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Application of 3D AVA to Successfully Delineate Seismic Interfaces Related to Lithology and Fluid Variation – a Case Study from the Bongkot Field, Gulf of Thailand

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Abstract

Seismic amplitudes reflected from the same interface at different incident angles (or offset) are variable, and represent acoustic and elastic impedance contrasts between different rock types in the subsurface. This relationship between seismic amplitude variations and rock properties can be used in a quantitative manner under the right conditions, and is referred to as Amplitude Versus Angle (AVA). Depending on rock physics analysis carried out at nearby wells, the technique is mostly used to identify hydrocarbons in reservoirs of interest. AVA characteristics depend on rock properties, fluid types, reservoir depths, and seismic data quality. In many cases, gas-bearing reservoirs show AVA anomalies that are different from water bearing reservoirs. Based on the conclusions made in a rock physics study, an AVA project was carried out over the Bongkot field, a producing gas and condensate field in the Gulf of Thailand. The key objective was to verify whether the seismic amplitude information could be used to map seismic interfaces associated with lithology and fluid variations in the area.

The initial results of the QI feasibility study showed that gas reservoir classification would work best in the units down to approximately 2,000 m depth. Below this depth, any fluid detection methodology became more challenging, as the seismic AVA signatures for gas and brine became increasingly similar. This was because fluid changes were unable to significantly change the effective moduli in the reservoir rocks, as the rock itself “harden” due to decreasing porosity with depth. Seismic attribute testing carried out as part of phase II, and proved that hydrocarbon detection was a suitable methodology in this area, using a modified (far-near) x far attribute. The validation of the results was carried out in phase 3, and showed that reasonable predictability values were provided, even for the deepest reservoirs. However, very few wells used for validation penetrated the deepest reservoirs, so the statistical database to verify the gas sand predictability was limited.

The QI feasibility study suggested that lithology prediction based on seismic interface attributes would provide reliable results in this area. Based on this conclusion it was decided that a lithology cube should be produced to separate sand from shale in the study area. The attribute used for computing the lithology cube was a “weighted-stack attribute”, computed from intercept and gradient stacks derived from angle gathers. Further analysis conducted as part of phase III showed that the predictability of the lithology cube was reliable within the entire range of seismic data considered in this study. This study showed the benefit of conducting AVA studies to classify seismic interfaces associated with both fluid and lithology variations. The results of this AVA study can be used to provide detailed reservoir information, and may be used

directly for reservoir mapping, well planning, and could potentially also be used as part of the input to the geological model building in Bongkot Field.