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Identification and Quantification of Thinly Bedded Low Resistivity Pay in Peninsular, Malay Basin

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Abstract

In some fields in Peninsular Malaysia, there are reservoirs with thin laminations of sand and shale, which contains hydrocarbons, but not identified as hydrocarbon bearing, or hydrocarbon-in-place are not properly quantified. A low resistivity reservoir is a pay zone that has relatively low resistivity and thus calculated wet using conventional well log evaluation. A low contrast reservoir is a pay zone that has low resistivity contrast between sand and adjacent shale. The effect of both phenomena is that the apparent formation resistivity is dramatically reduced resulting in underestimation of calculated hydrocarbon saturation and volume of hydrocarbon-in-place. A number of factors have been found to act on measurements made by well logging instruments to produce low resistivity and/or low contrast. The factors include bed thickness, grain size, mineralogy, structural dip, clay distribution and water salinity and any combination of the above. Often a combination of interrelated factors causes the well logging instrument to measure lower resistivity than would ordinarily be expected inside a good productive formation. During data acquisition in wells using conventional logging tools, the actual resistivity of such thin-bedded pay zones are not measured. This is due to poor vertical resolution of the tools (compared to the thickness of laminations).

Previously, the interpretation methods rely on conventional formation evaluation, which largely bypassed and ignored the additional hydrocarbon potential associated with thin-bedded reservoirs. This motivates PETRONAS to pursue the low resistivity and/or low contrast study with an emphasis on quantification of hydrocarbon saturation. In this study, a Thomas-Stieber approach is performed to define the properties of clean sand, pure shale and the fluid. Hagiwara macroscopic anisotropy approach is used for the resistivity modelling. The resistivity model uses RTSand and laminates shale resistivity as inputs to calculate the horizontal resistivity (Rh) and vertical resistivity (Rv) and followed by saturation calculation using Waxman-Smitts method.

It is observed that the hydrocarbon saturation obtained from the analysis had improved. It represents the formation hydrocarbon saturations in thin-bedded reservoirs. The results are validated by perforating the zone of interest and produces 600 oil bbl/d and 0.2 mmscf/d. The use of this approach is encouraged to the wells with similar geological facies in order to optimise the resources assessment.