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Determination of the Environment of Deposition and the Hydraulic Conductivity Using Grain Size Analysis in Agbogugu and Environs, Anambra Basin, Southeastern Nigeria

Okonkwo, Henry Ifeanyichukwu[1] and Ogbobe, Emmanuel Nnabuchi[2]

[1&2]*Department of Geology and Mining, Enugu State University of Science and Technology, Enugu, Nigeria*.

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ABSTRACT: The geology of Agbogugu and its environs has been carried on a scale of 1:25,000. It is bounded by latitudes 06°13'00''N and 06°18'00''N and longitudes 007°26'00''Eand 007°31'00''E, with an areal extend of about 86.49km^2, overthree lithologic units. A total of six (6) sand samples were collected/analyzed in order to determine the paleoenvironment of deposition.The determination of hydraulic conductivity of sandstones within Agbogugu was carried out using grain size analysis. The results of grain size analysis show that they are medium grained sand (1.7581), moderately well sorted (0.9019), negatively skewed (-0.2078) and mesokortic (1.2089). The multivariate parameters indicates fluvial and shallow marine, which implies that it was deposited in a mixed environment. The histogram plots of weight percent against phi scale shows that 90% of the sediment reflect deposition in a Unimodal system (fluvial) with an influence of 5% bimodal and poly-modal respectively.The hydraulic conductivity has porosity values that ranged between 29.4199% and 43% and the hydraulic conductivity values range from 1.939m/day to 324.791m/day. These values of porosity and hydraulic conductivity are indications of moderately to high specific yield for the sandstone which is reasonable for economic water supply. The unconfined aquifer of the sandstone is the basic characteristic aquifer unit of the area.

KEYWORDS: Agbogugu, aquifer, hydraulic conductivity, paleoenvironment, multivariate.

I. INTRODUCTION

Accurate estimation of aquiferusing hydraulic conductivity has been a common issues encountred in groundwater development. Uma (1989) noted that these parameters are the basic tools used to assess the aquifer yield. Rural and urbandwellers relies solely on groundwater for their needs. Obasi et.al.(2013) evaluated groundwater resources using hydraulic parameters.Hazen formula (1892) plays a vital rolein using grain size d_{10}, to determine the relationship with hydraulic conductivity. Hydraulic conductivity of permeable medium rely on the distinctive of the medium and the attribute of the fluid. The resolution of the aquifer parameter such as porosity, hydraulic conductivity, transmissivity, void ratio (e), can be determined using results gotten from granulometric analysis. Aganigbo et.al. (2016) uses grain size parameter to determine the hydraulic conductivity and environment of deposition of Owelli Sandstone in Mbanabor area. Ezike et.al (2020) noted the paleoenvironment of deposition of Achara Ugwueme and Isuochi using grain size analysis.

In this study, empirical formulars, proposed by authors including Hazen (1892), Vukovic and Soro (1992), Fetter (2001), Hamill and Bell (1986) which relates the aquifer andgrain size parameter were employed toestimate appraise for some aquifer features.This work presents the geology, paleoenvironment of deposition of Agbogugu and the hydraulic conductivity employing the results of grain size analysis.

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II. THE STUDY AREA

Agbogugu and environs is in Anambra Basin south eastern Nigeria in Awgu LGA of Enugu State (figure 1.1). It lies between latitude $06^{0}13^{1}00^{11}$N and $06^{0}18^{1}00^{11}$N and longitude $007^{0}26^{1}00^{11}$E and $007^{0}31^{1}00^{11}$E. It has an area extend of about 86.49km^2, with communities/towns like Umuobom, Amofia,Ezioka-Mvuna, Isu-Awaa, Ihe, Ituku, Ozalla and Obe-Uno. The study are is characterised by hills (uplands) and lowland with the hill attaining above 200m which exposed the rock units of the area through road-cuts and riverchannels. It is characterised by a rhythmic sedimentation such as finesandstone, siltstone, sandy shale, shale heterolith, claystone and siltstone beds.

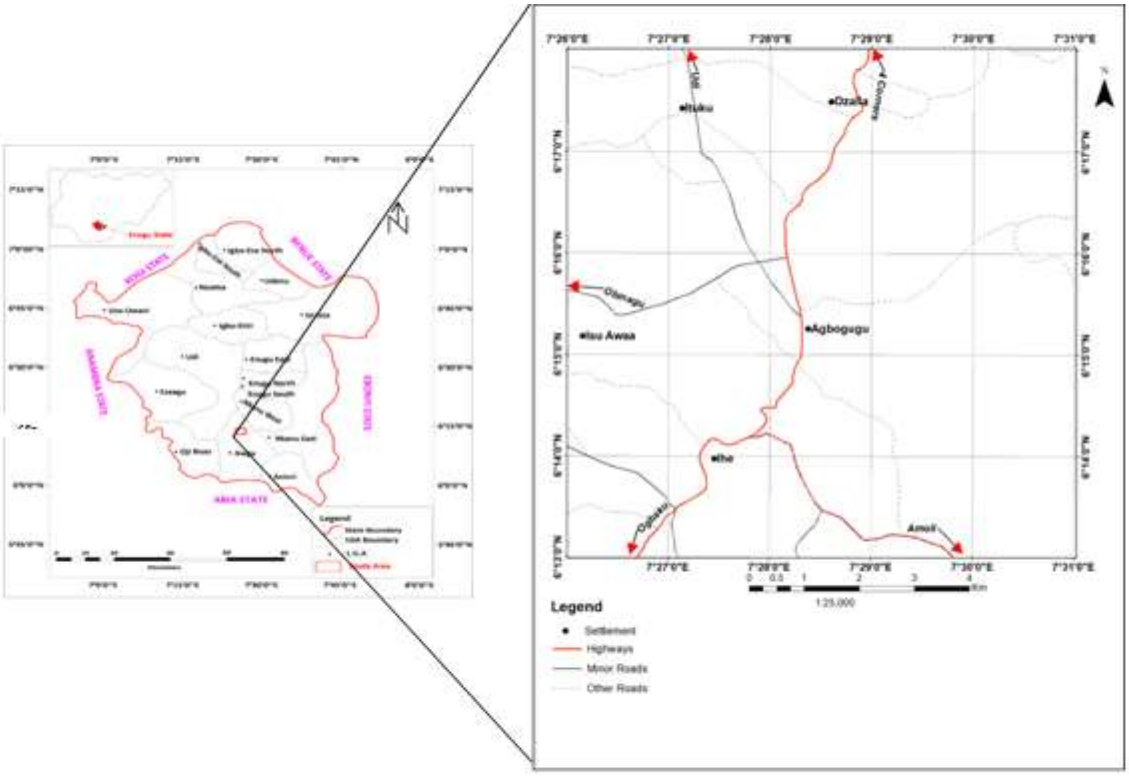

Figure 1.1: Location map of the study area

III. MATERIALS AND METHODS

The methods employed in this study include field work and collection of sand samples. Six samples were analysed using Folk and Ward (1957) statistical formulae to calculate mean size (M_Z), Kurtosis (K_G), skewness (S_{KI}) and sorting (δ). These parameters were further used to discrimante the multivariatr function Sahu (1964). Histogram plots of weight percent against phi scale was employed todifferentiate the current direction. Hydraulic conductivity was determined using empirical formulae proposed by authors including Hazen (1892), Vukovic and Soro (1992), Fetter (2001), Hamill and Bell (1986) which relates the aquifer and grain size parameters were employed to estimate for some aquifer characteristics. Determine D_{10}, D_{30}, and $D_{60}$where weight of 10,30 and 60 intercept withthe curve particle seize distribution.

Uniformity Coefficient $C_U = \frac{D_{60}}{D_{10}}$ (Fetter, 2001).

Gradation Coefficient $C_G = \frac{D_{30}^{2}}{D_{60} * D_{10}}$ (Fetter, 2001).

values above to calculate for porosity, void ratio and hydraulic conductivity.

Porosity (n) = $0.255(1+0.83^{Cu})$ (Vukovic, and Soro, 1992)

Void ratio (e) = $\frac{n}{1-n}$ (Hamill, and Bell, 1986)

Hydraulic Conductivity (k) $=\frac{g}{V} \times 6\times10^{-4}[1 + 10(n-0.26)] \times D_{10}^{2}$. (Hazen, 1892)

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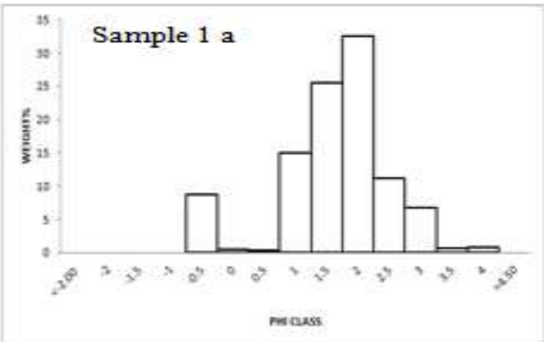
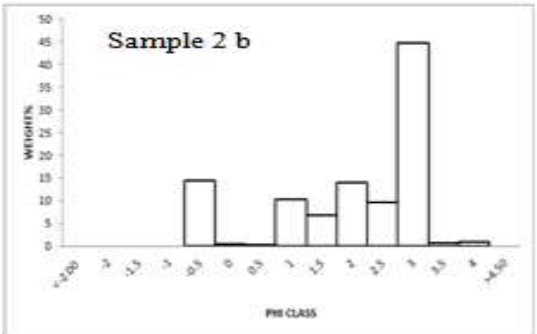
IV. RESULTS AND DISCUSSION

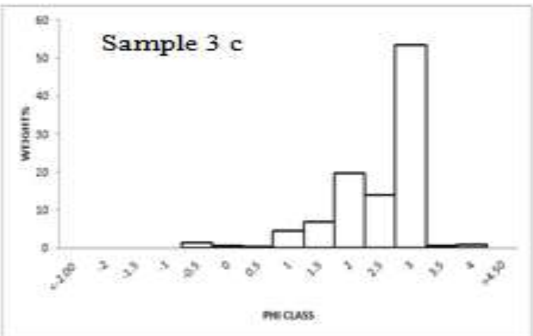
The univariate results of the studied sandstone units derived from cumulative probability curves as shown in table 1. Figure 1.2a-f shows the histogram plots.

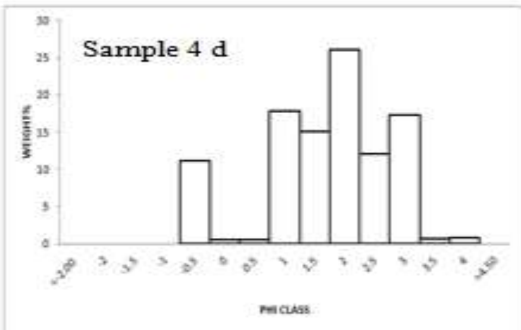
Table 1: Grain size distribution result

Sample no	Mean size	Sorting	Skewness	Kurtosis
1	1.6867 Medium grained sand	0.8692 Moderately well sorted	-0.3081 Very Negatively skewed	0.9716 Mesokortic
2	1.9633 Medium grained sand	1.0875 Poorly sorted	-0.7869 Symmetrical	1.0677 Mesokortic
3	2.2377 Fine grained sand	0.6712 Moderately well sorted	-0.6592 Symmetrical skewed	2.1516 Very lepokortic
4	1.7600 Medium grained sand	1.0019 Poorly sorted	0.3800 Poorly skewed	0.7768 Platykortic
5	2.2173 Fine sand	0.8775 Moderately well sorted	-0.7407 Symmetrical skewed	1.1261 Lepokortic
6	0.6833 Coarse sand	0.9038 Moderately well sorted	0.8680 Poorly skewed	1.1598 Lepokortic
Ave	1.7581 Medium grained sand	0.9019 Moderately well sorted	-0.2078 Negatively skewed	1.2089 Mesokortic









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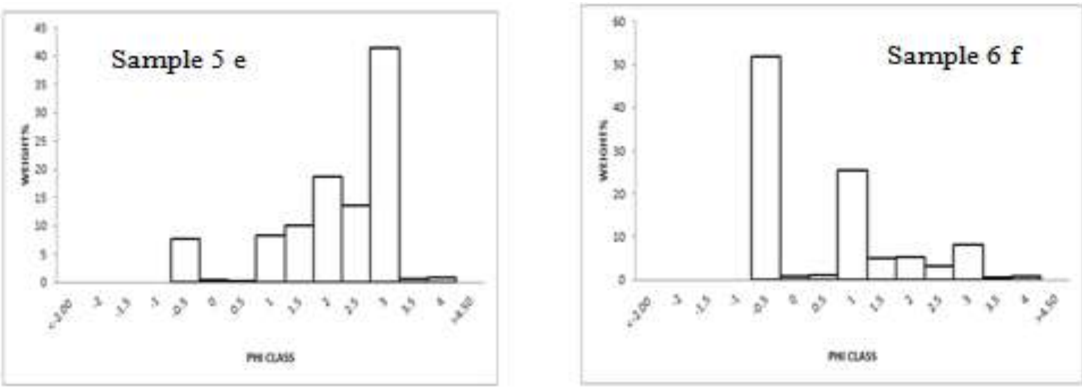

Figure 4.1a-f: Histogram plots of weight percent against phi scale

4.1. Environment of Deposition

In determining the deposition setting of the sediment (table 1), multivariate functions of Sahu (1964) was employed (table 2). Two functions of Sahu's work was used such as:

Yu: Shallow marine: Fluvial $=0.2852(M_Z)-8.760451(\sigma^2)-4.8932(S_{KI})+0.0482(K_G)$.

Yu > -7.419 indicates shallow marine deposits and Yu < -7.419 indicates fluvial deposits

Yu: Beach: Shallow marine $=15.6534(M_Z)+65.7091(\sigma^2)+18.1071(S_{KI})+18.5043(K_G)$.

Yu < 65.365 indicates beach deposits. And Yu > 65.365 indicates shallow marine deposits.

Table 2: Results of multivariate parameter

Sample number	Y_u: Shallow marine: Fluvial		Y_u: Beach: shallow marine	
1	-5.57907	Fluvial deposit	95.91692	Shallow marine
2	-5.06508	Fluvial deposit	107.6995	Shallow marine
3	-1.91248	Fluvial deposit	107.0092	Shallow marine
4	-10.0971	Shallow marine	114.6388	Shallow marine
5	-3.37621	Fluvial deposit	99.79378	Shallow marine
6	-11.9142	Shallow marine	107.2621	Shallow marine

The samples generally are moderately well sorted which reflect partly stable flow. The skewness are negatively skewed which implies that the velocity of the depositing agent operated at a higher value which common in wave and tide dominated environment such as beach and tidal inlets. The mean and kurtosis are medium grain and mesokortic respectively which is classified as normal curve. The histogram plots shows that the sediment are mainly Unimodal which suggest fluvial system with low variability of flow while sample 1 and 4 shows bimodal and polymodal respectively, which implies a beach environment with swash and backwash processes. The multivariate parameter indicates shallow and fluvial settings. This implies that the study was deposited in a mixed and moderately energy environment.

4.2. Hydraulic conductivity (k)

Results of porosity, and hydraulic conductivity (table 3) shows that the value of hydraulic conductivity ranges from 1.939m/day to 324.791m/day, averagely 27.0952m/day. While the porosity ranges from 29.4199% to 43.97888%, averagely 31.17019%. This values is good for geologic materials of sandstone, Kasenow (2002). Freeze and Cheery (1979), also indicated that unconsolidated sands have porosity values of 25-50%. However, the moderately porosity values of these sandstones may be due to external factors like transportation which might increase compaction.

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	Porosity (n) %	Hydraulic conductivity (k) m/day
	29.4199	324.791
	43.97886	27.095
	32.92049	1.939
AVERAGE	31.17019	27.0952

Table 3: Porosity, and hydraulic conductivity of the sample analysed

V. SUMMARY AND CONCLUSION

The environment of deposition of the sandstone within Agbogugu and the hydraulic conductivity has been analysed using data on grain size distribution and the grains are anisotropy. The porosity and hydraulic conductivity value ranges between 29.4199% to 43.97888%, and 1.939m/day to 324.791m/day. The environment of deposition indicates that the grains are fluvially agitated by shallow marine, beach processes.

REFEENCES

[1]. Aganigbo, C.I., Akudinobi, B.E.B., Okoro, A.U., and Okoyeh, E.I., 2016. Determination of the hydraulic conductivity, Transmissivity and the environment of deposition of Owelli Sandstone, in Anambra Basin, Southeastern Nigeria, Using Grain Size Distribution Analysis. Journal of Environment and Earth Science, v. 6, no. 2, p. 95-101.

[2]. Ezike, C. E., Okonkwo, H.I., and Iyi, E.C., 2020. Paleo-enviromental deduction from pebblemorphometry and textural studies of sandstone deposits of Isuochi and Environs, Anambra Basin, Southeastern, Nigeria. Global Journal of Geological Sciences, v. 18, p. 23-33.

[3]. Ezike, C. E., Okonkwo, H.I., and Nnamani, C.H., 2020. Paleo-enviromental analysis of Anambra Basin sediments. Acase of Achara-Ugwueme and environs, Southeastern, Nigeria. International Journal in Physical and Applied Science, v 7, p. 6-26.

[4]. Fetter, C.W., 2001. Applied Hydrogeology. Prentice Hall, Upper Saddle River, NJ, xvii. 598pp.

[5]. Folk, R. L., Ward, W. C., 1957. Brazos River bar (Texas): a study in the significance of grain size parameters. J Sediment Petrol, v. 27, p. 3–27.

[6]. Freeze, R.A., and Cherry, J.A., 1979. Groundwater. Prentice-Hall, Englewood Cliffs, New Jersey. p. 250-263.

[7]. Hamill, L., and Bell, F.G., 1986. Groundwater resource development. Library of congress cataloguing in pub. Data. p. 12-32.

[8]. Hazen, A., 1892. Some physical properties of Sand and Gravel: Mass state Board of Health, Rept. p.539 -556.

[9]. Kasenow M.C., 2002. Determination of Hydraulic conductivity from grain size analysis. Water Resources Publications. LLC, High land, Ranch, Colorado.

[10]. Obasi, P.N., Aghamelu, O.P., and Akudinobi, B.E.B., 2013. Determination of Hydraulic conductivity of sandstones of Ajali Formation in Uturu Area (southeastern Nigeria) using grain size analysis. Journal of Natural Sciences Research, v. 3, no. 3, p. 49-54

[11]. Sahu, K. B., 1964. Depositional Mechanism for Size Analysis of Clastic Sediments. Jour. Sed. Petrology, v. 34, p. 73-83.

[12]. Uma, K.O., 1989. An appraisal of the Groundwater Resources of the Imo River Basin: Nigerian Journal of Mining, 22 (1 & 2), p. 305-315.

[13]. Vukovic, M., and Soro, A., 1992. Determination of hydraulic conductivity of porous media from grain-size composition. Water resource pub, Littleton, Colorado.