Lili Zhong, “Simulation of Tri-Axial Induction Tools in Dipping Anisotropic Beds”

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At the end of the 1950s, the induction logging tool was invented to measure the conductivity of earth formations. Until recently, the basic theory of induction well logging has not taken into account conductivity anisotropy in the geological formations. Also, the early basic theory of induction logging applies to cases in which the tool orientation and the bedding plane are perpendicular. However, in the oil industry deviated boreholes are widely drilled now, and anisotropy is often found in reservoirs. Therefore the issue of induction logging in deviated wells drilled in anisotropic formations becomes very important.

A set of simulation codes is developed in this dissertation to simulate induction tools in deviated wells drilled in anisotropic formations. The software is complete with user-friendly graphical interface and highcomputation speed. The simulation code can be applied to a newly developed class of induction tools with transmitting and receiving coils oriented in three mutually perpendicular directions. The new tool is often referred to as the “tri-axial induction tool.” The axis of the tool may intercept a formation with a constant dip angle, a constant azimuthal angle and a constant orientation angle.

The theory of this new tri-axial induction tool is briefly discussed and summarized. Formulas for the electromagnetic fields generated by these three transmitting coils have been derived. The derivation uses the coefficient propagator method to facilitate computer coding under the assumption of a negligible borehole effect and no invasion. The structures of the new simulation code are designed elaborately to improve the efficiency of the simulation. The FORTRAN code has been integrated into the existing Wellog Simulator. Because the new induction tool has three transmitting and three receiving coils, a total of nine logs are to be obtained at each logging depth. Therefore, the software will compute nine distinctive logs at each logging depth and display the results on the computer screen and record them in an ASCII file. To improve the usefulness of this code, we developed an inversion scheme based on the Jacobian

matrix method to obtain the apparent horizontal and vertical conductivities and the apparent dip angle at each logging depth.