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Expedited Interpretation vs. Assertive Structural Models: A Case Study in Brazilian Pre-Salt Segmented Fault Systems

Leonardo Ventura (Universidade Federal Fluminense), Aurelio Kasakewitch Ribeiro (Petrobras), Jorge Andre Braz de Souza (Petrobras), Dan Hemingway (Petrotechnical Data Systems Ltd), Victoria O'Connor (Petrotechnical Data Systems Ltd), Francisco Abrantes Junior (Universidade Federal Fluminense)

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Expedited seismic interpretation workflows, increasingly supported by automation and AI, have significantly improved speed, repeatability, and initial consistency of identifying faults and horizons across large seismic volumes, particularly in structurally complex areas. These advances enable geoscientists to process vast datasets faster, facilitating earlier decision-making and reducing subjectivity in initial interpretations. Automated tools can efficiently highlight major structural features and help standardize interpretation practices.

However, their application in geologically complex environments such as the segmented fault systems of the Brazilian pre-salt can introduce significant structural miss-representations in some areas. In these settings, thick and often stratified salt layers attenuate seismic signals and degrade image quality, making it harder to resolve fault intersection locations, the corresponding horizon configurations and their propagation. As a result, structural modelers often face challenges including inaccuracies in fault geometry, geologically inconsistent horizons that disrupt the stratigraphic framework, incomplete or oversimplified fault segmentation, and misaligned fault-horizon relationships. These issues lead to uncertainties in reservoir compartmentalisation, petrophysical properties distribution, and fluid flow behavior, directly impacting reservoir performance forecasts and field development decisions. Therefore, while automated interpretation tools are valuable, robust quality control workflows are essential to ensure structural models accurately represent subsurface complexity.

To mitigate these risks, this study applies a workflow co-developed by Petrobras in partnership with PDS Group for Ava Structure. The tool enables a semi-automated, geology-driven quality control of seismic structural interpretations. Its core functionality centers on the systematic extraction of high-resolution interpretation fault throw data and the subsequent evaluation across multiple interpreted horizons, enabling interpreters to assess how well fault geometries align across different stratigraphic levels. Detected inconsistencies are automatically ranked by severity, allowing interpreters to prioritize adjustments based on geological relevance.

Building on the throw analysis, the workflow integrates seismic attributes and structural statistics to guide refinements in fault trace alignment, improve fault-horizon consistency, and detect interpretation artifacts and inconsistencies. It also suggests alternative segmentation scenarios, such as identifying when a fault interpreted as a single structure may consist of several smaller faults with varying degrees of linkage, or the reverse. Probabilistic fault tip extension workflows are perfomed that extrapolate interpreted faults into the subseismic domain, enabling semi-automatic generation of alternative structural frameworks with distinct compartmentalisation and damage zone configurations. These capabilities make the tool both diagnostic and generative, enhancing the robustness of structural interpretations.

Integrating this method into expedited interpretation workflows improves both efficiency and geological soundness. In pre-salt environments where structural complexity directly influences reservoir performance, this combined approach helps reduce uncertainty and supports the development of more reliable structural models. Rather than replacing automation, this workflow complements it by adding a layer of geologically informed quality control, enabling faster and more confident decision-making in exploration and field development.