Robust resistivity model estimation for layered earth using AEM data over alluvium-covered hard rock

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SUMMARY

The Airborne Transient Electromagnetics (AEM) derived resistivity model facilitates the translation of resistivity into useful hydrogeological information. The resistivity model if they are inconsistent makes translation difficult and may give inaccurate results and bias our interpretation. To find reliable AEM resistivity estimates, some one-dimensional inversions, following the forward simulations-based sensitivity analysis, were attempted using an open-access Python code, namely SimPEG. Initially some field AEM data from Dausa, Rajasthan were inverted to recognize the major geological layers. Following 1D inversion results of field data and some borewells, we considered a five-layer model consisting of top alluvium, underlain by successions of clay, sand, weathered layers and basement hard rock simulating the alluvium-covered-hard rock terrain, for generating the vertical magnetic field decay responses with addition of some random noise. Synthetic data were inverted to obtain the smooth and sparse models using different start model resistivities. Most of the given layers were reconstructed in both the inverted models, where two intermediate moderately resistive sand and weathered layers with insignificant resistivity contrast are seen as one layer. Despite having high resistivity variation at the interface between weathered and basement rock, smooth models could not properly see it, whereas sparse models can mark it more effectively. In both the models, the shallow-conductive clay layer is well detected and has constrained the conductance same as the true model but the resistivity and thickness of this layer are still away from the true model. We have varied the resistivity and thickness of this second layer, computed the forward responses and suggested the robust layer parameters based on RMS error between the perturbed and true model's synthetic responses, consistent with the borewell information. Given the above, it is planned to perform forward simulations to train a neural network for predicting the possible resistivity-lithology-hydrogeology translation on a case-by-case basis.

Keywords: AEM, SimPEG, layered-earth, Alluvium-covered hard rock