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Tectonic setting of the Taubaté Basin (Southeastern Brazil): Insights from regional seismic profiles and outcrop data

Nathan Cogné [a,*], Peter R. Cobbold [a], Claudio Riccomini [b], Kerry Gallagher [a]

[a] Geosciences-Rennes, Université de Rennes 1, Campus de Beaulieu, 263 av. du General Leclerc, 35000 Rennes, France
[b] Instituto de Geociências, Universidade de São Paulo, Rua do Lago 562, CEP 05508-080, São Paulo, SP, Brazil

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ABSTRACT

In southeastern Brazil, a series of onshore Tertiary basins provides good evidence for post-rift tectonic activity. So as better to constrain their tectonic setting, we have revisited outcrops in the Taubaté and Resende basins and have reinterpreted 11 seismic profiles of the Taubaté Basin. Where Eocene to Oligocene strata crop out, syn-sedimentary faults are common and their senses of slip are mainly normal. In contrast, for two outcrops in particular, where syn-sedimentary faults have put Precambrian crystalline basement against Eocene strata, senses of slip are strongly left-lateral, as well as normal. Thus we distinguish between thin-skinned and thick-skinned faulting. Furthermore, at four outcrops, Precambrian basement has overthrust Tertiary or Quaternary strata. On the seismic profiles, basal strata onlap basement highs. Structures and stratigraphic relationships are not typical of a rift basin. Although normal faults are common, they tend to be steeply dipping, their stratigraphic offsets are small (tens of metres) and the faults do not bound large stratigraphic wedges or tilted blocks. At the edges of the basin, Eocene or Oligocene strata dip basinward, have been subject to exhumation, and in places form gentle anticlines, so that we infer post-Oligocene inversion. We conclude that, after an earlier phase of deformation, probably during the Late Cretaceous, the Taubaté Basin formed under left-lateral transtension during the Palaeogene, but was subject to right-lateral transpression during the Neogene. Thus the principal directions of stress varied in time. Because they did so consistently with those of the adjacent regions, as well as those of the Incaic and Quechua phases of Andean orogeny, we argue that the Tertiary basins of southeast Brazil have resulted from reactivation of Precambrian shear zones under plate-wide stress.

1. Introduction

Southeastern Brazil is a mountainous area of high relief, reaching an altitude of nearly 2800 m in the Serra da Mantiqueira. Over most of the region, the rocks at outcrop are Precambrian gneisses or granites. However, along a strip close to the continental margin, there is a series of sedimentary basins, which formed in the Tertiary (Fig. 1). The valley of the river Paraiba do Sul crosses the Taubaté, Resende and Volta Redonda basins and follows a remarkably straight course for a distance of some 250 km, almost parallel to the coastline. The valley separates the Serra do Mar, nearer the coast, from the Serra da Mantiqueira, further inland. The sharp relief and the presence of Tertiary basins are indicators of Cenozoic tectonic activity.

The Taubaté Basin, which is the largest of the Tertiary basins, is about 170 km long and 20 km wide. According to seismic profiles, well data and geophysical modelling of gravimetric data, the Tertiary strata are 800–850 m thick (Carvalho et al., 2011; Fernandes and Chang, 2002; Marques, 1990; Mendonça Filho et al., 2010; Padilha et al., 1991, 2002; Vidal et al., 2004). At outcrop, from the fossil record, the rocks are Eocene to Mio-Pliocene in age (Melo et al., 1985; Riccomini et al., 2004, Fig. 2). At the base of the Volta Redonda Basin, an ankaramitic lava flow has yielded an age of 48 ± 1 Ma (Riccomini et al., 2004). Toward the base of the Taubaté Basin, Marques (1990) identified two stratigraphic units on seismic sections, but these units do not crop out. However, we infer for them a Palaeocene to Eocene age, by comparison with (1) Palaeocene ages of fossil mammals from the fault-controlled Itaboraí Basin, close to Rio de Janeiro (Bergqvist and Ribeiro, 1998; Rodrigues-Francisco and Cunha, 1978; Kellner and Campos, 1999; Marshall, 1985), and (2) the Eocene age of the ankaramite at Volta Redonda that is stratigraphically above.

* Corresponding author. Present address: Geology Department, Trinity College Dublin, Dublin 2, Ireland.
E-mail addresses: nathan.cogne@hotmail.fr, cognen@tcd.ie (N. Cogné).

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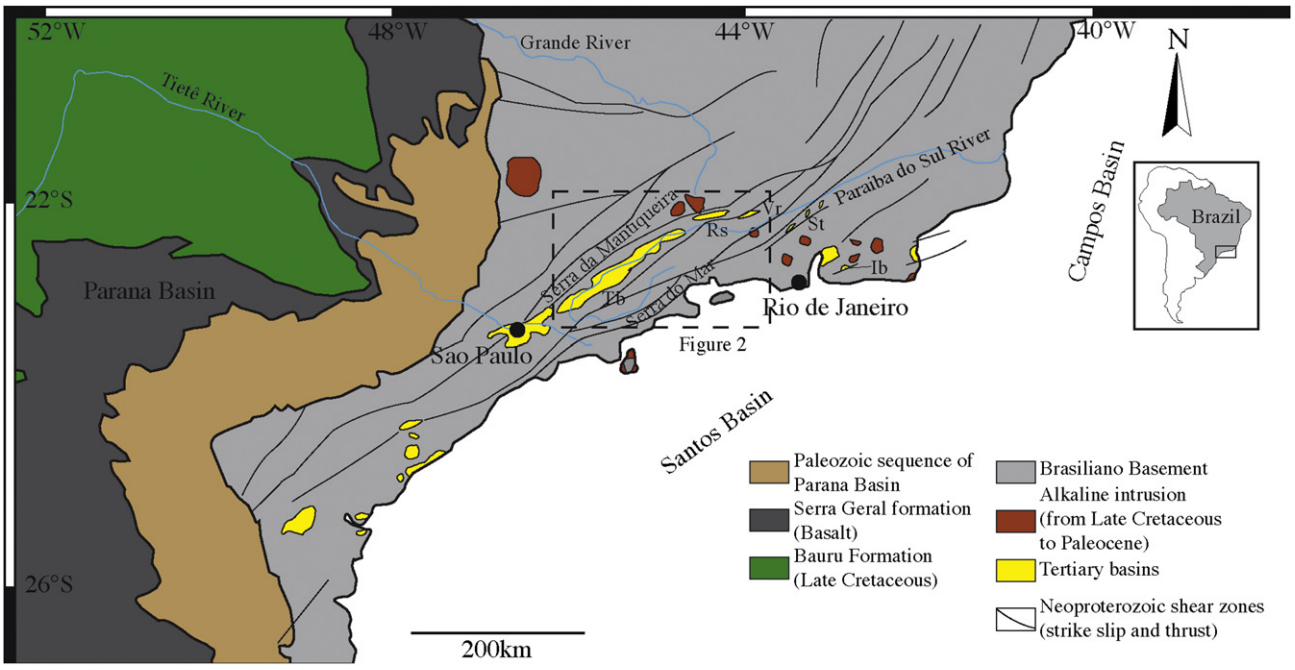

Fig. 1. Schematic geological map of southeastern Brazil (after Gontijo-Pascutti et al., 2010, and Hiruma et al., 2010, modified). Eastern Tertiary basins are Taubaté (Tb), Resende (Rs), Volta Redonda (Vr), Santana (St) and Itaboraí (Ib). Dashed rectangle indicates area of Fig. 2.

Offshore, erosion on the shelf of the Santos basin was synchronous with strike-slip faulting of Precambrian basement along a hinge line (Cobbold et al., 2001), before deposition of flat-lying mid-Eocene strata. The Taubaté Basin also is fault-controlled. On regional seismic profiles, Marques (1990) showed that the basin is asymmetric. On one side, a steep normal fault puts Tertiary strata against Precambrian basement, whereas on the other side, the strata onlap the gently dipping top of the basement. The polarity

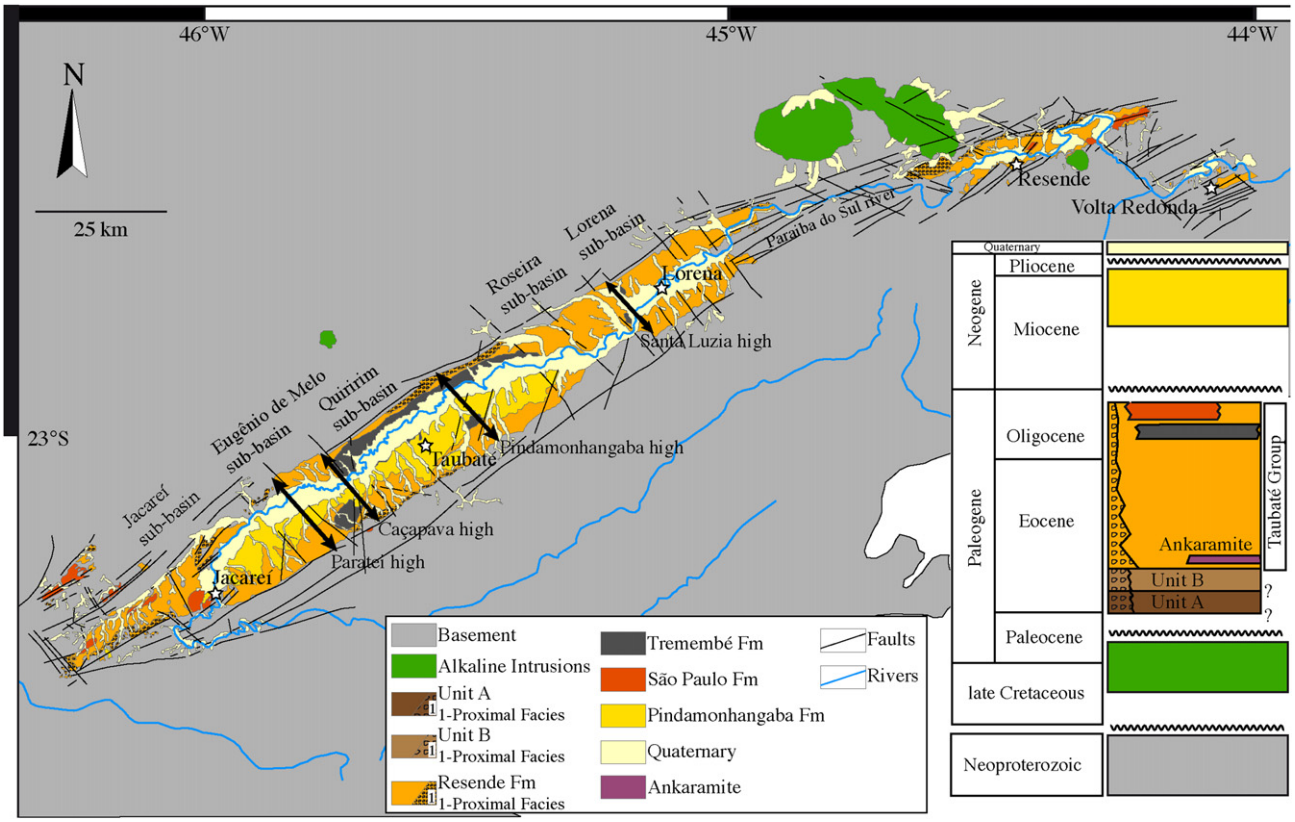

Fig. 2. Geological map and stratigraphic chart of central part of "Rift Continental do Sudeste do Brasil", including Tertiary basins of Taubaté, Resende and Volta Redonda (Riccomini et al., 2004, modified). For Taubaté Basin, basement highs separate sub-basins (Jacareí, Eugênio de Melo, Quiririm, Roseira and Lorena). Main faults (black traces) have formed by reactivation of Precambrian shear zones. Paraíba do Sul river drains all basins, from SW to NE. Stratigraphic units A and B do not crop out, but are visible on seismic profiles. For area of map, see Fig. 1. Stars indicate towns.