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Geophysical Characterization of Shallow Anomalies: A Case Study from Gulf of Thailand

Tharit Tangkijwanichakul*, Tosapol Tongpet, Julara Kaewtapan, Phinphorn Amonpantang, Pimchanok Wohandech, Benjalak Sornchangwat, Natthawut Suppaiboon and Thaninnat Charasthanantchai

PTT Exploration and Production Public Company Limited, Bangkok, 10900, Thailand
* Corresponding author. E-mail address: tharitt@pttep.com

Abstract

The PTTEP development plan in the Gulf of Thailand has four proposed wellhead platform locations. Two out of four platforms (A and B) sit above the shallow anomalies. It is unclear from 3D seismic data if those anomalies are gas-bearing bodies which could cause drilling constraints. The conventional tools include amplitude brightness, phase character, frequency attenuation, and velocity push-down which are qualitative. The conventional risk assessment using these tools proves inconclusive. To elaborate, for both platforms A and B, the anomalies exhibit two positive indicators: bright amplitude and phase reversal (platform A as a tuning effect). Conversely, frequency attenuation and velocity push-down are mysteriously absent in both areas. This case study proves a technical mystery. The advanced quantitative-based tools are the high-resolution velocity field and Q attenuation model. Due to rapid technological advancement in full-waveform inversion (FWI), and the analysis of AVO class from pre-stack migrated gathers, a gas-bearing formation is expected to exhibit localized velocity drop, anomalously low Q value, and AVO class 3 (brightening with offset). To validate our proposed tools, we integrate well data from nearby fields in the Gulf of Thailand that drilled through the suspected shallow anomaly. We use this hard evidence (some wells encounter gas, some do not) to confirm the usability of localized low-velocity zone, anomalous Q value around the anomaly, and AVO as additional gas indicators. The proposed quantitative-based geophysical tools yield enticing results. For the total of five wells from nearby fields in the Gulf of Thailand, each well was drilled through the anomaly that shares the same conflicting qualitative characteristics as those at platforms A and B do. The analysis from these wells suggests that there is a 1) positive correlation between having both localized velocity drop (and anomalous Q – if available) and class 3 AVO and gas presence and 2) positive correlation between not having a low-velocity zone around the anomaly (and no anomalous Q – if available) and class 4 AVO and non-gas formation. The observation has elevated the paradigm of seismic characterization of shallow anomalies. Platforms A and B shallow anomaly issues are the pioneering cases to employ these technically rigorous and comprehensive risk criteria.

Keywords: shallow anomaly, FWI, AVO