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Advanced seismic interpretation approaches for Azimuthaly sectored Seismic data

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Global Seismic Interpretation Approach for Azimuthally Sectored Seismic Data in the Iara Cluster

With the significant advances in seismic acquisition and processing methods in recent years, the amount and quality of information contained in seismic data have increased substantially. At the same time, the evolution of new seismic interpretation techniques has enabled more efficient value extraction from these data, reducing uncertainties and fastening decision-making processes.

In the specific context of reservoir characterization, one example of these advances is the analysis of multi-azimuth seismic data. These datasets, which incorporate different acquisition angles, allow for more detailed and insightful structural imaging, enhancing the identification of complex geological features and reservoir heterogenies. However, the complexity and the higher amount of data to analyze create a significant challenge, as they require considerable time and effort from seismic interpreters.

The present work illustrates the application of a new seismic interpretation workflow, tailored specifically to multi-azimuth data. The core strategy is based on a semi-automated technology constructing Relative Geological Time (RGT) models. For each of the seismic cubes corresponding to distinct azimuthal acquisition, individual RGT models were built, enabling automated horizon extraction and the application of comparisons analysis directly between the respective models.

The study was conducted on the Iara Cluster zone, located in the Santos Basin, offshore Brazil. This region is characterized by complex pre-salt geological structures, where accurate imaging and characterization are crucial for reservoir modelling. Given the structural complexity and the importance and heterogeneity detection, the application of advanced multi-azimuth seismic interpretation techniques becomes particularly relevant. Thus, the geological settings of the Iara Cluster offers an ideal scenario to apply and validate the proposed methodology for multi-azimuth seismic analysis and RGT models construction.

Once all the RGT models related to each azimuth sector were genereatad, the first step of the workflow consisted in the calibration of each model in order to have the same values distribution to later compare them. After that, for each azimuthal sector, two RGT derived attributes were generated, the timeshift and the amplitude difference nd the respective maps of each one was extracted for the Base of salt, Barra velha and Intra Alagoas intervals.

The t*imeshift*s attribute highlights the vertical differences between mapped horizon points from seismic data acquired at distinct azimuths. The resulting maps show that areas with greater vertical variation tend to align with major NW-SE fault lineaments. These differences may be attributed not only to variations in seismic illumination but also possibly to zones of increased anisotropy. The second attribute, amplitude difference, was calculated based on the variation of amplitude values across azimuthal volumes. Negative amplitude differences can indicate regions where azimuthal variations are more pronounced, suggesting areas of higher anisotropy, particularly in structurally complex zones with fracture networks (Wang et al., 2014). On the extracted maps, these negative zones often coincide with major fault lineaments, reinforcing the interpretation that they can be a reflect of higher density fracture area (possibly associated with fault damage zone).

This study also demonstrated that the use of RGTs can enhance structural analysis and reduce interpretation time. However, to ensure a more robust and reliable interpretation, it is essential to

integrate these products from the RGT modelswith well data, including image logs and geomechanical profiles, which allow for proper calibration and tying of seismic signatures to actual rock properties.