International Petroleum Technology Conference 2025

IPTC-24837-Abstract

Mapping Hydrocarbon Sands, Offshore Peninsular Malaysia

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Objectives

A quantitative interpretation (QI) study comprising absolute simultaneous inversion of 9 seismic angle stacks (0 - 45°) followed by lithology and fluid prediction calibrated to 21 wells was conducted over 1,860 km^2 of merged 3D seismic from 6 surveys located offshore peninsular Malaysia.

Project objectives were to map hydrocarbon distributions and explore hydrocarbon potential over a large vertical interval composed of fluvial, hydrocarbon-filled reservoirs at multiple levels.

Project challenges included vertically varying elastic property responses that complicated lithology and fluid interpretations over the inversion window, anisotropy affecting sonic logs measurements, over-pressuring near the base of the inversion window and seismic data inconsistency between surveys.

Method

Fit-for-purpose workflows enabled optimal integration of the wireline and seismic data for reservoir characterisation.

A depth-dependent rock-physics interpretation framework was established using wireline elastic properties to account for the vertically varying characteristics. The interpretation criteria incorporated multiple reservoir and non-reservoir lithology types across normal and over-pressure formation. A novel, empirical method was used to correct anisotropy that affected sonic log measurements in deviated wells (Ronghe, et al, 2022).

Data inconsistency across surveys was addressed through careful seismic conditioning and wavelets extrapolations. This included spectral balancing, lateral amplitude compensation and AVA scaling of the angle stacks. Bayesian wavelet estimations per stack (Gunning and Glinsky, 2006) were vertically interpolated using linear weights and laterally extrapolated using a survey-based weight horizon.

A constrained simultaneous inversion algorithm was used to derive absolute elastic properties. Probabilistic lithology and fluid volume predictions from inversion P-impedance and Vp/Vs results used a Bayesian classification scheme calibrated to the established depth dependent interpretation framework.

Results

The simultaneous inversion results were of very good quality, matched project wells and agreed with three blind wells (Figure 1) provided after completion of the project. 3D analysis of the interpretation outputs has enabled mapping fluvial deposits, characterising their lithology and fluid fill, differentiating between sand-filled and shale-filled channels, and understanding prospectivity.

Novel information

Careful, meticulous data conditioning and fit-for-purpose workflows used for optimal integration of well and seismic data have enabled the mapping of fluvial sands and hydrocarbon distributions at multiple vertical levels. The results help in characterising reservoirs, making development decisions and assessing prospects.

This project has addressed issues and provided solutions to commonly found problems in the Malay Basin: anisotropy affecting recorded sonic log measurements in deviated wells, presence of multiple lithology types that affect reservoir properties such as porosity, uncertainty of hydrocarbon fill in fluvial deposits at multiple levels over large vertical intervals, differentiation between sand-filled and shale-filled channels, presence of over-pressures affecting reservoir characterisation and, often, inconsistent seismic data across multiple vintages and surveys. The project workflows would apply to data sets across the Malay Basin to improve prospectivity.

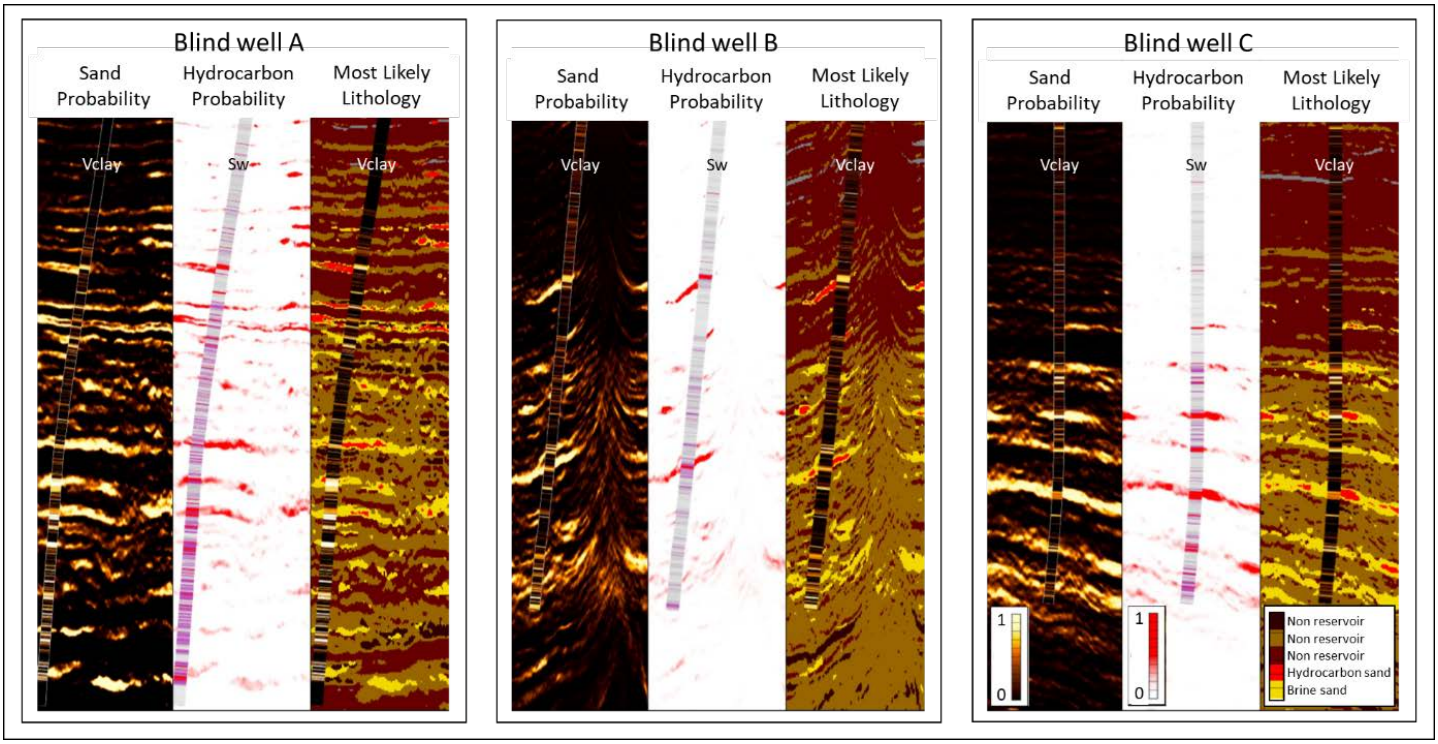

Figure 1. Interpreted volumes compared against wells blind to the project.

References

Gunning, J. and Glinsky, M.E. 2006, Wavelet Extractor: A Bayesian well-tie and wavelet extraction program: Computers and Geosciences, v. 32, pp. 619-36.

Ronghe, S., Locke, A., Teng, S., Sia, C.C., Chuang, A. 2022. Empirical anisotropy corrections in deviated well logs from the Malay Basin. APGCE.