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Machine Learning Seismic Interpretation on Pre salt Play in Santos Basin, Brazil

Maria Pessoa (SLB), Johanna Navarrete (SLB), Stefano Trezzi (SLB), Juliana Jannuzzi (SLB), YASMIN LEONE (SLB), Miguel Acosta Perez (SLB), Emmanuel Sargoussi (SLB)

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Summary

In recent years, Artificial Intelligence (AI) in combination with automation, high-performance computing, and clouds has been at the forefront of emerging technologies shaping our world (Maniar *et al*., 2018). Among the most recent techniques of seismic data acquisition and processing, on a smaller scale but still significant, seismic interpretation has advanced over time, among such techniques stands out Machine Learning Assistant Interpretation, which has gained importance and market space.

The applicability of Machine Learning in less complex geological settings can save time and help Geologists to obtain horizons and faults mapped more quickly and they can dedicate more time to map areas with greater challenges which the main result will be further seen in the 3D structural framework.

We illustrate novel application of Machine Learning (ML) assisted fault and horizons seismic interpretation in Santos Basin with focus on pre salt reservoir, which is the greatest challenge, due to failures associated with the reservoirs arising from tectonics during the opening of the South Atlantic in the Early Cretaceous that was the final stage of the complex rifting history of West Gondwana between South America and Africa (Chang *et al*., 1992).

Introduction

Several recent 3D surveys of large ocean floor nodes in deep water (OBN) have been applied to efficient and high-quality seismic data in the Santos and Campos Basins, aiming to provide superior images that are crucial for identifying key structures and seismic facies to characterize complex reservoirs (Cobo *et al*., 2021).

Understand the tectonic-sedimentary depositional model for the Pre-salt of Santos and Campos Basin, such as buildup and carbonate ramp associated with faults with the main directions NW/SE according to the Passive Margin basins after the opening of the South Atlantic in the Early Cretaceous (Zalán, 2017b).

The mapping of faults and the configuration of truncated horizons up dip over the structural highs, which are the biggest challenge for the interpreter during the construction of a three-dimensional geological model represents one of the most important phases of the relevant in the workflow aimed at understanding the reservoir of an oil field, both regarding the volume of work involved in terms of Impact on results.

The applicability of intelligent integrated subsurface modeling utilizing machine learning has as primary objective is to provide faster performance and, ultimately, facilitate the optimized management of reservoirs

Methodology

The workflow solely uses the Machine learning applicability on the pre salt reservoir level, below the base of the salt (Figure 1). The pre-salt is comprised of syn-rift sequences of clastic sediments, basalts, evaporites and include lacustrine carbonates reservoirs (Carlotto *et al.,* 2017).

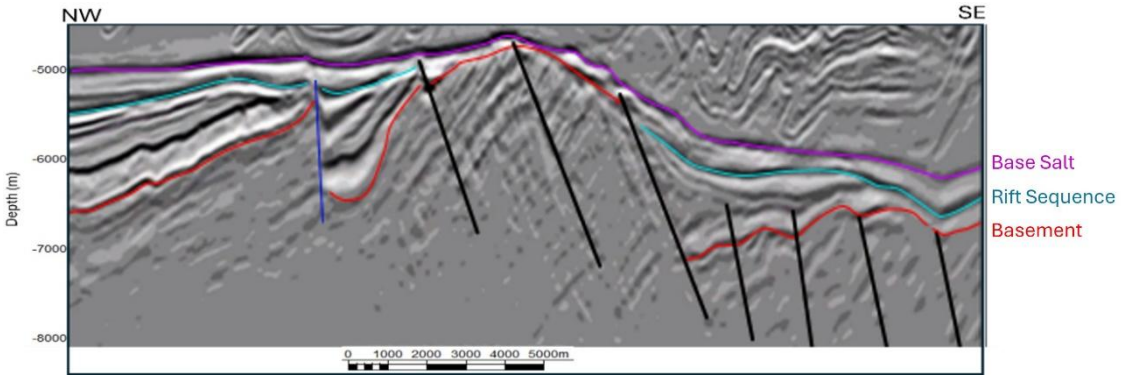

Figure 1: Display on the pre salt reservoir in Santos Basin, Brazil

Machine learning involves creating systems that can automatically improve and adapt without being explicitly programmed. The algorithm uses data, statistics, and trial and error to learn and try to replicate the capabilities of experienced interpreters (Smith *et al.,* 2022). The model makes predictions or decisions based on the data patterns recognized within seismic responses, and these predictions are then refined over time as the model is exposed to more data.

For this analysis, we tested three volumes, each representing a different processing image step that improves the results: 3D Fast Track, 3D-Full Track No IMA and 3D-Full Track with IMA, that brought us more assertive interpretation.

The efficiency and precision gains from using machine learning assisted fault and horizons interpretation presents benefits that single seismic volumes can be evaluated thoroughly, and multiple seismic datasets consistently for multi-scenario analysis to reduce subsurface risk and inform better decisions at all phases of the exploration and production asset lifecycle (Okie *et al*., 2020)

The Geoscientist validates the results through model management in Machine Learning. Based on the extraction of the segmented fault network in this phase, the interpreter reinforces the faults. In this case in the central part of the volume the machine learning did not identify faults. Thus, the interpreter created labels (faults) that improved the interpretation. Labels can be single faults that were mapped in some lines or crossline.

Results

We illustrate the segment faults which were extracted and evaluated from the 2 seismic volume, 3D Full track with IMA and 3D-Fast Track. The best result was obtained from the 3D Full track with IMA that shows an increase in the number of mapped faults, Figure 2.

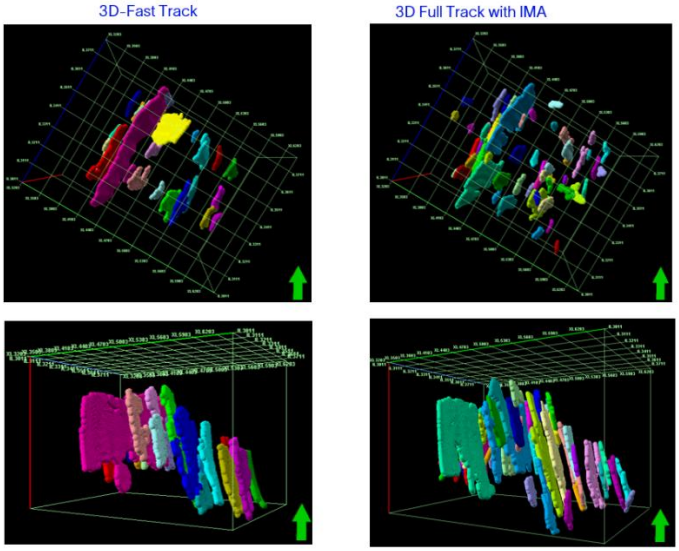

Figure 2: The comparison between results of the fault patch extraction from the 3D Fast track (23 faults) and 3D full track with IMA (63 Faults)

The structural framework that is the main outcome following the use of the Machin Learning Seismic Assistant technology that will be used directly as the main input for Geological Models (Static and Dynamic Modeling)

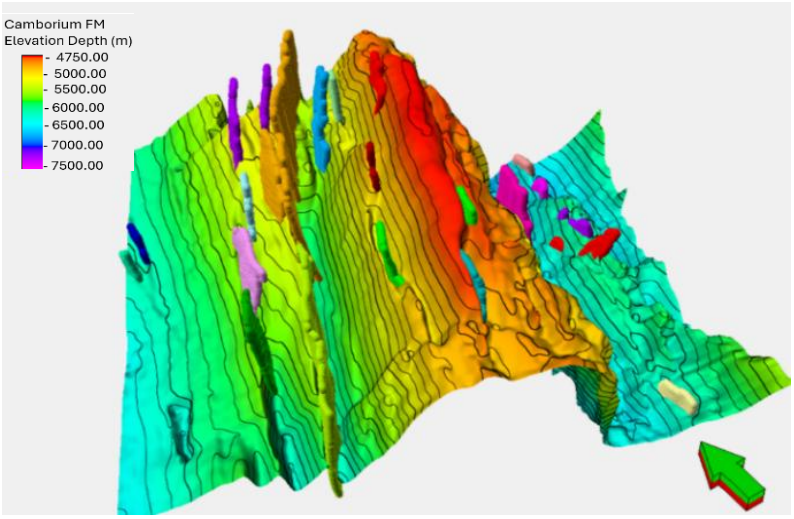

Figure 3: 3D Structural Framework on the pre salt reservoir in Santos Basin, results of Machine Learning Assistant Fault and horizon Seismic Interpretation.

Conclusions

The functions of the machine learning seismic prediction both for fault and horizon mapping presented enabled significant improvements in the overall seismic interpretation from the point of view of time, efficiency and quality of the results.

The value of Seismic Interpretation Machine Learning tools lies in their ability to expedite the interpretation process across different volumes during seismic processing projects, leading to faster and more efficient quality control. We are perfectly aware that the experience of the seismic interpreter is essential to better conduct the use of technology, validating and obtaining more assertive results.

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