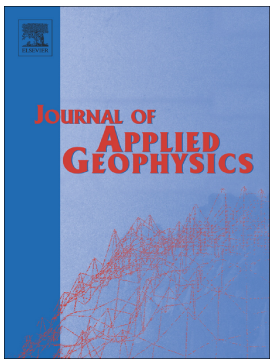

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Apparent resistivity for transient electromagnetic induction logging and its correction in radial layer identification

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Abstract: We propose an algorithm for calculating all-time apparent resistivity from transient electromagnetic induction logging. The algorithm is based on the whole-space transient electric field expression of the uniform model and Halley's optimisation. In trial calculations for uniform models, the all-time algorithm is shown to have high accuracy. We use the finite-difference time-domain method to simulate the transient electromagnetic field in radial two-layer models without wall rock and convert the simulation results to apparent resistivity using the all-time algorithm. The time-varying apparent resistivity reflects the radially layered geoelectrical structure of the models and the apparent resistivity of the earliest time channel follows the true resistivity of the inner layer; however, the apparent resistivity at larger times reflects the comprehensive electrical characteristics of the inner and outer layers. To accurately identify the outer layer resistivity based on the series relationship model of the layered resistance, the apparent resistivity and diffusion depth of the different time channels are approximately replaced by related model parameters; that is, we propose an apparent resistivity correction algorithm. By correcting the time-varying apparent resistivity of radial two-layer models, we show that the correction results reflect the radially layered electrical structure and the corrected resistivities of the larger time channels follow the outer layer resistivity. The transient electromagnetic fields of radially layered models with wall rock are simulated to obtain the 2D time-varying profiles of the apparent resistivity and corrections. The results suggest that the time-varying apparent resistivity and correction results reflect the vertical and radial geoelectrical structures. For models with small wall-rock effect, the correction removes the effect of the low-resistance inner layer on the apparent resistivity of the larger time channels.

Keywords: transient electromagnetic induction logging; radial layer; apparent resistivity; correction algorithm; Halley's optimization

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