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Seismic Reprocessing and Revelation of Geological Features in the Taubaté Basin

Amanda Lins, Luciana Rios (GISIS/UFF), Guilherme Lenz (GISIS/UFF), Marcos Lopes (GISIS/UFF), Marco Cetale (GISIS/UFF)

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Abstract Summary

This paper presents the reprocessing of legacy seismic data from Taubaté Basin, originally acquired by Petrobras in the 1980s and 1990s. Using conventional tools, the aim was to generate good quality images and deepen the understanding of the geological processes associated with the formation and evolution of the basin.

Introduction

The National Agency for Petroleum, Natural Gas and Biofuels (ANP) holds an extensive collection of legacy seismic data, originally mainly from the 1980s and 1990s, acquired by Petrobras in various brazilian sedimentary basins. Although much of the data has been considered obsolete given the technological limitations at the time of acquisition, the advance in the processing techniques and the greater computational capacity available now allow the extraction of new and improved information from these datasets (Porsani and Pestana, 2008).

Within this context, the objective of the present study is to apply new methods of seismic processing to legacy data from the Taubaté Basin. The new procedures aim to generate higher-quality images and thus contribute to a better understanding of the geological processes that shaped the region. Understanding such processes is of great importance, since the origin of this basin and its sedimentary deposition are related to the formative and deformational tectonics of the *Rift Continental do Sudeste do Brasil* (RCSB).

Theory, Data and Method

The Taubaté Basin is located in the eastern region of São Paulo state, Brazil. It is a hemigraben located in the central segment of the RCSB, whose deposition occurred between the Upper Eocene and the Lower Oligocene. As mentioned before, its study is of great relevance for understanding the tectonic and depositional processes that affected the region during and after the development of the RCSB. Regarding geological sequences, the main formations that occur in the basin are the Pindamonhangaba, São Paulo, Tremembé and Resende formations (Riccomini, Claudio, 2002).

Representing the basal portion of the Taubaté Group, the Resende Formation (Fm.) consists of deposits of alluvial fans and intertwined river systems dating back to the Eocene. Another important formation of the group, the Tremembé Fm. is composed of successions of dolomites, shales and massive claystones. Its deposition was a syntectonic process within a 650 thousand years window during the Oligocene, and took place in a lacustrine paleoenvironment of the playa-lake type (Freitas, 2007; Riccomini, 1989).

The dip line chosen for reprocessing, identified as line 58 (Figure 1), has a total extention of 18,075 meters and is aligned in the NW - SE direction. It is located in a region where the sedimentary package is expected to contain the Pindamonhanga, Tramembé and Resende formations. The data were acquired using an array of four Vibroseis sources, 120 receivers arranged in a split-spread configuration and spaced 25 meters apart, and with a 50 meters shot interval and minimum offset.

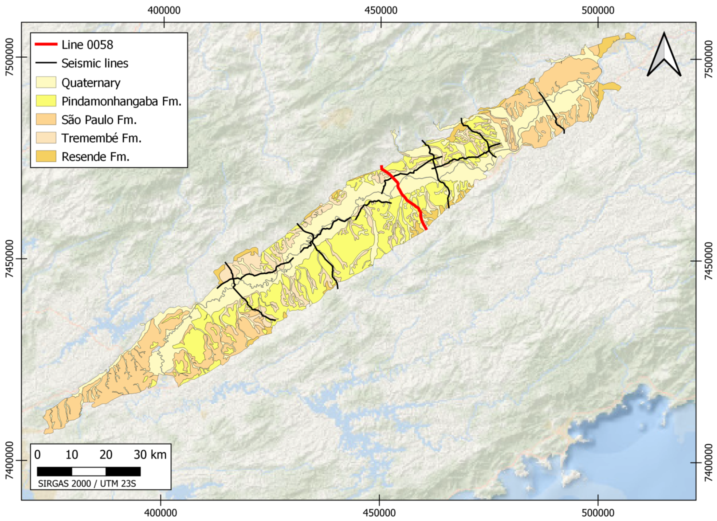

Figure 1: Map showing the seismic lines surveyed in the Taubaté Basin, with line 58 highlighted. Author: Guilherme Lenz.

Seismic line processing was performed using the Epos software, from AspenTech, and consisted of conventional steps (Figure 2). It was a first attempt to improve imaging with the aim of better understanding the geological features of the subsurface.

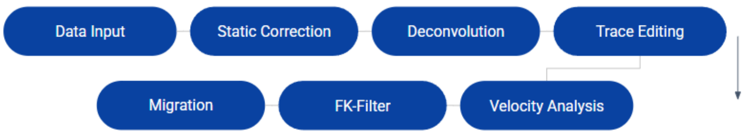

Figure 2: Processing workflow.

After the input of the data, the association of geometry was carried out. It is important to mention that the geometry inputted into the software followed the information present in the acquisition observer's report.

The source and receiver arrays used during acquisition were designed for the attenuation of surface waves. This methodology proved to be highly effective in reducing the ground-roll. This, combined with the limited bandwidth signal of the Vibroseis source (12 and 56 Hz) and pre-filtering, resulted in relatively clean input data, with no significant contamination from high or low frequencies. Therefore, no additional filtering was performed before the static correction stage.

Static correction consists in time shifts applied to seismic traces to compensate for delays due to variations in near-surface layers. After the correction, adjustments could be observed in the shape of the reflection hyperbolas, leading to more coherent seismic events. However, some distortions still persisted, which were attributed to the sinuosity of the acquisition line, an issue that will be addressed more appropriately in future improvements to the processing flow.

To improve the temporal resolution and whiten the data, a gap deconvolution was applied. The gap parameter coinciding with the first zero crossing point of the autocorrelation was the one that provided the best results, enhancing data resolution and the attenuating the residual reverberations.

After further analysis, some near-offset traces that were still directly affected by ground-roll remnants were removed, as they contributed to more noise than signal and reduced the overall seismic resolution. To address additional types of noise, especially those affected by aliasing, a *fk*-filter was applied. Despite introducing some residual noise, the filter proved effective and improved overall data quality.

With the noise attenuation steps completed and the velocity analysis performed, the data was stacked and time migrated using a numerical approximation of the Kirchhoff method.

Results

Figure 3 shows the time migrated section provided by ANP together with the section obtained after reprocessing the data. As can be seen, reprocessing highlighted some geological faults and allowed imaging of surface layers, which are not present in the ANP section. The observed results may contribute for a better understanding of the geological features of the subsurface, as well as for a more precise interpretation of the processes that shaped the basin. They may also open the possibility of studies related to seismic anisotropy, possibly associated with shales of the Tremembé Fm., an interesting research topic to be explored in the future.

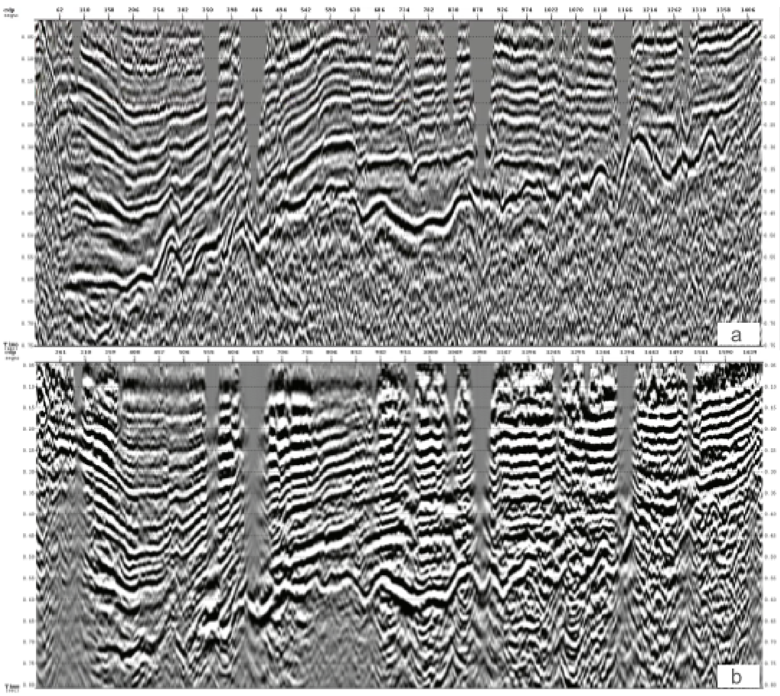

Figure 3: (a) Original time migrated section from ANP; (b) Time migrated section obtained after data reprocessing.

Conclusions

The reprocessing of legacy data from the Taubaté Basin presented successful and promising results. Using the discussed workflow, it was possible to improve data resolution, resulting in better visualization of some faults and surface layers. This work draws attention to the value of seismic datasets that are usually considered obsolete. If worked properly, they can still provide high-quality interpretive products that enhance the understanding of sedimentary areas, like the Taubaté Basin.

Acknowledgments

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