

## Numerical Sensitivity Test of Three-Electrode Laterolog Borehole Tool

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### Abstract

Finite element numerical simulation has been carried out to investigate quantitatively the response of the three-electrode laterolog borehole tool (LL3) on radial and vertical heterogeneity of the rock. In order to calculate the apparent resistivity from the electric potential and the current discharge of the measurement electrode the probe coefficient of the LL3 tool with finite electrode extent was determined. Two independent methods, a finite element modeling and a semi-analytical solution, resulted in the probe coefficient of approx. 0.15 m with a relative deviation of 2.4% due to the different geometry, resolution and electronics of the models. It was established that LL3 is only slightly sensitive to the presence of mud when the borehole diameter is  $d \leq 30$  cm and the ratio of the resistivity of rock and the borehole mud is  $1 \leq R_t/R_m \leq 1000$ . Vertical heterogeneity test pointed out that the layer boundaries can be localized exactly even for thin bedded layer (with a thickness of 1 m) and the presence of low-resistive borehole mud. Correction factors were suggested to decrease the biasing effect of the low-resistive borehole mud and the shoulder beds on the apparent resistivity observed by LL3. Finally, it was verified that the probe has large penetration depth with excellent vertical resolution, what explains the enduring popularity of the LL3 tool in well logging.

**Key words:** well logging, three-electrode laterolog, LL<sub>3</sub>, finite element numerical modeling, borehole geophysics.

Full text is available at

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