Table 1: Vertical electrical sounding data acquired around students' hostels

ELECTRODE CONFIGURATION		GEOELECTRIC FACTOR, K	TRAVERSES									
			VES 1 Lat. 05°34'05.1" N; Long. 005°50'30.6" E; Elevation 13m		VES 2 Lat. 05°34'07.7" N; Long. 005°50'35.7" E; Elevation 12m		VES 3 Lat. 05°34'04.3" N; Long. 005°50'38.2" E; Elevation 12m		VES 4 Lat. 05°34'09.1" N; Long. 005°50'38.6" E; Elevation 14m		VES 5 Lat. 05°34'22.2" N; Long. 005°50'35.2" E; Elevation 11m	
AB/2 (m)	MN/2 (m)		R (Ω)	ρ_a (Ωm)	R (Ω)	ρ_a (Ωm)	R (Ω)	ρ_a (Ωm)	R (Ω)	ρ_a (Ωm)	R (Ω)	ρ_a (Ωm)
2	0.5	11.78	68.09	802.1	46.87	552.129	109.6	1291.1	116.7	1374.7	90.62	1067.5
3	0.5	27.5	37.51	1031.53	24.64	677.6	60.24	1656.6	55.01	1512.8	52.2	1435.5
6	0.5	112.36	12.77	1434.84	6.758	759.329	18.7	2101.1	18.2	2045	17.09	1920.2
9	0.5	253.79	6.143	1559.03	2.72	690.309	8.327	2113.3	7.667	1945.8	8.358	2121.2
9	2	60.5	28.36	1715.78	13.47	814.935	35.3	2135.7	30.37	1837.4	31.07	1879.7
15	2	173.64	11.67	2026.38	4.854	842.849	8.987	1560.5	8.966	1556.9	7.231	1255.6
25	2	487.93	3.980	1941.96	2.102	1025.63	2.741	1337.4	2.538	1238.4	2.264	1104.7
40	2	1250	1.350	1687.5	0.8845	1105.63	0.9362	1170.3	0.8256	1032	0.8083	1010.4
50	2	1961.14	0.787	1543.42	0.53	1039.4	0.53	1039.4	0.4884	957.82	0.505	990.38
75	2	4416.5	0.251	1108.54	0.1878	829.419	0.1787	789.23	0.1604	708.41	0.1878	829.42
75	10	868.21	1.167	1013.2	1.117	969.791	0.9616	834.87	0.7839	680.59	0.9068	787.29
100	10	1555.71	0.451	701.625	0.4285	666.622	0.4315	671.29	0.3401	529.1	0.3747	582.92
150	10	3520	0.2152	757.504	0.07462	262.662	0.1096	385.79	0.07941	279.52	0.07599	267.50

Table 2 is a summary of the interpretation of the results of the Vertical Electrical Sounding in the study area. The results show that the area is characterized by four geoelectric subsurface layers. Figure 8 shows the lithologic cross-section for the study area as deduced from the inferred lithology in Table 2.

Table 2: VES data interpretation results in the study area

Sounding Locations	Geoelectric Layers	Resistivity, ρ(Ωm)	Thickness, *h*(m)	Depth, D(m)	Inferred Lithology	Curve Type
VES 1	I	668.5	1.5	1.5	Clayey Topsoil	AQ
	II	2601.9	17.7	19.3	Coarse-grained sand	
	III	634.4	27.2	46.4	Clayey sand	
	IV	647.3	-	-	Clayey sand	
VES 2	I	573.1	3.1	3.1	Clayey Topsoil	KQ
	II	1155.3	20.4	23.4	Medium-grained sand	
	III	1631.2	19.1	42.6	Coarse-grained sand	
	IV	74.1	-	-	Wet clay	
VES 3	I	1065.6	1.0	1.0	Silty Topsoil	KQ
	II	2520.2	5.2	6.2	Coarse-grained sand	
	III	1102.7	43.5	49.8	Medium-grained sand	
	IV	221.9	-	-	Clay	
VES 4	I	1231.0	1.3	1.3	Silty Topsoil	KQ
	II	2362.5	4.7	6.0	Coarse-grained sand	
	III	1106.2	34.1	40.1	Medium-grained sand	
	IV	209.9	-	-	Clay	
VES 5	I	760.7	0.9	0.9	Clayey Topsoil	KQ
	II	3026.1	2.8	3.7	Coarse-grained sand	
	III	1046.9	48.0	51.7	Medium-grained sand	
	IV	100.7	-	-	Clay	

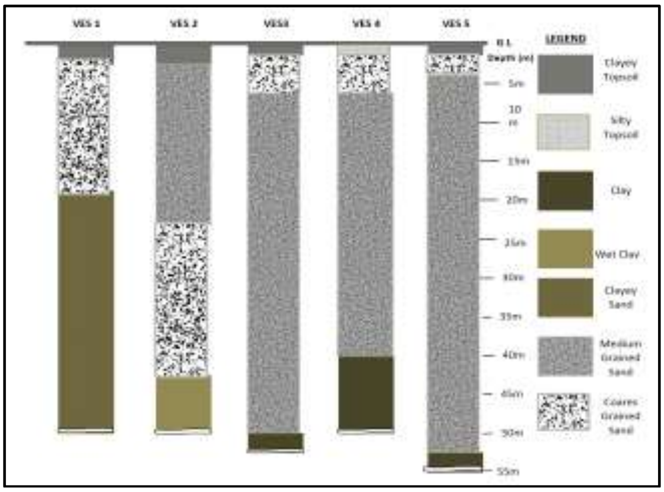

Figure 8: Lithologic cross section for the area

5.2 Discussion

VES 1: Four geoelectric layers of AQ curve type are delineated at this location. Inferred lithologies are characterized by a 1.5m thick topsoil that is composed of clayey sand with resistivity of 668.5 Ωm to a depth of 1.5m. Below this formation is a 17.7m thick coarse-grained sand to a depth of 19.3m. This is a *shallow aquifer zone* with resistivity value of 2601.9Ωm. This is followed by two layers of clayey sand formations with resistivity values of 634.4Ωm and 647.3 Ωm respectively with undetermined thicknesses and depths since they make up the last layers.

VES 2: Four geoelectric layers of KQ curve type are delineated at this location. The 3.1m thick topmost sediment to a depth of 3.1m is characterized by clayey topsoil materials with resistivity of 573.1 Ωm. Underlying this layer are a 20.4m thick medium-grained sand to a depth of 23.4m with resistivity of 1155.3 Ωm and a 19.1m thick coarse-grained sand to a depth of 42.6m with resistivity of 1631.2Ωm. The third layer constitutes the *deep aquifer zone*. Below this zone is a layer of wet clay with resistivity of 74.1Ωm and undetermined thickness and depth.

VES 3: Four geoelectric layers of KQ curve type are delineated at this location. Soil layers here are characterized by a porous and permeable 1.0m thick silty topsoil with resistivity of 1065.6 Ωm and depth of 1.0m.

Below this layer is a 4.7m thick coarse-grained sand to a depth of 6.0m. This is a *shallow aquifer zone* with resistivity value of 2520.2Ωm. However, this is followed by a 43.5m thick aquiferous medium-grained sand formation with resistivity values of 1102.7Ωm to a depth of 49.8m. Below this zone is a layer of clay with resistivity of 221.9Ωm and undetermined thickness and depth.

VES 4: Four geoelectric layers of KQ curve type are delineated at this location. Similar to VES 3, lithologies here are also characterized by a porous and permeable 1.3m thick silty topsoil with resistivity of 1231.0 Ωm to a depth of 1.3m. Underlying this layer is a 5.2m thick coarse-grained sand to a depth of 6.2m. This is a *shallow aquifer zone* with resistivity value of 2362.5Ωm. However, this is followed by a 34.1m thick aquiferous medium-grained sand formation with resistivity value of 1106.2Ωm to a depth of 40.1m. Beneath this zone is a layer of clay with resistivity of 209.9Ωm and undetermined thickness and depth.

VES 5: Four geoelectric layers of KQ curve type are delineated at this location. The 0.9m thick uppermost layer to a depth of 0.9m is characterized by clayey topsoil materials with resistivity of 760.7Ωm. Underlying this layer are a 2.8m thick coarse-grained sand to a depth of 3.7m with resistivity of 3026.1Ωm and a 48.0m thick medium-grained sand to a depth of 51.7m with resistivity of 1046.9Ωm. The second layer constitutes the *shallow aquifer zone*. Below the third layer is a layer of clay with resistivity of 100.7Ωm and undetermined thickness and depth.

6. CONCLUSION

The study reveals that the aquifer characteristics (depth, thickness, resistivity and lithology) vary laterally and vertically from one VES location to another around the students' hostels in FUPRE. This may be due to the difference in mineralogical compositions of the rock types that make up the soil. This non-uniformity in aquifer characteristics implies that prolific groundwater will not occur under the same conditions in different parts of FUPRE hence, the need for this study. The low resistivity values obtained are observed to be prevalent in zones with high clay rock-forming minerals which bound the aquifer top and bottom while the high resistivities are observed to be dominant in zones with medium-grained and especially coarse-grained sands which constitute the potential aquifer materials.

Two potential groundwater aquifer zones are delineated in the study area. The *unconfined shallow aquifer* ***zones*** found at VES 1, 3, 4 and 5 locations have shallow overburden depth ranging between 3.7-19.3m and coarse-grained sand columns with thicknesses ranging between 2.8-17.7m and the *confined deep aquifer zone* found at VES 2 location coinciding with deep overburden layer at a depth of 42.6m and coarse-grained sand column with appreciable thickness of 19.1m.

7. RECOMMENDATION

Sequel to the findings of this study, it is recommended that boreholes for sustainable groundwater supply around the Students' Hostels should be drilled and screened at a depth ≥40.0m at VES 2 location. However, aquifers at VES 1, 3, 4 and 5 have potentials for groundwater but are vulnerable to contamination since they are unconfined. Unconfined aquifer zones have higher tendency of allowing the permeation of contaminant fluids into the groundwater such that in any event of contamination such water becomes unsafe for both domestic and industrial uses.

It is also recommended that electrical resistivity and hydrogeological surveys should be conducted at different locations in FUPRE to delineate the appropriate deep aquifer zones before any borehole(s) are drilled for potable groundwater supply to avoid possible contamination.

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