

## Delineating subsurface structures for deep aquifer study using MT, and airborne geophysics. Case study of the Voltaian sedimentary basin, Ghana West Africa.

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### SUMMARY

Locating groundwater productive zones in the near surface in the Voltaian sedimentary basin in Ghana has been challenging over the past years causing water scarcity among residents in the basin. Resident relies sole on groundwater for their domestic supply as a result of extreme temperatures and high evapotranspiration following a prolong dry season, causes surface water bodies to dry up. To address this challenge, airborne geophysical data and magnetotellurics data has used to attempt to delineate aquifers deeper beyond the weathered zone in the basin. The results of the integrated geophysical approach suggest the presence of a low resistivity layer lies between 200m to 550 m within the sandstones and could have potential for holding groundwater.

**Keywords:** Magnetotellurics, Inversion, Airborne geophysics, water resources, Voltaian Sedimentary Basin

Groundwater is the main source of potable water for indigenes in the northern part of the several kilometers deep Voltaian Sedimentary Basin (VSB) in Ghana (Figure 1).

Groundwater exploration in the VSB over the years has yielded very little success with a failure rate of about 60 percent (Agyekum and Asare, 2016). Electrical resistivity tomography has been the main geophysical technique used for groundwater exploration in the VSB targeting the weathered zone of the near surface. The low yields of boreholes have pushed contractors to target deeper aquifers as against the shallow aquifers in the basin to supply sufficient water to cover the rapid economic development coupled with population growth in the basin. The complexity and paucity of the outcrops has hampered sufficient mapping of the basin structure down to the Proterozoic basement. To address this problem, and to offer a detailed description of the basin structure, a preliminary integrated geophysical investigation approach using existing airborne geophysical data (obtained from the Ghana geological survey authority) and magnetotelluric (MT) data obtained from field survey undertaken within the scope of this project in the north part of the VSB. The target areas for MT soundings were identified from airborne geophysical data (EM, magnetic and gravity, Fugro (2009)). Vertical gradient maps of the airborne magnetic data and Euler solutions of the airborne gravity data revealed the presence of several geological structures (faults and folds) within the thick platform sediment (Figure 3) revealing their potential as deep-seated aquifers. The depth to basement is observed to averaging about 4.5 km with the MT while with the

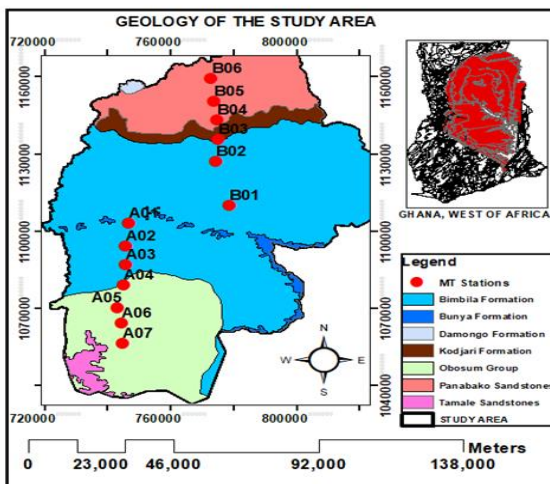
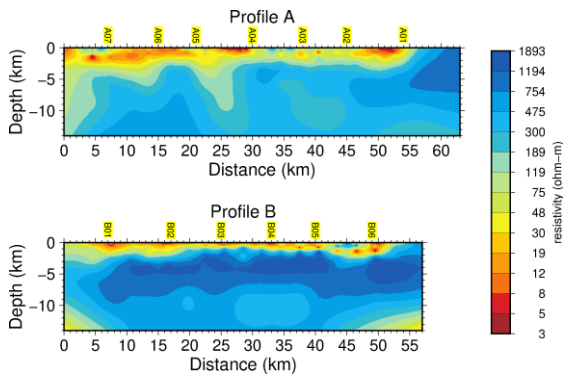


Figure 1 : Geology of Voltaian Sedimentary Basin

airborne gravity and magnetic data, the depth is 5.5 km and 4 km respectively. A total of 13 broad-band MT soundings along two profiles lines orienting north-south were conducted. A preliminary 3-D inversion of the whole data set showed the presence of conductive layers within the basin (Figure 2).



**Figure 2.** Southern and northern resistivity sections from the 3-D inversion results.

One dimensional MT inversion of the Berdichevsky invariant (e.g. Simpson and Bahr, 2005) was used to improve the vertical resolution at each site. The average thickness of the low resistive layer is about 300 m and with values which ranges between a few tens of ohm m corresponding to resistivity values of fresh groundwater. Further work will target proper delineation of the possible deep-seated aquifers possibly within the sandstones known to intercalate with the shales and

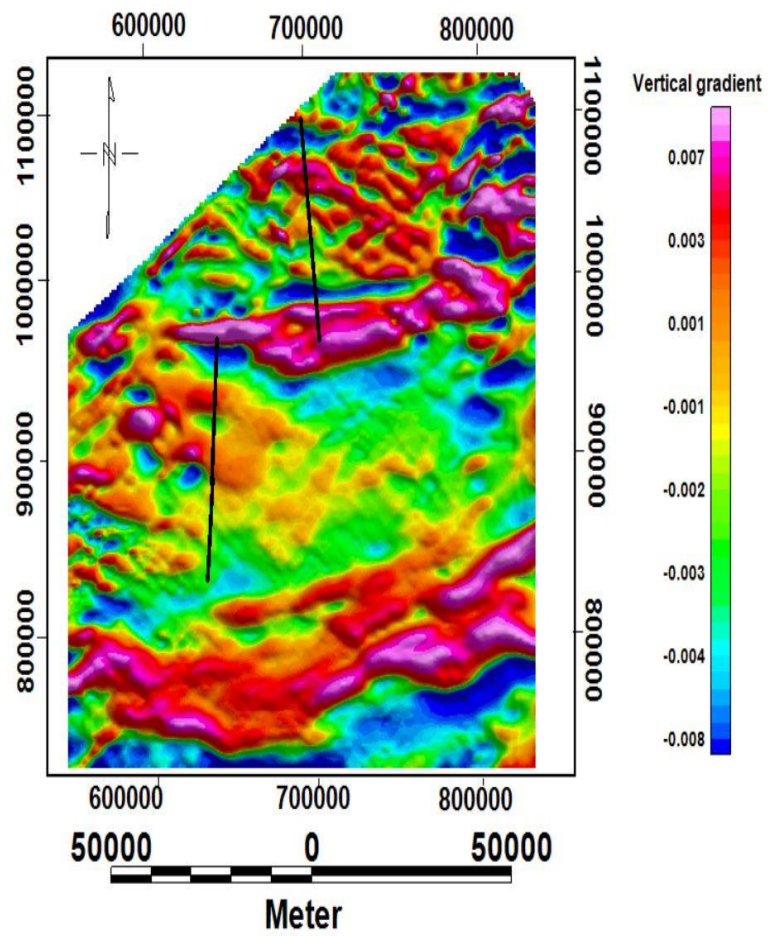
siltstones in the area. Also, we will be carrying out composition analysis as well as porosity and permeability test of some outcrops in the region to further improve this work.

#### ACKNOWLEDGEMENTS

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**Figure 3.** The vertical derivative of the magnetic data shows geological structures in the northern part of the Voltaian sedimentary basin in Ghana.