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Influence of Absorption on AVO Anomaly Detection: Observations based on the gas-prone reservoirs discovered in Guajira Basin, Offshore Colombia

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Introduction

Prominent gas accumulation has been discovered in the Guajira basin offshore Colombia during 2022. The appraisal well drilled during 2024 confirmed the dimension of the gas bearing reservoirs. Spectral analysis of the seismic data revealed seismic signal absorption effects, which can be quantified using the dimensionless parameter known as the Q factor. A detailed analysis was conducted to evaluate the influence of the Q factor on the detection of Amplitude Versus Offset (AVO) anomalies, utilizing a comprehensive comparative approach with seismic modeling. It was observed that absorption effects, which vary as a function of the source-receiver offset and the depth of the layers, can be mistakenly interpreted as AVO phenomena. In other cases, these effects can distort or even prevent the detection of an existing anomaly, hindering seismic interpretation.

To address these issues, we performed three-dimensional elastic and viscoelastic seismic modeling using a representative model which properties were extracted from the first well. This well revealed Lower Miocene turbidite reservoirs from the Uitpa Formation, with significant gas accumulations. The discovery stands out due to the strong seismic signal response, characterized by a clear Type 2 AVO anomaly with high standard deviation, excellent structural control of the anomaly, and the presence of flat spots, which aided in the assessment of the discovery's potential. These Direct Hydrocarbon Indicator (DHI) characteristics identified in the wild cat well are also observed in other prospects in the region, making this new exploratory frontier a low-risk opportunity.

Method

Using the tools of 3D elastic and viscoelastic modeling, models were created with varying Q factors, in addition to simulating other AVO depth scenarios. It is well known that greater depths require longer propagation times, which amplify the absorption effects of the signal in a viscoelastic medium. Our results indicate that, although absorption attenuates AVO anomalies, they remain detectable in the context of the target. However, it is important to highlight that, under different geological conditions, such detection may not be possible. This underscores the critical need for correcting absorption effects during seismic data processing, especially for new prospects in the Guajira basin. Accuracy in correcting these effects is essential to ensure the reliability of interpretations and the feasibility of future exploratory operations.

Results and Conclusions

Additionally, the interplay between absorption effects and changes in Q factor highlights the importance of advanced modeling techniques in seismic analysis. By incorporating realistic viscoelastic parameters, the models can better simulate subsurface conditions, leading to improved understanding of signal behavior at greater depths. For instance, in the Gua-Off 0 block, where new prospects are being evaluated, precise correction of absorption effects becomes even more crucial. Variations in geological settings and reservoir characteristics demand tailored approaches to maintain the integrity of seismic interpretations. As exploration targets move to increasingly complex environments, the refinement of these methodologies will play a pivotal role in reducing uncertainty and enhancing decision-making processes in exploratory projects.