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Comparison of Resolution Capacity of Different Electrode Arrays in Delineating Fractured Zones Using Electrical Resistivity Modeling

Lukumon Adeoti[1], Seun Afolabi[1], Kehinde Ishola[1], and Bolaji Adegbola[2]

[1]University of Lagos
[2]Lagos State University

Abstract

This article compares the resolution and effectiveness of different electrode arrays in imaging fractured zones in a basement complex for hydrogeological investigation by employing numerical simulation since each of the electrode configurations gives different response when applied to the same geologic structure. Forty-eight synthetic geologic models based on the lithology characterization in the basement terrain were created for the study. Apparent resistivity was calculated over the model at varying depth, thickness and resistivity using the forward model software by employing three electrode configurations namely: Dipole-Dipole (Dpdp), Pole-Dipole(Pdp), and Wenner(Wen). The synthetic forward responses then served as input to inversion process which was contaminated with 10% Gaussian noise. The reconstructed image from the inversion was analysed in terms of geometries and inverted resistivity values. An evaluation of the accuracy/deviation of the inverted resistivity data sets from the true model was carried out using basic statistical approach via Root Mean Square (RMS) misfit, Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). The plots of MAPE and RMS against depth reveal trend of deviation with depth. A field survey was carried out to justify the results from the theoretical simulation using the three arrays with their corresponding parameters employed in the theoretical simulation. The results reveal that the true resistivity of the target is rarely resolved and the resistivity of the inverted model depends on the resistivity contrast and the target depth of burial. The study also shows that the resolution of resistivity imaging depends on the array configuration. Wenner array gives the best response at shallow depth of burial (limited to about 5 m) and less susceptible to an edge effect, but dipole-dipole gives the best resolution at deeper depths, followed by pole dipole.