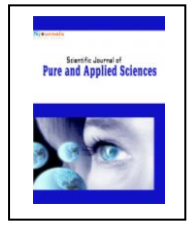
Sjournals
Scientific Journals
Scientific Journal of Pure and Applied Sciences (2013) 2(1) 1-9
ISSN 2322-2956

Contents lists available at Sjournals
Scientific Journal of
Pure and Applied Sciences
Journal homepage: www.Sjournals.com



Original article

Effect of formation characteristics on hydraulic conductivity in unconfined bed in Etchie, rivers state of Nigeria

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A R T I C L E I N F O

Article history:
Received 03 December 2012
Accepted 28 December 2012
Available online 29 January 2013

Keywords:
Hydraulic conductivity
Soil
Water

A B S T R A C T

Formation characteristics determine the hydraulic conductivity of the soil, the major parameter that determine the rate of hydraulic conductivity of the soil in study location are void ratio and permeability of the soil, degree of void ratio and permeability where determine to evaluate the rate of hydraulic conductivity and storage coefficient,the results from these two parameters shows the variation deposition of void ratio and permeability in the study location. Ground water hydrogeological data where found to be unavailable in the study area this condition has resulted to a lots of abortive well, this has also cause a lot of abandoned ground water project done by government, this type of economic waste is a serious concern and need to be addressed., the study is imperative because it will improve the result of ground water exploration in the study area, the result from this study will definitely serve as baseline for professional to apply in the development of ground water system in the study area .

1. Introduction

Water supply problems are very common in most localities in Rivers state just like in most savanna; the situation is really disturbing in savanna areas like in the study area of this work. In most cases, water required for domestic and agricultural uses are obtained from rivers, streams and shallow hand-dug well. Moreover, most of these rivers and streams are often situated at great distances from the villages they serve. The surface water sources are usually ephemeral/seasonal and prone to contamination by human beings and animals. The consequences of these pathetic situations on the water supply systems of the people in this region are the prevalence of such water-borne diseases like guinea worm, cholera and typhoid fever. According to United Nations International Children Education Fund's Rural Water Sanitation, UNICEF-RUWATSAN Project (1988), more than one million people are yearly affected by guinea worm. A prevention of the scourge of such water-borne diseases could have saved a lot of scarce resources spent on health care facilities. There is no gainsaying the fact that substantial losses in man-hours required for productive ventures associated with the sick and their relatives who care for them could have been saved and channeled to other productive sources. In view of this scenario, the provision of sustainable potable water for the people should be the main priority of any government which is serious in eradicating poverty and enhancing the socio-economic status of its people. Moreover, according to the United Nations, one of the cardinal programmes of the Millennium Development Goals (MDG) is the provision of potable water to every community so that the impoverishment of the rural folks in most especially, the tropics and the least developed countries (LDCs) can be wiped out from the global road map of economic development. As a contribution to the improvement and development of the water resources in this region, this work was aimed at identifying the nature, extent and spatial distribution of the components of the aquifer in the southwestern/south-central part of the Lower Niger Basin. It is hoped that the results of this study could also be used to determine the groundwater potentials of the study area (Bellow. 2007). The Niger Delta is a coastal arcuate delta of the River Niger covering an area of about 75,000km^2. The subaerial Niger Delta has an extensive saline/brackish mangrove swamp belt separated from the sea by sand beach ridges for most of the coastline. Water supply problems relating to salinity are confined to the saline mangrove swamp with associated sandy islands and barrier ridges at the coast. Geologically, rocks of the Niger Delta are subdivided into three Formations which are Akata, Agbada and Benin Formations (Short and Stauble, 1967). The Benin Formation consisting predominantly of massive highly porous sands and gravels with locally thin shale/clay interbeds forms a multi-aquifer system in the delta. Many boreholes have been drilled into the aquifers of the Benin Formation yielding good quality water but many have also been abandoned due to high salinity. Oil and gas are produced from sand reservoirs in the Agbada Formation while the Akata Formation consists of uniform shale rocks.

In the Benin basin, salt water intrusion into the Recent Sediments aquifers occurs beneath a fresh water lens in a belt stretching from the coast line to a distance of about 5km in some places. Salt water intrusion has also been found to occur in the confined aquifers of the Coastal Plain Sands in a zone stretching from Apapa to Lekki within Lagos metropolis. The salt water bearing sands overlie fresh water aquifers which are exploited by boreholes. In the eastern part of the Benin basin represented by Akodo, the fresh water aquifers in the Coastal Plains Sands are sandwiched between salt water - bearing sands. The Coastal Plains Sands in a zone between Lekki and Akodo around Lakowe estimated to be about 20 km wide consists predominantly of clay with only about 60 m of sand overlying about 240 m of clay unlike the other areas of the basin where sand represents between 70 to 95 percent of the about 300 m thick horizon. A geologic east - west cross-section along the coast shows the variation in geology and water quality in the Benin basin (Oteri, and. Atolagbe, 2003).

The geology and Geomorphology of the Niger delta have been described in detail by various authors (Allen, 1965; Merki, 1970; Akpokodje, 1979 and 1987; Assez 1970 and 1976; Avbovbo, 1970; Oomkens, 1974; Burke, 1972; Rement, 1965 and Short and Stauble, 1967). The formation of the present day Niger delta started during early Palaeocene and it resulted mainly from the build-up of fine-grained sediments eroded and transported by River Niger and its tributaries (Efeotor and Akpokodje 1990).

Transmmissivity is widely employed in groundwater hydraulics; it is known to be the rate at which water of a prevailing kinematics viscosity is transmitted through a unit width of aquifer under a unit hydraulic gradient. (Todd 2004). Transmmissivity of an aquifer (also called its transmissibility) is the product of the hydraulic conductivity and the saturated thickness of the aquifer Hd. (Coduto, 1999).According, to Schwartz and Zhang (2003). Aquifers play a key role in supplying water to wells. When a pump is turned on in a well, the water level in the well casing (and the hydraulic head) is reduced, causing ground water to flow from the aquifer into the well of the water that is pumped from the well, much of it initially come from “storage” in the aquifer. Thus, aquifers have at least two important characteristics, some ability to store groundwater and to transmit this water to a nearby well; these properties depend to an important extent on the geologic setting The ease which water can move through an aquifer is more explicit, it is the rate at which water prevailing kinematics viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient. The concept of transmmissivity is similar to hydraulic conductivity. The main different is that transmmissivity is measurement that applies across the vertical thickness of an aquifer is b, the transmmissivity (T) is T = bk where k is the hydraulic conductivity of the aquifer. Transmmissivity has unit of (L2/T) for example, ft2/day, m^2 (day); (Schwartz and Zhang, 2003 Eluozo and Nwofor, 2012).

2. Materials and methods

2.1. Permeability test and void ratio

Falling-head test method is the method applied. This method is usually employed to determine a coefficient of permeability for fine grain soil. The soil sample is usually undisturbed and very often the u 4 sampling tube can be used as container during the test. A coarse filter screen is placed at the upper and lower ends of the sample tube. The base of the sample tube is connected to the water reservoir, to the top of the sample tube is connected a glass stand pipe of known cross section area. This pipe is filled with water as the water seeps down through the soil sample; observations are taken of time versus height of water in the standpipe above base reservoir level. Series of tests are performed, using different sizes of stand pipe and the average value of the coefficient of permeability is taken. Note must be taken of the unit of weight of the sample's moisture content.

Furthermore, falling-head permeability test using the standard mild parameter, a substantial head loss can occur through the thick porous stone in the base. The small water entry orifice through the cap may produce a sample cavity from local flow condition. Care is required to produce a water tight system. Use a mater stick to obtain the hydraulic head h1 and h2. In the falling test, since water flow through the sample as the level of water in the stand pipe drop over a time interval at the rate of flow can determine the value of *k* by plotting in pole against it and finding the gradient. Notice that in a falling head test, the effective stresses change because the pore pressure change as the level of water in the standpipe falls. Any volume changes that occur as a result of these changes of effective stress have to be neglected.

Value of the coefficient of permeability measured in laboratory permeability test are often highly inaccurate, for a variety of reasons such as autotrophy (i.e. value of *k* is different for horizontal and vertical flow) and small sample being unrepresentative of volume of soil in the ground and in practice value of *k* measure from insitu test are much better. Its sample are collected from bore hole drilling site (i.e. aquifer material) through insitu method of sample collection on a sequence of 3 metres interval in several locations, but notice is taken on the dynamics of the sample based on the type of deposition. Other tests include void ratio and porosity for all the study area.

3. Result and discussion

Result and discussion of formation characteristics on hydraulic conductivity in unconfined bed are presented in tables and figures below

Table1
comparison of permeability and void Ratio at various Distances.

Distance	KCm/s x 10^{-3} VALUE	void Ratio location 1
3	0.009	0.33
6	0.009	0.22
9	0.008	0.25
12	0.072	0.29
15	0.061	0.98
18	0.059	0.12
21	0.054	0.14
24	0.053	0.35
27	0,04	0.98
30	0.037	0.32

Table2
Comparisons of permeability and void Ratio at various Distances.

Distance	KCm/s x 10^{-3} VALUE	void Ratio location 2
3	0.008	0.41
6	0.008	0.31
9	0.008	0.56
12	0.07	0.06
15	0.059	0.07
18	0.054	0.19
21	0.053	0.04
24	0.046	0.06
27	0.042	0.00098
30	0.04	0.09

Table3
Comparisons of permeability and void Ratio at various Distances.

Distance	KCm/s x 10^{-3} VALUE	void Ratio location 3
3	0.008	0.29
6	0.008	0.34
9	0.0075	0.33
12	0.061	0.23
15	0.06	0.27
18	0.059	0.14
21	0.046	0.1
24	0.044	0.12
27	0.04	0.11
30	0.04	0.07

Table4
Comparisons of permeability and void Ratio at various Distances.

Distance	void Ratio location 4	KCm/s VALUE
3	0.31	0.0085
6	0.41	0.0083
9	0.38	0.0073
12	0.33	0.05
15	0.16	0.054
18	0.2	0.05
21	0.2	0.046
24	0.02	0.044
27	0.98	0.042
30	0.015	0.037

Table5

Comparisons of permeability and void Ratio at various Distance.

Distance	void Ratio location 5	KCm/s x 10^{-3} VALUE
3	0.09	0.008
6	0.1	0.008
9	0.07	0.0075
12	0.15	0.062
15	0.13	0.061
18	0.12	0.059
21	0.24	0.054
24	0.36	0.044
27	0.49	0.046
30	0.57	0.04

Table6

Comparisons of permeability and void Ratio at various Distances.

Distance	void Ratio location 6	KCm/s x 10^{-3} VALUE
3	0.19	0.003
6	0.25	0.0082
9	0.38	0.008
12	0.13	0.0059
15	0.11	0.054
18	0.15	0.046
21	0.99	0.042
24	0.44	0.04
27	0.1	0.037
30	0.08	0.037

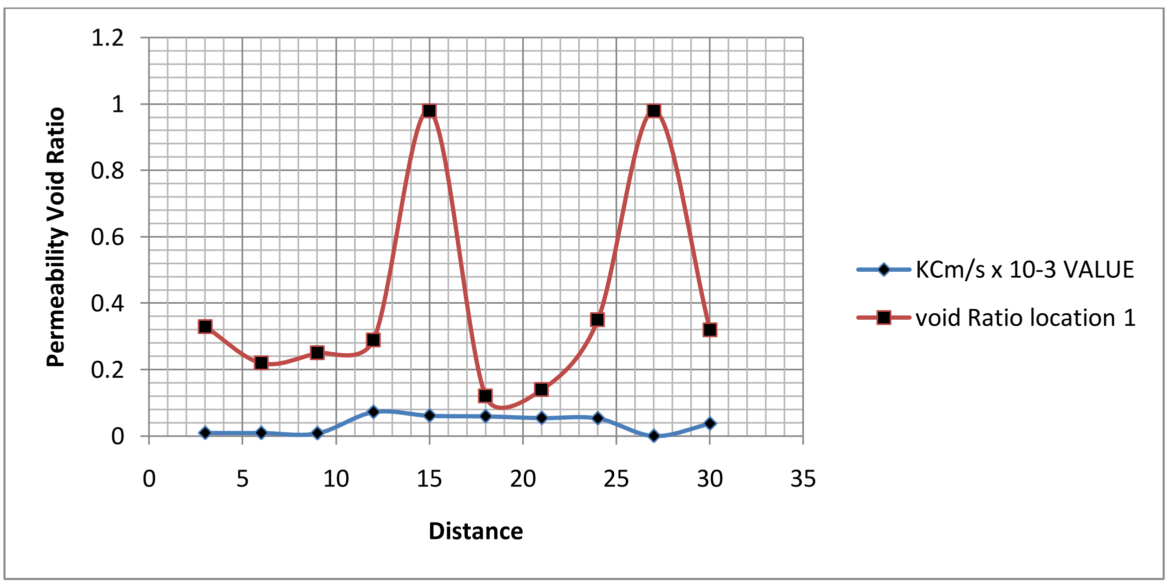

Fig. 1. Comparisons of permeability and void Ratio at various Distances.

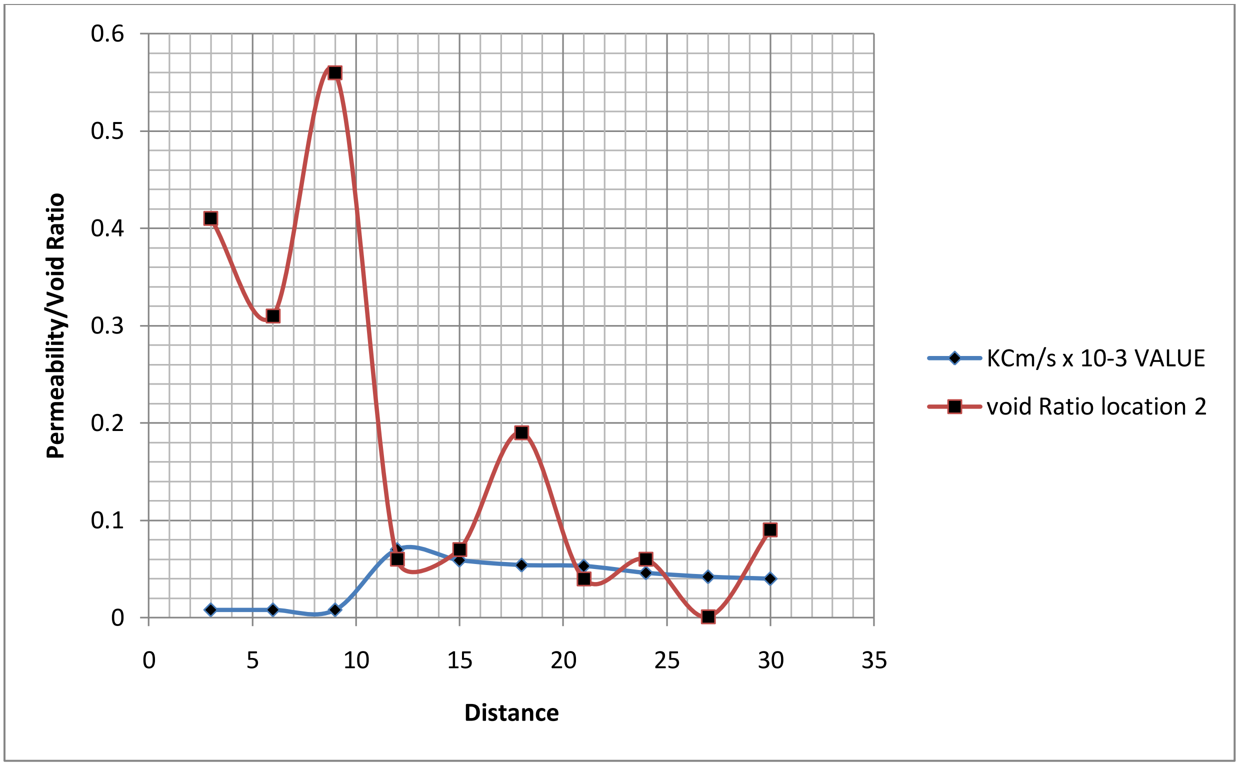

Fig. 2. Comparisons of permeability and void Ratio at various Distances.

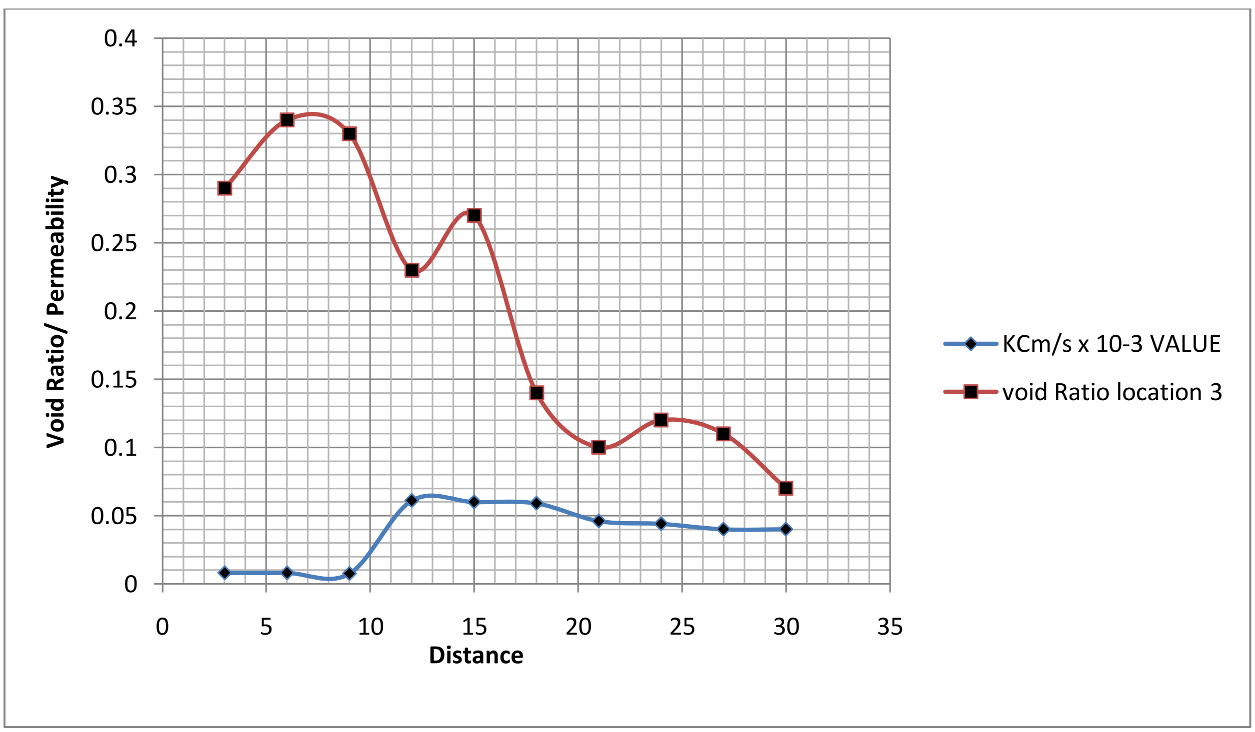

Fig. 3. Comparisons of permeability and void Ratio at various Distances.

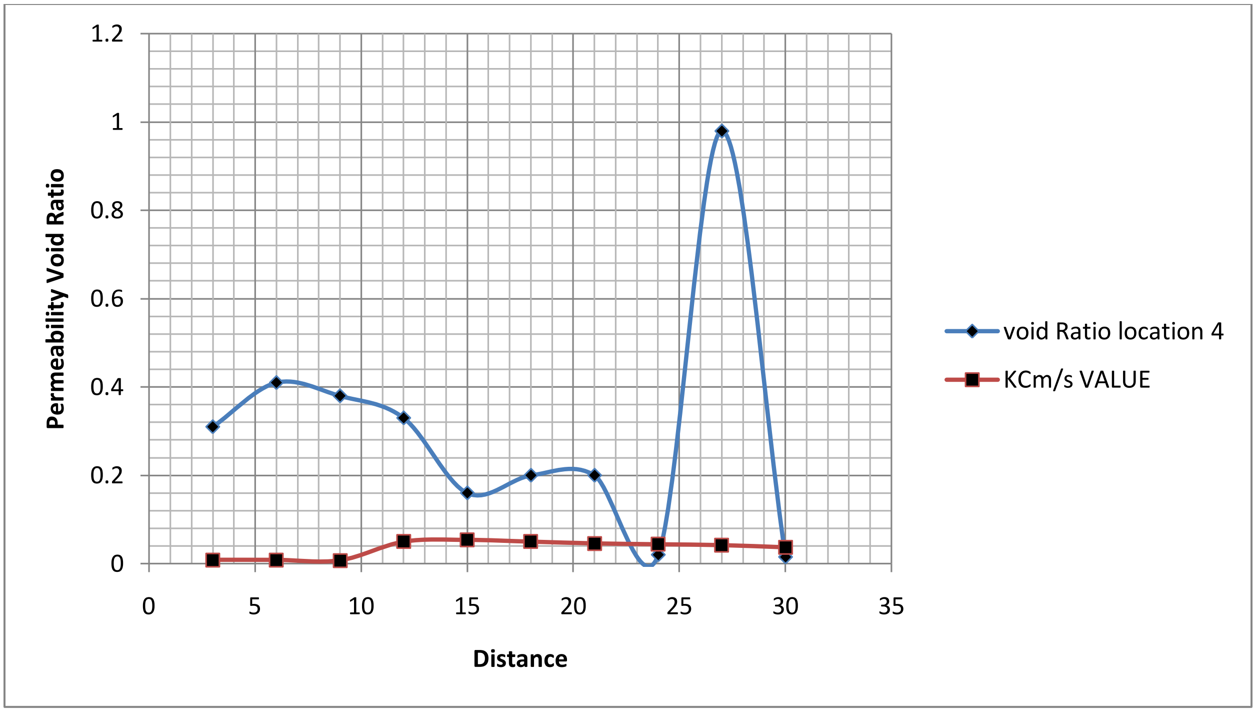

Fig. 4. Comparisons of permeability and void Ratio at various Distances.

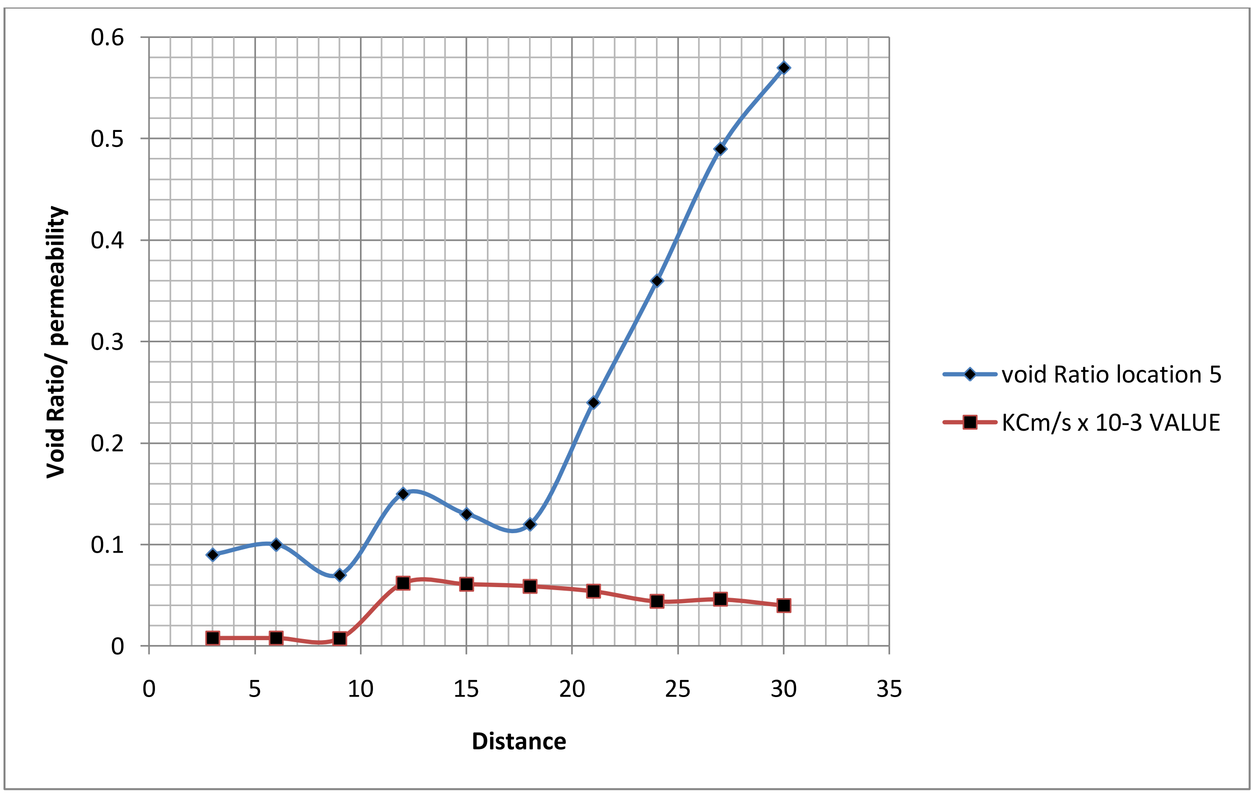

Fig. 5. Comparisons of permeability and void Ratio at various Distances.

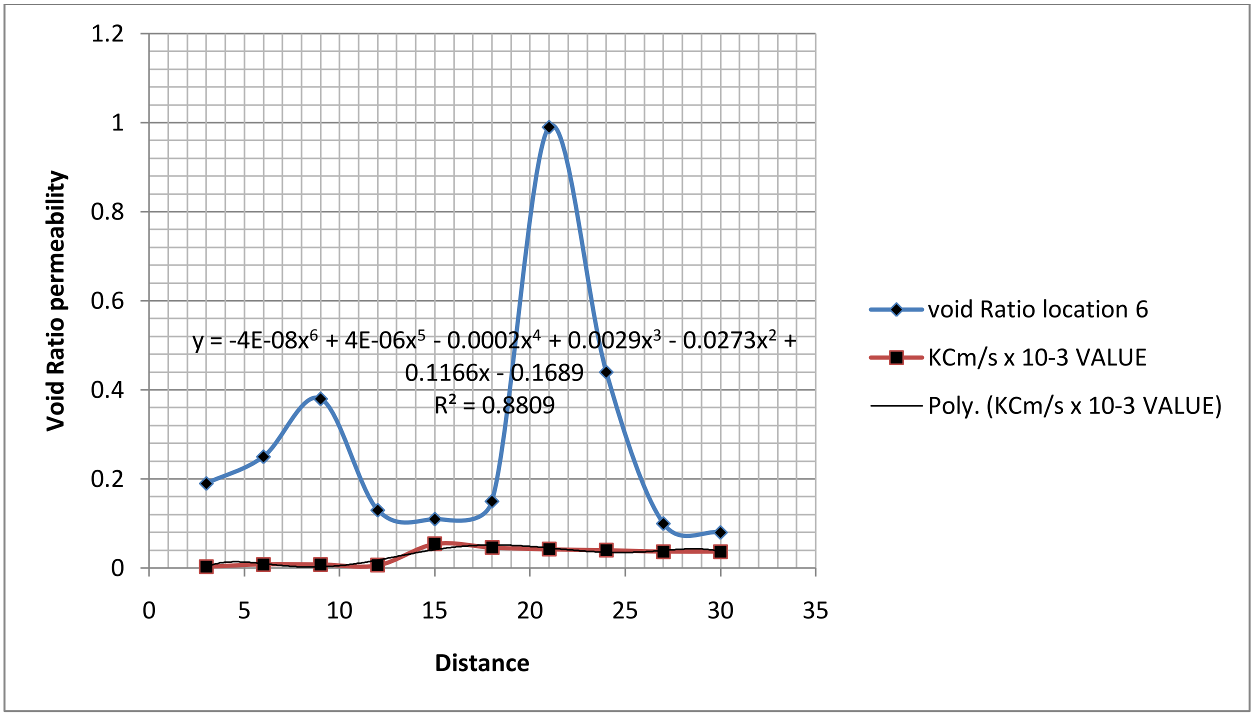

Fig. 6. Comparisons of permeability and void Ratio at various Distances.

Void ratio and permeability is one of the characteristics of groundwater system, the rate of void ratio and permeability determines the yield rate of an aquifer. Figure 1 show that void ratio experienced fluctuation where the optimum value was obtained at fifteen metres suddenly decreased with distance and deposit the highest degree of void ratio at eighteen metres finally experienced a rapid increase between twenty-seven to thirty metres. While the rate of permeability experienced a gradual increase between three and nine metres, maintaining a linear increase between twelve to twenty-four metres, fluctuation between twenty-seven and thirty metres were observed. The rate of disintegration from sedimentary deposits determine the stratification structure of the stratum, it also determined the rate of permeability of the formation. Figure 2 experienced low void ratio between six and nine metres but at silty strata formation, sudden decrease was experienced, fluctuating form twelve metres to thirty metres where observed. While the permeability zone observed gradual increase between three and nine metres. Sudden increase was experienced at twelve and fifteen metres where it finally experienced slight decrease linearly from eighteen to thirty metres.

Figure three experienced a low void ratio between three and nine metres, and finally fluctuates down from twelve to thirty metres, while that of permeability maintained high degree of permeability between three and nine metres , and suddenly experience low permeability between fifteen and thirty metres more so, permeability of soil experienced high degree between three and nine metres and finally main slight low of permeability from twelve metres to thirty metres Figure four observed low void ratio in an oscillation form between three and twenty four metres, a high degree of void ratio where observed between twenty one and twenty four metres, sudden low of void ratio where recorded between twenty four and thirty metres. While permeability maintained similar trend like figure three, high degree of permeability where observed between three and nine metres, slight low where observed from twelve and thirty metres.

Figure five observed deposited high degree of void ratio in a fluctuation between three and eighteen metres, rapid low of void ratio where void observed between twenty one and thirty metres, while permeability where also found to deposit high degree between three and nine metres ,and developed slight low level of permeability from twelve and thirty metres. Figure six experienced vacillation between three and eighteen metres but suddenly observed the lowest degree of void ratio between eighteen and twenty seven, high degree where observed between twenty seven and thirty metres. Formation characteristics are the major role of the deposition of ground water in soil, these parameters established a relationship between void ratio and permeability the storage of ground water depend of the degree of void and permeability of the soil, geological formation constitute these formation characteristics, the study is imperative because it established various rate of hydraulic conductivity and storage coefficients of water in aquiferious zone, the variation of both parameters are base on the stratification of the soil in the study location.

4. Conclusion

The study of formation characteristics on hydraulic conductivity in unconfined bed has been examine, the study streamline the relationship between void ratio and permeability in soil, the study where able to produce the depositional variation at every depth in void ratio and permeability in the study location, the yield rate and storage of ground water are determine by these two parameters, the study has produce a baseline to determine the yield coefficient, that will be applied to design ground water in the study area, there a lots of abortive well s lack of hydro geological data on the area, most part of the study area has resulted to several abortive well, other method to prevent this is to ensure that pregeophysical surveyor are carried out before ground water explorations carried out. These conditions are neglected in the exploration of ground water resulting to abortive well in the study location.

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