

# Depositional and Diagenetic Controls on Reservoir Quality and their Petrophysical Prediction within the Upper Cretaceous Doe Creek Member of the Kaskapau Formation at Valhalla Field, northwest Alberta

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## Abstract

Valhalla Field, discovered in 1977 and located in northwest Alberta, Canada, produces from the Upper Cretaceous Doe Creek Member of the Kaskapau Formation. Original reserves in place are 279 million barrels of oil and 44.7 billion cubic feet of natural gas, of which 79 million barrels (29% recovery factor) and 32.1 billion cubic feet (72% recovery factor) are estimated to be recoverable by the Alberta Energy Resources Conservation Board. To date, almost 65 million barrels of oil (82% of recoverable reserves) have been produced by primary and secondary (waterflood) techniques.

This study evaluates the depositional and diagenetic controls on reservoir quality within the Doe Creek at Valhalla Field in order to identify reservoir-prone facies and predict the distribution of those facies in wells lacking core control. Analysis of core and well log data indicates that intervals of highest porosity (22% - 36%) and permeability (100md – 1,000md) are preferentially associated with meter-scale sandbodies deposited in proximal lower shoreface and upper shoreface environments. Porosity and permeability data from calcite cemented zones are lower in value; however greater than 80% of porosity values and 60% of permeability values observed within cemented zones occur above the cutoffs for reservoir porosity (12%) and permeability (10 md). This suggests that calcite-cemented zones at Valhalla may act more as a baffle than a barrier to fluid flow.

Based upon the correlation of depositional facies with shale volume ( $V_{sh}$ ) and deep resistivity ( $R_d$ ), the Doe Creek reservoir interval can be subdivided into 4 reservoir facies that generally coincide with depositional environments. Highest reservoir quality is associated with  $V_{sh} \leq 0.09$  and  $R_d \geq 38$  ohm-m, high reservoir quality with  $V_{sh} > 0.09$  to  $\leq 0.12$  and  $R_d < 38$  to  $\geq 21$  ohm-m, intermediate reservoir quality with  $V_{sh} > 0.12$  to  $\leq 0.33$  and  $R_d < 21$  to  $\geq 14$  ohm-m, and poorest reservoir quality with  $V_{sh} > 0.33$  and  $R_d < 14$  ohm-m. Calcite-cemented intervals are successfully predicted in shoreface sandstone bodies where they are greater than 0.5m thick and have neutron-density porosity separation of  $> 7$  porosity units.