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Research Article

ASPECTS OF THE HYDROGEOLOGY AND HYDROGEOCHEMISTRY OF UROMI AND ENVIRONS, SOUTH - SOUTH NIGERIA

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ABSTRACT

The effect of sub surface Geology on the availability of ground water was investigated in the area of study, the major rock units were identified this was done through careful study of borehole logs drilled in the area. The results showed that the sediments belonged to the Ameki Formation formed during the widespread regression consisting of an alternation of sand and shale with minor lignite occurrences with the water occurring in these sandwiched sand bodies so that the aquifer is a perched aquifer. The depth to water was also investigated in all the wells studied and this was used to construct the water table contour map of the area. Water samples were taken from both Rainfall, surface, sub surface water for laboratory analysis for both physico- chemical and heavy metal analysis. The results of the analysis are shown in the tables and charts under the results and discussion section.

Keywords: Hydrogeology, Uromi, Physico-chemical analysis, Ameki Formation

INTRODUCTION

Over 71% of the universe is covered with water, it is a renewable resource due to the interplay of the components of the Hydrologic cycle and constitutes about the most single resource available to mankind. A large variety of the building materials, aviation materials, ceramics, metals and other substances important to modern technological civilization (which are resources in a modern context) were of no use to the earliest cave dwellers but even at that age, water was an inevitable necessity as was evident in their entire life revolving around the availability of water. It must be noted that the wide variety of minerals now known today were formed as a result of complex geologic processes which either occurred due to the presence of water or were influenced by the presence of water as several surface processes such as mass transport and movement, downhill march of materials, earthquakes, sedimentation were as a result of water.

Water is the single most important agent sculpturing the earth's surface. Mountains may be raised by the action of plate tectonics and volcanism but they are primarily shaped by water. Water has always and still has a great role in human affairs. Throughout human history, streams have served as a vital source of fresh water and often of fish for food. Before the widespread use of fossil fuels, flowing water pushing paddle wheels powered mills and factories, before the use of gas turbines and wind to generate electricity, water has long been used to generate electricity, for these and other reasons, many towns sprang up and grew along streams and rivers.

The discipline hydrogeology or "Geohydrology" did not gain any relevance until the opening of the nineteenth century. According to American geologists, hydrogeology is a term used for all studies both of surface and groundwater which includes a substantial amount of geological orientation. This same Discipline tries to relate the influence of lithologic units and geological processes to the occurrence and availability of water.

Hydrogeochemistry is a sub discipline which deals with the chemical and microbial analysis of water especially derived from geological materials paying particular attention to their suitability for drinking.

Aim of the Study:

The aim of the research is to study the entire hydrological regime within the study area paying key attention to:

The mode of occurrence, distribution and movement of groundwater in the area.

The degree of contamination or the quality of both surface and ground water.

Scope of the Study:

The study involved noting and describing the water bearing rock units and where they lie beneath the surface.

Collecting information on existing wells or boreholes, depth to water, lithology of each well including the strata yielding water.

Analysis of water sample from various wells both for chemical and bacteriological contamination.

Location of Study:

Uromi is a town located in the South South region of Nigeria precisely Edo state and is the Administrative Headquarter of Esan North East local Government. It lies between latitude N 06^{0} 40^{1} 10.0^{11} and N 06^{0} 44^{1} 01.0^{11} and longitude E 06^{0} 14^{1} 52^{11} and E 06^{0} 23^{1} 0.1^{11}. The other town covered by this study is the neighbouring town Ubiaja.

Geography and Geomorphology:

Generally, Uromi has a high topographic relief with the surface appearing to be roughly flat (popularly referred to as the Ishan plateau). Measured heights above sea level could be up to 1400 feets, it belongs to the tropical continental region. The relief is very gentle, scarce observable igneous intrusions. The vegetation is thin, rivers and streams are sparsely observable at the central part of the plateau(Uromi) but only seen visibly as one descends down the plateau from Uromi towards Ubiaja and then Emu, drainage pattern is dendritic.

REGIONAL GEOLOGY

Geology of Southern and South western Nigeria:

The oldest sedimentary rock of Southern Nigeria consists of non- fossiliferous, arkosic, gravelly, poorly sorted, commonly cross bedded sandstones of Albian age derived from the basement complex, this is known as the Asu River Group. The Asu River Group is composed of dark micaceous sandy shale and fine grained sandstone with a rich Ammonite fauna an index fossil indicating the Albian age, this was a transgressive phase. Rocks of Cenomanian age occur only North of Calabar (Odukpani Formation) and consists of alternating sandstones, shales, sandy shale and fossiliferous limestone this was a regressive phase. The Odukpani Formation was deposited in a shallow water environment close to the Oban massif. The Turonian is evidenced by the development of the thick Ezeaku shales composed of grey flaggy calcareous shale with interbedded limestone lenses, this was a transgressive phase. Folding, faulting and uplifting in early Santonian time signified the end of the Aptian-Santonian sedimentary phase. Erosion of the Coniacian, Turonian and in some places Albian sediments occurred with the uplifting of the Abakaliki anticlinorium. Subsidence occurring after the folding initiated renewed marine transgression and hence the deposition of the Nkporo shale of Campanian-Maastrichtian age as well as the lateral equivalents; Owelli sandstone and Enugu shale.

In the South east of the Niger, the Maastrichtian is represented by the deltaic, Mamu Formation, Ajali Formation and Nsukka Formation containing coal seams at several levels.

Marine transgression was widespread throughout the Tertiary (Short and Stauble, 1967). The predominant Stratigraphic unit of the Paleocene is the Imo shale. It is typified by bluish grey, fossiliferous, locally sandy shales which may range into the Eocene. The onset of the regressive Eocene phase and the formation of the modern Niger Delta occurred with the deposition of Ameki Formation which in the South east is often heterogenous composed of sandstones, shales, calcareous shales, marl and fossiliferous limestone, this heterogeneity is a proof of shallow water sedimentation. In the South west it is predominantly shaly, and grades into the sandy Ilaro Formation and lagoonal clay of the Oshosun Formation.

Surface evidence of the Oligocene and Miocene units is limited and often questionable. The main units representing these ages are the Ogwashi- Asaba and Ijebu Formation, both of which are sandy with lignite seams (Reyment 1965). The Benin Formation which is of Miocene to Recent in age is the youngest Stratigraphic unit and consists of yellowish white continental sands with pebbly bands.

Local Geology:

Available borehole information from borehole drilled by Shell Petroleum Development company and Government agencies like the Benin-Owenna River Basin Development Authority show that the area is underlain by sediments belonging to the Ameki Formation formed during the Eocene. The sediments are greyish-green, sandy clay with calcareous concretions and whitish clayey sandstones. Before moving up the plateau, the area is bounded to the South by the Benin Formation of Miocene age which is a lateral equivalent of the Ogwashi-Asaba Formation. It consists of fine to coarse grained sandstones. To the North, it is bounded by the Imo Shale that outcrops at Agbede. The Imo Shale consists of clayey Shale, fine textured, dark grey and bluish-grey shale with occasional mixture of ironstone and thin sandstone bands. Carbonized plant remains may be locally present. The Formation becomes sandy towards the top where it may consist of alternation of bands of sandstones and shale.

Hydrogeology of the Study Area:

Among the indicators to the occurrence of Ground water is that it is more likely to occur under valleys than under hills or plateau. Since the area under study is an elevated platform, groundwater is more likely to occur at greater depths if present than at valleys.

A study of the borehole logs from Amendokhian reveal alternation of sand and clay. The upper sands are dry in most places and only occur as perched aquifer. These perched aquifer are not widespread and occur at shallow depth, because of the cost of drilling to great depths, the residents have dug shallow hand dug wells to tap this water which is often seasonal. The lithologic log studied at Ivue shows Lignite seams typical of the Ameki Formation penetrated at several depths. The Aquifer occur at great depths of about 180 fts. The lithologic log also show an alternation of sand and clay. The Aquifer bearing units are the medium to coarse grained sands. The lithologic log at Ubiaja also show some Lignite seams penetrated at depths of about 170-210 fts, with the aquifer occurring at 220 fts.

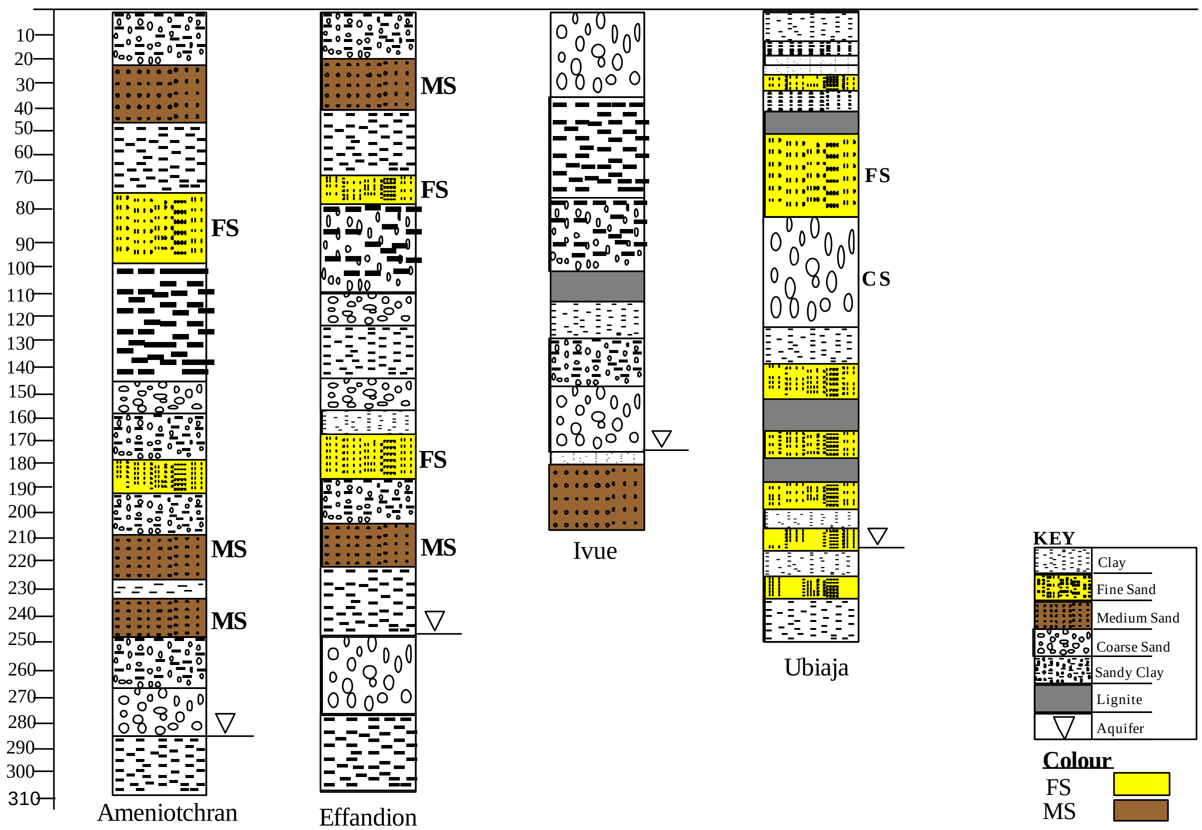
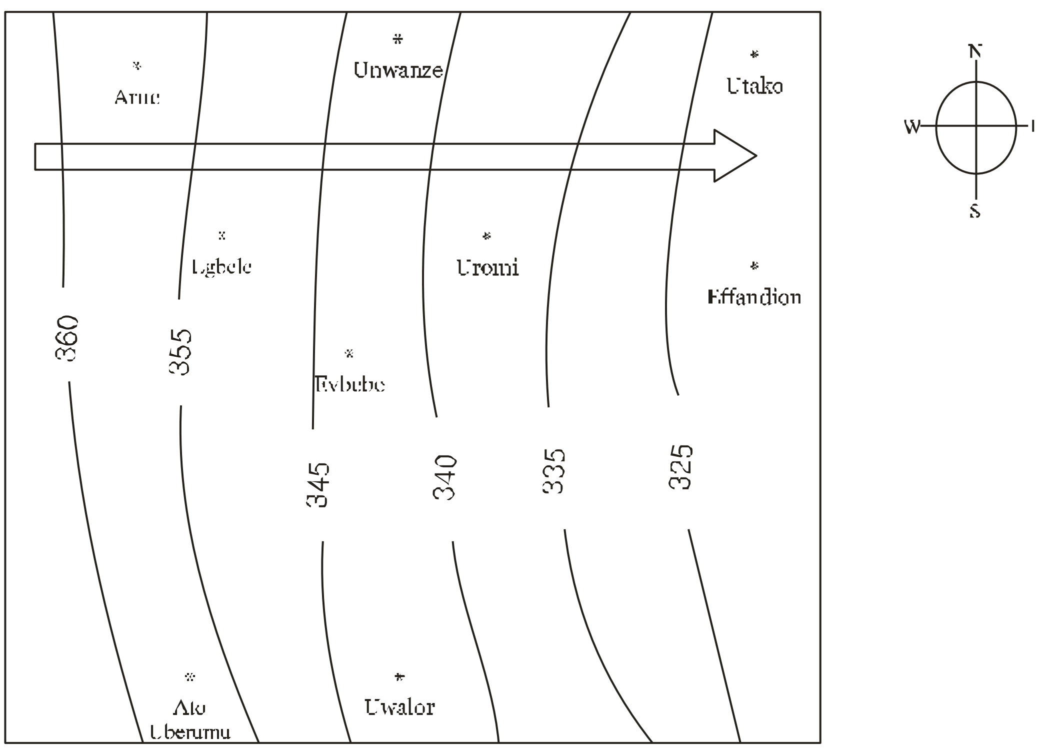


Figure 1: Lithologic logs of Bore holes in the area of study

METHODOLOGY

Water Level Measurement:

After the collection of the water sample, the depth to water for the various wells sampled were measured. This was done using a depth sounder. In the simplest form, a depth sounder is a measuring tape that uses several mechanisms to indicate the presence of underground water. The measuring tape is usually graduated in metres or feet; at its lowermost end is a conductor which is lowered into the well to measure the water level, at the other end of the tape is a multimeter which is an electrical device that indicates the presence of electrical current by the deflection of the pointer. The tape is lowered into the well, any depth where the conductor deeps into water is recorded as it could be determined by the deflection of the multimeter pointer. The tape is then moved up first to get out of water and slowly moved in again and the depth at which the first deflection is observed is recorded as the true water level. This procedure is then repeated for other wells. Measured depths recorded are 32m, 34m, 36m, 44m, 48m, 50m, 51m and 99m. The value of the measured water depth obtained is then subtracted from that of the elevation above sea level and used to construct the water table contour map.



Water table contour map of Uromi and environs.

Sample Collection:

Water samples were collected from the hand dug wells at Uromi and Ubiaja, the water samples were collected in one litre polythene bottles and subsequently taken to the laboratory for analysis. The water samples were preserved in the refrigerator to prevent recrystalization of the metals. The sample bottles were rinsed with the water to be collected to prevent spurious results, the sample bottles were also heated with hot water to kill any micro organism that may be originally contained in the bottle. The heavy metals were preserved by adding concerntrated Hydrochloric acid to 10ml of water. With all these standard procedures observed, the samples were then analyzed to determine the physical/chemical conditions of the water, the heavy metal content and the degree of microbial contamination of the water.

RESULTS

The results from the physico-chemical and heavy metal analysis carried out on the water water samples are presented in the tables below. The results from the water level measurement were also used to construct the water table map as presented in the figure of water table below.

SAMPLE LOCATION ONE (UWALOR ROAD UROMI):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	10	15
Turbidity NTU	0.24	5
Taste	tasteless	Unobjectionable
Ph units	6.60	6.5-9.5
Total solids (mg/l)	14.10	500
Chloride (mg/l)	15.60	250
Phosphate (mg/l)	0.00`	10
Sulphide (mg/l)	0.015	0.05
Copper (mg/l)	0.002	2
Iron (mg/l)	0.001	3
Nitrate (mg/l)	0.004	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	6.25	20
Zinc (mg/l)	0.04	3
Sulphate (mg/l)	0.02	250
Calcium (mg/l)	11.57	NS
Potassium (mg/l)	0.60	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 80 colonies/100ml

Confirmation for *E.coli* – negative

SAMPLE LOCATION TWO (ST. ANTHONY'S CATHOLIC CHURCH UROMI):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	10	15
Turbidity NTU	0.66	**5**
Taste	tasteless	Unobjectionable
Ph units	6.01	6.5-9.5
Total solids (mg/l)	20.4	500
Chloride (mg/l)	15.60	250
Phosphate (mg/l)	0.001	10
Copper (mg/l)	0.003	2
Iron (mg/l)	0.001	3
Nitrate (mg/l)	0.005	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	5.47	20
Zinc (mg/l)	0.052	3
Sulphate (mg/l)	0.012	250
Calcium (mg/l)	10.28	NS
Potassium (mg/l)	0.80	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 60 colonies/100ml

Confirmation for *E.coli* – negative

SAMPLE LOCATION THREE (EGBELE UROMI):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	5.0	15
Turbidity NTU	0.70	5
Taste	tasteless	unobjectionable
Ph units	6.38	6.5-9.5
Total solids (mg/l)	22.65	500
Chloride (mg/l)	9.93	250
Phosphate (mg/l)	0.001	10
Copper (mg/l)	0.004	2
Iron (mg/l)	0.002	3
Nitrate (mg/l)	0.006	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	3.13	20
Zinc (mg/l)	0.032	3
Sulphate (mg/l)	0.018	250
Calcium (mg/l)	9.0	NS
Potassium (mg/l)	0.54	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 0 colonies/100ml

Confirmation for *E.coli* – negative

SAMPLE LOCATION FOUR (RAINFALL SAMPLE):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	4.0	15
Turbidity NTU	0.85	5
Taste	tasteless	Unobjectionable
Ph units	6.45	6.5-9.5
Total solids (mg/l)	21.074	500
Chloride (mg/l)	9.93	250
Phosphate (mg/l)	0.001	10
Copper (mg/l)	0.001	2
Iron (mg/l)	0.003	3
Nitrate (mg/l)	0.004	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	4.69	20
Zinc (mg/l)	0.041	3
Sulphate (mg/l)	0.014	250
Calcium (mg/l)	6.42	NS
Potassium (mg/l)	0.40	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 10 colonies/100ml

Confirmation for *E.coli* – negative

SAMPLE LOCATION FIVE (EBHOIYI UROMI):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	5.0	15
Turbidity NTU	0.45	5
Taste	tasteless	Unobjectionable
Ph units	6.00	6.5-9.5
Total solids (mg/l)	11.10	500
Chloride (mg/l)	15.60	250
Phosphate (mg/l)	0.001	10
Copper (mg/l)	0.004	2
Iron (mg/l)	0.001	3
Nitrate (mg/l)	0.002	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	3.16	20
Zinc (mg/l)	0.34	3
Sulphate (mg/l)	0.002	250
Calcium (mg/l)	5.14	NS
Potassium (mg/l)	0.55	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 40 colonies/100ml

Confirmation for *E.coli* – negative

SAMPLE LOCATION SIX (OYOMON UBIAJA):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	10	15
Turbidity NTU	0.45	5
Taste	tasteless	Unobjectionable
Ph units	6.08	6.5-9.5
Total solids (mg/l)	20.01	500
Chloride (mg/l)	11.34	250
Phosphate (mg/l)	0.01	10
Copper (mg/l)	0.001	2
Iron (mg/l)	0.002	3
Nitrate (mg/l)	0.003	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	3.13	20
Zinc (mg/l)	0.021	3
Sulphate (mg/l)	0.016	250
Calcium (mg/l)	7.71	NS
Potassium (mg/l)	0.45	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 50 colonies/100ml

Confirmation for *E.coli* – negative

SAMPLE LOCATION SEVEN (UOKHA UBIAJA):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	5.0	15
Turbidity NTU	0.78	5
Taste	tasteless	Unobjectionable
Ph units	6.07	6.5-9.5
Total solids (mg/l)	32.4	500
Chloride (mg/l)	8.51	250
Phosphate (mg/l)	0.001	10
Sulphide (mg/l)	-	0.05
Copper (mg/l)	0.002	2
Iron (mg/l)	0.001	3
Nitrate (mg/l)	0.001	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	3.13	20
Zinc (mg/l)	0.040	3
Sulphate (mg/l)	0.01	250
Calcium (mg/l)	5.13	NS
Potassium (mg/l)	0.35	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 90 colonies/100ml

Confirmation for *E.coli* – negative

SAMPLE LOCATION EIGHT (EFFANDION UROMI):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	10	15
Turbidity NTU	1.24	5
Taste	tasteless	Unobjectionable
Ph units	6.17	6.5-9.5
Total solids (mg/l)	25.0	500
Chloride (mg/l)	15.60	250
Phosphate (mg/l)	0.001	10
Copper (mg/l)	0.003	2
Iron (mg/l)	0.003	3
Nitrate (mg/l)	0.002	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	3.13	20
Zinc (mg/l)	0.003	3
Sulphate (mg/l)	0.018	250
Calcium (mg/l)	6.43	NS
Potassium (mg/l)	0.64	NS
Lead (mg/l)	0.05	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 60 colonies/100ml

Confirmation for *E.coli* - negative

SAMPLE LOCATION NINE (OHA RIVEER UROMI):

PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	15.0	15
Turbidity NTU	2.00	5
Taste	tasteless	Unobjectionable
Ph units	6.35	6.5-9.5
Total solids (mg/l)	32.056	500
Chloride (mg/l)	14.19	250
Phosphate (mg/l)	0.001	10
Copper (mg/l)	0.001	2
Iron (mg/l)	0.003	3
Nitrate (mg/l)	0.005	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	3.91	20
Zinc (mg/l)	0.050	3
Sulphate (mg/l)	0.067	250
Calcium (mg/l)	6.43	NS
Potassium (mg/l)	0.65	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total microbial count 70 colonies/100ml

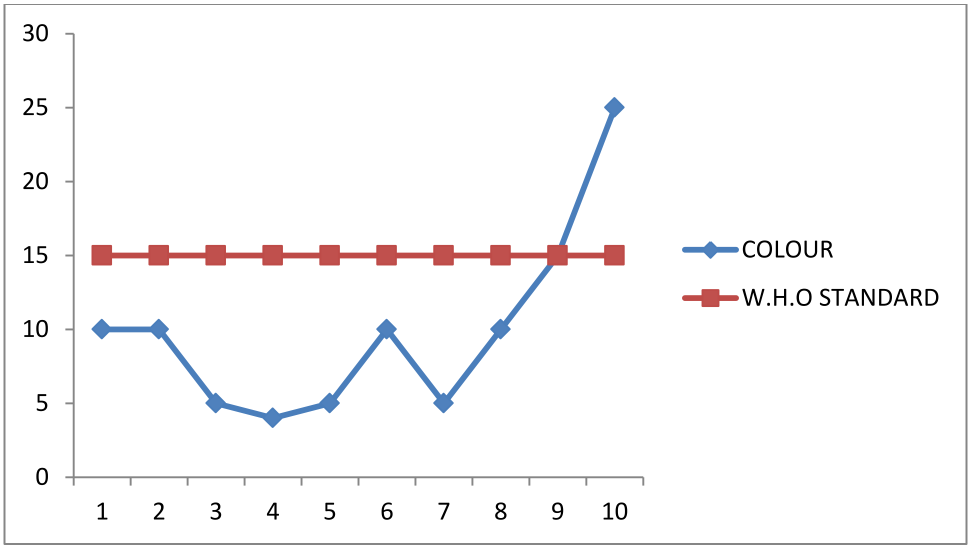
Confirmation for *E.coli* - negative

SAMPLE LOCATION TEN (RIVER UTOR):

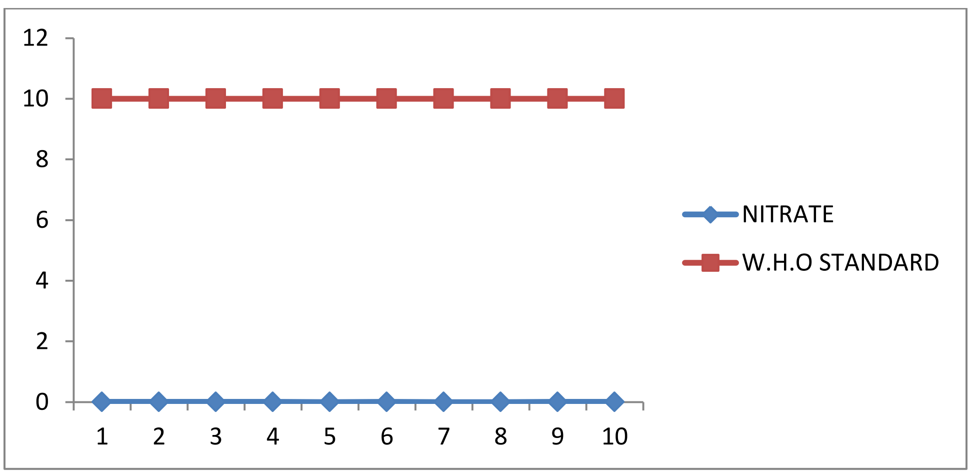
PARAMETER	VALUE	W.H.O STANDARDS
Odour	odourless	unobjectionable
Colour TCU	25	15
Turbidity NTU	2.06	5
Taste	tasteless	Unobjectionable
Ph units	6.10	6.5-9.5
Total solids (mg/l)	35.045	500
Chloride (mg/l)	16.35	250
Phosphate (mg/l)	0.001	10
Sulphide (mg/l)	-	0.05
Copper (mg/l)	0.003	2
Iron (mg/l)	0.001	3
Nitrate (mg/l)	0.004	10
Manganese (mg/l)	0.00	0.4
Magnesium (mg/l)	1.56	20
Zinc (mg/l)	0.014	3
Sulphate (mg/l)	0.009	250
Calcium (mg/l)	7.71	NS
Potassium (mg/l)	0.96	NS
Lead (mg/l)	0.00	0.1
Chromium (mg/l)	0.00	0.003
Arsenic (mg/l)	0.00	0.01

Total Microbial count 120 colonies/100ml

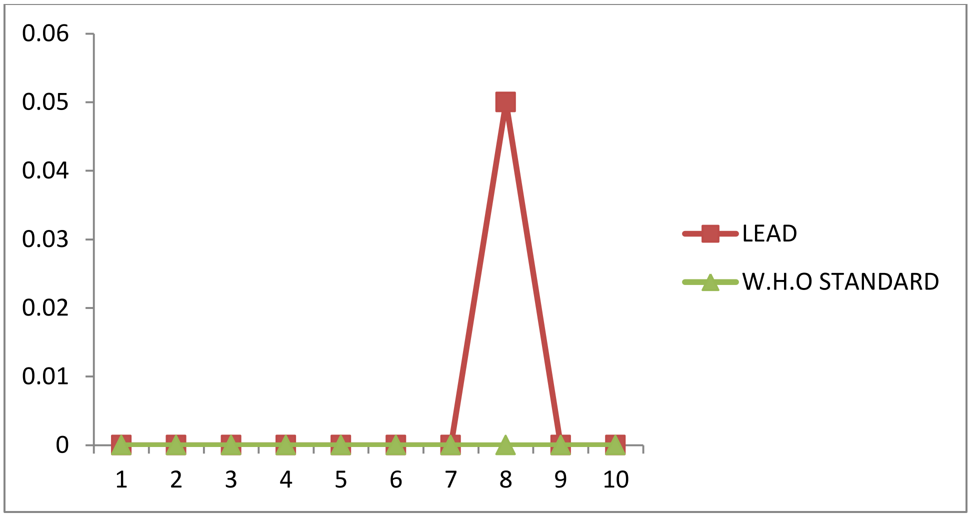
Confirmation for *E.coli* – positive



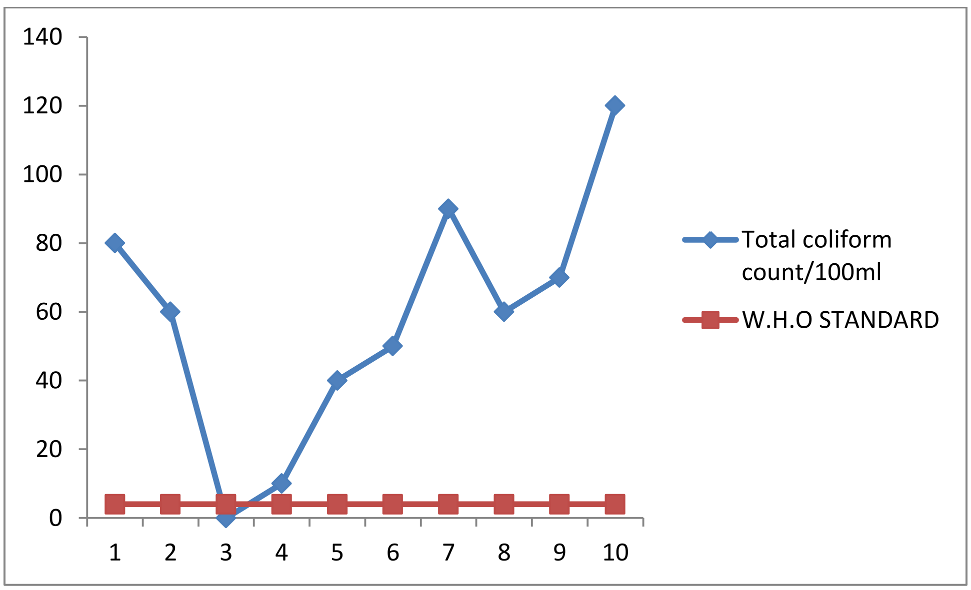
Colour Variation along sampled locations



Nitrate variation along sampled locations



Lead Variation along sampled locations



Total coliform count/100ml variation along sampled locations.

DISCUSSION OF RESULTS

A study of the lithologic logs show that the sub-surface geology consists mainly an alternation of sand and clay with the clay being the dominant member, there also occur lignite seams. The clays were formed at the opening of the Eocene regressive phase due to the sedimentation in quiet water marine environment that prevailed at that time. The lignite seams were probably forms during the carboniferous when large coal bodies were deposited. The water currently harnessed are from the sand bodies sandwiched between the clay layers, the aquifer thus is confined and occur as perched aquifer because it occurs above local impermeable layers of clay.

The lignite seam occurs geologically the same way the aquifer occurs, this is because lignites are formed in areas of moderate pressure so that the confining pressure from the clay formation would have provided good conditions for the formation of lignite. So far no artesian flow has been recorded in the area. If this condition prevails and the impervious clay layer intersects a sandy formation at a slope, a spring would be formed.

Water Quality Analysis:

A careful study of the tables and charts on the physico chemical parameters and heavy metal content show that the observed values all fell below the World Health Organization acceptable standards for drinking except for that of Colour which was above the 15 Hazen limit in the rivers sampled. The total coliform count which is an indication of microbial contamination for the surface water showed higher values as the confirmation for *E.coli* at sample location ten (River Utor) was positive, this is so due to the magnitude of human activities and animal sources that release pathogens directly into the river. Therefore, local residents and inhabitants must be discouraged from using the water from the rivers as source of drinking or even for domestic purposes as is the current practice as there is fear of epidemic outbreak in the area. At location eight (Effandion Uromi) the water from the well contained minor amounts of Lead (0.05mg/l), this fell above the World Health Organization standard, drinking water when taken with such minor quantities of Lead over a long period of time could become harmful to health. The source of the Lead could probably be from an abandoned dumpsite close to which the well was drilled. Therefore proper inspection must be carried out so as to choose the best sites where wells would be sited in the area.

CONCLUSION

The study revealed that the sediments underlying the area of study belonged to the Ameki Formation formed during the widespread marine transgression of the Tertiary. The water currently harnessed from the shallow hand dug wells showed good physico-chemical results as parameters fell below the World Health Organization standards for drinking water except for Lead occurrences in location eight which was above the World Health Organization standard.

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