Low Resistivity, Low Contrast Pay Definition Using Multi-Resolution Graphical Clustering Techniques on the Complex Miocene Reservoirs of the North Malay Basin

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The Miocene fields of the Malaysia Thailand Joint Development Area (MTJDA) form an important (10 TCF GIIP) gas complex in the north Malay Basin. Significant geological complexity exists associated with clay-rich, heterogeneous reservoirs deposited in a marginal marine and estuarine depositional setting. Low resistivity low contrast (LRLC), bioturbated muddy and rippled heterolithic sandstones are common (~10-41% GIIP by field), but until recently have been poorly understood. A holistic multidisciplinary study combined with a novel multi-resolution graphical clustering (MRGC) approach was successfully employed to determine the distribution of LRLC facies. This resulted in an improved understanding of reservoir architecture GIIP estimate, recovery factors, and facilitated field development and management.

The MRGC coarse to fine self organizing maps approach is a non-parametric method partitioning data sets on the basis of their "data structure"; it handles continuous and discrete data. According to their neighboring relationships, data points are clustered into "attraction sets" which are progressively and hierarchically merged into electrofacies. These are automatically ordered along the shortest path through the most typical points of each electrofacies, thus defining a natural sequence of facies evolution. This is an elegant, impartial and reproducible approach to electrofacies propagation.

The study involved the rigorous integration of 1640 feet of core data including sedimentology, petrology and petrophysical data with modern log suites. This resulted in high degree of confidence in reservoir facies characteristics in cored wells. LRLC definition in the MTJDA is challenging due to subtle lithological variations and scale issues. However, confidence in the MRGC model was achieved by employing an iterative approach and carrying out blind tests against cored wells. This was followed by the propagation of electrofacies in 80 uncored wells. The MRGC model was generated using V-shale, effective porosity (phie) and total porosity (phit) logs. By using these processed logs, issues associated with log vintage, tool type, etc were negated.

This approach enabled key LRLC lithofacies to be propagated to all wells and incorporated into a detailed sector model. Success was achieved on a highly complex problem due to the application of an integrated, multidisciplinary work flow and new technology. This approach has applications in other complex fields.