean–continent transition (OCT) zone is a matter of debate. Zalán et al. (2011) suggested the existence of exhumed mantle and thick crustal blocks along the hyper-extended domain, and imaged normal thickness oceanic crust at the eastern end of the São Paulo Plateau. Nevertheless, the nature of the crust along the OCT and the hyper-

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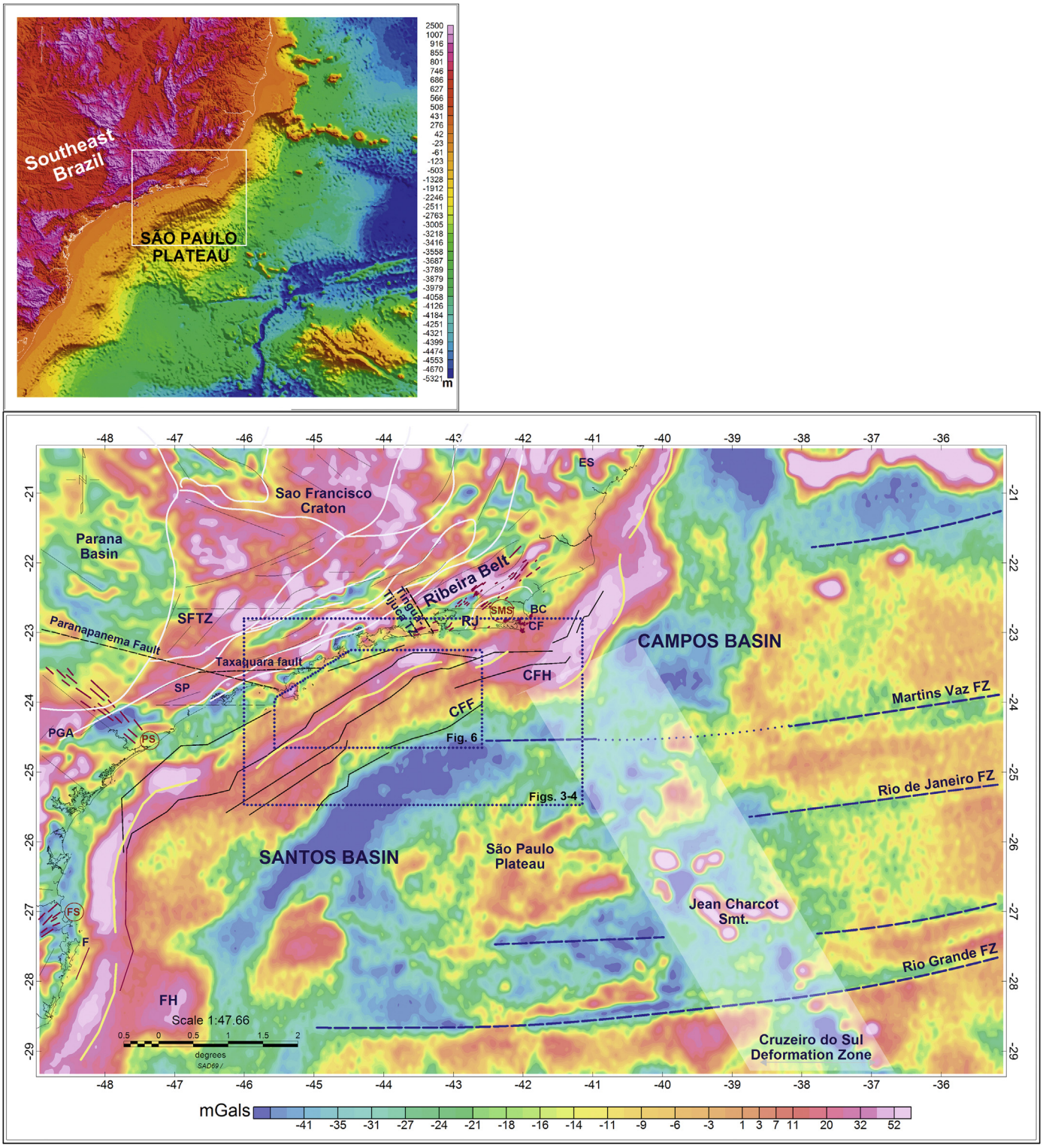

Fig. 1. Regional map of the Southeastern Brazilian Margin, showing the main continental and marginal features. The inset map on the top corresponds to topography/bathymetry map of Southeast Brazil, showing the regional morphology of the São Paulo Plateau (source: ETOPO1 map from NGDC website), with the study area represented by a white rectangle. BC-Búzios Cape; CF-Cabo Frio; ES- Espírito Santo; F-Florianópolis; FH- Florianópolis High; FS- Florianopolis Dyke Swarm; FZ- Fracture Zone; PGA- Ponta Grossa Arch; PS-Ponta Grossa Dyke Swarm; RJ- Rio de Janeiro; SP- São Paulo; SMS- Serra do Mar Dyke Swarm. Black lines- offshore faults (after Kumar and Gamboa, 1979) and onshore lineaments (simplified from the geological map of the Geological Survey of Brazil– CPRM and Fulfaro, 1974; Rideg, 1974; Zalán and Oliveira, 2005 white lines- onshore main geological terranes (Geological Survey of Brazil – CPRM); yellow lines- gravity gradient interpreted as indicating the necking zone; blue dashed lines- westward prolongation of the oceanic fracture zones. The large dotted polygon represents the magnetic and gravity anomaly grids area (see Figs. 3 and 4, respectively); the small dotted polygon represents the magnetic basement grid area (see Fig. 6). The white ribbon represents approximately the area of the Cruzeiro do Sul Deformation Zone.