Mapping of Laterite Zones using Electrical and EM Observations towards the Solution of Various Problems Related with Delineation of Groundwater in parts of West Bengal, India

Abstract

Laterite is an impervious rock that lies on the surface as well as subsurface and causes widespread problems related with delineation of groundwater in different parts of the world. Present study area, parts of West Bengal, India suffers from this problem. Electrical and electromagnetic studies are carried out to solve several issues related with groundwater occurrence. Electrical resistivity surveys were performed at a regular interval from Subarnarekha River at Bhasraghat (south) to Kharagpur (north) to map the lithological variations in this area. Two-dimensional Electrical Resistivity Tomography **(**ERT) surveys are performed at 9 locations (separated by 3 to 4 km distances) covering about 30 km along a profile in E-W direction centrally located between Kangsavati (in the north) and Subarnarekha (in the south) rivers. Study reveals that NW region of the study area is problematic due to the presence of secondary laterites as a cap on the earth subsurface which prevents the rainwater infiltration. But on the other hand, the SE region has well saturated aquifer zones. So puncturing the top laterite layers and allowing the runoff water to penetrate in to the subsurface may solve the problem in NW region. Building water sheds for agriculture in western part of the principal profile line could help in increase of the groundwater level.

In some parts of the study area, borehole data reveals that the presence of conducting layer (thin aquifer zone) at greater depths. However, 1D resistivity sounding and 2-D resistivity imaging fails to delineate the thin conducting layers. In the present study, detection of such aquifer layers has been theoretically investigated using various frequency and time-domain electromagnetic methods. It has been observed that presence & absence of aquifer layers at large depth can be depicted well by the Audio frequency MT (AMT) and Time-domain EM methods. Further, the study demonstrates that maximum variation in the responses (with and without aquifers) is observed from the AMT measurements. Study reveals that AMT data together with DC resistivity measurement will be able to solve such problem. It is important to highlight that practically it will also be challenging for both methods as AMT data will have small signal to noise ratio (due to dead band region of MT measurement) and time domain measurement will require very sensitive device to measure transient signal which will be in μV (microvolt) to nV (nanovolt) range at later times or transient will become too noisy at later times. It is interesting to highlight that even AMT sounding data also does not reflect the exact number of layers from either apparent resistivity or phase data, but systematic inversion/joint inversion is able to resolve the above-mentioned ambiguity and delineate the presence of aquifers at depth. The Very Fast Simulated Annealing (VFSA) global optimization approach has been used to the study the efficacy of joint interpretation of DC resistivity and AMT sounding in solving the practical problem in the area. The approach is general and similar approach can be used to solve practical problems associated with other geophysical applications such as mineral investigation.

Key words: lateritic terrains, Groundwater, Schlumberger resistivity soundings, 2D ERT, artificial recharge, TEM sounding, AMT sounding, Suppression ambiguity, Joint inversion.