Influence of Rock Mineralogy on Subsurface Water in Ado-Ekiti, Nigeria

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Abstract

Sudden geometric increase in population of Ado-Ekiti has lead to an increase in demand for water and harnessing of subsurface water reserve. This research investigated the possible infiltration of dissolved mineral from weathered rock into subsurface water in the area (basement complex rocks), and comparing the mineral level with the set standard for quality water by the World Health Organization Physical test were carried out on hardness, colour, odour, conductivity, pH, and turbidity. Chemical test for sodium (Na^+) and potassium (K^{2+}) was also done using experimental scientific set standard. The analysis of the sodium, potassium ions, and the conductivity of the water indicate that dissolved mineral from rocks have great influence on the underground water property. The level of the dissolved mineral is within the acceptable limit for water quality standard set by the W.H.O. Sourcing for underground water should not be based on hydro geological variable alone but possible chemical interference from the geology of the environment (rock type).

Introduction

Ado-Ekiti found in Ekiti Central Local Government area of Ekiti state, is located geographical between latitude $7^0 3^1$ and $7^0 49^1$ north of the equator and longitude $5^0 7^1$ and $5^0 27^1$ east of the Greenwich Meridian. It is bounded in the north by Ido-Osi and Oye local government areas,

in the west by IJero and Ekiti south west, lkere and Emure-Ise-Orun local government areas.

Topography and Drainage

The relief of Ado-Ekiti is relatively low with isolated hills and inselbergs that are dome-shaped. At the base of these rocks are boulders littering all over the place (Ayoade, 1982). The major river draining the area is Ireje River which flows south-east, it is associated with simple form of minor tributaries. Ireje River is seasonal with characteristic reduction in volume or total dry up in case of extreme drought. Ado-Ekiti has a planimetric area of about 84km^2 (Ebisemyu, 1989).

Geology (Rock type)

The geology of Ado-Ekiti belongs to the basement complex (igneous rock) rock of South Western Nigeria. Major lithiological rock units are basically crystalline basement rocks. These include coarse grained charnokite, fine grained granite, medium grained-granite and porphyritic biotite-hornblend granite, with superficial deposit of clay and quartzite. Association of the fine-grained charnokite and the porphyritic biotite-hornblend granite suggest a common age (Ombtoyinbo, 1994).

The charnockitic rock is the most abundant in the area. The charnockite ranges in colour from dark-green, to greenish-grey rock with milky quartz and greenish feldspar. The outstanding feature of the coarse grained variety of charnokite rock in Ado-Ekiti is that it is similar to those of Oyawoye (1961, 1965, 1972), described as "bauchite" around Bauchi Nigeria. Other occurrences are in form of small dykes or veins in other granitic rocks. The rock is generally even textured and homogenous with mineral aggregates mainly of biotite and feldspar phenocryst. The superficial deposits are clay,

quartzite rumbles and fine sand (SiO_2). The clay is believed to have be formed from the weathering of feldspar mineral present in charnockitic rocks due to alteration of igneous rocks by hydrothermal process and the quartzite rumbles due to high degree of cyclic weathering.

People and Population

Ado-Ekiti is inhabited by the Yoruba of South Western Nigeria. According to 1991 census the population is about 900,000 inhabitants; the increase has made people in the town to depend on subsurface water to compliment the pipe borne water which is always never sufficient. The main objective of this study is to investigate possible influence of dissolved mineral from rock in the underground water and compared the level of mineral present with the set standard for quality Water by the world Health Origination (WHO).

Instrument and Method of Analysis

In carrying out the research five wells was located at three different locations (totalling 15 wells). Test for odour, conductivity and temperature of the water were carried out on the field while the chemical analyses for the mineral were done in the laboratory. The analyses were focused on physical and chemical parameters.

Methods of Analysis

Conductivity and Temperature

The conductivity and temperature was measured using EXTECH digital conductivity meter. The conductance and temperature electrode were inserted in the water sample after sampling and allowed to equilibrate for about five minutes before value recorded.

PH

The pH of the samples was determined in the laboratory, within 24 hours of collection, using portable Philip Haris pH meter. The electrode was inserted into distilled water buffer 7.00pH value which was used in standardizing the instrument. The pH value was determined by inserting the electrode into the sample after each buffer standardization.

Turbidity

Measurement of turbidity was determined using the Hack Laboratory Turbidometer (Model 2100A) furnished with the instrument are our standard formalin dilution used in standardization of the instrument. The standards rated at 0.61,10,100 and 1000 NTU. They are usually used when the sample turbidity exceeds or falls below the existing range. The riser was used when standardizing the 100 and 1,000 NTU ranges. The turbidity was determined by pouring each water sample into the sample cell which was placed in the cell holder assembly and covered by light shield. After selecting the desired range, the standardized control was adjusted and a meter reading equal to the Nephelometric Turbidity unit (NTU) value for the sample was obtained.

Colour

The colour of the water samples was obtained colorimetrically by comparing the colour of water sample with standard colours. In determination of the colour, the LIVIBOND Nessleriser was used, the 50ml Nessleriser tube was filled to the mark with the sample and measured against the livibond colour disc. The colour of the water sample was recorded in Hazen unit.

Hardness

The hardness of the water samples was determined calorimetrically with the aid of the LIVIBOND comparator. Two 10ml moulded cells were filled to the mark with sample. One of the cells was placed in left hand compartment of the comparator while the hardness tablet (Eriochrome) was added to the second cell. This was crushed with a stirring rod, after complete dissolution of the tablet, the cell was complete dissolution of the tablet, and the cell was placed in the right hand compartment of the comparator and rotated, facing good daylight, until a colour match was obtained. Some of the sample was diluted with distilled water, when the obtained colour did not match any of the available columns on the disc, in other to obtain their hardness. Hardness calculated as $CaCo_3$ was recorded in parts per million (ppm).

Flame Photometric Determination of Sodium ion (Na^+) and Potassium (K^{2+}) ions

The sodium ion (Na^+) and potassium ion (K^+) content of the samples were determined with Gallen Kanp flame Analyzer. Standard solution was prepared in the range of 1,2,3,4 and 5 mol/L, the samples were aspirated into the flame analyzer calibration graph and concentration of Na^+ and K^{2+} in the sample was determined. The concentration was determined in part per million (ppm) as mol/L.

Analysis and Presentation of Result

The values obtained do not vary significantly. Well samples 2,3,7,9 and 10 have little above the determining value of 5 Hazen. Well samples 1,4,5,6,8,11,12,13,14 and 15 are in the acceptable value of 5 Hazen. (See table 1)

As shown in table 2 below, there is no significant variation in the Turbidity values, the least value of 0.40 NTU is recorded from well

sample 4. While the highest average value of 2.80 NTU is from well sample 13 and 14.

There are very high conductance values recorded as in table 3 below. The highest value is 6910u/cm (sample 6) and the east value is1020u/cm (sample 9). The values obtained vary between 25ppm (sample 5) to an average of 200ppm (1, 11, and 13). While sample 15, 14, 12 and 2 have close values. (See table 4 below)

Table 5 shows that the pH value shows no variation. The values are between 6.0 and 7.4. The temperature of the samples show slight variation, the value ranges from 24.80^0C and 29.20^0C while the least value is recorded from well sample 14(24.80^0C). Sample 2, 3,4,5,6,7,8,9, and 15 show close average value of 27.91^0C, while well samples 1,11,12,13 and 14 have an average value of 25.87^0C.

In the cations tested as show in table 6, Sodium (Na^+) concentration ranges between 11.2ppm and 90.46, highest concentration of Na^+ is from sample 3 (90.46ppm). On the average sodium ion concentration is about 43.12ppm. Potassium ions (K^+) concentration ranges from 06.80ppm and 150.08ppm and highest concentration in well number 6(150.80ppm) and least concentration of 06.80ppm) sample). The calcium ion (Ca^{2+}) concentration ranges from 3.06ppm (sample 15) and 31.57ppm (sample 3) while well 1,2,4,8,9,11 and 14 show nil concentration.

Discussion

In view of the complexity of factors used in determining water quality and contents, and the large choice of variables used to describe the status of water bodies in compositional and qualitative terms, the following were observed. (See figure 1 below)

Conductivity

It was observed during the investigation that conductivity is widely varied. Sample of water from charnokitic igneous rock environment have higher conductance than the granite environment this can be traced to the dissolved component in the charnockitic rocks since ionization increases conductivity in water.

Colour, Turbidity and pH

The water in the wells were moderately coloured and not beyond the set standard by WHO (that should not be greater than 10 Hazen). Turbidity values show variations but not higher than the 5mg/Litre World Health Organization standard. Finally the pH is within WHO acceptable and recommended value for drinking water.

Sodium (Na^+) and potassium (K^+)

The values of sodium and potassium obtained are directly related to the lithiology (rock type) of the study area. The sodium which is from weathered granitic and charnockitic rocks that contain Plagioclase feldspar, the presence of potassium is connected with rocks that is made of Orthoclase feldspar e.g. weathered microcline that infiltrate the underground water.

Conclusion

The result from this research shows that Ado-Ekiti is endowed with abundant reserve of underground water. Though the geology (dissolved minerals from bed rock) influences the subsurface water reserve considerably, and whether it constitute health problem depend on the level of mineral concentration. Based on the data analysis presented earlier on, the chemical parameter of the well water that include test for sodium, potassium, calcium and Magnesium indicate that these minerals are from dissolved element from bed rock which is

granite and charnockite rocks. Also the result showed that the minerals are within the acceptable limit by World Health Organization for drinking water standard.

Recommendation

Based on these findings, harnessing of underground water should not be based on hydrogeological facts alone, but critical analysis of the elemental composition of the water should be done in relation to the geochemistry of the area, and possible treatment carried out before consumption.

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Table 1 Colour

Well site	Sample No	Hazen colour
1	WS A1	5
2	WS A2	5-10
3	WS A3	5-10
4	WS A4	5
5	WS A5	5
6	WS B1	5
7	WS B2	5-10
8	WS B3	5
9	WS B4	5-10
10	WS B5	5-10
11	WS C1	5
12	WS C2	5
13	WS C3	5
14	WS C4	5
15	WS C5	5

Table 2 Turbidity

Well site	Sample No	Turbidity (NTU)
1	WS A1	2.6
2	WS A2	0.43
3	WS A3	0.5
4	WS A4	0.40
5	WS A5	1.8
6	WS B1	2.5
7	WS B2	2.7
8	WS B3	2.55
9	WS B4	1.25
10	WS B5	0.50
11	WS C1	1.70
12	WS C2	2.70
13	WS C3	2.80
14	WS C4	2.80
15	WS C5	2.0

Source: Field test

Table 3 Conductivity

Well site	Sample No	Conductivity (un/cm)
1	WS A1	2650
2	WS A2	2650
3	WS A3	2450
4	WS A4	2920
5	WS A5	6780
6	WS B1	6910
7	WS B2	1140
8	WS B3	2210
9	WS B4	1020
10	WS B5	2330
11	WS C1	2200
12	WS C2	2120
13	WS C3	2120
14	WS C4	2570
15	WS C5	2030

Source: Field data

Table 4 Hardness

Well site	Sample No	Hardness $CaCo_3$ (ppmg/L)
1	WS A1	200
2	WS A2	125
3	WS A3	200
4	WS A4	65
5	WS A5	25
6	WS B1	100
7	WS B2	160
8	WS B3	100
9	WS B4	150
10	WS B5	180
11	WS C1	200
12	WS C2	125
13	WS C3	200
14	WS C4	122
15	WS C5	120

Source: Laboratory analysis

Table 5 pH and Temperature

Well site	Sample No	pH	Temperature (^{0}C)
1	WS A1	7.2	26.51
2	WS A2	6.7	27.10
3	WS A3	6.5	27.20
4	WS A4	6.0	29.20
5	WS A5	6.5	28.07
6	WS B1	6.8	28.02
7	WS B2	6.9	28.01
8	WS B3	6.8	27.01
9	WS B4	6.5	28.61
10	WS B5	7.4	28.62
11	WS C1	7.1	25.61
12	WS C2	6.8	26.42
13	WS C3	6.8	26.03
14	WS C4	6.0	24.80
15	WS C5	6.10	27.30

Source: Field data

Table 6 Result of Mineral Dissolved in Water Samples

Well site	Sample No	Na^{+}(ppm)	K^{+}(ppm)	Ca^{2+}(mg/L)	Mg^{2+} (mg/L)	Ca^{2+} (mg^{2+}mg/L)
1	WS A1	66.17	90.00	-	-	-
2	WS A2	52.87	72.80	-	-	-
3	WS A3	90.46	128.1	36.32	36.32	67.89
4	WS A4	30.56	20.0	-	-	-
5	WS A5	17.01	06.80	-	-	-
6	WS B1	62.07	150.08	12.50	35.08	47.58
7	WS B2	21.84	56.0	9.63	9.47	19.10
8	WS B3	35.63	18.0	-	-	-
9	WS B4	11.26	10.40	-	-	-
10	WS B5	52.07	88.0	11.88	32.26	44.14
11	WS C1	37.50	19.58	-	-	-
12	WS C2	26.44	20.80	13.00	10.0	23.0
13	WS C3	99.00	12.00	35.5	29.2	64.70
14	WS C4	25.20	10.20	-	-	-
15	WS C5	18.80	11.20	3.06	3.47	6.53

Source: Laboratory analysis

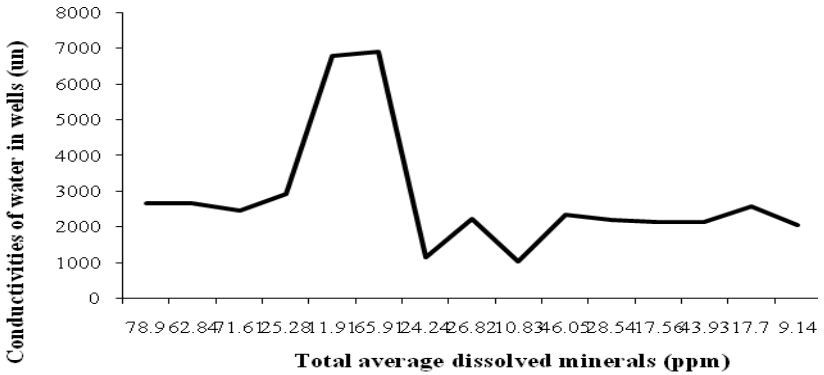

Figure 1: Conductivity of water in wells versus total average dissolved minerals