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Appraisal of the groundwater potential in Iwo township a part of Southwestern Nigeria

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Abstract

Groundwater exploration was carried out through applicable electrical resistivity investigation with the aim of delineating probable zones of groundwater prospect within the near-surface geological formation in the study area. The dominant rocks in the study area are migmatite gneiss, biotite /biotite-muscovite granite and potassic syenite which falls within the Crystalline Basement Complex of southwestern Nigeria. **F**orty (40) Resistivity Sounding were explored using Schlumberger arrangement with the current spacing (AB/2) of a hundred metre at purpose by ABEM resistivity meter. The sphere knowledge obtained were analysed quantitatively by iteration package "WINRESIST" and qualitatively by partial curve matching. Bedrock resistivity, longitudinal conductance, reflection co-efficient and overburden thickness, longitudinal conductance parameters were calculated and their plots were prepared also and used for assessing the aquifer prospects. The results show that the subsurface lithology consists generally of three to five layers which are QH. A, KH. K, HKH. H and HA -types resistivity curves mainly. The geo-electric layers display 3–5 horizons viz: the topsoil (34.0-63277.4 Ωm), clayey sand (7.9 -8322.1 Ωm), fractured bedrock (19.9 -10347Ωm) and the fresh bedrock (55.5 -5461.6 Ωm). The overburden thickness isopach plot showed an overburden thickness varies of 5.0 to 39.5m with values larger than thirty metres within the study space. About 75% of the studied groundwater samples revealed low to medium potential zone, while 15% and 10% revealed high and very-high potential zones respectively. Subsequently, the groundwater potential rating of the study area is viewed as normally low. A large portion of Northern and Eastern portions of studied areas which showed moderate to good protective capacity.

Keywords: Groundwater potential; Vertical Electrical Sounding (VES); Geoelectric parameters; Aquifer; Groundwater Protective Capability

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Introduction

Groundwater is a natural resource that contributes substantially to the needs of most municipal ,domestic and industrial purposes worldwide, due to its occurrence within the overlying unconsolidated material derived from in-situ weathering of bedrock and the porous and permeable layer of the saturated zone in the subsurface (Jones,1985 Olayinka et al., 1999;Adewoye et. al., 2017; Bayewu et al., 2017). However, its provisions in terms of quality and amount are step by step decreasing because of poor groundwater management (Adejumo et al. 2018).The demand for this incalculable resource has improved expressively because of civilization, technological advancement and socio-economic development (Olayinka et al., 1999, Adewoye et. al., 2017). This has strengthened the application of appropriate geophysical and/or hydrogeologic search to locate areas of sustainable groundwater prospect in the near-surface aquifer (Olayinka et al.,1999; Olorunfemi et al., 1999). Groundwater resource analysis and the property within the Basement Complex rocks is usually carried out with the use of resistivity geophysical approach using Vertical Electrical Sounding (VES) (Olasehinde and Bayewu,2011;Adewoye et al., 2018 ;Oloruntola and Adeyemi, 2014) because its requires a reliable understanding of aquifer hydrogeological characteristics units . The Vertical Electrical Sounding (VES) has proven very current with hydrological studies because of the simplicity of the method (Ibrahim et al., 2012; Bayowa et. al., 2014). The productive exploitation of geological formations needs a correct concept of the hydrogeological features (Abiola et al., 2009). The Vertical Electrical Sounding (VES) technique was chosen as a result of field supplying are easy and also the analysis for knowledge is a smaller amount tedious and economical (Adepelumi et al., 2013; Oladunjoye et al 2017; Bayewu et al., 2017). VES has been used largely to find areas of high and reliable groundwater prospect within the crystalline and sedimentary rocks (Adagunodo et al. 2017;Adewoye et al. 2018; Joel et al. 2020). The groundwater potential of a basement complex area was determined by some factors such as overburden thickness, reflection coefficient; longitudinal electrical phenomenon were used for assessing the formation potential (Adabanija et. al., 2014; Bayewu et al., 2017). High overburden thickness and low reflection coefficient improve the productivity of boreholes in some parts of southwestern Nigeria basement complex (Olorunfemi and Olorunniwo 1985). In this study, the electrical phenomenon values and reflection constant is engaged in evaluating the groundwater prospect of the studied area . This can perform a baseline study for hydrological experts/engineers in the Federal Republic of Nigeria.The rise in population cum civilization in Iwo township has improved the demand for potable water usage.

Location and geology of the study area

Iwo is located between latitude 7^0 36' and 7^0 41'N and longitude 4^0 8' and 4^0 15'E , southwestern Nigeria (Fig. 1a).The drainage patterns of Iwo are well drained with rivers, the direction of the flow of the rivers is towards the Osun river with rugged topography. The drainage pattern is of Sub-dendritic type . Climate of the study area is tropical with two characteristic annual seasons dry and rainy season with the dry season spans from November to February while the wet season spans from March to October and peaks in June/July. The temperature displayed an growing trend throughout the year. .Vegetation is controlled by seasonal changes with a mixture of tropical rain forest and derived savannah. The dominant rocks in the study area are migmatite gneiss, biotite /biotite-muscovite granite and potassic syenite (Fig. 1b).

Method of study

A total of forty (40) VES points were totally probed and VES information acquired using the Schlumberger arrangement using ABEM resistivity meter (Figure 2). The resistivity of the subsurface sites were examined by applying electric current into the ground through two current electrodes and evaluating the resultant voltage variances amongst pair's potential electrodes. Measurements of current and potential difference were done repeatedly at these same points with a larger current electrode separation (AB/2) in each succeeding electrode probe to determine the depth to the basement rock. The values recorded were then plotted on a log–log paper as points with the resistivity values being on the vertical axis and the current electrode spacing (AB/2) on the horizontal axis with all points joined together. The Win Resist computer program was used for automatic iterative interpretation so as to reduce the geo-electrical sounding curves into values number of layers (N), thickness (h) and resistivity of individual layers. All the field VES curves were interpreted qualitatively and quantitatively using curve matching techniques. Parameters such as Isoresistivity, reflection coefficient ,overburden thickness and overburden protective capability were calculated and their maps were prepared also and used for assessing the aquifer prospects . The geoelectric parameters derived is based on apparent resistivity and thickness,

Longitudinal conductance (S) = $h/\rho a$………………………………………… **(1)**

Where S is the longitudinal conductance, h is thickness and ρa is apparent resistivity of the aquiferous layer and

Transverse resistance (T) = $h.\rho a$,, **(2)**

Where T is the transverse resistance, h is thickness and ρa is apparent resistivity of the aquiferous layer.The parameters T and S were named the "Dar – Zarrouk parameters "by Maillet (1947)

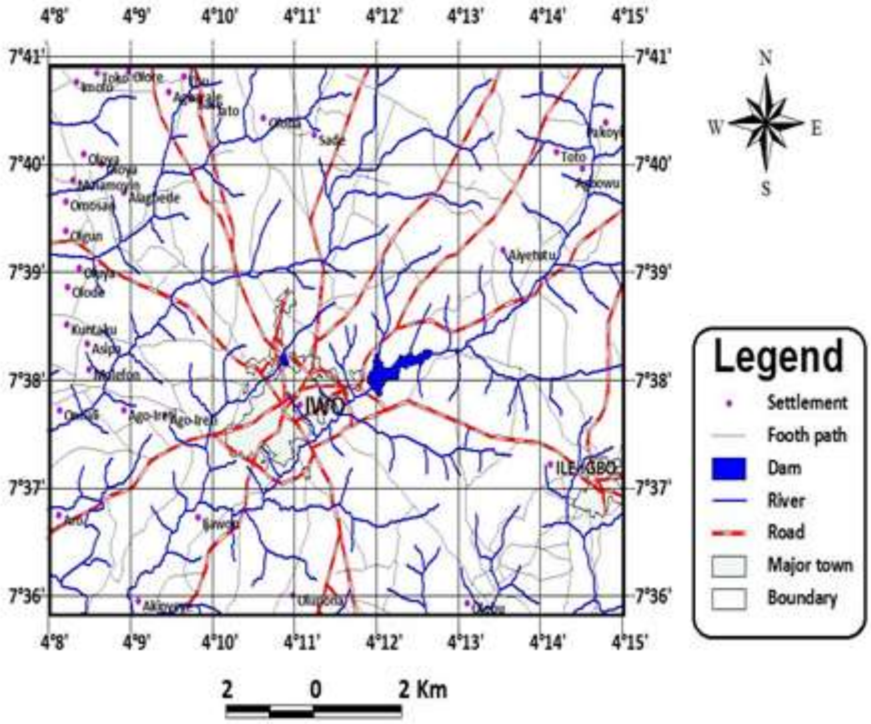


Figure 1: Location and Accessibility Map of Iwo Area

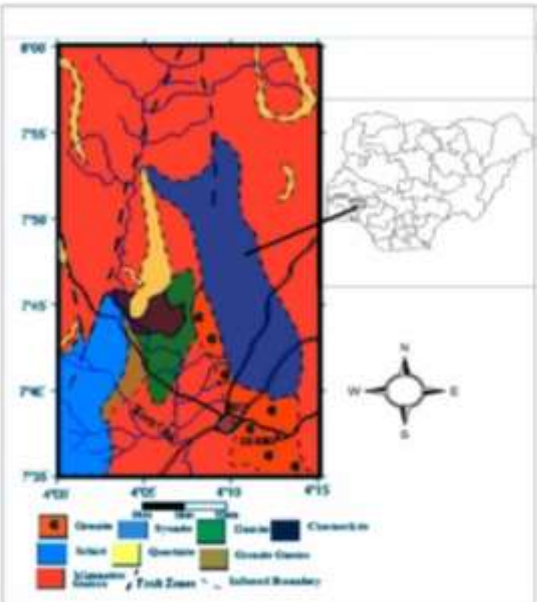
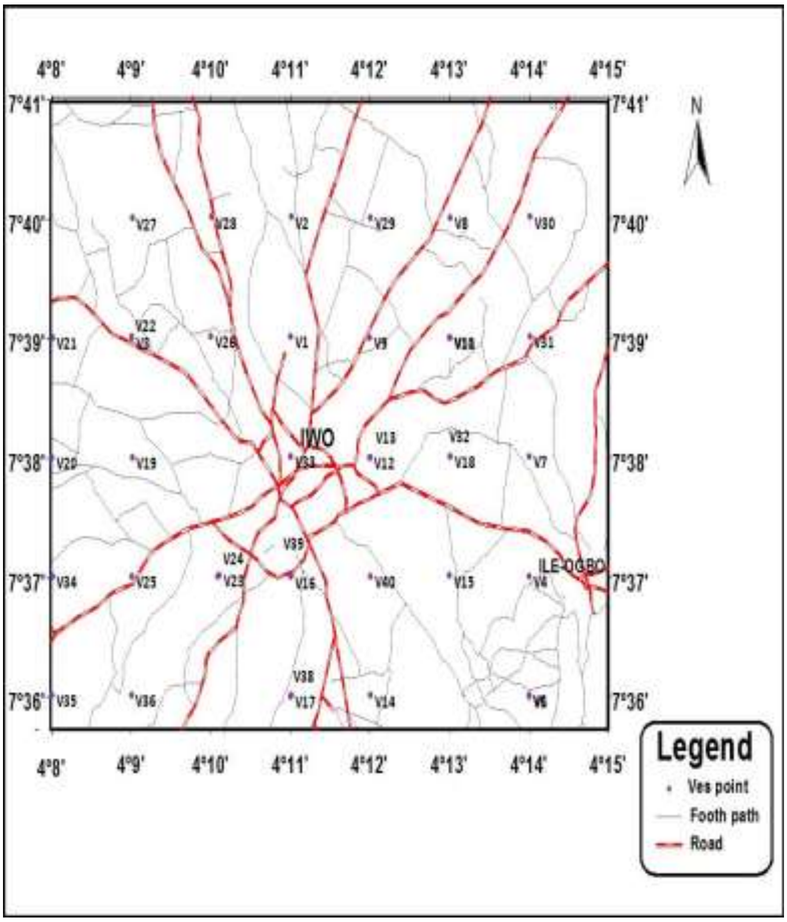


Fig. 1b : Geologic map of the study area and VES stations.



V 1	Agbowo Odori Rd., Iwo
V 2	Cashew plantation, Ejibo Rd
V 3	Kara, Old Oyo Rd, Iwo
V 4	Oke-Odo, Ile Ogbo
V 5	Alapo area, Ile Ogbo
V 6	Ajagbangba Rd.
V 7	Aba-Aje Ogun
V 8	Igege Village
V 9	Forest Hotel, Iwo
V 10	Powerline, Osogbo Rd
V 11	Aiyetutu Village
V 12	Water side, Iwo
V 13	Ile Ogbo Rd. Olupona
V 14	Oluponna Rd. Ileogbo
V 15	Ilu Okesaju, Iwo
V 16	Ponyan Olupona, Iwo
V 17	Araro, Olupona
V 18	Morinu, Iwo
V 19	Titilayo hotel, Osogbo Rd
V 20	Molefon, Iwo
V 21	Oluya, Oyo Rd Iwo
V 22	Alagbede Village
V 23	Mogbede Compound, Iwo
V 24	Igbo Ite, Iwo
V 25	Adeke area, Iwo
V 26	Agoro Rd, Iwo
V 27	Jato, Iwo
V 28	Oloba Village
V 29	Ogbaga, iwo
V 30	Pakoyi, Village
V 31	Telemu, Iwo-Osogbo
V 32	Ile Ogbo Rd. Olupona
V 33	Lawyer Atanda, Iwo
V 34	Technical College,Iwo
V 35	Aro Village
V 36	Ogo Oluwa Comm., Iwo
V 37	Iwo Muslim Comp. Sch.
V 38	Kobao Ope, Iwo
V 39	Olupona's Palace
V 40	Koba Ope phase 2, Iwo

Figure 2: Locational Map Showing VES Points

Result and discussion

This research observed that the most dominant curve type from the results is H-type curve (Figure 3) having about 47%. Almost 37.25% soundings are 4 layered, that is HA, HK, KH, and QH; 9.50% are 5-layered making up of HKH-type and 53.3% are 3-layered which are H and A -types (Table 1a and 1b).

Table 1a: Summary of Geoelectrical (VES) Results obtained from Study Area

	LOCATION NAME	EASTING	NORTHING	RHO 1	RHO 2	RHO 3	RHO 4	RHO 5	T 1	T2	T 3	T 4	CURVE TYPE
V 1	Agbowo Odori Rd., Iwo	4.1865666	7.662033	592.2	97.8	114.1	515.3		0.8	3.5	34.1		HA
V 2	Cashew plantation, Ejibo Rd	4.1924333	7.6776666	303.7	58.9	1087.6			1.1	8.5			HA
V 3	Kara, Old Oyo Rd, Iwo	4.1600666	7.6506333	749.9	39.8	638.8			1.3	15.1			H
V 4	Oke-Odo, Ile Ogbo	4.2357666	7.6269833	567.4	84.4	509.3			1.2	9.1			H
V 5	Alapo area, Ile Ogbo	4.2392666	7.6069333	562.4	208.7	122.6	2048.4		0.8	2.4	24.3		QH
V 6	Ajagbangba Rd.	4.23355	7.6116166	381.9	81.1	1979.4			1	5.2			H
V 7	Aba-Aje Ogun	4.2411333	7.6413166	77.5	72.7	97.3	55.5	252.7	1.3	2.4	6.2	15.6	HKH
V 8	Igege Village	4.22925	7.6722666	6327.4	8322.1	1255	3213.4		0.8	1.2	26.1		KH
V 9	Forest Hotel, Iwo	4.2016333	7.6570833	1653.6	280.9	1292.9			1.7	8.5			H
V 10	Powerline, Osogbo Rd	4.21795	7.6504166	511.9	426.1	47.7	134.5		1	2.8	17.9		QH
V 11	Aiyetutu Village	4.2308166	7.65715	270.9	172.4	52	1219.3		1.1	2	7.6		QH
V 12	Water side, Iwo	4.2009666	7.6344833	844.3	43.6	10347			1.3	7			H
V 13	Ile Ogbo Rd. Olupona	4.2101333	7.6046166	562.6	37.6	4991.5			1.3	12.9			H
V 14	Oluponna Rd. Ileogbo	4.22775	7.6073666	259.1	36	1145.9			0.9	5.3			H
V 15	Ilu Okesaju, Iwo	4.2207	7.62985	194.5	610.4	148.7	2762.2		0.9	2.5	32.9		KH
V 16	Ponyan Olupona, Iwo	4.1909	7.61765	414.6	7.9	1295.6			0.8	6.6			H
V 17	Araro, Olupona	4.1871333	7.6003166	139.8	38.2	2545.8			1	6.5			H
V 18	Morinu, Iwo	4.1763	7.6443666	34	62.8	721.6			2	13.7			A
V 19	Titilayo hotel, Osogbo Rd	4.1627333	7.6345333	226.9	23.1	345.9			0.7	9.6			H
V 20	Molefon, Iwo	4.1404333	7.6369666	875	56.5	1135.8			1.5	10.9			H
V 21	Oluya, Oyo Rd Iwo	4.1433167	7.6573666	733.3	54.8	1353			1.4	5.5			H
V 22	Alagbede Village	4.1529666	7.6645167	1326.3	2056.3	90.8	2452.9		0.7	1.6	12.7		KH
V 23	Mogbede Compound, Iwo	4.17765	7.6300833	81.1	25.3	181			1.3	16.4			H
V 24	Igbo Ite, Iwo	4.1686	7.6209	634.1	60	924.5			1.6	6.8			H
V 25	Adeke area, Iwo	4.1575666	7.6254666	446.9	950.1	145.9	959.8		1.3	3.2	35		KH
V 26	Agoro Rd, Iwo	4.1701333	7.6602	564.8	301.2	63.8	1142.3		0.8	3.1	10.7		QH
V 27	Jato, Iwo	4.16355	7.6814	235.7	79.8	272	131.7	741.9	0.5	1.5	7	21.7	HKH
V 28	Oloba Village	4.1795666	7.67865	2325.3	198.5	3698.1	1955.3		1.1	3.9	20.6		HK

V 29	Ogbaga, iwo	4.2106833	7.6760333	267	196.4	318.7	3562.7		0.9	5.9	21.5		HA
V 30	Pakoyi, Village	4.24975	7.6792333	162.5	104.7	19.9	403.3		1	1.5	10.9		QH
V 31	Telemu, Iwo-Osogbo	4.2433167	7.6621833	570.8	666.3	509.2	2513.8		1	2	3.3		KH
V 32	Ile Ogbo Rd. Olupona	4.2311	7.6454833	365.4	90.7	181.4	2544.5		0.9	4.7	18.4		HA
V 33	Lawyer Atanda, Iwo	4.1908333	7.6456833	196.1	80.8	226.2	5461.6		0.8	2.5	10.4		HA
V 34	Technical College,Iwo	4.1420833	7.6260167	730.5	97.5	864.7			1.2	15.2			H
V 35	Aro Village	4.1361333	7.6121333	1206	915.4	77.5	1770.3		0.9	1.4	8.6		QH
V 36	Ogo Oluwa Comm., Iwo	4.1530833	7.6114	225.5	34	5340.2			1	6			H
V 37	Iwo Muslim Comp. Sch.	4.1716167	7.6086167	273.7	407.6	8618.4			1.1	4.2			A
V 38	Kobao Ope, Iwo	4.1932167	7.6094833	1470.7	127.6	1402.1			0.9	13.6			H
V 39	Olupona's Palace	4.1944833	7.62775	380.2	43	780.5			1	9.6			H
V 40	Koba Ope phase 2, Iwo	4.2102167	7.6246833	742.1	84.1	896.2			0.7	9.2			H

Table 1b: Summary of the Calculated VES Parameters Results obtained for Groundwater Potential.

VES NO	Longitudinal Conductance	Transverse Resistance	Transverse Resistivity	Longitudinal Resistivity	Anisotropy Coefficient	Reflective Coefficient
V 1	0.335999	4706.87	122.5747	114.2861	1.035628	0
V 2	0.147934	834.72	86.95	64.89363	1.157534	-0.14526
V 3	0.381131	1575.85	96.08841	43.02988	1.494344	-0.38139
V 4	0.109935	1448.92	140.6718	93.69188	1.225329	-0.20046
V 5	0.211128	3929.98	142.9084	130.2529	1.047455	-0.98404
V 6	0.066737	803.62	129.6161	92.90218	1.181181	-0.16499
V 7	0.394588	1744.29	68.40353	64.62435	1.028824	0.5
V 8	0.021067	47803.94	1701.208	1333.812	1.129357	-0.99831
V 9	0.031288	5198.77	509.6833	326.0042	1.25037	-0.21979
V 10	0.383787	2558.81	117.9175	56.54181	1.444123	-0.95019
V 11	0.161815	1037.99	97.00841	66.12477	1.211219	-0.96402
V 12	0.16209	1402.79	169.0108	51.20606	1.816756	-0.53495
V 13	0.345396	1216.42	85.66338	41.11225	1.443484	-0.35142
V 14	0.150696	423.99	68.38548	41.14249	1.289249	-0.24873
V 15	0.229974	6593.28	181.6331	157.8441	1.072712	-0.9865
V 16	0.837373	383.82	51.86757	8.837165	2.422654	-0.70885
V 17	0.17731	388.1	51.74667	42.29876	1.106057	-0.10046
V 18	0.276976	928.36	59.13121	56.68353	1.021363	-0.02113
V 19	0.418669	380.59	36.95049	24.60175	1.225539	-0.20062
V 20	0.194635	1928.35	155.5121	63.70911	1.562361	-0.41877
V 21	0.102274	1328.02	192.4667	67.46573	1.689025	-0.4809
V 22	0.141174	5371.65	358.11	106.2521	1.83586	-0.96603
V 23	0.664251	520.35	29.39831	26.64656	1.050366	-0.0491
V 24	0.115857	1422.56	169.3524	72.50343	1.528327	-0.40044
V 25	0.246167	8727.79	220.9567	160.46	1.173465	-0.98548
V 26	0.17942	2068.22	141.6589	81.37323	1.319414	-0.96809
V 27	0.211422	4999.44	162.8482	145.2072	1.059004	-0.05727
V 28	0.025691	79512.84	3105.97	996.4641	1.7655	-0.51421
V 29	0.100873	8251.11	291.5587	280.5506	1.01943	-0.01924
V 30	0.568219	536.46	40.03433	23.58245	1.302932	-0.89529
V 31	0.011234	3583.76	568.8508	560.781	1.007169	-0.99641
V 32	0.155716	4092.91	170.5379	154.1272	1.051891	-0.05055
V 33	0.080997	2711.36	197.9095	169.1417	1.081703	-0.07838
V 34	0.15754	2358.6	143.8171	104.1004	1.175382	-0.1602
V 35	0.113243	3033.46	278.2991	96.25285	1.700392	-0.96528
V 36	0.180905	429.5	61.35714	38.6943	1.259242	-0.22651
V 37	0.014323	2012.99	379.8094	370.0286	1.01313	-0.01304
V 38	0.107195	3058.99	210.9648	135.2675	1.248844	-0.21863
V 39	0.225886	793	74.81132	46.92632	1.262628	-0.22906
V 40	0.110337	1293.19	130.6253	89.72524	1.20658	-0.18561

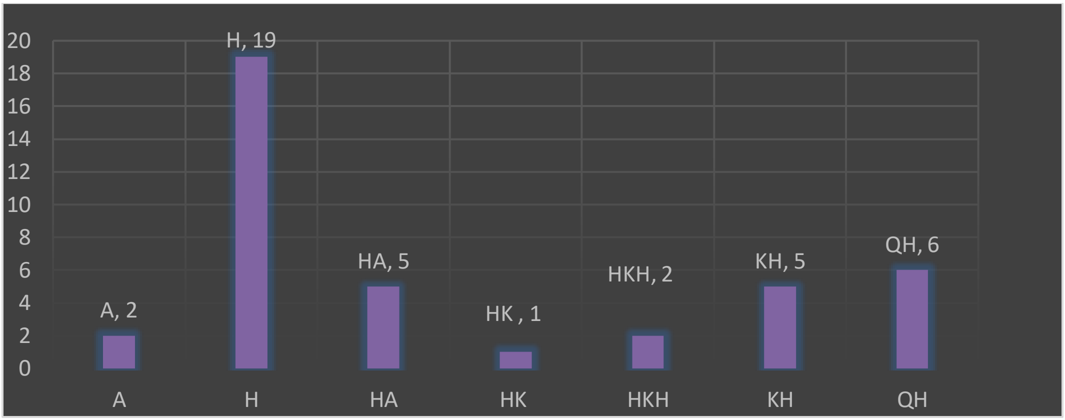


Figure 3: Observed Curve Types Frequency in the Study Area

Overburden thickness isopach

Overburden thickness is all formation/material overlaying the basement zone. The overburden thickness below sounding points was contoured at two metres interval (figure 4). This was achieved so as to permit a general view of the aquifer geometry. This is presumed to be topsoil, the lateritic soil and weathered bedrock. Their values range between 5.4 m - 38 m. Those studied points with thick overburden agrees with the basement depression and these are identified as high potential for groundwater predominantly in the basement terrain (Meju *et al*., 1999 ; Wright, 1990 and Olorunfemi & Okhue, 1992). The Northeastern (VES 1 and VES 27); Eastern (VES 15) and Western (VES 25) sections of the study area have thick overburden thickness indicating promising points for groundwater prospects while the Southern sections displayed thin overburden thickness.

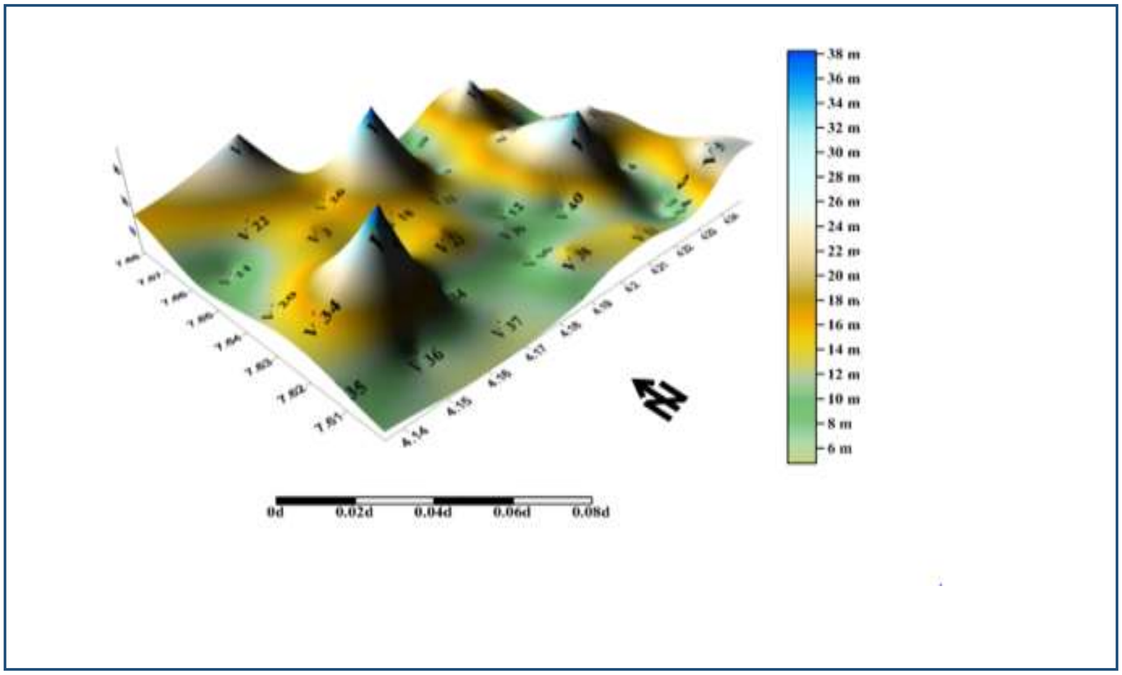


Figure 4: Overburden Isopach Map of Part of Iwo Township

Coefficient of anisotropy

The resultant overburden co-efficient of anisotropy plot (figure 5) shows value ranging between 0.5 - 2.4 (Table 1a and 1b). The northern and southern sections display co-efficient of anisotropy (λ) to be of elevated values. There are some peaks recorded very close to the South-central and western parts of the study area had high co-efficient of anisotropy. All the portions with peaks are described as likely prospect for groundwater . The mean co-efficient of anisotropy of the southwestern Nigeria igneous and metamorphic rocks ranged from 2.12 - 1.56, respectively (Olorunfemi *et al*., (1991) ; Olorunfemi & Olorunniwo, 1985) and groundwater prospect increase linearly with rise in λ

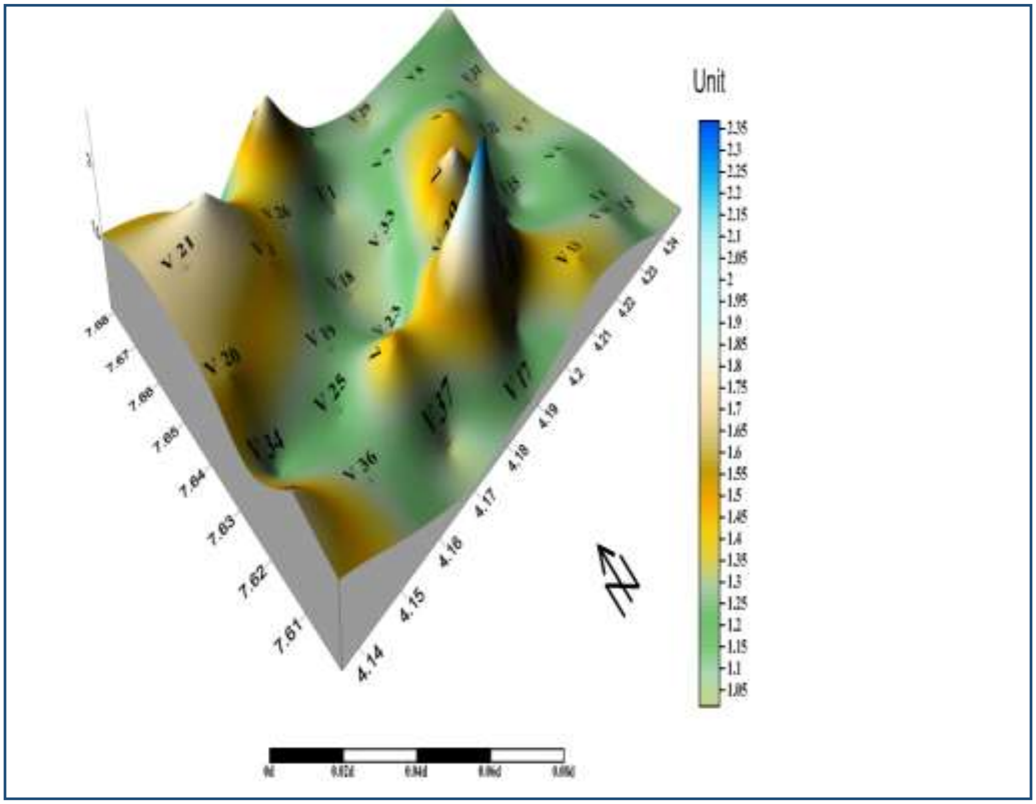


Figure 5: Coefficient of Anisotropy Map of Iwo

Weathered layer isothickness

This is defined as the materials that lies between the topsoil and the bedrock. The lithological materials cum thickness differs amongst 4m and 37.8m.The Isopach plot produced with a 2 m contour interval (figure 6) was made to observe the weather-beaten basement horizon reflected being the main component of the aquifer in the studied area varied from place to place.Weathered portions is perceived to be thickest mainly around the Northern sections followed by the Western sections, and also some part of the Eastern region an area where groundwater potential is most outstanding. The South part of the study space displayed thin weathered sections.

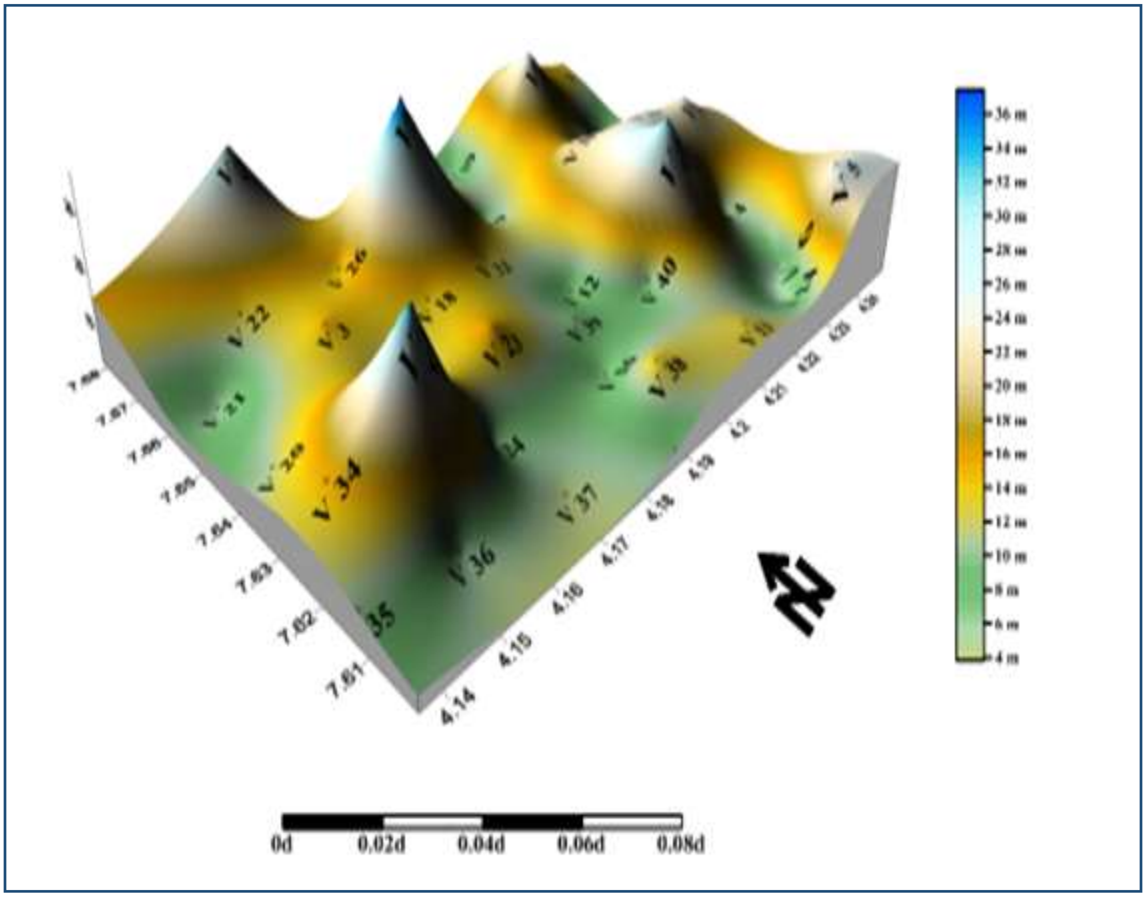


Figure 6: Weathered Layer Iso-thickness Map of Iwo

Bedrock lithology

The bedrock Lithology plot (Figure 7) expressed the contoured bedrock altitudes below the VES points. These were gotten from the difference between the overburden thicknesses and the surface elevations.The plot r6eveals bedrock through the subsurface topography of the bedrock thereby indicating best zones for groundwater prospects.The studied areas with basement trough are promising points for groundwater prospects (Okhue and Olorunfemi,1991).The studied plot shows a sequence of basement depressions and basement ridges. Eastern;Southern central; Northern, Westernpart (VES 40, 1, 25,34 and 22) are selected for depressions while South-central , North central and Northeastern part (. VES 2, 8, 4, 39 and 18) are elevations areas. Areas with troughs are described as thick overburden cover whereas basement elevation points are described as thin overburden cover. Omosuyi and Enikanselu (1999) agrees with the findings that the depressions areas in the basement complex serves as a promising points for the development of groundwater.

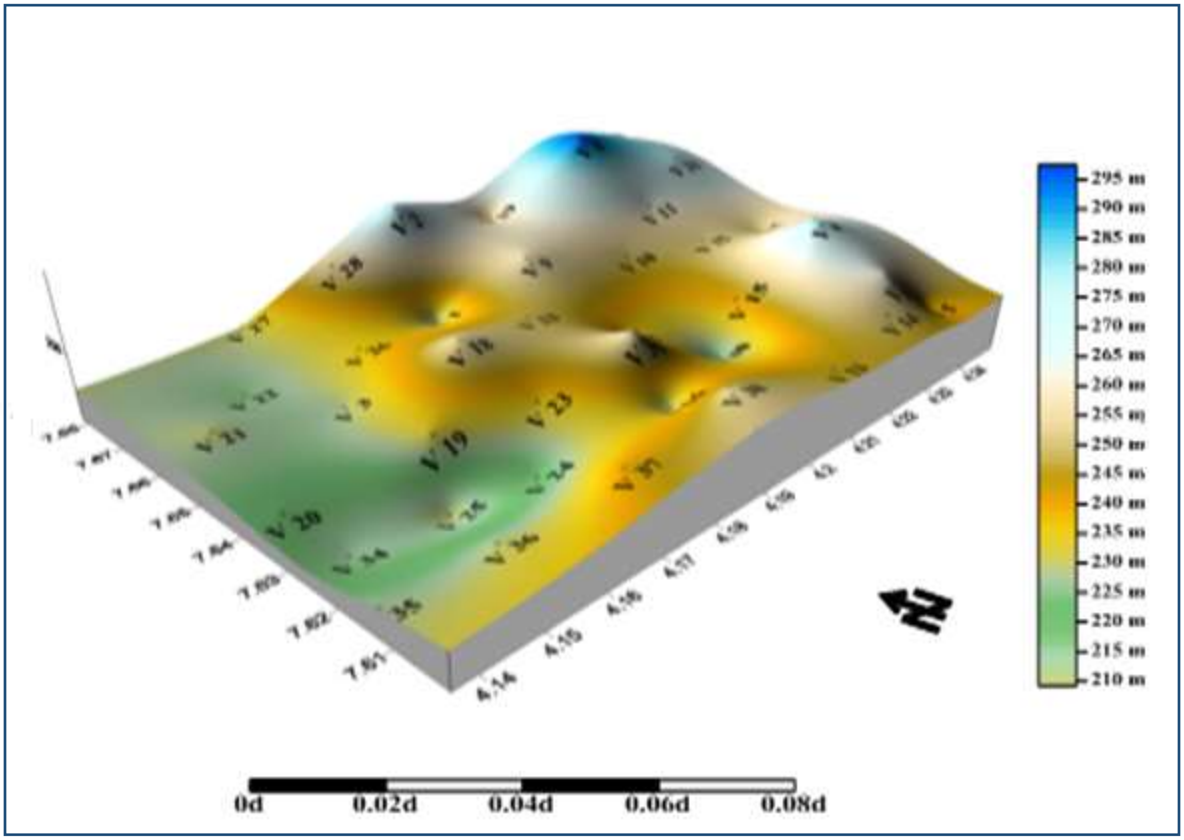


Figure 7: Bedrock Relief Map of Iwo

Overburden protective capability rating

The Dar-zarrouk parameters, Transverse resistance (T) and Longitudinal conductance(S), obtained from the geoelectric layer parameters (Table 1), were used to determine the overburden protective capacity.It is a natural act of retarding and filtering polluted underground fluid using longitudinal conductance deductions of the studied areas (Olorunfemi et al., 1999). The longitudinal conductance values range between 0.011 to 0.837 mhos and were adopted to generate the map (Figure 8 and Table 1b).In Table 2,the protective capability of the overburden was grouped into poor, weak ,moderate and high protecting capability Oladapo and Akintorinwa (2007).Wherever there is a conductance values larger than 0.7 mhos ; between 0.2 - 0.69 ; between 0.1 – 1.9 and smaller than 0.1 mhos, it is regarded as excellent; moderate; weak and poor protective capability zones respectively. The longitudinal conductance values satisfactorily agrees with this rating, 6 VES points have the poor protective capacity ; twelve VES points shows the weak protective capacity ; 20 VES points show moderate protective capacity rating and solely 2 VES points have the high protective capability. Portions of the studied areas liable to high rates of infiltration either from precipitation or surface contaminants; and leachates are regarded to be of poor and weak protective capacity zones. High protective capability zones agrees with the longitudinal conductance areas . High longitudinal conductance is characterised comparatively by the extremely soundproof clayey overburden, this proffers a protective cover to the underlying geological formation. The protective capability map offers visual facts of the vulnerable zones that facilitate to shield groundwater resources.

Table 2:Protective capacity rating (Oladapo and Akintorinwa, 2007)

Longitudinal Conductance (Ω-1)	Protective Capacity Rating
>10	Excellent
5 – 10	Very good
0.7 – 4.9	Good
0.2 – 0.69	Moderate
0.1 – 0.19	Weak
<0.1	Poor

Groundwater potential study

The study area was assessed for groundwater prospects .The results from VES interpretation was evaluated to produce coefficient of anisotropy, bedrock relief, overburden thickness, longitudinal conductance and weathered layer maps (Figure 8). The Southern finish of the study space with colour deep blue on the map represent the Poor groundwater prospects zones (VES 14) whereas the realm with colour lightweight blue represent the Low groundwater prospects zones (VES points 1, 6, 7,29, 33, 30, S 31, and 40), the realm with white colour represent the Medium groundwater prospects zones are (VES points 2, 3, 4, 8, 9, 10, 19, 21, 23, 24, 26, 28, 15, 32, 36, and 38), space with lightweight red colour represent High groundwater potential zone (VES 12, VES 13, VES 22, VES 20, VES 27, VES 34, VES 35 and VES 39) and conjointly the Southern a part of the study space with crimson colour represent the Very-high groundwater potential zone (i.e VES 16). The studied area observed as high groundwater potential (VES 12, VES 13, VES 22, VES 20, VES 27, VES 34, VES 35 and VES 39) displays thick overburden thickness as well as low reflection coefficient.Whereas the low groundwater potential (VES points 1, 6, 7,29, 33, 30, S 31, and 40) displays thin overburden thickness with high reflection coefficient.

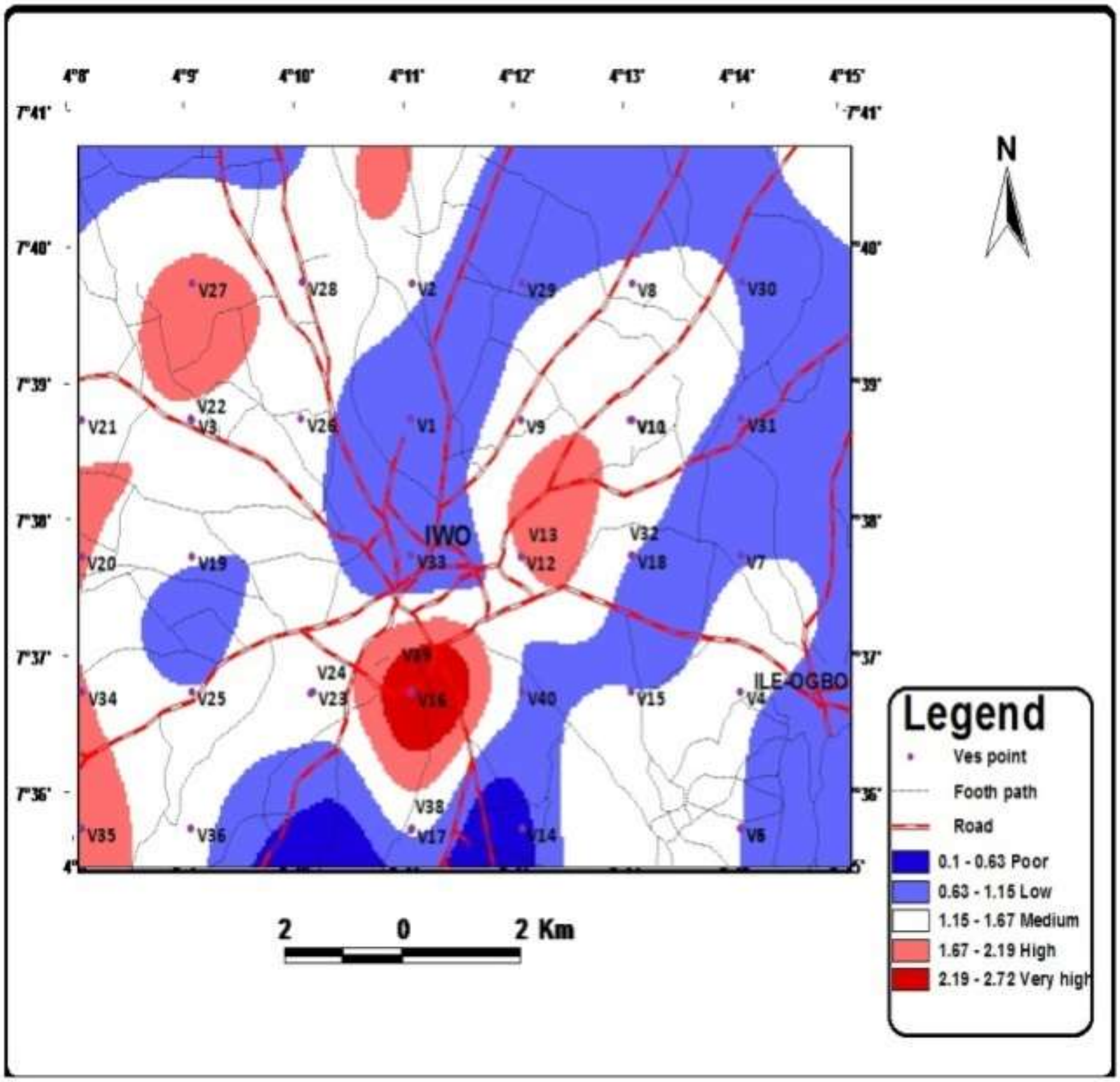


Figure 8: Groundwater Prospective Capability Plot of the Study Area.

Conclusion

Groundwater potential in the Iwo Township was examined to monitor and assess the groundwater resources. Sounding curves obtained differed from K , H and A-types to the advanced KH, QH , HA and HKH types. The geoelectric sections revealed 3–4 subsurface units consisting of topsoil, clayey sand ,fractured bedrock and fresh bedrock , The results from VES interpretation was evaluated to produce coefficient of anisotropy, bedrock relief

,overburden thickness ,longitudinal conductance and weathered layer maps. About 75% of the studied groundwater samples revealed low to medium potential zone , while 15% and 10% revealed high and very-high potential zones respectively. .Subsequently, the groundwater potential rating of the study area is viewed as normally low. A large portion of Northern and Eastern portions of studied areas which showed moderate to good protective capacity. This concur with a thick clayey sections which satisfactory guard the aquifer from contaminants

References

Abiola O, Enikanselu PA, Oladapo MI (2009). Groundwater potential and Aquifer protective capacity of overburdenunits in Ado – Ekiti, Southwestern Nigeria. Int.J. Phy. Sci.4(3): 120 – 132.

Adabanija M.A, A.O Afolabi and A.T Olatunbosun 2015 : Integrated approach to investigation of ooccurence and quality of ground water in Ogbomoso North, Southwestern Nigeria, Environmental Earth Science.73(1),139-162.

Adagunodo T.A., Adeniji A.A., Erinle A.V., Akinwumi S.A., Adewoyin O.O., Joel E.S., Kayode O.T. (2017). Geophysical Investigation into the Integrity of a Reclaimed Open Dumpsite for Civil Engineering Purpose. Interciencia Journal, 42(11): 324 – 339.

Adejumo R.O., Adagunodo T.A., Bility H., Lukman A.F., Isibor P.O. (2018). Physicochemical Constituents of Groundwater and its Quality in Crystalline Bedrock, Nigeria. International Journal of Civil Engineering and Technology, 9(8): 887 – 903.

Adepelumi, A. A., Akinmade, O. B., and Fayemi, O., (2013). Evaluation of groundwater potential of BakinOndo State Nigeria. *Universal Journal of Geosciences*. 1(2): 37- 45.

Adewoye, A. O, Olayinka, A.I and Abimbola, A. F. (2017). *Hydrogeochemical Geometry of Subsurface Layers in Odo-Oba Town, Southwestern Nigeria.International Journal of Engineering and Technology. IJET-IJENS 17(4):9-24.* *http://www.ijens.org*

Adewoye, A. O.A. A. Adegbola and P. I. Olasehinde (2018). Evaluating Aquifer Potential of Crystalline Basement Area of Southwestern Nigeria Using Hydrogeological and Geophysical Techniques. Adeleke University Journal of Engineering and Technology. [AUJET] Vol. 1, No1, 223-230 *aujet.adelekeuniversity.edu.ng*

BayewuO. O.,OloruntolaM. O., MosuroG. O., LaniyanT. A., Ariyo S.O. and Fatoba J.O.(2017): Geophysical evaluation of groundwater potential in part of the southwestern Basement Complex terrain of Nigeria.*Applied Water Science*volume 7, pages 4615–4632

Bayowa, O., Gabriel, Olorunfemi, O., Martins, Akinluyi O, Francis, Ademilua O, Lawrence, (2014). A further comprehensive approach to assessing the groundwater potential of the basement complex terrain of Ekiti State, Southwestern Nigeria *International*

Journal of Scientific and technology. 3: pp. 35-46

Ibrahim, K.O., Olasehinde, P. I, Akinrinmade, and Isa, A. (2012). Geoelectrical Soundings to Investigate Groundwater Potential of Orisunmibare Village in the Ilorin South Area of Kwara State, Nigeria. Pp. 21-25.

Joel E.S., Olasehinde P.I., Adagunodo T.A., Omeje M., Oha I., Akinyemi M.L., Olawole O.C. (2020). Geo-investigation on Groundwater Control in some parts of Ogun State using Data from Shuttle Radar Topography Mission and Vertical Electrical Soundings. Heliyon, 6(1): e03327. https://doi.org/10.1016/j.heliyon.2020.e03327.

Jones,M. J.,1985.The weathered zone aquifers of the basement complex areas of Africa. Q. J. Eng. Geol. 18,35–46.

Maillet R (1947). The fundamental equations of electrical prospecting". Geophysics. 12:529-556.World Gazette (2011). Colourful map of Nigeria with 36 states. www.world-gazette.com

Meju, M. A., Fontes, S. L., Oliveira, M. F. B., Lima, J. P. R., Ulugerger, E. U. and Carrasquilla, A. A. (1999): Regional aquifer mapping using combined VES-TEM-AMT? EMAP methods in the semi arid eastern margin of Parnaiba Basin, Brazil. *Geophysics*. 64(2), 337–356.

Okhue, E. T. and Olorunfemi, M. O. (1991): Electrical resistivity investigation of a typical Basement Complex area. The ObafemiAwolowo University campus case study. *J. Mining Geol., Vol*. 2, (27), 63–69.

Oladapo M. I. and Akintorinwa O. J. (2007). Hydrogeophysical Study of Ogbese Southwestern, Nigeria. *Global J. Pure and Applied Sci*. 13(1): 55-61

Oladunjoye, M.A., Salami, A.J., Aizebeokhai, A.P.,Sanuade O.A., and Kaka S.I. (2017): Preliminary geotechnical characterization of a site in southwest Nigeria using integrated electrical and seismic methods. J. GeolSoc India. 89: 209. https://doi.org/10.1007/s12594-017-0585-z

Olasehinde, P. I. and Bayewu,O.O.,2011.Evalution of Electrical resistivity anisotropy in geological mapping: a case study of Odo Ara, westcentral Nigeria. Afr. J. Environ. Sci. Technol. 5(7), 553–556.

Olayinka, A.I., Abimbola, A.F., Isibor, R.A., Rafiu, A.R., 1999. A geoelectrical-hydro-geochemical investigation of shallow groundwater occurrence in Ibadan, south-western Nigeria.Environ.Geol.37(1–2),31–39.

Olorunfemi, M. O. and Olorunniwo, M.A. (1985): Geoelectric parameters and aquifer characteristics of some partsof southwestern Nigeria. *GeologiaApplicata E, Idrogeologia*, XX, part 1, pp. 99–109.

Olorunfemi, M. O. and Okhue, E. T. (1992): Hydrogeologic and Geologic Significance of a Geoelectric Survey at Ile- Ife, Nigeria *Journal of Mining andGeology, Vol*. 28, (2), 221–229.

Olorunfemi, M. O., Ojo, J. O. and Akintunde, O. M. (1999): Hydrogeophysical evaluation of the groundwaterpotential of Akure metropolis, SouthwesternNigeria. *J. Mining Geol., Vol*.2 (35), 207–228.

Olorunfemi, M. O., Olanrewaju, V. O., and Alade, O. (1991): On the electricalanisotropy and groundwater yieldin a Basement Complex area of SouthWestern Nigeria. *Journal of AfricanEarth Sciences, Vol*. 12, No. 3, pp.467–472.

Oloruntola,M.O., Adeyemi,G.O.,2014. Geophysical and hydrochemical evaluation of groundwater potential and character of Abeokuta area, southwestern Nigeria. J. Geogr. Geol. 6(3), 162–177.

Omosuyi, G. O. and Enikanselu, P. A. (1999): Direct Current Resistivity Sounding for Groundwater Potential in Basement Complex of North-Central Nigeria. *J. Sci. Eng. Tech., Vol*. 1, (2), 331–334.

Wright, E. P. (1990): Basement aquifers in Africa. *Commonwealth Science TechnicalPaper, Vol*. 273, (2), 363–394.