Elastic properties modeling and its impacts over channelized turbiditic reservoirs characterization

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Abstract

The exploration, development and production of hydrocarbons over decades has fostered an understanding of the spatial organization and sedimentary record filling of channelized reservoirs in deep-water environments. The improvements in the quality of three-dimensional seismic data allow a better dealing with the geological complexities inherent to this type of reservoir. However, the scale of investigation of the seismic method does not provide the fully representation of the observed heterogeneities in outcrop data evaluation, as well as through well drilling lithology information. The seismic information scale presents information only at the interface between two lithological layers, and not inside it, as desired for the reservoir characterization. In addition, the effects of attenuation, absorption and dispersion affect the propagation of seismic waves within the Earth, decreasing its energy and resolution capacity as this wavefield propagates into the subsurface. Another important statement about the seismic data is that it is subject to the tuning effect, where the input wave signal interferes with the output signal of a geological layer, affecting the amplitudes of the seismic trace and, consequently, the estimation of the real thickness. The geophysical-geological reservoir characterization and modeling are well-established techniques to mitigate the estimating information uncertainties from data acquired in a three-dimensional space. Although the good representation of detailed rocky content in the vertical direction, there is great inaccuracy in the spatial representation of the depositional elements and their respective geological features. The seismic data inversion (can optimize the spatial distribution of these heterogeneities by recovering information throughout the entire rock content, even lacking the confidence regarding the resolution aspect. In addition, their information may have direct correlations with the physical properties of the rocks and their porosity degree. Direct modeling of elastic properties is a tool to analyze how these parameters vary. This variation depends on the architectural elements of the channelized systems and their filling patterns, and it is expressed through the seismic data response and its derived attributes. This study presents a modeling case of 1D and 3D elastic properties in parameterized models. We took real data collected at offshore portions of the Sergipe-Alagoas Basin, outcrop data from analog systems and information from conceptual models obtained in the literature in order to optimize the geological models usually used in the oil industry. It demonstrates possible warnings of seismic amplitude data, usage under tuning effects. As well as how it lead to misunderstanding of thin-bedded turbiditic channels characterization, through 3D modeling. It presents the results of elastic inversion as an alternative to extrapolate the hard data spatially as a trend. The understanding of the seismic responses according to the modeled properties provided an equation that relates elastic parameters and the thickness to the compressional and shear impedance attributes difference. Our modeled equation was able to optimize the construction of a reliable geological model of turbiditic channelized reservoirs of Maastrichtian age from the Calumbi Formation in the mentioned basin, representing a feasilble geological reality in subsurface.