Thin Bed Resolution by Estimating Resistivity Profiles from Porosity Log Responses

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Abstract

An important issue in petrophysical analysis of standard log suites is the differences in vertical resolution of the various log measurements. Porosity logs and gamma ray tools have a vertical resolution of six inches to one or two feet, whereas many of the resistivity tools have vertical resolution in the order of several feet at best. Therefore, when measurements are combined for saturation calculations, inherent errors are introduced.

We have recently developed petrophysical rock physics/fluid substitution models based on equations from the geophysical literature – Gassmann and Krief. Source data for the models is gamma ray, density and neutron logs, all with comparable vertical resolutions. Pseudo porosity logs – density, neutron, and acoustic – are derived, with a complete range of assumed gas/water saturation combinations.

By comparing the pseudo logs with measured data, it is possible to estimate continuous profiles of gas saturation, as "seen" by each individual porosity log. These calculations involve no assumptions as to formation water salinities.

Since profiles of gas saturation are available, pseudo resistivity curves can be generated for each of the porosity logs individually, by solving for resistivity in Archie's Equation. Assumptions have to be made concerning water resistivity, cementation factor and saturation exponent, in order to solve the Archie's Equation.

The resulting pseudo resistivity curves, when compared with standard resistivity measurements, frequently show more variation and indicate the details of reservoir layering. Additionally, the suite of resistivity curves – actual measurements and pseudo curves – give insight with respect to the changing mud filtrate invasion profiles.

Examples from both clastic and carbonate reservoirs from North America will be presented.