

EXPLORATION FOR GROUNDWATER WITHIN THE LAW FACULTY OF IBBU LAPAI, NIGERIA

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ABSTRACT

This study was conducted to evaluate the structural competence of the subsurface geological materials on which the building of the Faculty of Law, IBBUL Niger State, Nigeria was erected. It as well geophysically characterized the site quality, suitability and possible viable groundwater resources location. Five Vertical Electrical Soundings (VES) points were investigated in the study area employing ABEM Terrameter SAS 300C with Schlumberger electrode configuration of maximum electrode separation AB/2 = 60 m. The field resistivity data were modeled and interpreted using IPI2WIN computer software. The results were presented in the form of pseudo cross section, geo-electric sections along three cross sections, and log table. The interpreted results showed that the geo-electric sections consist of mainly three layers, which are: Top soil, Aquifer layer, weathered basement layer. The resistivity value and subsurface layer thickness for the top soil varied from 0.09 to 24.60 Ω m and 5.05 to 32.70 m respectively. The aquifer layer had resistivity values ranging from 128 to 264 Ω m and thickness between 14.50 and 15.80. The weathered layer resistivity varied from 37.70 to 449 Ωm with thickness of 13.40 m to 67.60 m. Geo-electric sections along VES point 1 revealed the weakest geologic materials with highest moisture content materials and at very shallowest depth, thus not suitable for locating any civil engineering infrastructure. VES points 3 and 4 are the delineated areas suitable for building development, thereby ascertaining the suitability and quality of the location for the faculty building already on scene. Viable Borehole drill point was delineated at a point midway between VES points 4 and 5. Adoption of Geophysical site characterization as top pre-building development expert standards with strong legislative backings in order to establish; the topography elevation, clay & moisture contents, and the depth to the weak zones before embarking on any building construction was recommended.

Keywords: Clay and Moisture content; Weakest geological materials; Geo-electric sections; Expert standards; Pre-building development.



Geophysically investigating a Building Construction site prior to the commencement of the construction project is an important stage in building and locating any civil engineering infrastructure. Several geophysical approaches have been used for the success of foundation investigations; Geophysical methods, particularly the electrical resistivity technique, had been extensively used for a wide variety of engineering and environmental problems (Falae, 2014). Non availability of geophysical data characterizing the building site may likely constitute challenges to the faculty in near future necessitating the need to geophysically investigate the site in order to ascertain the durability and safety precautions of the already constructed building structures within the faculty. Construction of buildings for students' accommodation need cautious approach to avoid the incidence of building failures and collapses that constitute major issues of concern, affecting urban development in Nigeria and the world at large today.

Documented research carried out within Institute of Agriculture Research and Training Moor Plantation Ibadan, Southwestern Nigeria, by Babatunde et al. (2021) with the aim of ascertaining the suitability of the proposed site for building construction and usage showed that the applied technique of Electrical Resistivity was competent. In addition, it further justified the need for geophysical site investigation as pre-condition before any civil construction to avoid problems of differential settlement or building collapses. Consequently, when determining foundation parameters, topography elevation, clay & moisture contents, and the depth to weak zones should be put into top considerations.

This study is intended to serve as post-construction and general site characterization/site condition evaluations at Faculty of Medical Sciences, IBBU Lapai, Nigeria. This is to aid the geotechnical Engineers. A building constructed at a site without properly considering the underground strata or its load-bearing capacity may settle excessively or differentially, causing development of cracks in building which may ultimately lead to its failure and



collapse. Subsurface geological features such as fractures, voids and nearness of water table to the surface are among the inconveniences that pose considerable constraints to building constructions especially to their foundation (Andrews et al., 2014). Geophysical methods, particularly geo-electrical resistivity techniques, have been extensively used for a wide variety of engineering and environmental problems (Olufemi et al., 2017 and Talabi and Ogundana, 2015). The use of electrical resistivity technique has been the most convenient tool for the geophysicists because of the wide range of natural resistivity values exhibited by the geologic features. The use of electrical resistivity survey thus become the optimum choice, as a result of its economic conveniences; time saving, non-invasiveness and easy to carry out (Andrews, et al., 2014). In addition to the engineering applications, the method can also be of great importance in the site groundwater resources investigation (Dogara et al., 2016).

In this study also, the non-invasive geophysical technique involving Vertical Electrical Sounding using Schlumberger array was adopted to investigate the subsurface conditions with the aim of determining the competency of the location upon which the Faculty Building structure was laid.

SITE LOCATION AND GEOLOGY

The Building Site for the Faculty of Law IBBU Lapai, Niger State lies between Latitude coordinates 9° 02' 60.00" and 9° 03' 60.03" N; and longitude 6° 33' 59.99" and 6° 34' 12" E falls within the Bida basin Complex of Nigeria (Fig. 1). The surface terrain is fairly uniform permitting easy stretch of the Schlumberger array. The study location point is indicated by the circled pointed by arrow on the Map (Figures 1 a and b).





Figure 1(a): Map of Ibrahim Badamasi Babangida University main campus showing the study area



Figure 1 (b): Google Map of IBBUL main campus showing the study area



Lapai Journal of Science and Technology, Vol. 9, No. 1 (2023) MATERIALS AND METHODS

The site investigation involved Vertical Electrical Sounding (VES), which was carried out at 25 VES points across 5 profiles with the aids of ABEM SAS 300C Terrameter, four electrodes (C1, C2, P1, P2), measuring tape and hammers. Other materials used were GPS, Cutlass and water.

The methodology involves injecting electric current I (in amperes, A) into the ground through the two current electrodes (C1, C2), while two other electrodes P1 and P2 connected between the current electrodes were used to measure the resulting potential difference in V (volt, V) (Fig. 2). Schlumberger electrode configuration of maximum electrode separation, AB/2 of 60 m was used. The potential electrodes remained fixed while the current electrodes were expanded simultaneously about the center of the spread (Fig. 2). When the distance between the current electrodes was large, the distance between the potential electrodes were increased to have a measurable potential difference. The apparent resistivity measurements at each station were plotted against electrode spacing (AB/2). The VES data obtained were modeled using computer software (IPI2Win). The results obtained (Pseudo cross section, geo-electric sections, layer resistivity, thicknesses and depth) along direction N-S were produced.



Figure 2: Principle of VES; Two current (C1 and C2) and two potential electrodes (P1 and P2) in the standard configuration.



Lapai Journal of Science and Technology, Vol. 9, No. 1 (2023) RESULTS AND DISCUSSION

The results from the investigated five VES points within the Law Faculty Buildings were presented as Pseudo cross section, geo-electric sections, thicknesses and depth (Figure 3). Figures 3 to 8 are the modeled field data for VES points 1 to 5, three geo-electric layers were probed across all the VES points (Table 1 to 5). The variations in resistivity zones were represented by the various colour codes as indicated in the figure 3. The scale of the of color codes indicated low resistive geologic features represented by black to blue range, while along that direction red colour represented the geologic features with high resistivity values. In VES point 1; low resistive features outcropped around the depth of 5 m which is interpreted as high moisture content zone, indicative of a very weak and weathered layer zone due to its high moisture content. This point is also characterized by a sharp fault as a result of the serious active weathering with lowest resistive geologic feature whose resistivity values varied between 0.09 and 24.60 Ω m (Table 3). Such features were observed to have outcropped to the surface indicating a possible recharge point, though having increased resistivity values towards the topsoil interpreted still as conductive zone. The thickness of the zone varied between 5.05 and 32.70 m with the depth variation of between 5.05 and 37.80 m. this point could not be a good site for locating any civil engineering structures such as building considering its low resistivity/high moisture content.





Figure 3: Pseudo cross section showing VES points 1 to 5.



Figure 4: Resistivity versus (AB/2) curve for VES point 1 at the building edge of law faculty, IBBUL



Table 1: Log-Log table VES points 1 at the building of faculty of law, IBBUL

N	P	h	d	Alt
-1	24.6	5.05	5.05	167.4
2	1.66	32.7	37.8	134.8
з	0.0932	482	520	-347.
4	8.51			

VES POINTS 2 AND 3

These two points revealed highest resistive geologic feature represented by the red color code which extends up to close to profile 4. The resistivity values ranged between 31.90 and 44.90 Ω m. This implied a zone of highly consolidated zone with the pick (449 Ω m) at the midpoint between VES point 3 and 4 (Figure 3). These two points are indicative of some good engineering significance. This is favored by the wide thickness variation, which varied from 13.40 to 67.60 m.



Figure 5: Resistivity versus (AB/2) curve for VES point 2 at the building edge of law faculty, IBBUL



N	Р	h	d	Alt
1	251	14.3	14.3	158.9
2	53.8	36.8	51.1	122.1
3	37.7	61.9	113	60.2
4	221			

Table 2: Log-Log table VES points 2 at the building of faculty of law, IBBUL



Figure 2: Resistivity versus (AB/2) curve for VES point 3 at the building edge of law faculty, IBBUL



N	P	h	d	Alt
1	449	35.5	35.5	138.6
2	179	13.4	48.9	125.2
3	31.9	67.6	116	57.64
4	229			

Table 3: Log-Log table VES points 3 at the building of faculty of law, IBBUL

VES POINT 4 AND 5

In these points also, three geo-electric layers were probed (Tables 4 and 5). The two points were characterized by low resistive geologic features. The resistivity of the two zones ranged between 38.50 and 264.00 Ω m. This implied zones of higher conductivity, most especially at VES points 4 and 5 where the higher conductivity outcropped to the topsoil (Figure 3). These areas may be interpreted as recharge points due to the clearly exhibited fractured geologic features indicative of weak zones. The second layer which has resistivity values ranged between (128 and 264) Ω m is interpreted to be the aquifer zone. It has a viable thickness variation of between (14.50 and 15.80) m at the depth variation of between (30.6 and 48) m. The observed outcropped highly resistive feature located midway between the VES points 4 and 5 (Figure 3) could be a good point for drilling the faculty borehole or any groundwater source. This is because there appears to be some consolidation from the topsoil to some shallow depth which can house/support or prevent the groundwater resource from sinking.





Figure 7: Resistivity versus (AB/2) curve for VES point 4 at the building edge of law faculty, IBBUL

Table 4: Log-Log table VES points 4 at the building of faculty of law, IBBUL

N	P	h	d	Alt
1	47.2	33.5	33.5	141.8
2	158	14.5	48	127.3
3	38.5	70.6	119	56.67
4	208			



Figure 8: Resistivity versus (AB/2) curve for VES point 5 at the building edge of law faculty, IBBUL



Table 5: Log-Log table VES points 5 at the building of faculty of law, IBBUL

N	Р	h	d	Alt
-	46.7	14.8	14.8	152.7
2	264	15.8	30.6	136.9
3	62.4	257	288	-120.1
4	437			



CONCLUSION

Geophysical investigation involving Electrical resistivity method has been carried out in the study area to delineate the various lithological units at the Law Faculty Building, IBBUL, Niger State, Nigeria. Five VES measurements were taken and the results obtained from the interpretation of the modeled field data through IPI2Win computer software were used to prepare Pseudo cross section, geo-electric sections along five cross sections so as to reveal the subsurface lithologic successions. Three major layers were delineated from the study area which comprises topsoil, aquifer layer and weathered basement. Geo-electric section between VES point 1 revealed that the area has the weakest sequence of moisture at the shallowest depth up to the topsoil. This makes the area to be not favorable or suitable for locating any high building or civil engineering infrastructural facilities. This therefore confirmed the quality, suitability and durability of the faculty building site. Owing to relatively thick weathered layer along Profile 4 and 5, the area may be considered for drilling borehole to harness groundwater potentials for the Law Faculty.

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Sample for suggested review Table 1a: Summary of VES results along profile A in the study area for Field 1

VES	No of	Layer	Thickness	Depth	Type Of	Inferred Lithology
Station	Layer	Average	(m)	(m)	Curve	
		Resist (Ωm)				
	1	13.4	0.60	0.00		Top soil
A_0	2	2396.9	20.2	0.60	A	Consolidated Clay
	3	753.3	00	20.8		Weathered Basement
A_1	1	124.9	0.9	0.00	к	Top soil
	2	973.6	24.4	0.9		Consolidated Clay
	3	266.4	00	25.3		Weathered Basement
A_2	1	101.0	1.0	0.00	A	Top soil
	2	4170.0	33.3	1.00		Basement
	3	4541.8	00	34.1		Weathered Basement
A ₃	1	410.4	1.8	0.00	K	Top soil
	2	578.2	28.0	1.8		Consolidated Clay
	3	568.8	00	29.8		Weathered Basement
A4	1	86.8	0.7	0.00	A	Top soil
	2	468.5	23.3	0.7		Clay
	3	1090.3	00	24.00		Weathered Basement
A_5	1	15.6	0.9	0.00	A	Top soil
	2	197.2	38.5	0.9		Clay
	3	770.2	00	39.4		Weathered Basement

