Borehole size and mud resistivity evaluation from logging-while-drilling propagation resistivity measurements in vertical and low-angle wells

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Extended Abstract

Borehole size evaluation is critical for smooth deployment of casing and cement volume calculations. For large boreholes beyond the range of traditional logging-while-drilling (LWD) ultrasonic and nuclear-derived calipers, the borehole influence on deep-reading propagation resistivity measurements can be used to derive an average borehole diameter. A recently developed technique solves for the borehole parameters (hole size, HD; mud resistivity, Rm; formation resistivity, Rt; and tool eccentricity, Ecc) from LWD propagation resistivity measurements in vertical and low-angle wells. The physical problem is described by the following simplified mode. Assuming circular borehole with diameter HD, LWD resistivity tool parallel to borehole and can be decentered. Mud in the borehole has resistivity Rm. Earth formation outside of the borehole is assumed to be homogeneous with resistivity Rt.

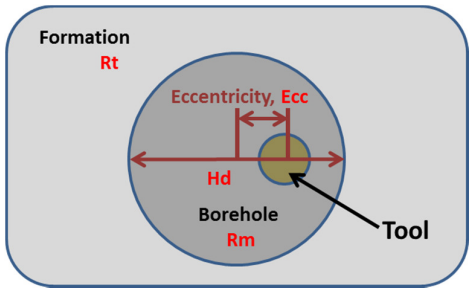

Figure 1. Physical problem and model set up.

For this simplified model, LWD resistivity tool responses can be computed with an analytical solution and an inversion product was developed to invert borehole model parameters from LWD resistivity measurements. In addition to casing and cement volume applications of the caliper data, mud resistivity inverted from data transmitted while drilling can be used to detect water flows. A sensitivity analysis and error propagation study was carried out to evaluate the performance of the inversion. Based on error propagation results, this product can deliver inversion results and inversion uncertainty.

Inversion performance prediction is essential for job planning. A planner based on error propagation provides estimated inversion uncertainty for any given scenario, allowing users to evaluate whether the inversion will deliver a fit-for-purpose solution in their conditions.

This product has been applied in the field and well accepted by the industry. The main feature of including tool eccentricity, delivering inversion uncertainty, and the job planner tool that allows user to predict whether a reliable caliper can be derived in their specific operating conditions, makes it a unique product in the industry.

We will present the algorithm of forward modeling, inversion, error propagation and the design of job planner. We will also show synthetic examples and interesting field cases.