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Review Article

Impact of lithospheric heterogeneities on continental rifting evolution: Constraints from analogue modelling on South Atlantic margins

A. Cappelletti [a,b,*], F. Tsikalas [a,c,1], Y. Nestola [d], C. Cavozzi [d], A. Argnani [e], M. Meda [a], F. Salvi [a]

[a] Eni E&P, Via Emilia 1, I-20097 San Donato Milanese, MI, Italy
[b] Eni Us Operating Co. Inc., 1200 Smith St., Suite 1700, Houston, TX 77002, USA
[c] Eni Norge AS, P.O. Box 101 Forus, NO 4064 Stavanger, Norway
[d] NEXT — Natural and Experimental Tectonics Research Group, Department of Physics and Earth Sciences "Macedonio Melloni", University of Parma, Via G. Usberti 157/A, I-43100 Parma, Italy
[e] ISMAR-CNR, Via Gobetti 101, I-40129 Bologna, Italy

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A B S T R A C T

Lithospheric-scale experiments integrated with restored crustal transects are used to study the evolution of the Central Segment (confined between the Rio Grande Fracture Zone to the south and the Chain Fracture Zone to the north) of the South Atlantic margin. The presence of crustal inhomogeneities, located within the Brazilian Santos and Campos basins, have been analysed and modelled in order to better understand their effects on the rift evolution and resulting structural architecture of the conjugate rifted margins. The results show that heterogeneities located within the lower crust can have a remarkable impact on the along-margin segmentation promoting articulated basins with horsts and grabens in response to a relative "strong" rheology, and focused and deeper basins related to a relatively "weak" rheology on the equivalent parts of the conjugate pairs. In particular, at the early-stage rift evolution the deformation is concentrated at the inner margin where, in the presence of a weak lower crust rheology, a main deep listric half-graben fault and associated thick and wedge-shaped syn-rift basin sequences are developed. A strong lower crust rheology, instead, gives rise to more planar, rotated, domino-type faulted basins with thinner sequences directly controlled by the individual fault-blocks. At the late-stage rift evolution, once the effects of the initial crustal rheology inhomogeneities are reduced due to the lithosperic thinning process, the outer margin records a late syn-rift sequence which shows comparable thicknesses for both cases of lower crust rheologies. This tectono-stratigraphic evolution of the rifting process gives rise to along-margin alterations in symmetry versus asymmetry of the width and structural architecture. The performed analogue modelling experiments also indicate that during the rifting evolution pieces of brittle mantle are preserved and could be elevated beneath the developed upper crustal structures, giving rise to complicated predictions for the along-margin heat-flow.

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* Corresponding author at: Eni Us Operating Co. Inc., 1200 Smith St., Suite 1700, Houston, TX 77002, USA.
E-mail addresses: alessio.cappelletti@enipetroleum.com (A. Cappelletti), filippos.tsikalas@eninorge.com (F. Tsikalas), yago.nestola@unipr.it (Y. Nestola), cristian.cavozzi@unipr.it (C. Cavozzi), andrea.argnani@bo.ismar.cnr.it (A. Argnani), marco.meda@eni.com (M. Meda), francesca.salvi@eni.com (F. Salvi).
[1] Also at: Department of Geosciences, University of Oslo, P.O. Box 1047 Blindern, NO-0316 Oslo, Norway.

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1. Introduction

The rifting processes and the mechanism with which the continental crust is, through stretching and thinning processes, eventually broken are still far away to be completely understood (e.g. Ebinger, 2005; Reston and Pérez-Gussinyé, 2007; Rosenbaum et al., 2008; Rosendahl et al., 2005; Sawyer et al., 2007). Several generic models describing the above processes have been proposed during the end of the last century (e.g. Barbier et al., 1986; Lister et al., 1986; McKenzie, 1978; Wernicke, 1981), and have defined the complex interaction of structural and magmatic relationships during the continental rifting and breakup. This interaction results in a wide variety of margin styles, ranging, among others, from narrow to wide, and from "magma-poor" to "magma-dominated" conjugate-pair rifted margins (e.g. Blaich et al., 2011; Menzies et al., 2002; Péron-Pinvidic et al., 2013; Sawyer et al., 2007). "Magma-poor" rifted margins are those where volcanic products are sporadically distributed along the margin while the crust is affected by highly intensive, faulting of the brittle rheology (e.g. Iberia–Newfoundland margins, Péron-Pindivic and Manatschal, 2009; Australian–East Antarctic margins, Close et al., 2009; Direen et al., 2007). On the other hand, "magma-dominated" rifted margins are those where magma products are very well diffused and recognised along the rifted margins, and are characterised by seaward dipping reflector (SDR) sequences close to the continent–ocean boundary (COB), large igneous provinces both onshore and offshore, and voluminous along-margin crustal igneous intrusions (e.g. Namibia margin, Gladczenko et al.,

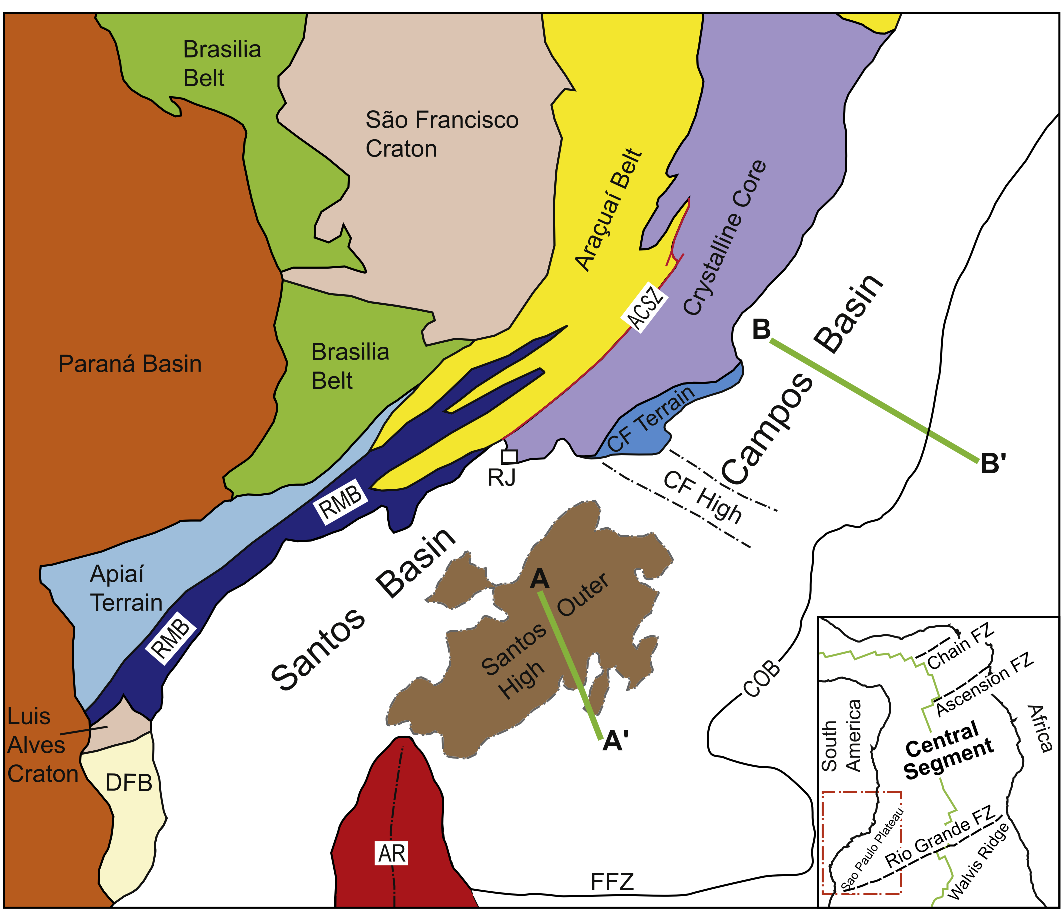

Fig. 1. Simplified geological map of southeastern Brazil (modified from Peres et al., 2004; Heilbron et al., 2008) depicting the main geological provinces and the location of the two restored seismic transects in Santos and Campos basins. ACSZ, Abre Campo shear zone; AR, Abimael Ridge; CF, Cabo Frio; COB, continent–ocean boundary; DFB, Dom Feliciano Belt; FZ, Fracture Zone; FFZ, Florianopolis Fracture Zone; RMB, Ribeira Mobile Belt; RJ, Rio de Janeiro.

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