Characterization of Potential Fractured Basement Reservoirs Using Robust Attribute Techniques, Offshore Thailand

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Abstract

Pre-Tertiary basement high structures in the Gulf of Thailand are one of the Pre-Tertiary prospects sealed by Oligocene syn-rift lacustrine shales and charged by lateral and vertical migration from late Oligocene kitchen. These prospects have remained underexplored due to geological risks and drilling operation concerns. Recently, a study was conducted to evaluate the potential of these basement prospects, which are interpreted as Mesozoic continental meta-sedimentary rocks equivalent to the Khorat Group. The study was based on regional geological studies, real-world outcrop analogies, and observed characteristics presented in the recently reprocessed 2022 QPSDM image.

The results of the study suggest that the most important risk to petroleum discovery in these basement highs is the unknown timing of formed fractures and their distribution. Several seismic attributes, including variance, chaos, curvature, and instantaneous frequency, were generated to identify potential seismic-scale fractures. All generated attributes were able to capture major fault trends in NNW-SSE direction that aligned exceptionally well with the present-day maximum horizontal stress orientation and the top basement fault interpretation. The variance cube was able to detect higher-resolution possible fractures within the basement rocks. It was then used as an input to ant tracking, which computed a coherent signal based on swarm intelligence to find optimal connectivity within the edge volume. Afterwards, the lineament detection software called "RoseSight" helped construct relative lineament density maps based on Hough Transform from the input ant tracking cube. The resulted fracture density maps suggested that one of the basement highs had the most densely populated fractures, which helped to characterize it as being the lowest risk among the three prospects. It was noted that all these data-driven tools had data quality limitations, but the results were proven to be considerably reliable based on the fault detectability at shallow section, coherency among all attributes, and consistently aligned lineament orientation to the major fault trend.

While the timing of the opened or re-opened fractures could only be supported by the regional rifting tectonic evolution, the fractures distribution on the other hand could essentially be characterized using various seismic attribute methods in combination with present-day stress analysis. Nonetheless, all mentioned techniques could be further improved by obtaining better seismic image from the new acquisition configuration with larger offset. Without an appropriate well operation, this fractured basement play assumption would remain uncertain and yet to be proven.

Keywords: attribute, fractured basement, ant track, variance