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WARIN SRIPANYA : MATHEMATICAL SOLUTIONS OF ELECTRIC POTENTIAL AND MAGNETIC FIELD RESPONSE FROM HETEROGENEOUS MEDIA. THESIS ADVISOR : ASSOC. PROF. SUABSAGUN YOOYUANYONG, Ph.D. 96 pp.

Magnetic field and electric potential resulting from the injection of electric current into the ground can be used to explore the earth's structures. We derive analytical solutions of the steady state magnetic field due to a direct current source on four types of multilayered earth structures including layers having constant, exponentially, linearly and binomially varying conductivities. The Hankel transform is introduced to our problems and analytical results are obtained. Our solutions are achieved by solving a boundary value problem in the wave number domain and then transforming the solution back to the spatial domain. The propagator matrix technique is used to formulate recurrence relations for solving the problems. One of these relations is applicable to general cases in which the layers have either constant or exponentially varying conductivities. Another one is generalized in all cases where the layers have constant, linearly or binomially varying conductivities. The effects of magnetic fields obtained from the DC and MMR methods are plotted and compared to show the behavior in response to different ground structures at many depths while some parameters are approximately given. The ground structures of rice paddy field and marine shrimp aquaculture farm are used to investigate the magnetic field responses. The magnetic fields obtained from different ground structures and methods of investigation are very much different, especially for the first 5 metres of source-receiver spacing. The curves of magnetic fields show some significance to the depth of overburden layer. An inverse problem via the use of the Newton-Raphson optimization technique is introduced for finding a conductivity parameter of the ground. The method leads to very good results and has high speed of convergence. Analytical solutions of the electric potential are derived for the problem of a buried current source and a buried receiver. The models of a layered earth are developed for source and receiver electrodes buried anywhere within transitional ground structures including layers having linearly and binomially varying conductivities. The propagator matrix technique is also applied to make upward and downward recurrences for solving the problems. Our solutions can be used to interpret hole-to-hole, hole-to-surface and conventional surface array data. The inversion processes, using the Newton-Raphson and quasi-Newton methods, are conducted to estimate the conductivity variation parameters. A regularization technique can also be applied to inverse problems arising in geoelectrical resistivity sounding. We propose here to use a regularized inversion scheme for interpretation of magnetic field data gathered from a horizontally stratified layered earth. The iterative scheme using the regularized conjugate gradient method is applied to estimate the conductivity parameters of the ground. The L-curve criterion is used to determine a suitable value of the regularization parameter. The final inverted model obtained is qualitatively in good agreement with the real model from synthetic data. A comparison of inversion results obtained from our scheme, conventional conjugate gradient and Levenberg-Marquardt methods on a test data set clearly demonstrates an edge over the other two stated schemes as far as the robustness is concerned. The scheme described here has been successfully used for geophysical inversion of magnetic field data.

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Thesis Advisor's signature ....

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