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Proposal of a Baseline Data Collection for Seismic Fracture Characterization in Brazilian Pre-Salt Reservoirs: An Initial 3D Model.

Maria González (Aspentech), Alexandre Maul (Petrobras), Cleverson Guizan (Universidade Federal Fluminense)

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Abstract

Seismic data is essential for fracture modeling, as it could offer 3D information on fracture intensity, despite its limitations in resolution. While seismic reflection attributes detect large fractures, smaller fractures below seismic resolution need to be studied using well and outcrop data. Traditionally, 3D modeling involves the combination of 1D wellbore data with 3D seismic data. Thus, to expand the utilization of seismic data for this purpose, various techniques are being developed to understand the impact of distinct seismic acquisition, processing and interpretation methods on detecting smaller fractures. In the Brazilian pre-salt reservoirs, some challenges are particularly important for fracture characterization with seismic data. These reservoirs are very deep, covered by a thick and heterogeneous salt layer, and feature complex carbonate reservoir facies. Therefore, a representative dataset to test several approaches for effectively characterizing and modeling fractured zones becomes a necessary task. In this work, we intend to summarize a minimum dataset we believe is primordial for a good 3D representation of fractures in pre-salt fields. To create the dataset, important horizons such as seafloor, relevant post-salt unconformities, top and base of the salt, and base of the reservoir will be added. Faults with significant displacements, especially those created by salt dome movements, must be included. Various software options available on the market can be used for this task. After completing the structural framework, facies will be modeled in three key portions: post-salt with siliciclastic and sometimes carbonate layers, the heterogeneous salt, and lacustrine reservoir carbonate facies. Based on these facies, properties such as P-wave velocities, S-wave velocities, and density will be modeled. These properties are necessary for constructing an impedance model, which will enable the creation of synthetic seismic data. Porosity estimates from different sources (literature, open access data) will be used to input porosity properties. Discrete Fault Networks (DFN) will be modeled based on horizon deformation analysis and other assumptions like damage zones definition. Acquisition geometries based on parameters used in the Brazilian pre-salt will be tested to generate seismic amplitudes, using classical approaches. As a result, we will have an initial 3D model that represents a robust structural and stratigraphic framework for synthetic seismic modeling. The thoughtful estimation of properties such as P-wave and S-wave velocities, density, and porosity will enhance the accuracy of synthetic seismic data. This baseline model not only addresses the unique challenges posed by the pre-salt environment but also provides a valuable tool for improving the characterization and modeling of fractured zones with seismic information.