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Investigation for ground water Potentials Ataplot in Ifiteawka, Awkasouth local government area, Anambra state, Nigeria.

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ABSTRACT;
ThegeophysicalinvestigationreportistheresultoffieldelectromagneticsurveyusingADMT300sforthesinkingofasuccessfulboreholeataplotin,IfiteAwka,AwkaSouthLocalGovernmentArea,AnambraState.Pre–drillinggeophysical surveyshappenstobeascientificmethodofdeterminingtheexistenceofgroundwater.This therefore, necessitatedthecommissioningofconsultinghydro geologiststocarryoutthissurvey. ThefieldelectromagneticsurveyusingADMT300swasthereforecarriedoutattheproposedsite to determine its water bearing formations. ***.*** *Thisreportinvolvesstudiesofthephysiography,localgeologyandhydrogeologyaswellastheconductoffieldelectromagneticsurveyusingADMT300sforthesubsurfacegroundwaterinvestigation.Based on the geological and geophysical studies, aboreholedepthofnotlessthan8****23feet (270meters)****isrecommendedtobedrilled at the project site IfiteAwka,AwkaSouthLocalGovernmentArea,Anambra.*

Key words; Groundwater, Hydro geologist, Geophysical survey, Subsurface, River basin

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I. INTRODUCTION

In the face of increasing scarcity of water resources, there is a need for a holistic study of groundwater resources and potential of any proposed borehole drilling. The study area fall within Anambra River Basin. The most important aquiferous formation in the basin is the Ajali Formation. This formation is underlain by about 585m of the Mamu formation and Nkporo shale. A geophysical survey for groundwater is a cost-effective and non-intrusive method used to detect and assess potential sources of groundwater. It involves techniques such as electrical resistivity imaging and seismic methods to analyze subsurface geology and identify water-bearing formations. These surveys help in pinpointing the location of underground layers that contain water, which is critical for determining the best drilling locations for boreholes.

PROJECTLOCATION

IfiteAwkaislocatedatAwkaSouthGovernmentArea,Anambrastate.Globally,itisatLatitude$06^{0}14^{I}22.8^{II}$Northofthe Equatorand Longitude $006^{0}05^{I}42.3^{II}$East ofGreenwichMeridianatanelevationof91 meters.

GEOLOGYOF THEAREA

IfiteAwkaandenvirons includingtheprojectlocationliesatthecrestofstructure–theAwka–Orluridge,whichactsasagroundwaterdivide.Thisstructureisunderlainby theImoClay/Shalegeologicalunit.It isof Paleoceneinage.TheImoClay/Shaleisanarrowstripgeologicalunitrunningroughlynorth–southwiththreesandymembers,namely-theUgwuobaSandstone,TheImoClay/Shaledevelopedasthickbluishtogreyishclayswithamaximumthicknessofabout1000m.Thisformationisessentiallyanaquiclude,exceptforthesmall lenticularsands,whichconstitute goodaquifersinsomelocalities.EntireformationwasdepositedinamarineenvironmentduringthePaleoceneageofthecretaceousera.

HYDROGEOLOGY

Hydro geologically,AmanseafallswithintheMamuRiverBasin.TheRiverMamuisaveryimportanttributaryoftheAnambraRiver.ItrisesprincipallyfromtheEziama/AkokwahighlandstotheSouth,andisjoinedbynumeroustributariesrisingfromtheEnuguUkwu/Agulu/Ekwulobia ridgetotheeast.Theriverflowsroughlysouth-north, makinganorthwestbendsaroundEbenebetojointheAnambrariver.

ThemostimportantaquifersinMamuRiverBasinaretheAjaliFormation,theUgwuoba andAmenyiSandstoneoftheImoClay/ShaleandtheNankaSands.Theseaquiferousunitshoweverdidnotextendtotheprojectlocation.

II. METHODOLOGY

GEOPHYSICALINVESTIGATION

Groundwaterbehaveslikeaweakelectrolyte.Duringtheprocessofinfiltrationofrun-offfromrainwaterintothesubsurfacewhere I tisstoredasgroundwater,itpassesthroughdifferentrockcolumns, leachingsomeofitsmineralcontentasitpercolatesdownwards.Thisdissolvedmineralcontentinggroundwatermakesitactlikeaweakelectrolyte.Asaresult,electricalgeophysicalapproachisverysuitableforgroundwatersurveys. Datafrominstrumentcapableofdetectingelectricalresponsesinthesubsurfacewhereutilised.Theinstrumentanditsmeasuringtechniquearoeherediscussed.

ADMT300S

ThisADMTseriesinstrumental useelectromagneticfieldoftheearthasaworkingfieldsourcetoexaminetheelectricalstructureofthesubsurface. Theelectromagneticresponseoftheearthcanrevealtheelectricalvariationsofthegeologicalbodiessatdifferentdepthinthesubsurfaceviadifferentfrequencysampling. Thedepthoftheelectricalvariationscausedbyvariousgeologicconditionslikeelectrolyticgroundwatercanbedeterminedbysamplingfromhigherfrequencyvaluestothelowon essence frequencyisinverselyproportionaltowavelengthwhichrelatesdirectlytodepth Theelectromagneticwavepropagationtheoryexplainedby Helmholtzequationsshowsthatthepropagationofelectromagneticwavepassingthroughafilter (earth)obeystheMaxwellequation.Assuminganon-magneticanduniformlyconductivesubterraneangeologicalmediumwherethereisnochargeaccumulation,thentheMaxwellequationcanbesimplifiedto:

$$\left.\begin{aligned} \nabla^2 H + k^2 H &= 0 \\ \nabla^2 E + k^2 E &= 0 \end{aligned}\right\} \quad (1)$$

H=Magneticcomponent
E=Electricalcomponent

Wherekiscalledthewavenumber(orpropagationcoefficient)andit'sexpressedas:

$$k = [\omega^2 \mu\varepsilon - i\omega\sigma\mu]^{\frac{1}{2}} (2)$$

Consideringthatpropagationcoefficient,K,asacomplexnumber,whichimpliesthatKhasboththerealandtheimaginary path,K=b+ia;where**a**iscalledthephasecoefficientwhereas**b**istheabsorptioncoefficient. IntheelectromagneticfrequencyrangemeasuredbythisADMTseriesrangefrom0.1Hzto5 kHzwhichareverylowandasaresultthedisplacementcurrentcaused .ThisfurthersimplifiestheKas:

(3)

AmagneticfieldwithachangeinHelmholtzequationinducesachangeintheelectricfieldandaresult;wecanhavethemagnet toelectricrelationship:

$$\frac{E}{H} = -\frac{i\omega\mu\sigma}{k} = -\frac{i\omega\rho}{k} \quad (4)$$

ThesurfaceimpedanceZis definedastheratioofthesurfaceelectricfieldandthehorizontalcomponentofthemagneticfield.Inthecaseofauniformearth,thisimpedanceisindependentofthepolarizationoftheincidentfield,anditrelatedtotheearth'sresistivityandthe:

$$Z = \frac{E}{H} = \sqrt{\omega\mu\rho e^{i\pi/4}} \quad (5)$$

Theformulainequation5canbeusedtodeterminetheresistivityoftheearth layer:

$$\rho = \frac{1}{5f}\left|\frac{E}{H}\right|^2 \quad (6)$$

Forthedepthtotheearthlayerwiththeresistivitydescribedinequation6,theSkindepthapproximationcanbeutilisedonthebasesthatthemediaisnon-magnetic:

$$\delta \approx 503\sqrt{\frac{\rho}{f}} \quad (7)$$

Giventhemathematicalrelationshipinequation7,thedepthofpenetrationofelectromagneticwaveisdependentonfrequencyandresistivityoftheearthlayer.Thehighertheresistivity,thegreaterthedepthofpenetration.Thelowerthefrequency,also,thegreaterthepenetrationdepth.

InADMT300s,amaximumdepthof300missampledandtheloweredresistivityintervalcanbesuggestiveofanaquifer.

Table1. PROBELOCATIONS

S/N	PROBEID	LATITUDE(°) (Degreedecimals)	LONGITUDE(°) (Degreedecimals)	ELEVATION (m)	Date
1	FID60	N06^{0}14^{I}22.8^{II}	E007^{0}05^{I}42.3^{II}	91	January,17th2025.
2	FID61	N06^{0}14^{I}22.0^{II}	E007^{0}05^{I}40.3^{II}	97	January,17th2025.

III. RESULTSANDDISCUSSION

2NOprobepointswereacquired(Table1)attheprojectsiteandaredenotedas**FID60andFID61**.Thetomographicsection isshown in Figure1&2.Adepthof300meterswasachievedateachprobepoint.

FID60

Thiswascarriedoutatwithintheprojectsiteabout10metersfromtheentrancegate.2N0groundwaterhorizonsweredetected.Thefirstgroundwaterhorizonoccurredatadepthrangeof160meters.Thesesecondgroundwaterhorizonoccurredatadepthrangeof200-250meters,Fromthe2Dcontourmapsection(Figure1),thesubsurfaceischaracterizedbyhighresistivity(impermeable)rocktypes,colourcodedredwithintercalationsofwetandsaturatedzonescolourcodedlightgreenandbluerespectively.Underlyingrockunitsaredominantly**Shale/Clay**withinterbedsof **Mudstone/Siltstone/Sandstone**.Saturationconnectivitylargelydoexist,hencemayenhanceconductivity.

FID61

Thiswascarriedoutstillwithintheprojectsiteatabout28metersfromtheentrancegate.Groundwaterhorizonsweredetectedatadepthof165meters.

However,deeperabstractionmaybepossibleattheprojectsiteatdepthrangeof250metersto300meters.Fromthe2Dcontourmapsection,thesubsurfaceischaracterizedbyhighresistivity(impermeable)rocktypes,colourcodedredwithintercalationsofwetzonescolourcodedlightgreen.Underlyingrockunitsaredominantly**Shale/Clay**withinterbedsof**Mudstone/Siltstone/Sandstone**hence isdiceytorecommendthispoint.

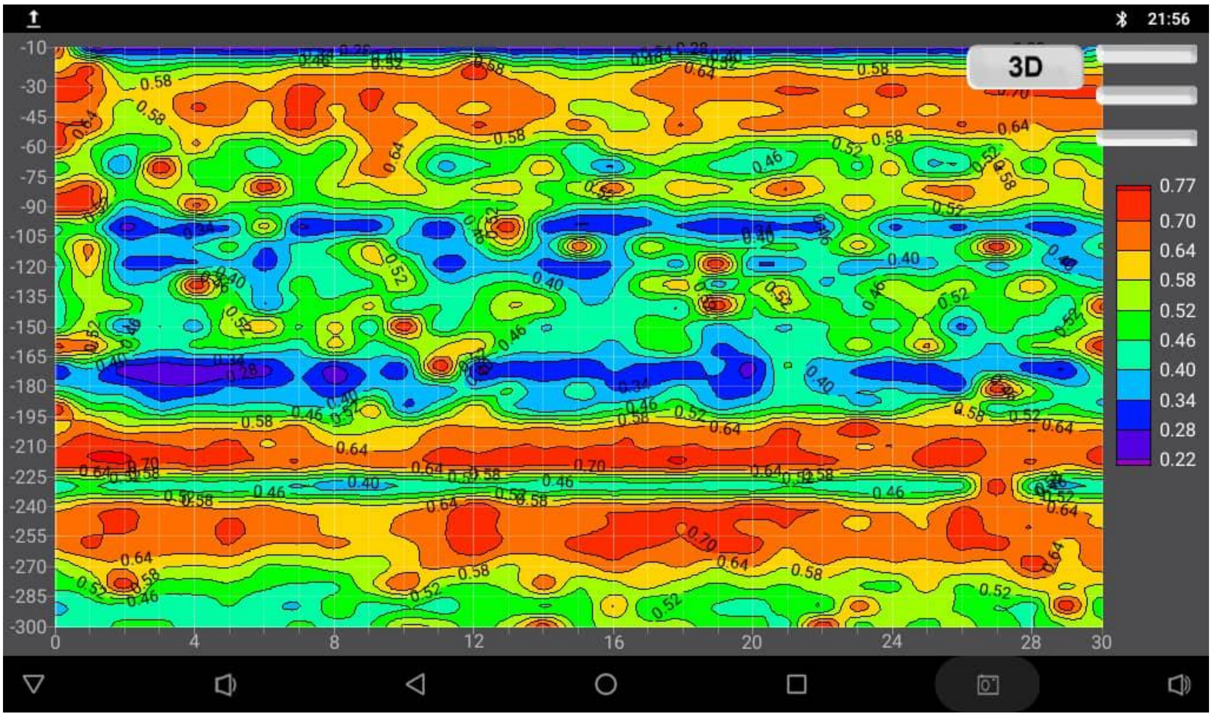

Figure1:FID60

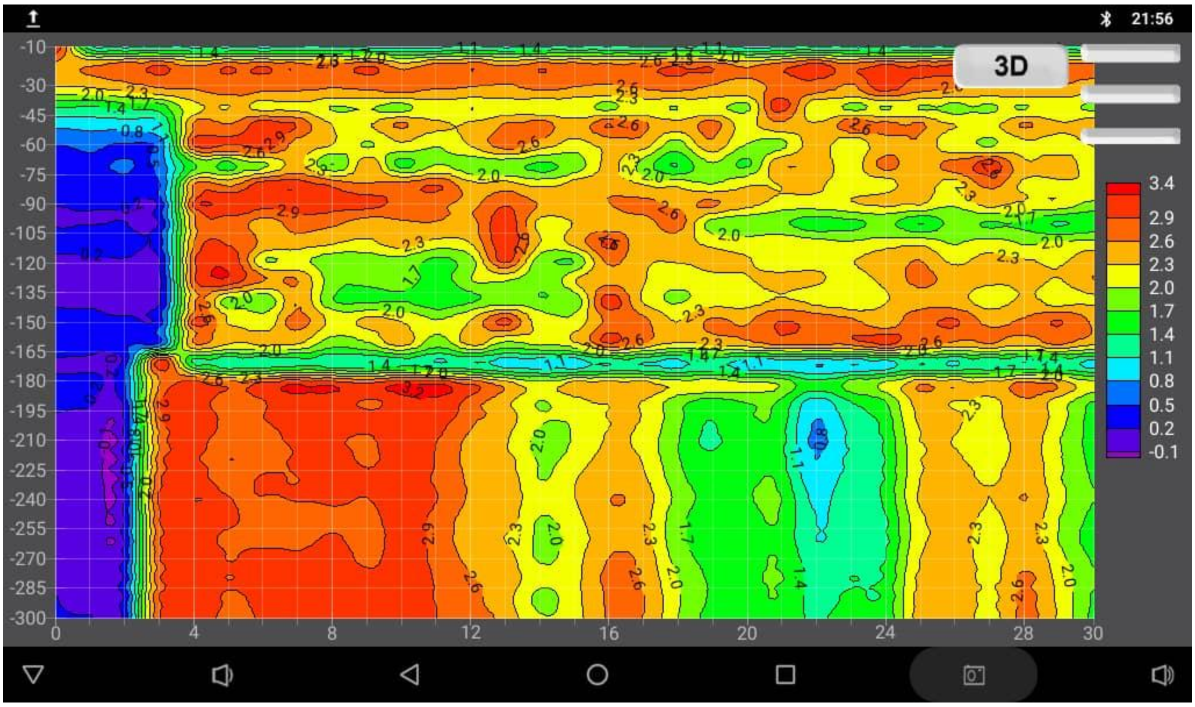

Figure2:FID61

IV. RECOMMENDATIONS

Basedonthegeologicalandgeophysicalstudies,aboreholedepthofnotlessthan8**23feet(270meters)**isrecommendedto bedrilledattheprojectsiteIfiteAwka,AwkaSouthLocalGovernmentArea,AnambraState.
Geophysicalloggingoftheboreholeshouldbeundertakenbeforeinsertionofscreensand casings.
TheentiredrillingprogrammeshouldbesupervisedbyacompetentandexperiencedGeologist/Water Engineer.
Thedrillingmethodrecommendedisthedirectrotarymethod,usinga**CompetentRotaryRig**.
Adequatepreparationsshouldbemadebyprovisionofadequatequantityofchemicalstoforestalltheincidenceofcollapse ,sincetheformationmaybemostlysandy.

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