

Accurate Water Saturation in Fresh or Unknown Rw's with Standard LWD Resistivity Tools

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Abstract

A recurrent issue in formation evaluation is that accurate water saturation estimates depend on accurate knowledge of in-situ water resistivity. Such a dependence has a major impact on resource estimates and on consequent operational and financial decisions, particularly in expensive offshore exploration and development environments, as well as in secondary recovery projects. Reservoir evaluation in the majority of deviated, high angle, and horizontal wells drilled today is based on data from logging while drilling (LWD) operations. The standard formation resistivity log data serve as input to water saturation models, which all require a known water resistivity. As accurate and values of water resistivity are difficult to obtain anywhere in the world, determination of oil and gas saturations suffers in accuracy. We present a reliable solution to this problem.

A field test of a new dielectric inversion technique has been concluded on over eighty data sets in wells from around the world. The LWD log data came from several service providers. The accuracy, efficiency and speed of the inversion algorithm was well quantified. Our key objective has been met: the typical LWD high-frequency (2 MHz) measurements provide a dielectric permittivity and electric conductivity that can be used to derive a waterfilled porosity estimate, which only weakly depends on formation water resistivity. This result is further combined with formation total porosity to allow the calculation of water saturation. We will present several examples of this evaluation-interpretation procedure.

Formation dielectric permittivity at these LWD frequencies has never been utilized before to derive this porosity estimate for a water saturation that is fairly immune to resistivity or salinity. Furthermore, all the voluminous, legacy LWD resistivity log data in operators' well archives can be easily re-processed for review/reassessment of reservoir saturations to allow comparison to historical production information in any assets. The dielectric-inversion software implementation accommodates and processes log data from all service providers.