Hydrogeochemical Analysis of Water Samples in Nando and Environs of the Anambra Basin of South Eastern Nigeria

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ABSTRACT

The study area falls within the Anambra basin. The mapped area is bounded by longitudes 6°55′E and 7°00′E and latitudes 6°15′N and 6°20′N. The lithostratigraphic units within the study area include the Imo Shale (Paleocene) and the Ameki Formation (Eocene). The Imo Shale is represented by the shale unit overlain by a sandy mudstone unit while the Ameki Formation is made up of a clay unit overlain by a sandstone unit. The sandstone units of the Ameki Formation are the prolific aquifers unlike the sandstone units found in the Imo shale. The hydrogeochemical analysis indicates that the quality of groundwater is fairly good and may be contaminated by weathering of feldspars, leaching of clay, sewage pollution, and limestone lenses of the Imo shale Formation.

(Keywords: hydrogeology, lithostratigraphic formations, shale, clay, aquifers, groundwater)

INTRODUCTION

This paper describes results of the chemical data of the tested water samples in Nando and environs of the Anambra basin in south eastern Nigeria. The area is bounded by longitudes 6°55′E and 7°00′E and latitudes 6°15′N and 6°20′N. The mapped area is made up of the Eocene Ameki Formation and the Paleocene Imo Shale Formation. The older formation, Imo Shale (Paleocene), unconformably underlies the younger Ameki Formation. The geologic contact between the two formations was delineated based on lithologic and topographic variations and particularly the outstanding high dips of the Imo shale (20° - 28°) as compared with the relatively low dips of the Ameki Formation.

The Imo Shale is made up of two nits namely the shale unit and the sandy mudstone unit (Figure 1). The shale unit is generally dark grey, silty, micaceous, and contains woody tissues. A shallow to deep marine environment is inferred from these sedimentary features.

The sandy mudstone unit overlies the shale unit and is pebbly in certain horizons. The clay unit and the sandstone unit represent the Ameki Formation in the study area (Figure 1). The sandstone unit is sharply graded (coarsening upwards), medium to coarse- grained, generally poorly sorted, and clayey to pebbly. The sedimentary features of the pebbles in the sandstone unit indicate sediment deposition in a deltaic environment.

The objective of the present investigation is to determine the portability and wholesomeness characteristics of surface water and groundwater resources of the project area, and by so doing familiarize the community water supply agency of Anambra State.

The sandstone units of the Ameki Formation are prolific aquifers unlike the sandstone units found in the Imo Shale. The hydro geochemical analysis indicated that the quality of groundwater is fairly good and may be contaminated by weathering of Feldspars, leaching of clay, sewage pollution, and limestone lenses of the Imo Shale Formation.

METHOD OF STUDY

Analytical methods employed in this research include determination of pH and chemical properties of water from springs and boreholes of the area under consideration.

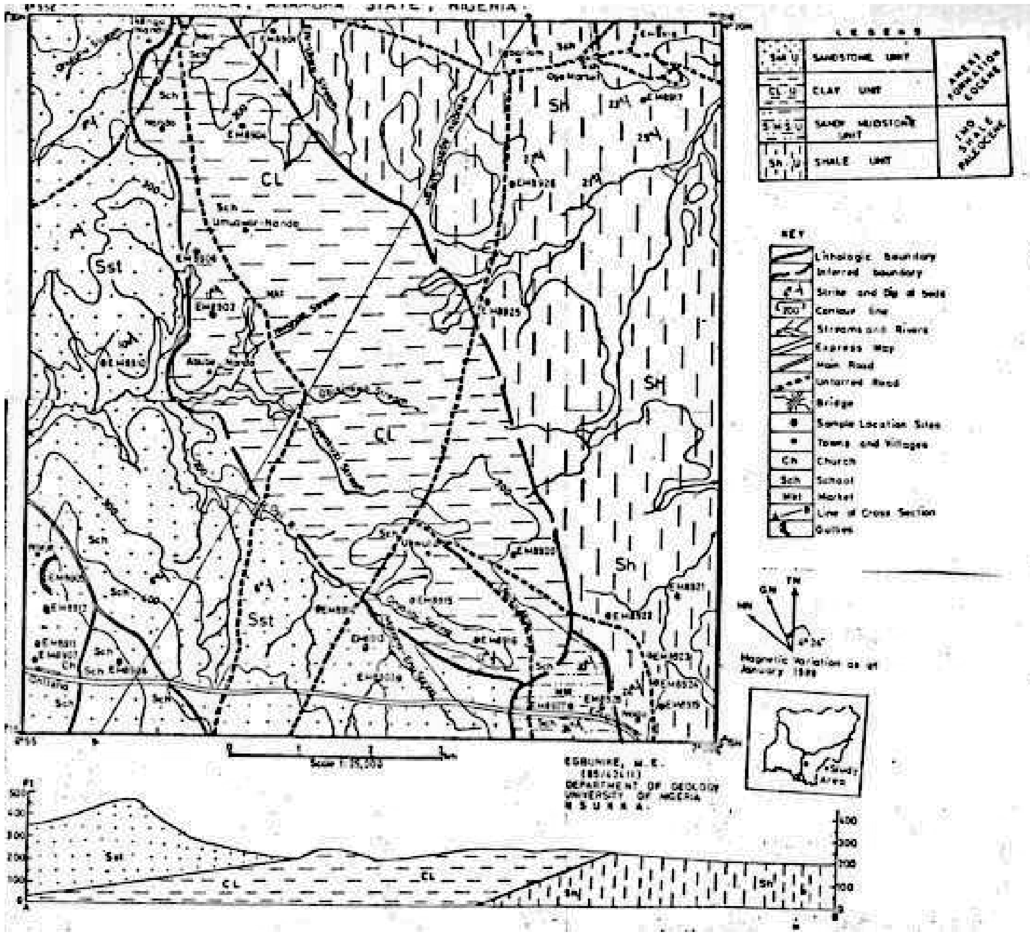

Figure 1: Geological Map of Nando and Environs in Anambra Local Government Area, Anambra State, Nigeria.

Nine water samples were collected and housed in sample bags specifically designed for this purpose. Locations from which the tested water samples were collected are shown in Figure 1. Inventory wells sunk into the Ameki Formation and Imo Shale were employed to locate depths to bedrock and water table. Water quality was determined through hydrogen ion value, pH and chemical tests.

RESULTS, DISCUSSION, AND CONCLUSION

The amounts of different elements present in milligrams per litre (mg/l) in the tested water samples are tabulated in Table 1. The hydrogen ion concentration (pH) is slightly acidic to slightly alkaline and it is generally good for drinking and some other domestic uses. The fact that the hydrogen ion concentration is more or less neutral affects the aggressiveness of the solution. Magnesium ion (Mg^{2+}) concentration is generally low. The availability of magnesium ion in groundwaters of the area could be explained by occurrence of magnesium with calcium carbonate cement in detrital sedimentary formation. The water samples collected from the mapped area is characterized by very low values and this may be as a result of deficiency of minerals capable of yielding magnesium ion in water. The magnesium content of groundwater in the area is generally good for human use.

There are generally high values of sodium and potassium in the water samples of the mapped area. Sodium must have entered the groundwater system through natural system (i.e. rainwater) (Spears, 1976). Another contributory

Table 1: Chemical Data of the Tested Samples.

Sample Number	Location	Spring	Borehole	Chlorides (Cl)/mg/l	Nitrates/mg/l	SO^4/mg/l	Sulphides /mg/l	pH	Total Hardness as $CaCO_3$/ mg/l	Mg^{2+}/mg/l	K^+/mg/l	SiO_2/mg/l	Na^+/mg/l	Al^{3+}	Phosphates (PO_4^-)/mg/l
EM8901	Nando	Mgbanaani	-	5.00	6.65	19.40	4.00	7.50	30.00	None	None	6.35	83.60	1.16	286.00
EM8902	Nando	Mgbanaani	BH1	5.70	3.54	None	4.00	6.80	30.00	1.95	132.00	9.06	26.40	2.90	286.00
EM8903	Nteje	Mgbanaenu	BH1	5.80	3.68	9.60	4.00	6.90	10.00	2.68	None	None	118.80	2.90	286.00
EM8917	Achalla	Mgbanaenu	HW1	5.70	6.65	2.00	4.00	6.50	50.00	1.46	312.40	4.54	198.00	1.16	2717.00
EM8918	Achalla	Mgbanaenu	BH2	5.20	6.65	4.00	4.00	7.00	10.00	0.73	57.20	5.44	22.00	2.32	715.00
EM8904	Nando	Mgbanaenu	HW2	5.20	5.01	4.00	4.00	6.00	10.00	0.49	255.20	6.35	None	2.32	572.00
EM8915	Ukwulu	Anyaobi	HW2	5.70	6.65	1.60	4.00	7.00	20.00	0.73	46.20	5.44	132.00	2.90	286.00
EM8920	Ukwulu	Anyaobi	BH3	5.70	3.68	4.00	1.60	6.90	196.00	0.73	57.20	7.25	74.80	0.58	858.00
EM8921	Nogu	Anyaobi	BH4	5.70	5.85	4.00	4.00	6.50	30.00	0.24	79.20	7.25	224.40	2.90	286.00

factor is an impurity in the cementing material where sodium ion and carbonate lattice (Hen, 1970). Other natural sources include weathering of feldspars (albite) and leaching of clay minerals (Spears and Reeves, 1975; Ogbukagu, 1976; Todd, 1980).

Ogbukagu, 1976 maintained that the high sodium ion in the Nanka sand area is probably due to the chemical breakdown of feldspar flakes. Though this is feasible, but due to the insufficiency and unreactive nature of these minerals, with respect the pH condition, the ion exchange phenomenon must be invoked to explain the high sodium ion concentration.

Moreover, the high values of potassium ion may be as a result of the presence of natural sources such as feldspars (orthoclase and microcline), feldpathoids, some micas, and clay minerals. The possible effect on the use of water in the mapped area is that more than 50mg/l of sodium and potassium in the presence of suspended matter causes foaming, which accelerates scale formation and corrosion in boilers. Sodium and potassium carbonate in recirculating cooling water can cause deterioration of wood in cooling towers. More than 65mg/l of sodium can cause problems in ice manufacture (Todd, 1980).

The chloride concentration are generally low because of the fact that chloride does not show any correlation with the components of pore water derived from mineral breakdown (Spears and Reeves, 1975) and because of the fact that in sedimentary rocks, the major source of chloride in groundwater, is due to evaporate (Hem, 1970). The concentration of rain water by evapotranspiration may be an important source of chloride in the area.

Another common source of chloride in groundwater is the leaching of chloride from fine grained marine shales which might retain some of this chloride for a long time. The influence of the marine Imo shale may also be a contributory factor in the chloride content of the groundwater around the southern part of the study area like water samples from the boreholes at Ukwulu and Nogu (with concentration of 5.70mg/l respectively).

The chloride concentration in the water samples are within the accepted limits for human consumption. The silica (SiO_2) content of the groundwater in the area is fairly homogeneous compared to the abundance of SiO_2 in the sediment, the silica content is very low. This is probably as a result of the strong silicon – oxygen bond which are highly resistant to

chemical attack coupled with pH condition of the area which is mildly acidic.

The concentration of nitrate in the mapped area is generally good and falls within the accepted limit. The potential source of nitrate in the area may include legume, animal excrement, and probably the atmosphere. The sulphate values ranges from 0.00 – 19.40mg/l. The major source of sulphate in the area may result from gypsum and oxidation of sulphide ores.

The aluminium ion (Al^{3+}) varies from 0.58 – 2.90mg/l. The aluminium concentration in the study area is within the accepted limit. Also the phosphate values range from 286.00 – 2717.00mg/l. It is generally high and this may as a result of possible sewage contamination or pollution. Where apatite is not much in the rocks, coliform tests should be carried out to ascertain the source of phosphate. Sulphide concentration is also low and lies within the accepted limit.

The total hardness values varies from 10.00 – 196.00mg/l. Based on the hardness classification of water by Sawyer and McCarty, 1967, we can conveniently classify the water samples as generally soft except the water sample collected from the borehole at Ukwulu with a maximum concentration of 196.00mg/l of $CaCO_3$. The water sample at Ukwulu borehole is hard and this may be due to limestone lenses or outcrops in the Imo Shale Formation. Here, the water needs to be treated before it reaches the standard for human consumption and other domestic uses.

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