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Multiparametric Model Building – application, analysis and results in deep water of Sergipe Basin

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Introduction

The exploratory blocks in the deep waters of the Sergipe Basin have major discoveries in turbidites from the Maastrichtian and Campanian. Although the Maastrichtian and upper Campanian reservoirs exhibit seismic responses (AVO) due to fluids, the lower Campanian sandstones do not always show the same responses. To study this phenomenon, integration tools were employed, including the construction of multiparametric models, seismic modeling, and multivariate analysis. The 3D mechanical models are derived from seismic data and include P-wave velocity (Vp), S-wave velocity (Vs), density (ρ) and quality factor (Q).

Method and/or Theory

The starting point for the construction of the models are two products of seismic processing: P-wave velocity (in low frequency) and amplitude seismic data. Both fields are processed and combined, generating a new P-impedance field with higher resolution and detail. From this, P and S velocities, as well as density, are derived, resulting in an expanded spectrum models. Additionally, based on seismic data and Vertical Seismic Profile (VSP) from wells in the region, a Q factor model was constructed, capable of describing the inelastic behavior of the studied area. Finally, from the mapped horizons over the seismic volumes and their ages, a volume of geological ages was generated. Thus, for a sector of the Sergipe Basin in deep waters, a multiparametric model with five properties (Vp, Vs, ρ, Q, and age) was created.

Results and Conclusions

The property volumes of Vp, Vs, and ρ were useful for quantitative interpretation and to check if such properties were consistent with facies and compaction function. These same properties, Vp, Vs, and ρ, along with the Q factor, were used for viscoelastic seismic modeling. With this numerical modeling system, synthetic seismic data with kinematic and amplitude characteristics similar to real seismic data was generated. This approach serves as a metric to evaluate whether the cited parameters (Vp, Vs, ρ, and Q) are adequate and constitutes a tool for quantitative interpretation. The synthetic seismic data exhibited good kinematic correspondence with the main events and horizons, although more work is needed to achieve correspondence between the amplitudes. The multivariate analysis of the properties revealed an important relationship between P-wave velocity and age. The cross-plot of those two properties show three distinct behaviors of the point cloud: the younger units, with less than 12 million years and designated as region 3, exhibit a higher gradient of velocity versus age; region 2, beneath region 3 and ages between 12 million years and Campanian 22, shows P-wave velocity with a lower gradient; and in region 1, the Vp of the older formations, from Turonian to Aptian, increases with the same gradient as the previous interval but is shifted upward by about 330 m/s. This compartmentalization into three regions is also observed in the cross-plot of Vp with depth. Region 1, underlying region 2, exhibits formations with higher elastic moduli and is stiffer. The study does not ascertain the cause of this compartmentalization, whether it is geochemical or erosive. If the cause is due to a regional erosive process, and this confirmation will come with further studies, the velocity difference indicates a gap of approximately 400 m when considering only mechanical compaction.

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