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AVO (Amplitude Versus Offset) analysis for evaluating hydrocarbon reservoirs.

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Introduction

The seismic method is a key geophysical technique for investigating the Earth's subsurface structure, with important applications in oil and gas exploration. It is based on the propagation of artificially generated seismic waves, whose data, recorded by geophones, allow for the construction of detailed images of the subsurface. AVO (Amplitude Versus Offset) analysis is an advanced technique that correlates seismic amplitude variations with rock properties, based on Zoeppritz equations. This analysis aims to identify “AVO anomalies,” i.e., significant deviations from an expected background trend.

Method and Theory

This project involves an extensive literature review and the use of 2D seismic sections from the Amazon Basin, provided by the REATE program (https://reate.cprm.gov.br/anp/TERRESTRE). The data are being processed using free software from DGB Earth Sciences (https://dgbes.com/software/download), specifically in SGY format via the OpendTect software. The methodology includes the study and derivation of the Zoeppritz equations and the approximation proposed by Shuey (1985), in addition to the extraction of AVO attributes (intercept and gradient) from seismic events. Numerical validation and elastic media classification will be conducted in later stages using representative seismic models.

Results and Conclusions

AVO (Amplitude Versus Offset) analysis is a well-established tool for hydrocarbon detection, though challenges such as seismic data noise and the need for well log calibration persist. Recent advances highlight the integration of machine learning techniques and petrophysical data as promising strategies to enhance seismic interpretation reliability.

In this study, 2D seismic data from Well 0036_Amazonas_57_POSTSTM-STM.1, processed using OpendTect software, revealed continuous reflectors between 1000 and 2000 ms (two-way travel time), with amplitude-versus-offset variations consistent with Class III AVO anomalies—indicative of gas in porous, consolidated formations. The absence of complex tectonic structures suggests that the observed variations are related to changes in the elastic properties of the rocks rather than structural effects.

Despite limited resolution, the data exhibit low noise and stability, enabling progression to advanced analytical stages such as intercept and gradient attribute extraction (Shuey, 1985). Preliminary results demonstrate the potential of AVO analysis for reservoir characterization in the Amazon Basin, even under suboptimal data conditions. Full well processing is expected to be completed by August 2025, with the goal of validating the method’s effectiveness for onshore hydrocarbon exploration in the region.

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