

Shanjun Li, “Analysis of Complex Formation Using Computer Techniques”

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Three fracture models, the plane-fracture model, the matchstick-fracture model and the cubic-fracture model, have been studied. Formulas of equivalent conductivity tensors of these fracture models are presented. Using these equivalency principles and by means of 3-D finite element method (FEM), dual laterolog responses in various fracture models have been computed and studied. A new conceptual 3-D electrode-type logging tool is presented. The tool can present six investigation depths while detecting 12 azimuthal resistivities. So the tool can show, at each logging point, the formation resistivity for different radial depths at various azimuthal angles around the borehole. The simulated results show that the tool can be used to more reliably determine the 3-D formation resistivity distribution in deviated and horizontal wells than most well logging tools widely used around the world.

By solving the two-phase fluid flow equations and the convective-diffusive equation using the finite difference method (FDM) and by means of the Archie's equation, the time-varying invasion profiles of formation water saturation, profiles of salinity distributions and profiles of formation resistivity are obtained. Using accurate computer codes for simulation of induction and laterolog tools in two-dimensional formation, a series of time-lapse dual laterolog and dual induction logs are obtained.

Based on a successive forward modeling algorithm, a 2-D inversion method and a 3-D inversion method using induction logs are presented. Because the Jacobian matrix only needs to be computed once in the algorithm, the new inversion method is computationally more efficient than least square methods, such as the Marquardt-Levenberg method.

Based on the Marquardt method and the 2-D inversion algorithm mentioned above, a 2-D inversion software of array induction logs is developed. Meanwhile, a few efficiency enhancements to improve the calculation speed and to stabilize the solution are introduced.

Based on the Marquardt method, another 2-D inversion software of MWD data is developed. Based on the investigation characteristics in the radial direction and vertical direction of MWD tools, a few efficiency enhancements to improve the calculation speed and to stabilize the solution are introduced also.