Reservoir Average Porosity Uncertainty Assessment with Limited Well Data

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Volumetric estimation has often to be made with very limited data or time, especially in exploration, appraisal or business development projects. Consequently, simplistic volumetric formulae like V=ah(phi)(1-Sw)Rf /Bo are used, where all the parameters represent field-scale average properties, a for area, h for reservoir thickness, phi for porosity, Sw for water saturation, Rf for recovery factor, and Bo for hydrocarbon surface volume factor. Proper uncertainty quantification of each parameter is critical to uncertainty assessment of recoverable resources.

This presentation focuses on the uncertainty of field average porosity. Determining the porosity distribution from 6-inch scale logs to represent the average porosity range at field scale leads to unrealistically wide uncertainty distribution. We propose a logical and consistent approach that combines Walther's Law, Central Limit Theorem and correlated thickness of the reservoir formation. From Walther's law, vertical progression of facies represents lateral facies changes. i.e. a vertical well would encounter most of the facies in the same depositional environment barring unconformities and major depositional environment changes. As a corollary, the range of the porosity logged from a vertical well approximates the range in the field at the same scale. The central limit theorem can then be applied to compute the uncertainty distribution for the field average porosity, but the continuous log samples are not random and independent. Techniques like autocorrelation or vertical variogram may be then used to determine the correlation length and reduce the gross number of log samples down to the number of independent and random samples. We can then invoke the central limit theorem to estimate the mean and standard deviation for the average field porosity. Several field examples are presented to validate the concept and workflow through blind test.

The approach is most applicable to fields with limited number of wells and when a simplistic formula is the best we can do for volumetric estimation. If more wells, 3D seismic data or other data are available, this approach can provide a reference start point.