GEO-ELECTRIC ASSESSMENT OF GROUNDWATER POTENTIAL OF THE BASEMENT COMPLEX WITHIN THE FEDERAL POLYTECHNIC EDE AND ENVIRONS, OSUN STATE, SOUTH-WEST, NIGERIA

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Abstract: An assessment of the groundwater potential of the basement complex within the Federal Polytechnic, Ede, south-west Nigeria, was conducted. Twenty-five points were systematically chosen within the North campus of the Federal Polytechnic and its environs, and assessed for aquifer's groundwater potentials, groundwater development, and reasons for the failure of some abandoned wells within the study area. The study was conducted using some geological investigations and electrical resistivity methods such as horizontal profiling and vertical electrical sounding using the Wenner array and Schlumberger configuration. Indications from the result show that the electrical resistivity values of the study area range from 40 to 85Ωm, 90 to 120 and 120 to 1,230Ωm. Further analysis of the result using specific interpretative models classified the study area into three potential groundwater zones, namely high groundwater potential terrain, low to medium groundwater potential terrain and poor to lean potential groundwater terrain. The investigation also revealed that the failure of the boreholes situated within the sports complex beside the rector's office and the one at the staff club were the result of sinking the boreholes in a poor to lean potential groundwater terrain. Similarly, boreholes sank within the high groundwater potential and sourced their water from the weathered and fractured zone, which formed the aquifer within the basement complex of the study area.

Keywords: aquifer, basement complex, potential, electrical resistivity, Schlumberger.

1. Introduction

The constant geometric increase in human population, scientific research and industrialization have directly influenced the global demand for water (Adeniran 2018, Akanbi 2019, Ibrahim et al. 2020) Mazhar, Hamid & Afzal 2019, Krachler et al. 2002,). The need for a good and abundant water supply for both humans' domestic, scientific research and industrial purposes cannot be overemphasized, and supplying such water has always been a matter of utmost interest to a hydrogeologist (Shankar, Aravindan & Rajendran 2006). Furthermore, the supply of good quality water in an institution where good water is needed for laboratory experiments and other purposes is essential. Basically, to be able to supply good water within the basement complex, there is a need for a detailed scientific groundwater exploration using the correct scientific tools and approaches to detect and examine hidden joints, faults and weathered zones in a rock that traps the quality and quantity of water needed by humanity. This research work was conducted at the Federal Polytechnic Ede campuses in Nigeria. The research work comprises an assessment of the groundwater potential of the basement rock complex underlying the campuses of the institution. The research was a sequel to the several failed and abandoned drilled well on the campuses of the institution in order to understand the nature of the aquifer system, the occurrence of groundwater in the area and the reasons for the failure of the abandoned wells on the campus. The study area (Ede, Osun state Nigeria) lies within the Precambrian crystalline rocks of South-west Nigerian (Adetunji & Alao-Daniel 2021). The geology of the area includes Pegmatite, Quartzite and Biotite Gneiss (fig. 2.0).

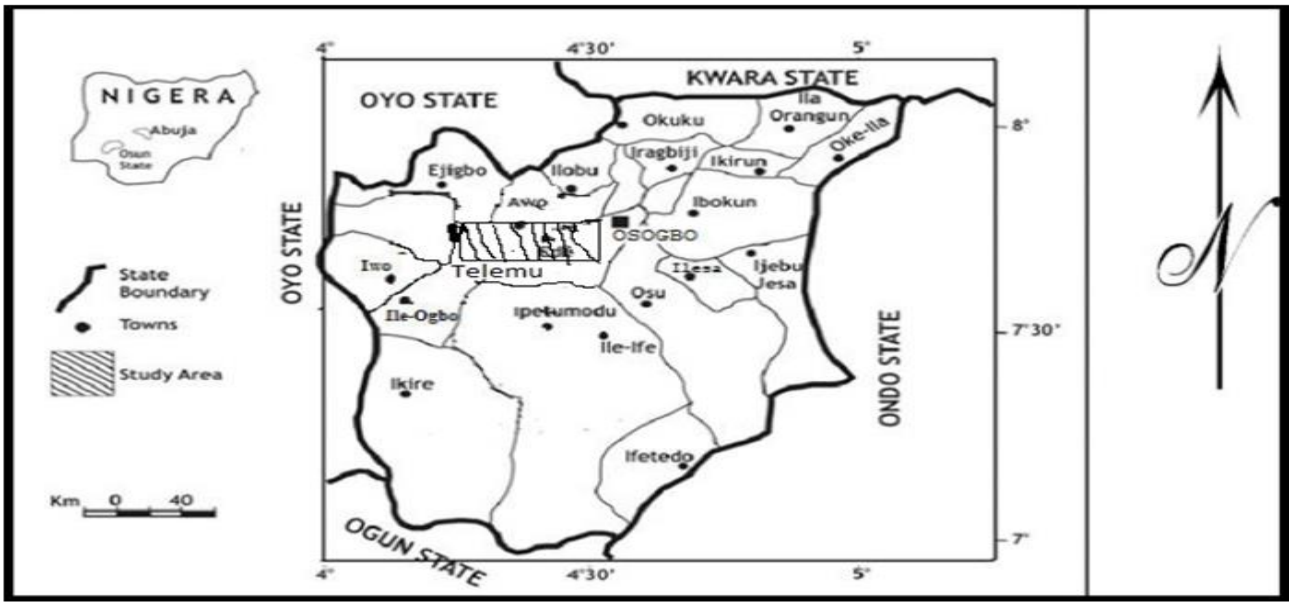


Fig. 1.0. Location map of the study area (after Salufu et al. 2019)

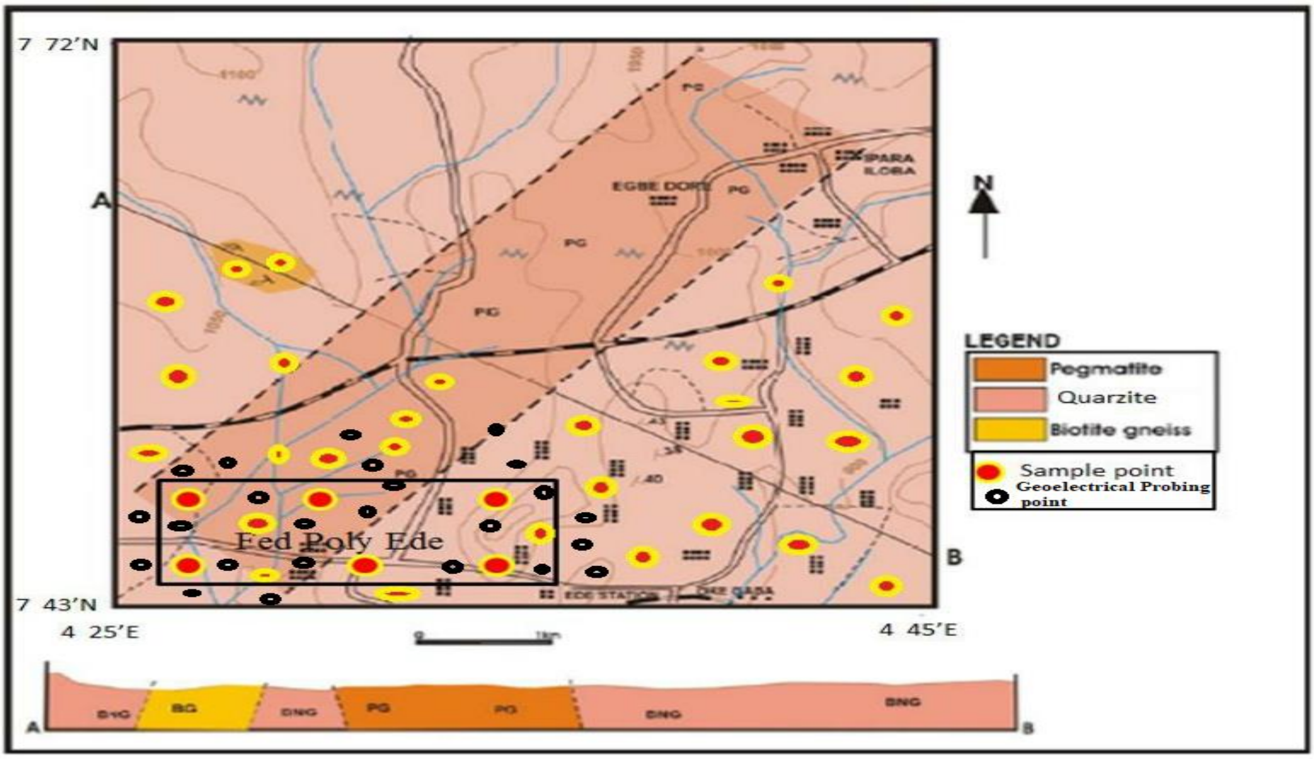


Fig. 2.0: Chart showing the Geology of the study area and probing points (Modified after Salufu et al. 2019)

Materials and Method

Twenty-five points within the study area were systematically selected and probed using lateral electrical profiling and vertical electrical sounding of the electrical resistivity method. Wenner array and Schlumberger configuration (fig. 3.0 and fig. 4.0) were adopted during data acquisition. ABEM SAS 1000 and Ground tester resist-meter were used during data acquisition. The procedure adopted for data acquisition is similar to that explained in detail by (Ammar

& Kruse 2016, Bahammou et al. 2019, Obiora, Ibuot & George 2016, Obiora et al. 2016). The lateral electrical profiling was first used to detect a viable point of groundwater location. The point was then probed further to locate the aquifer depth and thickness using vertical electrical sounding. The half-current electrode spacing and the apparent resistivity values measured on the field were plotted on a log-log paper. The plotted resistivity data were then curve-matched with the right master curve to model the accurate resistivity of the study area. The data were also analyzed using Res 3Div and IP2win to model the actual resistivity of the area.

Results and Discussion

The result of the vertical electrical sounding and interpreted resistivity data are presented in Table 1.0; fig. 5.0 to figure 8.0, respectively. Based on observations from the electrical resistivity data and layers Pseudo-section for resistivity in table 1.0 and figure 4.0 to 8.0, the 25 (twenty-five) points assessed for groundwater potential within the North campus can be grouped into three groundwater zones.

The high groundwater potential zone (figure 4.0 and fig. 5.0): Those points that fall within this zone have 3 to 5 resistivity layers, with the first layer's resistivity ranging from 137 to 260 Ωm. The second layer ranges from 48.8 to 162 Ωm with a thickness of 4.45-4.46 m. The third layer comprises 14.3 to 58 Ωm with 3.01-30.2 m layer thickness, suggestive of a good aquifer with high groundwater Potential typical of an H-curve type. The fort layers are made up of 608 to 16902 Ωm with a thickness of 12.7 m to infinity. The fifth layers have a resistivity range of 14.7 Ωm - infinity and 186 Ωm to infinity, respectively. The low to medium groundwater potential zone is made up of probed points with vadose water. The resistivity of the layers ranges from 142 Ωm for the first layer; to 40.1 and 1697 Ωm (fig. 7.0). The poor groundwater potential zone is made of points with no groundwater potential. This zone comprises the failed and abandoned wells (fig. 8.0). Their resistivity range from 142 to 1697 Ωm with thin thickness.

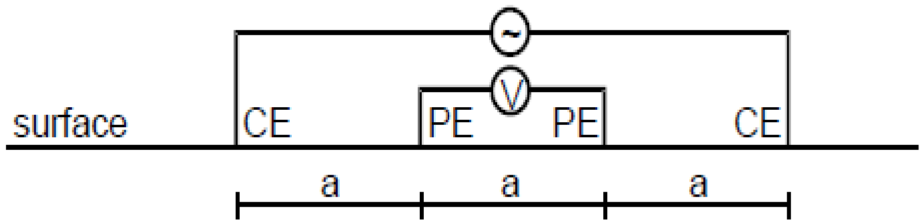


Fig. 3.0: Chart showing the Wenner array for lateral horizontal profiling

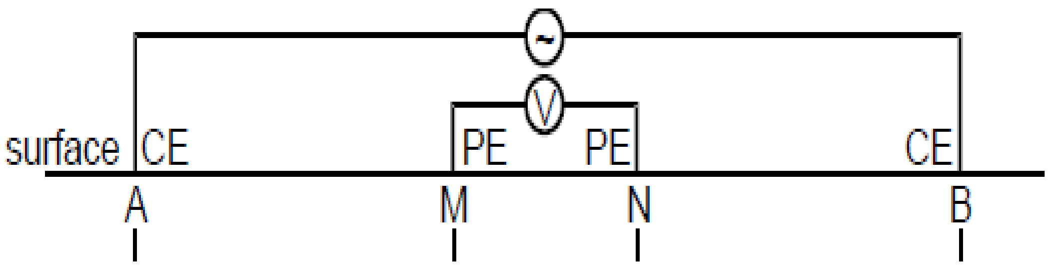


Fig. 4.0: chart showing Schlumberger array for vertical horizontal profiling

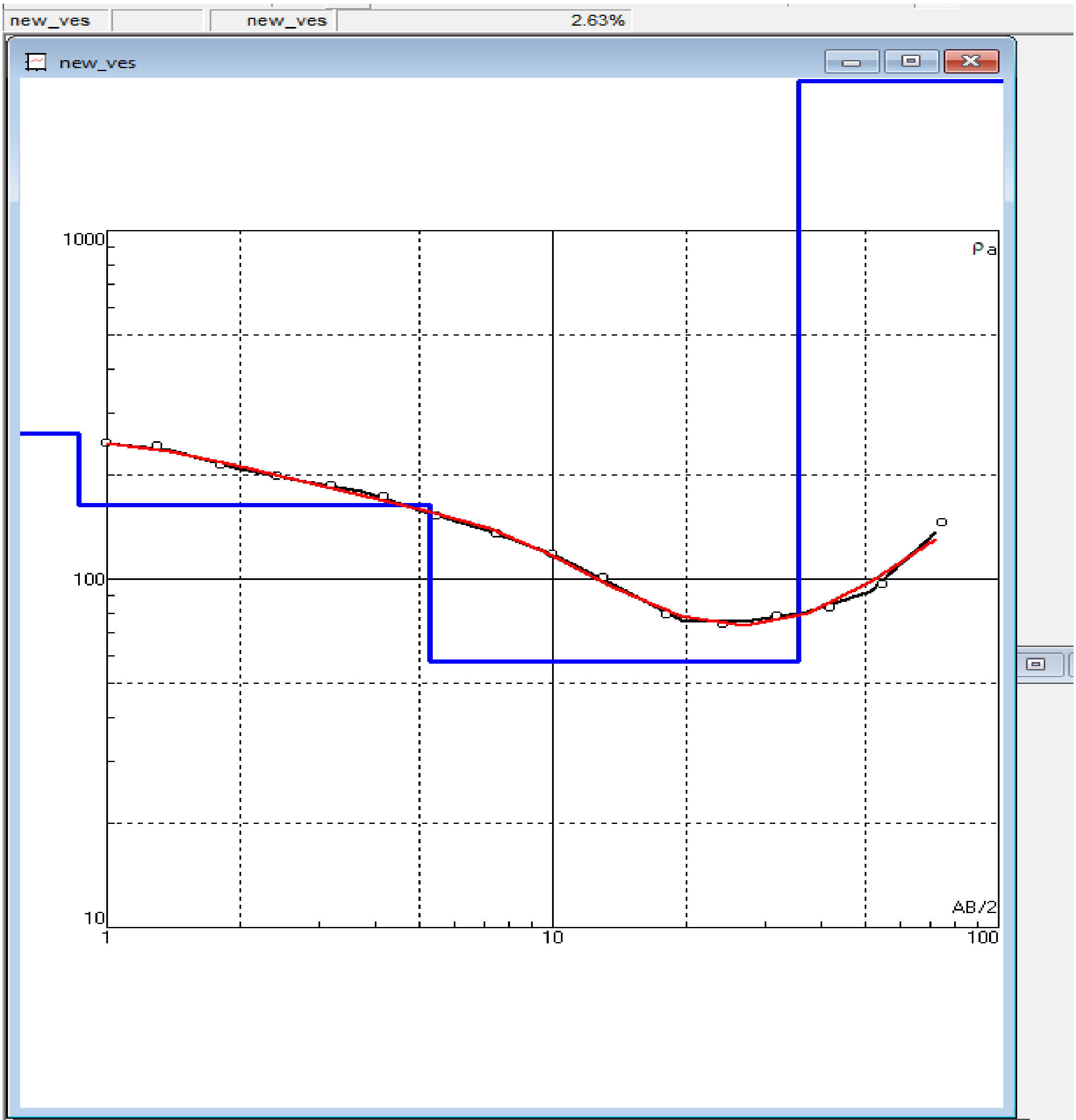
Table 1.0: Electrical resistivity data of the study area

S/N	Current Electrodes (AB/2)	Potential Electrodes (MN/2)	Geometry Factor (K)	Apparent Resistivity 1(kR1)	KR2 (Ωm)	Kr3
1	1.0	0.25	6.28	200	155	119
2	1.3	0.25	10.62	196	134	122

3	1.8	0.25	20.36	173	105	125
4	2.4	0.25	36.19	161	93.5	110
5	3.2	0.25	64.34	151	84	104
6	4.2	0.25	110.85	141	76.7	96.5
7	4.2	1.0	27.71	140	75.3	95.3
8	5.5	1.0	47.52	123	78.6	93.6
9	7.5	1.0	88.36	109	76.7	101
10	10	1.0	157.08	95.3	70.2	123
11	13	1.0	265.47	81.4	69.6	149
12	13	2.5	106.19	79.5	84.3	155
13	18	2.5	203.60	62.2	98.4	235
14	24	2.5	361.91	58.7	123	244
15	32	2.5	643.40	62	148	328
16	42	2.5	1108.35	65.3	201	442
17	55	2.5	1900.66	76.3	268	542
18	55	5	950.33	96.5	150.6	602
19	75	5	1767.16	145	130	702
20	100	5	3141.59		104	
21	133	5	5557.16		94.7	
22	133	10	2778.58		84	
23	180	10	5089.38		76.7	
24	240	10	9047.79		75.3	
25	320	10	16084.95		77.9	
26	420	10	27708.85		75.9	
27	550	10	47516.50			
28	550	20	23758.29			

Conclusion

An evaluation of the basement complex underlying the Federal Polytechnic Ede for groundwater potential was carried out using the electrical resistivity method with Wenner and Schlumberger arrays. Those points with resistivity values ranging from 40 to 85 Ωm and reasonable layer thickness indicate suitable aquifers with high groundwater potential. The aquifers with high groundwater potentials are zone of weathered rock and fractures within the basement complex. Those with a resistivity value range of 90 to 100 Ωm and thin to few-layer thickness indicate zones with low to medium groundwater potential. However, those with a resistivity value range above 100 Ωm indicate a zone with poor or lean groundwater potential. This explains why wells drilled in this zone end up as failed and abandoned wells.

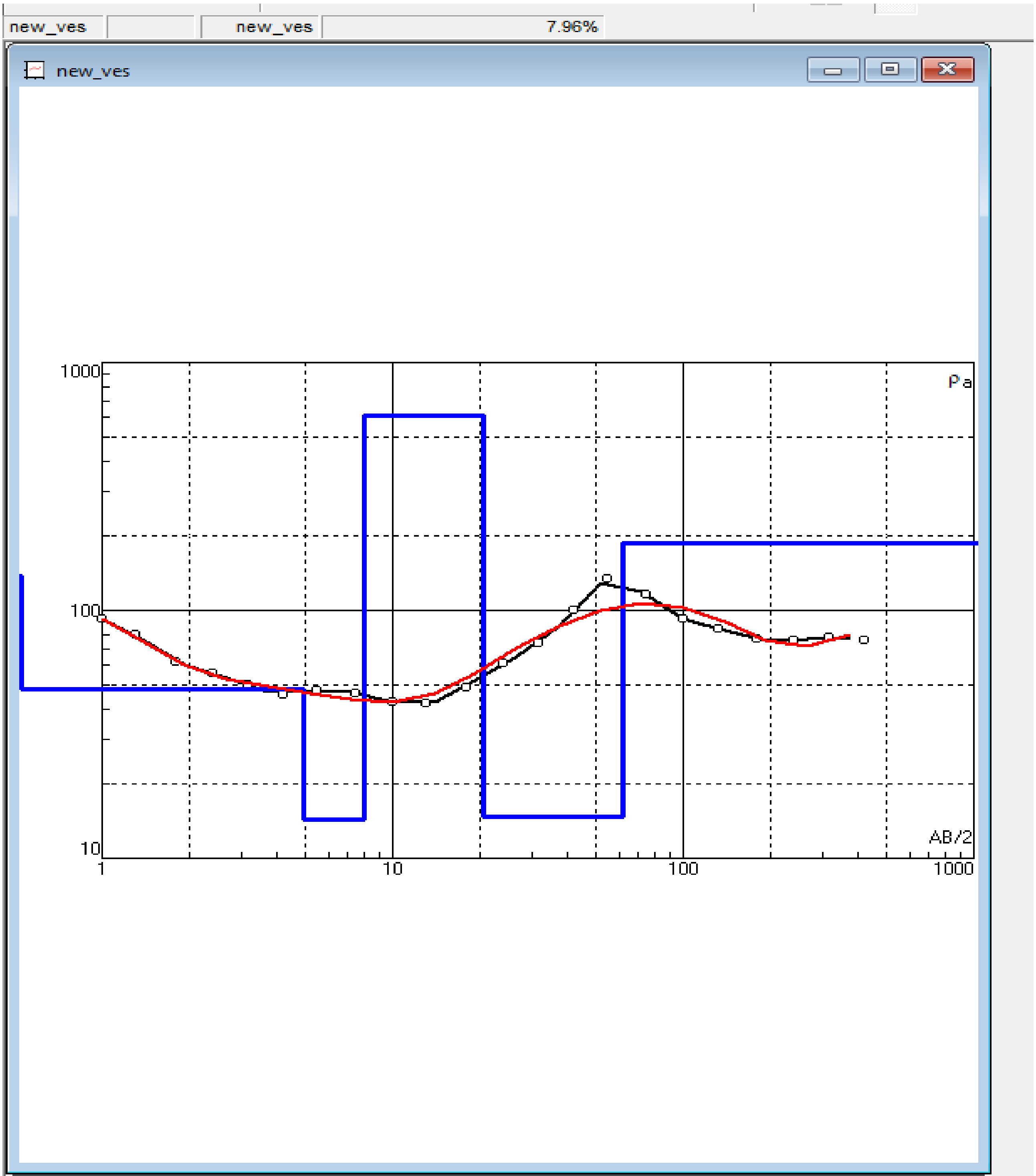


Error = 2.63%

N	1	2	3	4
ρ	260	162	58	16902
h	0.868	4.45	30.2	
d	0.868	5.31	35.5	
Alt	-0.8677	-5.315	-35.5	

Automatic minimization with number of layers selection

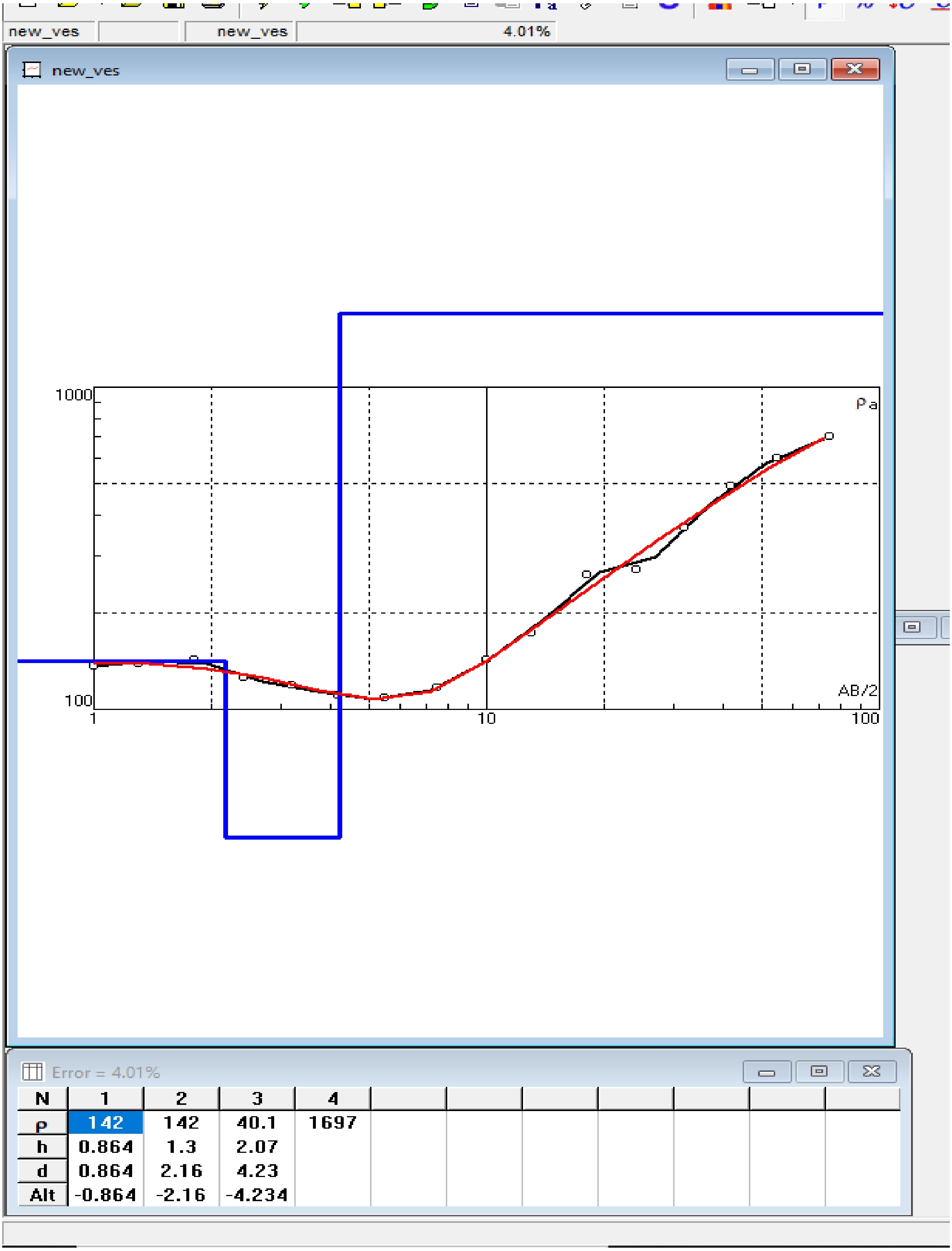
Fig. 5.0: Pseudo section of real resistivity for point A in high groundwater potential zone in the study area. (QHA-Type groundwater curve)



Error = 7.96%

N	1	2	3	4	5	6
ρ	137	48.4	14.3	608	14.7	186
h	0.475	4.46	3.01	12.7	41.6	
d	0.475	4.93	7.94	20.6	62.2	
Alt	-0.4752	-4.932	-7.94	-20.6	-62.23	

Fig. 6.0: Pseudo section of real resistivity for point B in high groundwater potential zone within the study area. (Model of QHK-Type groundwater curve)



N	1	2	3	4
ρ	142	142	40.1	1697
h	0.864	1.3	2.07	
d	0.864	2.16	4.23	
Alt	-0.864	-2.16	-4.234	

Fig. 7.0: Pseudo section of real resistivity for point C in low to mediun groundwater Potential zone in the study area (model of a QQA-type groundwater curve)

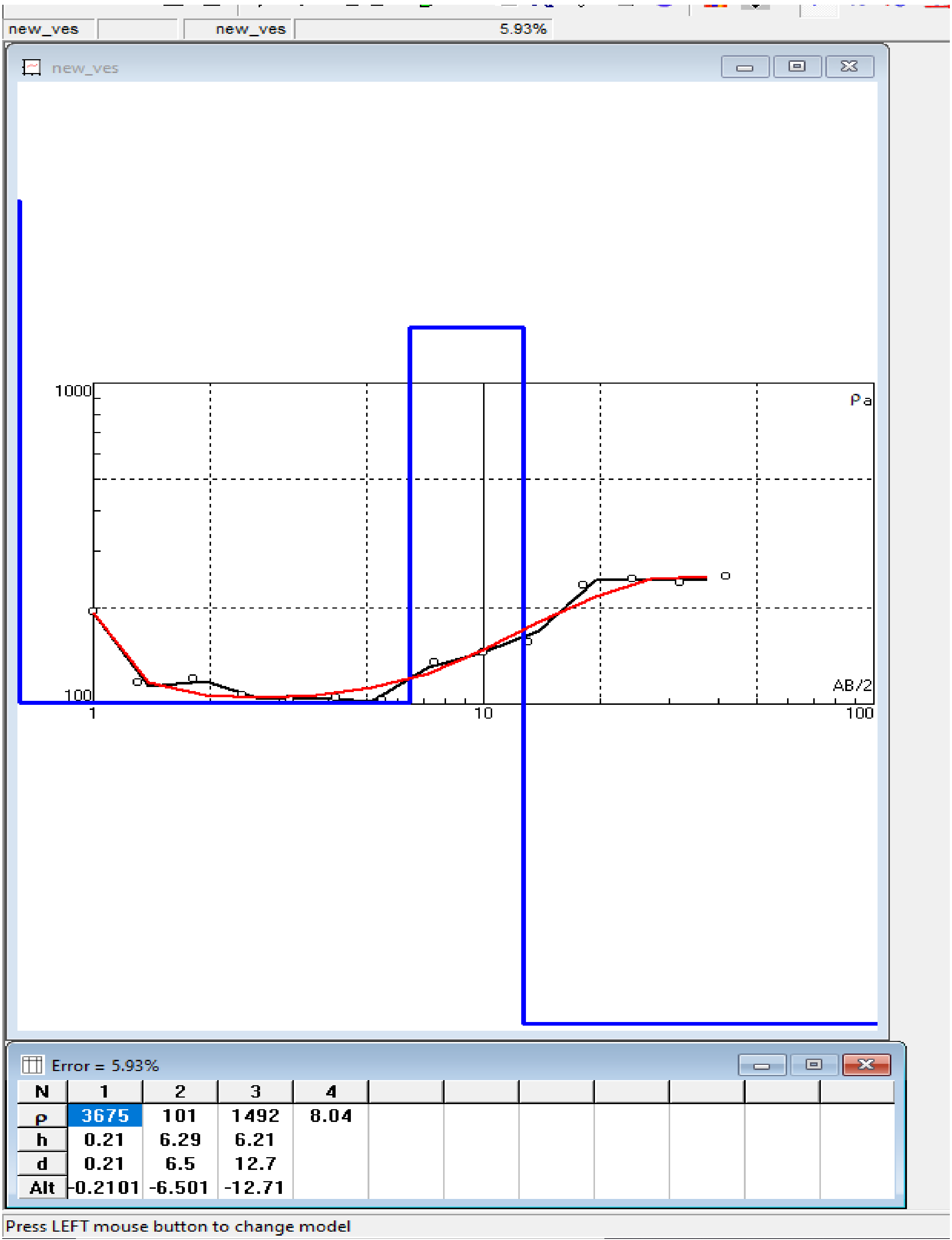


Fig. 8.0: Pseudo section of real resistivity for point D in a poor grounwater potential zone Within the study area

Reference

1. Adeniran, A. 2018. Assessment of Water Quality in Slum Area Ibadan.
2. Adetunji, A. & Alao-Daniel, A.B. 2021. Low temperature grain-scale retrograde alteration of detrital minerals in Ajali formation from Benin Flank Of Anambra Basin, Nigeria. *Ife Journal of Science* 22(3): 167–174.
3. Akanbi, O.A. 2019. Groundwater Recharge and Aquifer Transmissivity of Crystalline Basement Terrain. *Journal of Environment and Earth Science* null: null.
4. Ammar, A. & Kruse, S. 2016. Resistivity soundings and VLF profiles for siting groundwater wells in a fractured basement aquifer in the Arabian Shield, Saudi Arabia. *Journal of African Earth Sciences* 116: 56–67.
5. Bahammou, Y.A., Benamara, A., Ammar, A. & Dakir, I. 2019. Fracture zones detection for groundwater exploration integrating Resistivity Profiling and Very Low Frequency electromagnetic methods (Errachidia basin, Morocco). *Contributions to Geophysics and Geodesy* 49: 181–194.
6. Ibrahim, D., Ahmed, B., Habiba, A., Abdessalam, O. & Youssef, A.B. 2020. Hydrogeophysics Exploration Approximately Ain Al Atti (Region of Southeast Erfoud Morocco).
7. Krachler, M., Mohl, C., Emons, H. & Shotyk, W. 2002. Analytical procedures for the determination of selected trace elements in peat and plant samples by inductively coupled plasma mass spectrometry. *Spectrochimica Acta - Part B Atomic Spectroscopy* 57(8): 1277–1289.
8. Mazhar, I., Hamid, A. & Afzal, S. 2019. Groundwater quality assessment and human health risks in Gujranwala District, Pakistan. *Environmental Earth Sciences* 78: null.
9. Obiora, D.N., Alhassan, U., Ibuot, J.C. & Okeke, F. 2016. Geoelectric Evaluation of Aquifer Potential and Vulnerability of Northern Paiko, Niger State, Nigeria. *Water Environment Research* 88: null.
10. Obiora, D.N., Ibuot, J.C. & George, N.J. 2016. Evaluation of aquifer potential, geoelectric and hydraulic parameters in Ezza North, southeastern Nigeria, using geoelectric sounding. *International Journal of Environmental Science and Technology* 13: 435–444.
11. Salufu E. O., A., S.O., O., O.I. & Oji A. S. 2019. Assessment of Geochemical and Biological Composition of The Subsurface Water Within Federal Polytechnic Ede and Environs, Osun State, Southwest, Nigeria 6(10): 13.
12. Shankar, K., Aravindan, S. & Rajendran, S. 2006. Hydrochemical Profile for Assessing the Groundwater Quality of Paravanar River Sub-Basin, Cuddalore District, Tamil Nadu, India. *Current World Environment* 6: 45–52.