Impact Of Quarrying Activities on The Water Quality in Ikpeshi, Akoko-Edo, Edo State, Nigeria

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Abstract- This study focused on the impact of mining activities on the water quality in the study area. The study was conducted by insitu and laboratory analysis of surface water and groundwater samples collected from the area. The revealed that the groundwater is of rather fairly polluted quality with values slightly higher than the guideline values of WHO standard compared to the surface water. The Stiff diagram shows that the hydrochemical signatures of the surface water are the same, indicating that the surface water in the study area is affected by the geology and it is usually feed from runoff from the mines, exposing it anthropogenic activity. The hydrochemical signatures of the shallow groundwater (hand-dug well) were similar to that of the surface water, while that of the other groundwater shows a different signatures. This indicates that the groundwater hydrochemical is typically affected by geology and are not prone to anthropogenic activities compared to the surface water and shallow groundwater.

Indexed Terms- Physico-chemical, water quality, hydrochemical, mining

I. INTRODUCTION

Mining operations usually create negative environmental impact, both during the mining and post mining activities. Pollution comes from a variety of sources, including drilling and blasting operations, vehicle and equipment exhaust emission, exhaust release from factories, waste water disposal, poorly-managed winning of minerals and others. The rocks hosting these minerals usually contain trace elements and the process of crushing these rocks liberates these elements (heavy metals, non-metals) into the environment (air, soil or water) thereby posing a lot of environmental hazards [1]. This heavy metals usually affects the quality of water, the heavy metals concentration sequence of Fe>Mn>Cu>Zn>Cr>Pb>Cd>Ni>V, with Ca-HCO3 water type in Igarra, Edo State, Nigeria [2]. These activities usually result in environmental pollution and degradation [3]. Hence, most nations have passed regulations to reduce these environmental impacts.

Mining operations have negative effects on surface and groundwater, the mining activities in the study area pose major threat to the environment. This necessitated the investigation of the environmental impact assessment of mining operations on air, soil, and water quality of the study area.

The mining of dolomite in the study area, has necessitated the removal of overburden to strip the mineral deposit open for extraction/ exploitation, this has invariably led to redirection of a number of hydrological (water body courses and channels) thereby interfering with their natural physicochemical properties. Likewise, the pits created had accumulated water from surrounding formation thus affecting the groundwater levels. In a related manner, stripped overburden and other spoil dumped as heaps over surface soil in nearby have had rain precipitation infiltrated through them and discharge as run-offs from heap base to surrounding soils most times mixed with surface erosion.

II. THE STUDY AREA

The study area lies within latitudeN7°06' andN7°11'and longitude E006°08' and E006°15', in South Western Nigeria. The study covers the following quarries: Freedom Group Limestone Quarry, Fanolu Nigeria Limited and Goopex Limestone Quarry are all located at Ikpeshi, a village along the Ibilo-Auchi Expressway in Akoko Edo Local Government Area of Edo State.

The geology of the study area comprises of the crystalline basement complex rocks and the meta-sediments (figure 1). It lies within the Pre-Cambrian Basement Complex of Southwestern Nigeria. The granitic rocks in the study area intruded the most easterly schist belts [4], with the schist been foliated in NW-SE direction and some others N-S. There are also occurrences of joints, fractures and quartz veins in the granitic rock. The rock types in the study area includes migmatitegneiss complex, the metasediments (schists, calc-silicate rock, quartzites, marble, metaconglomerates, dolomitic-marbles) and the porphyritic older granite which are discordant, non-metamorphosed syenite dyke [5].

The calc-silicate rocks, marble and dolomite deposits in study area areas are of economic importance in the study area, which were been mined in the area.

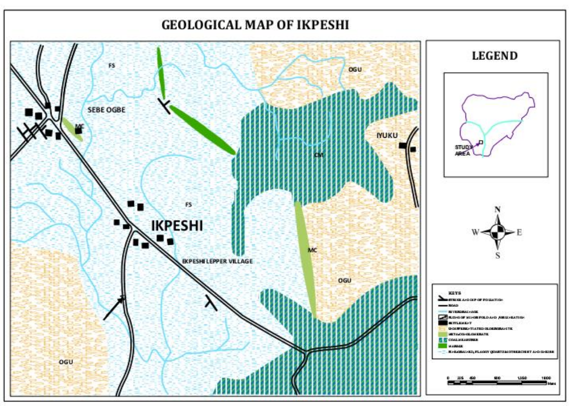


Fig. 1: Geology map of Nigeria [6]

III. METHODOLOGY

Surface and groundwater sampling were obtained from the quarries and immediate/neighboring environments at 12 and 18 locations respectively in a random fashion based on site observed relative importance to the study according to simple random standard sampling procedure.

The in-situ testing of water samples was done by collection of water sample into sample containers, and pH multi-meter was used to measure the physical parameter of the water sample. Electrical Conductivity was determined by switching the pH meter to EC mode and Total Dissolved Solid (TDS) determination by switching the pH meter to TDS mode. Titration method and Atomic Absorption Spectrometer (AAS) was used in the laboratory for quantitative chemical analysis of the major and minor ions and heavy metal concentration in the water samples.

IV. RESULTS AND DISCUSSION

The table I shows the statistical physico-chemical analysis of surface water and groundwater in the study area

Table I: Statistical Physico-chemical Analysis of Surface Water and Groundwater in the Study Area

Parameters	Mean		StD		Range	
	SW	GW	SW	GW	SW	GW
pH	7.53	6.39	0.73	1.15	2.40	4.2
EC µS/cm	306.58	308.28	105.10	185.76	355.00	805.50
Sal g/l	0.02	0.02	0.03	0.04	0.07	0.13
*Col.*Pt.Co	0.00	0.00	0.00	0.00	0.00	0.00
Turb. NTU	0.00	0.00	0.00	0.00	0.00	0.00
TSS mg/l	0.00	0.00	0.00	0.00	0.00	0.00
TDS mg/l	341.70	168.52	211.99	82.25	551.00	274.90
DO mg/l	2.58	2.88	0.55	0.91	1.70	2.80

BOD mg/l	1.17	1.04	0.65	0.49	1.90	1.50
COD mg/l	82.08	92.26	76.11	64.11	177.10	157.20
HCO_3 mg/l	292.48	226.54	122.14	104.06	285.40	372.10
Na mg/l	0.55	0.56	0.21	0.22	0.65	0.74
K mg/l	0.13	0.11	0.06	0.05	0.17	0.19
Ca mg/l	3.45	3.41	0.42	0.76	1.51	2.89
Mg mg/l	1.25	1.17	0.42	0.41	1.36	1.48
Cl mg/l	60.10	87.08	23.33	46.16	61.80	159.40
P mg/l	0.15	0.21	0.09	0.12	0.23	0.40
NO_2 mg/l	0.09	0.11	0.06	0.06	0.16	0.17
NO_3 mg/l	3.13	1.67	1.07	0.88	3.69	2.67
SO_4 mg/l	0.30	0.35	0.19	0.20	0.56	0.57
Fe mg/l	0.64	0.49	0.12	0.18	0.35	0.56
Mn mg/l	0.49	0.35	0.25	0.25	0.66	0.90
Cu mg/l	0.40	0.27	0.25	0.24	0.65	0.81
Zn mg/l	1.19	0.80	0.32	0.42	1.02	1.41
Pb mg/l	0.07	0.05	0.05	0.03	0.15	0.10
Cd mg/l	0.04	0.02	0.02	0.02	0.06	0.07
Cr mg/l	0.10	0.10	0.05	0.05	0.14	0.15
Ni mg/l	0.03	0.01	0.02	0.01	0.07	0.05
V mg/l	0.01	0.01	0.01	0.01	0.04	0.03

*SW – Surface water, GW – Groundwater, StD – Standard deviation.

The concentration of constituents in the groundwater (Table I) shows that the pH values of the groundwater has an average value of 6.39±1.15, and a range of 4.20. The pH values of the surface water from the study area shows that the surface water have an average value of 7.53±0.73, and a range of 2.40, which is slightly basic in nature as a result of slight increase in the pH value. in general, a water with a pH <7 is considered basic, the normal range for pH in groundwater is 6.5 to 8.5 (WHO, 2012).

The EC for the groundwater have an average value of 308.38±185.76 µS/cm, and a range of 805.50 µS/cm. The EC for the surface water have an average value of 306.58±105.10 µS/cm and a range of 355.0 µS/cm. The Salinity for the groundwater has an average value of 0.02±0.04 µS/cm and a range of 0.13 µS/cm. The Salinity for the surface water has an average value of 0.21±0.27 µS/cm and a range of 0.72 µS/cm, The Coloration for the groundwater has an average value of 0.00±0.00 µS/cm and a range of 0.00 µS/cm. The Coloration for the surface water has an average value of 0.00±0.00 µS/cm and a range of 0.00 µS/cm. The Turbidity for the groundwater has an average value of 0.00±0.00 µS/cm and a range of 0.00 µS/cm. The Turbidity for the surface water has an average value of 0.00±0.00 µS/cm and a range of 0.00 µS/cm. The Total Suspended Substance (TSS) for the groundwater has an average value of 0.00±0.00 µS/cm and a range of 0.00 µS/cm. The TSS for the surface water has an average value of 0.00±0.00 µS/cm and a range of 0.00 µS/cm.

The Total Dissolved Solid (TDS) for the groundwater have an average value of 341.70±211.99 µS/cm and a range of 274.90 µS/cm. The TDS for the surface water have an average value of 168.52±82.25 µS/cm and a range of 551.00 µS/cm. The Dissolved Oxygen (DO) for the groundwater has an average value of 2.88±0.91 µS/cm and a range of 2.80 µS/cm. The DO for the surface water has an average value of 2.58±0.55 µS/cm and a range of 1.70 µS/cm. The Biochemical Oxygen Demand (BOD) for the groundwater has an average value of 308.38±185.76 µS/cm and a range of 805.50 µS/cm. The BOD for the surface water have an average value of 1.17±0.65 µS/cm, with a minimum value of 0.30 µS/cm,, maximum value of 2.20 µS/cm and a range of 1.90 µS/cm. The EC for the groundwater have an average value of 308.38±185.76

μS/cm and a range of 805.50 μS/cm. The EC for the surface water have an average value of 306.58±105.10 μS/cm and a range of 355.0 μS/cm, this shows that the area is lightly polluted as a result of high EC and BOD.

The physico-chemical results of the water samples were used to interpret the water chemistry and the rock – water relationship in the study area. This was done by plotting a piper and stiff diagrams of the cations concentration in the water which is of the following order Ca>Mg>Na>K the anion concentration of the water in the study area which is of the following order HCO_3>Cl>SO_4. The significance of these orders is that it shows the relationship of the ions concentration in the water in the study area.

Piper diagram is a hydrochemistry diagram that is used for the classification of the water type or facies, as well as the rock – water relationship. The piper diagram for the surface water is shown in figure 2 while figure 3 shows the piper diagram for groundwater in the study area, this show that water in the area is of Calcium-bicarbonate (Ca-HCO_3) water type. This shows the relationship between the mining activities and their interaction with the water bodies in the study area, with the surface water been typical Ca-HCO_3 water than the groundwater, because it is readily exposed to mining activities than the groundwater.

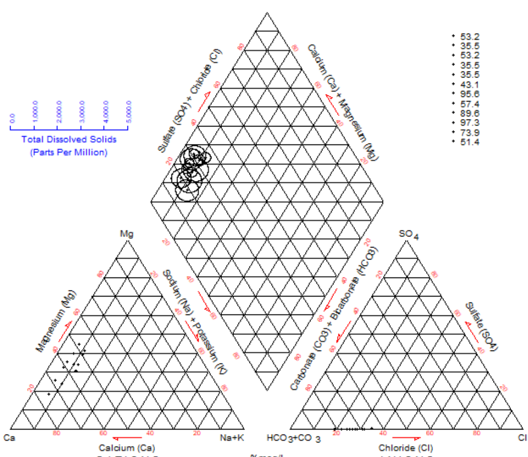


Fig. 2: Piper Diagram for Surface Water Classification

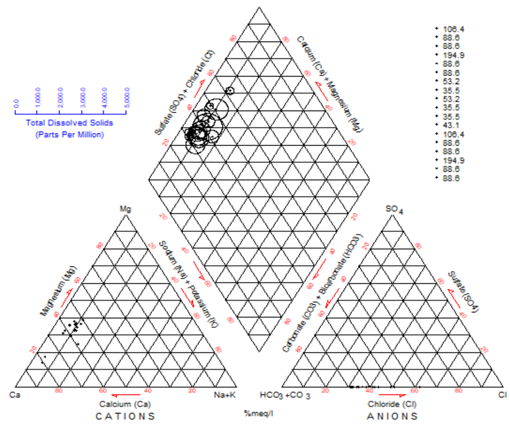
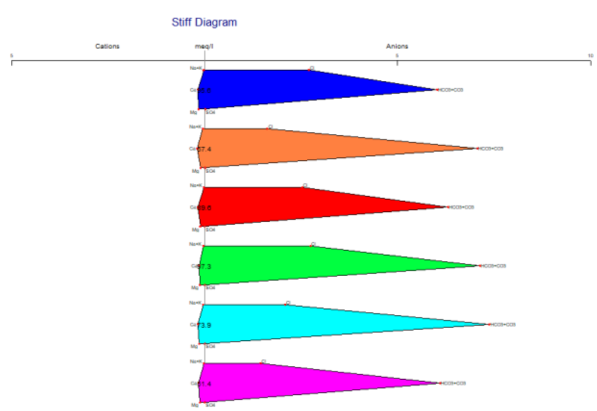


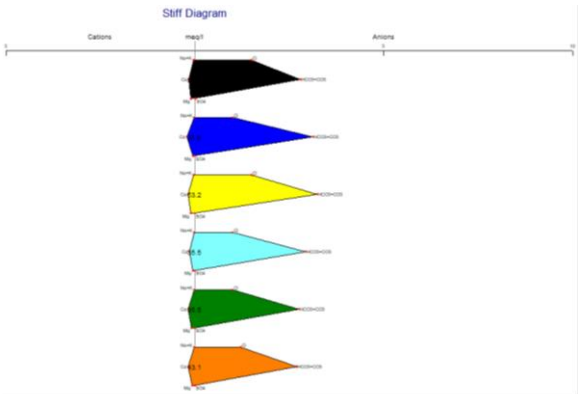
Fig. 3: Piper Diagram for Groundwater Classification

The diagram indicates that the concentration of Ca and Mg in the water is above 80 %, Na and K is less than 20 %. The concentration of HCO_3 and CO_3 is an average of 70 % and, SO_4 and Cl is about 25 %.

A Stiff diagram is a graphical representation of hydrochemical characteristics of the water and it displays the major ion composition of a water sample. It is a plot of cations concentrations on the left side of the diagram and the anions on the right, and each plotted point are connected to form a polygonal shape, which defined the water signatures. The Stiff diagram shows the hydrochemical signatures of the surface water and groundwater in figure 4 and 5 respectively.



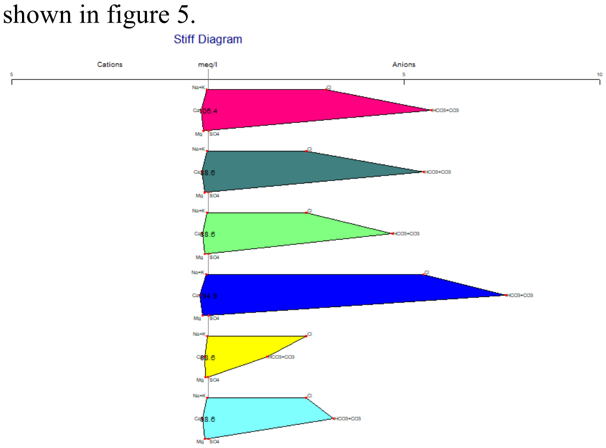
(a)



(b)

Fig. 4: Stiff Diagram for the Surface Water in the Study Area

Stiff diagram for the groundwater in the study area is shown in figure 5.



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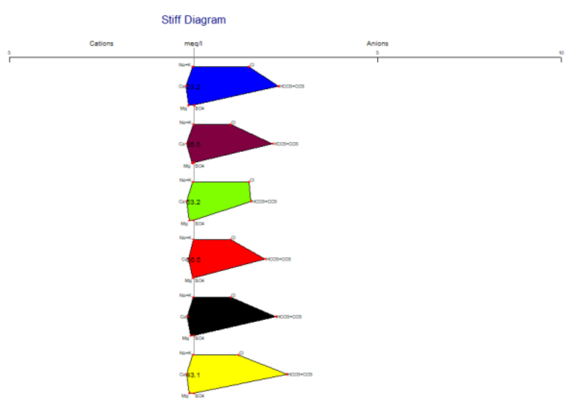

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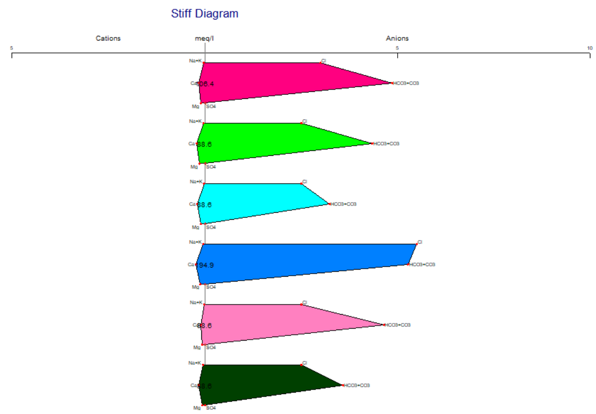

(c)

Fig. 5: Stiff diagram for the Groundwater in the Study Area

The diagram shows that the hydrochemical signatures of the surface water are the same, indicating that the surface water in the study area is affected by the geology and some were usually feed by the runoff from the mines, thereby rendering the water to be exposed to anthropogenic activity. The Stiff diagram indicates that the hydrochemical signatures of the shallow groundwater (hand-dug well) were similar to that of the surface water, while the hydrochemical signatures of the other groundwater (boreholes) shows a different signatures. This indicates that the groundwater hydrochemical is typically affected by geology and are not prone to pollution compared to the surface water.

CONCLUSION

The mean values recorded for all studied parameters were between 0.0 minimum and 833 maximum respectively. These suggest that the groundwater is of rather fairly polluted quality with values slightly higher than the guideline values of WHO standard compared to the surface water, while the surface water are highly polluted because the recorded values are than regulating agencies guidelines.

The Stiff diagram shows that the hydrochemical signatures of the surface water are the same, indicating that the surface water in the study area is affected by the geology and some were usually feed by the runoff from the mines, thereby rendering the water to be exposed to anthropogenic activity. The study reveals that the hydrochemical signatures of the shallow groundwater (hand-dug well) were similar to that of the surface water, while that of the other groundwater shows a different signatures. This indicates that the groundwater hydrochemical is typically affected by geology and are not prone to anthropogenic activities compared to the surface water and shallow groundwater.

REFERENCES

[1] Amadi A. N., Dan-Hassan M. A., Okoye N. O., Ejiofor I. C. and AminuTukur, (2013). Studies on Pollution Hazards of Shallow Hand-Dug Wells in Erena and Environs, North-Central, Nigeria. *Environment and Natural Resources Research,* 3 (2), 69 – 77.

[2] Umoru T. A., Sule T. U. N, Sanni E. B., Eguaoje S. O. and Abubakar S. R. (2021). Physico-Chemical Investigation of Groundwater Quality in Part of Igarra, Edo State, Nigeria. International Journal of Innovative Research and Advanced Studies, 8 (4), 130 – 134.

[3] Gibson G, and Klink J (2005). Canada's resilient north: the impact of mining on aboriginal communities. *Pimatisiwin*. 1(3), 116 – 139.

[4] Turner, D. C. (1983). Upper Proterozoic schist belts in the Nigerian sector of the Pan- African Province of West Africa. Precambrian Res, 21, 55–79.

[5] Odeyemi, I. B (1976). Prelimnaryreport on the field relationship of the Basement Complex rocks around Igarra, Midwest Nigeria, In Geology of Nigeria, edited by C.A Kogbe, 59 – 63. Elizabeth Publication, Lagos.

[6] Agomuo M. S and Egesi N (2016). Petrology and Structural Geology of Ikpeshi and It's Environ of Igarra Schist Belt Southwestern Nigeria. *International Journal of Science Inventions Today*, 5(4), 303-319

[7] World Health Organization, (2012). Guidelines, for drinking water quality. First addendum to the Third Edition Volume 1. Recommendation, 491 – 493.