Optimising Reservoir Characterisation Through Seismic Data Conditioning: A Case Study of Block22/NCMA4, Trinidad

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Abstract

Revisiting legacy towed streamer seismic data and their products for reservoir characterisation has become increasingly common. Given the high cost associated with acquiring new data, companies are constantly looking at ways to improve the fidelity of existing seismic datasets via reprocessing. A case study over 450 km^2 in Block 22 and NCMA-4, North Coast Trinidad is presented using a 2011 vintage towed streamer dataset. The study integrated geophysical forward modelling, pre-stack gather conditioning and seismic inversion to increase the frequency content of the data, remove uncertainty in AVO response and generate useful products for reservoir characterisation, development well placement and de-risking undrilled exploration prospects.

The Cassra and Iris fields are Pleistocene gas sands deposited in a shallow marine environment and basin floor setting respectively. The presence of dry gas in these highly porous, young reservoirs enables the use of seismic amplitude anomalies to detect and delineate directly the trapped hydrocarbons. Initial rock property modelling suggested that these gas bearing sands should show a Class III Amplitude Versus Offset (AVO) anomaly response (low impedance with an increase in amplitude with increased offset). However, analysis of the actual post migration CMP offset gathers showed a Class IV response (low impedance with a dimming of amplitude with increased offset). This mismatch between well-based geophysical modelling and actual seismic observations eroded confidence in any seismically driven reservoir characterization technique, such as net pay from seismic data, and generated uncertainty around applying AVO products to de-risk undrilled exploration prospects.

A post-migration targeted re-processing sequence was developed to address signal to random noise, short period multiples, offset dependent frequency and amplitude loss, gather alignment and rock property modelling. Rock property modelling using the Vp, Vs and density logs from well data were used to generate 1D and 2D models of the AVO response at the key reservoirs using Zoeppritz's equations. Synthetic CMP gathers were then generated and compared to actual seismic CMPs at the key well locations to validate the seismic response. Our approach utilized dense picking of the residual velocity and 6th order correction ensured gather flatness. Trim statics addressed any non-hyperbolic short wavelength features and multiple removal using Hi-Res radon was effective.

Two crucial steps for achieving good results were applying a spatial frequency filter and amplitude scaling across the offsets using a global scalar derived from the data. Two spectral enhancement methods were used; spatially varying Q compensation and Bandwidth Extension®. Both techniques resulted in improved bandwidth, which was beneficial for thin bed resolution and the AVO behavior of individual sands.

Our reprocessed dataset has significantly fewer multiples and has increased in frequency content from a 30Hz to a 50Hz dominant frequency wavelet. The AVO products are now calibrated to well data and conform to observations in the real seismic data. The result is a dataset which can be used with confidence for reservoir characterization and AVO analysis to de-risk undrilled prospects.