
**Submission code: 5PA95ZQ8PZ**

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# Use of full-azimuth seismic data for structural characterization

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## Introduction

One of the greatest current challenges in the reservoir characterization is enhancing hydrocarbon production of fractured reservoirs. To address this, it is increasingly important to better define the structural features, which serve as critical inputs for more accurate fractures modeling.

Seismic data has historically been used—either directly or indirectly—in such modeling workflows. It serves both as a structural framework for fault interpretation, feeding into damage zone models based faults distance, and through the generation of structural attributes used to derive fracture density properties.

In this context, the use of next-generation wide-azimuth (WAZ) seismic node data provides the necessary information to identify anisotropy associated with both fracture intensity and orientation—two key inputs for fractured reservoir modeling. Petrobras has recently launched an aggressive acquisition program of WAZ Node data, particularly targeting Pre-Salt fields, where dual-permeability models are required.

## Method

The key advantage of using azimuthal seismic data for fault and fracture characterization lies on its ability to maximize the sensitivity of seismic attributes through imaging across all azimuthal sectors. Unlike conventional seismic data, which are acquired in a single azimuth direction and thus primarily highlight faults orthogonal to that orientation, this new generation of seismic volumes captures information in all directions, enabling the imaging of fault sets regardless of orientation.

The methodology begins with building a structural model of the reservoir, including mapped faults and horizons. Displacement attributes are then generated to characterize fault offsets. These results are used to identify regions with the most extensive damage zones and, consequently, higher fracture intensities. In a subsequent phase, geometric attribute workflows are applied to seismic volumes sorted by different azimuths, allowing the visualization of previously undetected faults—literally from new angles.

## Results and Conclusions

Initial results from Pre-Salt fields in the Santos Basin indicate that the rich azimuthal content of these datasets can reveal new fault sets that are not visible in conventional seismic data. In some cases, these newly identified structures explain the presence of fracture corridors predicted by dynamic reservoir models, which are essential for history matching production data. The presence of such fractures alters the physical properties of the rocks and is one of the primary causes of the observed azimuthal anisotropy.

This study also demonstrates the potential of using attributes derived from WAZ data as direct inputs for fracture modeling workflows. These inputs include fracture distribution properties, fracture density volumes derived from geometric attributes, and fracture orientation obtained through dip, azimuth, and concentration properties—eliminating the need to rely on constant values that often fail to represent the heterogeneity of fracture orientations.