Advancing the stratigraphic knowledge of a Paleogene rift basin in SE Brazil using seismic and well data

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Abstract Summary

This study describes the subsurface stratigraphic analysis of the Resende Basin, a Paleogene hemigraben located in the Central Segment of the Continental Rift of Southeastern Brazil (CSRB) (Figure 1), aiming to advance the knowledge of its tectonostratigraphic evolution based on seismic data and a pioneer stratigraphic well. Three seismic units were recognized with remarkable correlation with density log and lithological profile of the well.

Introduction

The Continental Rift of Southeastern Brazil (CSRB) corresponds to a Paleogene NE-SW elongated and depressed geotectonic structure developed in the continental area adjacent to the Santos and Campos marginal basins (Ricominni et al., 2004). The main segment of this geotectonic feature includes São Paulo, Taubaté, Resende e Volta Redonda basins, which have been considered important analogues for the study of the initial evolutionary stage of rifts, particularly the Early Cretaceous rift of the Southeastern Brazilian Continental Margin. The Resende Formation is the main sedimentary record in the CRSB basins. This lithostratigraphic unit is characterized by the predominance of stratified feldspathic sandstones, with conglomeratic layers, interbedded to greenish-colored mudstones, associated with a syn-rift braided fluvial system that developed along the entire extent of the basin, and marginal alluvial fans. Despite its geological significance, the stratigraphic framework of the Resende Basin remains partially misunderstood, lacking subsurface investigations. The sedimentary filling of this basin is currently known almost exclusively through lithostratigraphic analysis based on the outcropping record. This study presents a subsurface stratigraphic analysis of the Resende Basin based on seismic data and a pioneer stratigraphic well.

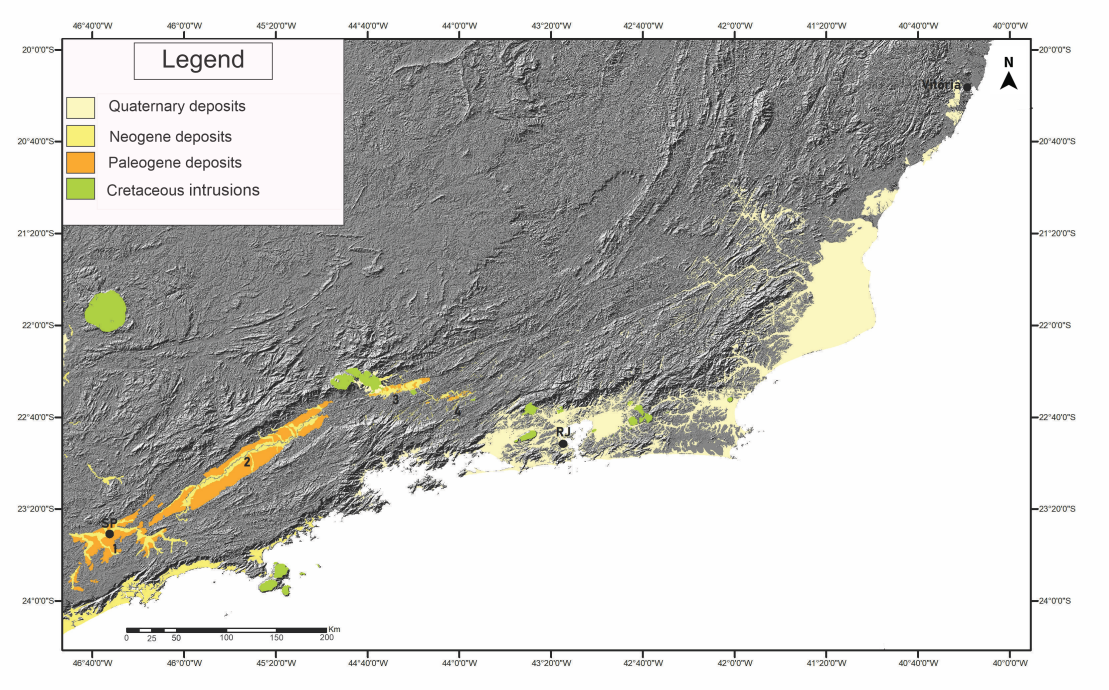

Figure 1: The basins of the central segment of the Southeastern Rift of Brazil. 1-São Paulo Basin, 2- Taubaté Basin, 3- Resende Basin, 4- Volta Redonda Basin

Method and/or Theory

This work was carried out in three main activities: acquisition, processing (imaging), and interpretation of a 2D seismic line; drilling of a stratigraphic well (RES-01) with continuous sampling, described at a 1:40 scale; and interpretation of a density well log. This study will address the interpretation of the seismic line, the interpretation of the density log, and the correlation of these products with the well lithological description of the well cores. The seismic line and the stratigraphic well are located near the city of Porto Real, Rio de Janeiro State (Figure 2). The seismic line is 636 meters long, and the stratigraphic well is 405 meters deep.

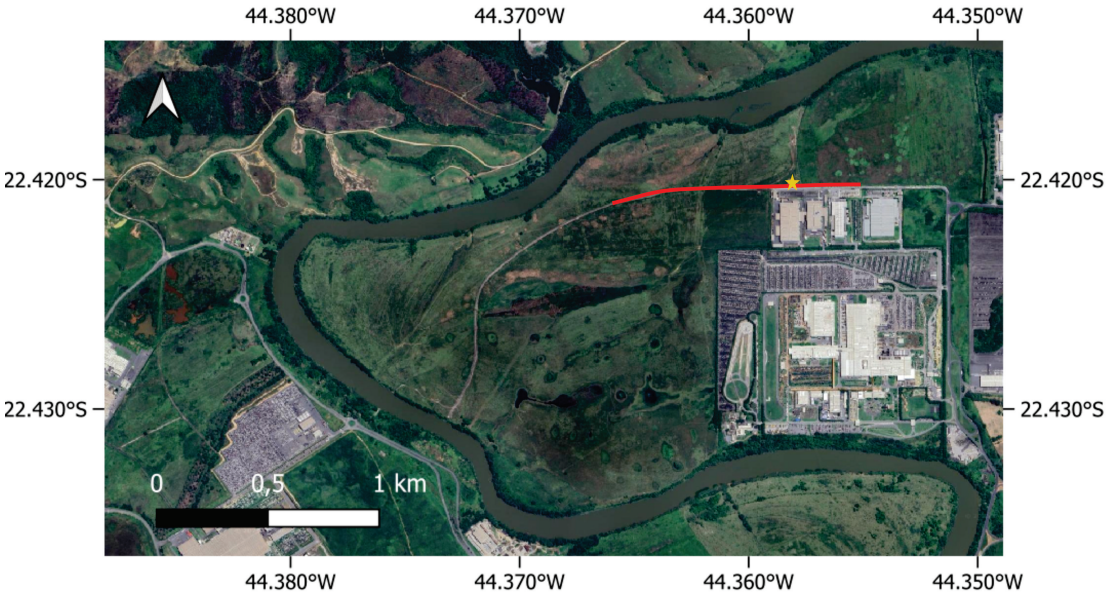

Figure 2: Location of RES-01 well and the seismic line. The line in red is the seismic line and the yellow star is the well location.

Results

The lithological profile of the well shows three geologic units: Quaternary fluvial deposits from 0 to 11 meters in depth, Resende Formation from 11 to 387 meters in depth, and basement from 387 to 405 meters in depth. Three seismic units were recognized in the seismic line (Figure 3). The upper unit (unit A), from 0 to 100 meters in depth, is characterized by prominent horizontal reflectors. In the well lithological log, this interval is predominantly associated with sandstones and occasional mudstones and conglomerates interbedded. The intermediate seismic unit (unit B), from 100 to approximately 250 meters in depth, exhibits low amplitude and discontinuous reflectors. In this interval, sandstones are predominant, with fewer interbedded lutites and with evidence of fault zones. In the lower and deepest seismic unit (unit C), from 250 to 380 meters in depth, the reflection pattern shifts back to more continuous reflectors. In this final interval, conglomeratic layers become more prominent, along with significant fracture zones. The density well log aligns closely with these main seismic intervals (Figure 3), showing lower density in the first 100 meters and at the deepest interval of the section, while an increase in density is observed between 100 and 250 meters. Based on the lithological well log the proeminent reflectors at approximately 250 meters depth correspond to a zone with significant carbonate cementation, which increases the rock hardness and generates the seismic contrast, and the reflector at 380 meters marks the impedance contrast associated with the top of the basement.

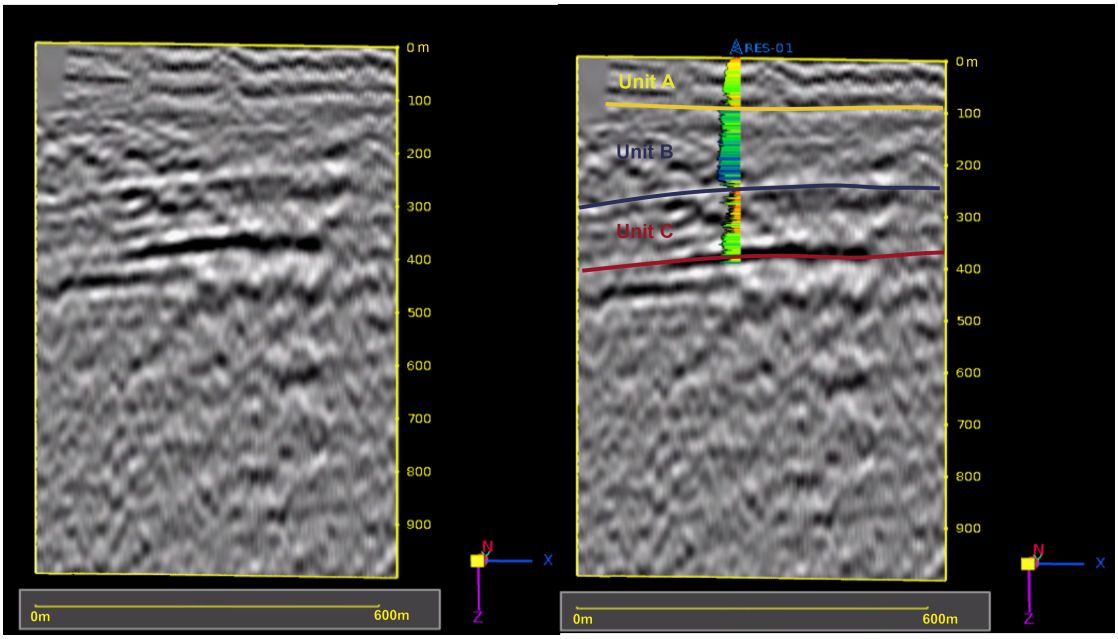

Figure 3: Seismic line displaying the three seismic units identified and the density profile.

Conclusions

This subsurface stratigraphic study, utilizing seismic data, density log, and lithological profile, has significantly advanced the understanding of the Resende Basin sedimentary filling. The identification of three distinct seismic units, each correlating with specific lithological characteristics and density variations, highlight the complex depositional history of the Resende Formation, pointing to the need to advance studies on the different depositional systems and tectonic and paleoclimatic controls on the CRSB evolution.

Acknowledgments

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