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Using New Dual Azimuth Seismic Data in Prospect Assessment – Jade Case Study, Santos Basin

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Abstract Summary

Update prospect mapping in Brazilian pre-salt using new seismic data has shown great importance in terms of better delineating and defining reservoir thickness. Since the beginning of pre-salt exploration, new acquisitions and better processing methods and technologies were able to deliver higher resolution images that increased the certainty of mapping carbonates and structural features in areas that are still untested by wells. The example used in this work is Jade block, previously analyzed in legacy data and now on offer again by National Agency (ANP) with the advantage of having new seismic data coverage. This work performed a new interpretation of the prospects closures and reservoir thickness using the new dual azimuth data, showing a change in closures geometry and structural framework, with both 4-way and 3-way types of trap as well as a new prospect in a deeper portion in central part of the block.

Introduction

Brazilian pre-salt has been explored since 2006[1] and plenty of 3D seismic data was acquired already in Santos Basin[2] due to the increasing amount of producing fields after the discoveries. Yet, new exploratory risks have been identified and some wildcat wells had an insufficient result.

To improve the success rate of wildcat wells, new seismic data acquired and processed with the most recent technology have shown great importance to identify pre-drill risks and better delineate prospect closures and expected reservoir thickness. Those aspects are relevant because the size and expected volumes are often a key factor for economic assessment and operator's interest. The National Agency (ANP) delineated Jade block geometry and performed a volumetric assessment[3] using 3D seismic data Pulsar, processed in 2018. After two bid rounds, the block remained on offer and will now be available again in the third bid round. During this time, new data was acquired covering all the prospects inside the block, with dual azimuth and imaging up to 20 km depth. This allowed a new interpretation with more recent technology, reducing uncertainties in interpretation, especially in base of salt horizon. This new interpretation showed different closures geometries for the prospects than the one previously performed with legacy data. The changes in geometries consequently affect volumes estimation and effective reservoir thickness.

Method and/or Theory

The new data survey was designed to improve seismic illumination by using longer cables for enhanced full-waveform inversion (FWI) and an orthogonal azimuth to achieve high-quality images of the sedimentary sequences, deep crust and upper mantle.

Compared to legacy data used in previous assessment, Nebula-C images up to 20 km depth and shows improvement related to carbonate facies, igneous intrusions in pre-salt level, base of salt continuity and intra-salt patterns, as well as post-salt igneous rocks intruding post-salt sediments in minibasins. Those features are important when analyzing seal and closure of the prospects.

With legacy data Pulsar, ANP identified 7 structural closures inside the block (Figure 1), composed of one main structure named Jade, the same as the block, and 6 upsides. The total

VOIP was 7.113 MSTB. The reservoir thickness map per prospect was also published in Technical Seminar of first Bid Round in Permanent Offer. The past Geological Chance of Success was varying from 25 to 31%. The reservoir thickness of the main prospect was 1000 meters.

The workflow consisted in loading both Legacy and new seismic data for comparison. We interpreted the horizons equivalent as the Base of Salt in both legacy and new data. The structural interpretation of the main faults that affect the carbonate section structure and compartmentalization was interpreted in new dual azimuth data.

The Base of Salt surface was used to limit prospect using maximum closure. This way it was possible to identify the main prospect Jade and 8 upsides (Figure 2). Additionally, igneous intrusion were also mapped in reservoir, intra-salt and post-salt intervals. 20 major fault planes in upper crust were also mapped in reservoir section. The faults are in two families of NNE/SSW and NNW/SSE orientation and allowed to identify that at least 4 upsides structures might have fault planes as limiting the closure due to fault offset, forming 3-way closures.

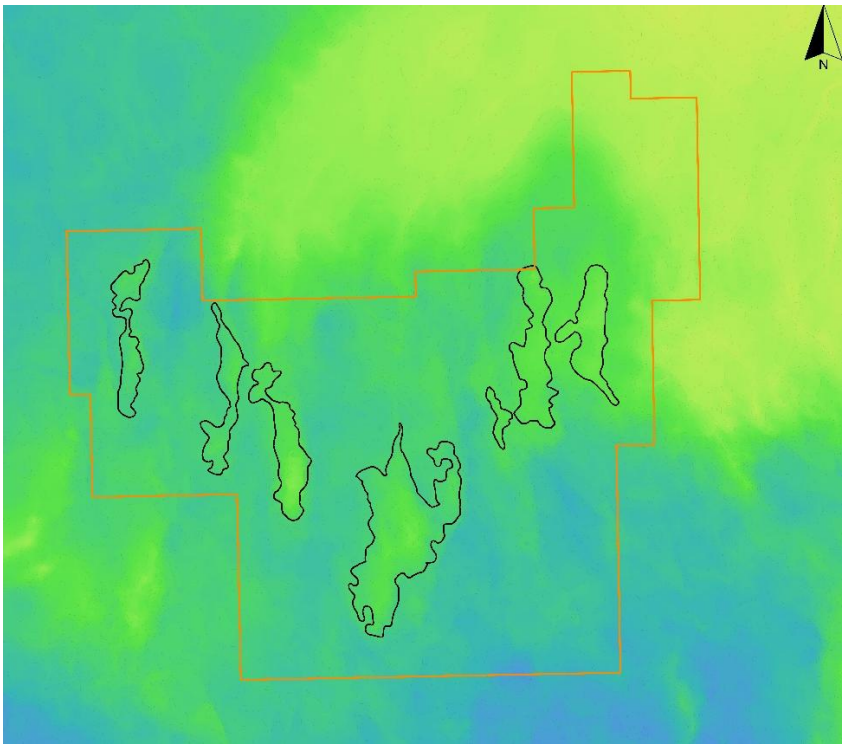

Figure 1: Map of Base of Salt surface in legacy data with previous closures in black polygons. Jade block in orange.

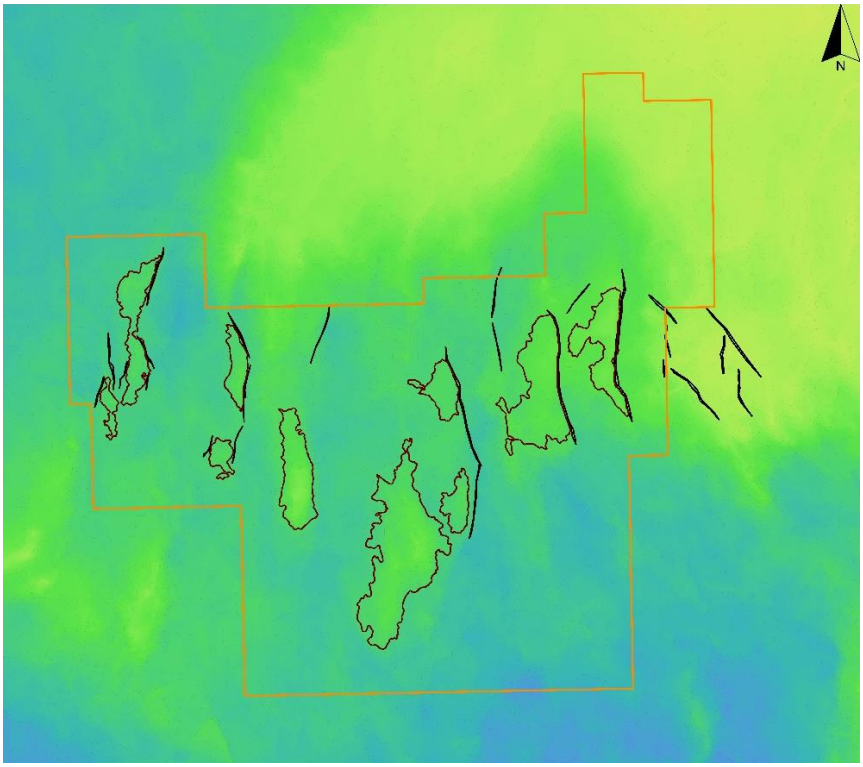

Figure 2: Map of Base of Salt surface in new data with closures in dark red and fault planes intersection in black. Jade block in orange.

This update shows significant details regarding reservoir setting and structural framework of rift and post-rift phase in the block area. The reservoir thickness map was created considering the closure depth as a flat bottom surface, showing a maximum thickness of 740 meters (Figure 3), which has a considerable difference with the thickness estimated with legacy data.

As a next step, we intend to perform an interpretation of the base of carbonate section as base of reservoir and run a volumetric assessment using the parameters of the new seismic volume interpretation.

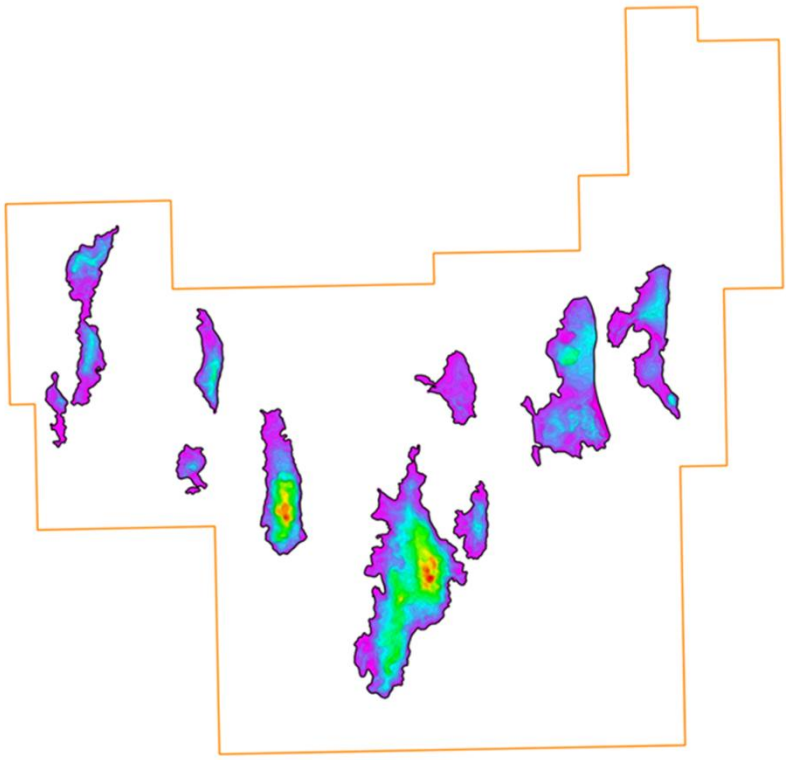

Figure 3: Map of reservoir thickness varying from 0 to 740 from cold to hot colors. The apex of structures is visible in red and the maximum thickness is 740 meters.

Results

With new data, we were able to obtain so far: Structural map of faults crossing reservoir section; Base of salt map as top of reservoir surface; Reservoir thickness map; Update of prospect structural closures.

Conclusions

The higher resolution of the data allowed to identify with greater certainty the base of salt, carbonate seismic facies in detail and fault planes. The amount of upsides changed from 6 to 9, not only due to compartmentalization but also because a new closure was identified in northern portion of the block. Also, the fault planes were more visible, allowing interpretation of polygon faults, showing that prospects in east portion are possible three-way closure against NNW/SSE faults.

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