Automatic Fault Extraction and Structural Characterization – A Study Case of Gato do Mato Field, Santos Basin, Brazil

Luis Henrique Cordeiro (Halliburton), David Freitas (Halliburton), Tulio Maia (Petrobras), Eduardo Caldato (Halliburton)

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Introduction

The Gato do Mato Field, located in the deep waters of the Santos Basin, represents a strategic area for the exploration of presalt carbonate reservoirs. This study aims to perform the structural and stratigraphic characterization of the pre-salt section through the integrated application of the Fault Likelihood and TecVA seismic attributes—recognized for their effectiveness in identifying geological structures. The workflow culminates in the construction of a representative structural framework for the target interval, supporting reservoir interpretation and compartmentalization analysis.

Method and/or Theory

The approach methodology involved the generation and application of seismic attributes to a post-stack depth-migrated volume (PSDM) covering approximately 600 km². Subsequently, fault detection and automatic extraction were carried out using a discontinuity detection method based on the calculation of semblance between adjacent seismic traces within an elongated fault-like analysis window, across multiple dips and azimuths, a principle behind the Fault Likelihood attribute. As a final point, the structural geological model of the area was constructed based on predefined regional horizons that correspond to the pre-salt section.

Results and Conclusions

The integration of attributes enabled the identification of two main fault systems in the study area: (i) post-salt faults detached within the salt layer trending NE-SW, linked to Albian-age halokinetic tectonics, and (ii) inherited basement-involved faults trending NW-SE that affect the syn-rift units of Barra Velha Formation. According to the analysis, these structures indicate a control in sedimentary accommodation space and facies distribution, particularly influencing the development of carbonate build-ups. The Fault Likelihood attribute proved to be highly sensitive for detecting sub-seismic faults and associated fracture zones, while the TecVA attribute enhanced lateral amplitude variations and revealed chaotic features interpreted as diagenetic conduits or stratigraphic controls. The stratigraphic and structural analysis revealed that key seismic facies of Barra Velha Formation - build-ups, carbonate platforms, debris flows, and lake-bottom deposits - are strongly controlled by pre-existing tectonic structuring. Additionally, erosional truncations were observed along the intra-Alagoas surface near major fault zones, indicating significant geometric reconfiguration of the upper Barra Velha during the beginning of the sag phase. The 3D tectono-stratigraphic model, based on key regional surfaces (basement, Pre-Alagoas, intra-Alagoas, base and top of salt) and guided by the Fault Likelihood attribute, allowed for detailed structural and depositional characterization of the southern portion of the Gato do Mato Field. The results highlight the importance of using advanced seismic attribute workflows in complex geological settings. The model clarifies the influence of rift/syn-rift tectonics on reservoir compartmentalization and hydrocarbon migration pathways. This integrated approach provides a robust framework for reservoir understanding, geological modeling, and exploratory risk reduction in pre-salt systems of the Santos Basin.