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Research Article

VARIABILITY OF BRINE WATER QUALITY IN KEANA AND AWE, NASARAWA STATE, NIGERIA

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ABSTRACT

This study examines the seasonal variability of water properties under mining activities in Awe and Keana Local Government Areas of Nasarawa State.. A total number of eighty (80) water samples were collected and analysed for the physical and chemical and environmental impact of brine water in the two areas. The results of the chemical analysis revealed that the cation concentration are in order of Ca^{2+} < Mg2 > Na, while that of anions are in the order HCO_3 > SO_2^{2+} > SO_4^{2+} > Cl. The concentrations of heavy metal (Cd, Cu, Nm, N, Pb, Zn, Al, Cr, and Fe) were determined in salt water using Aua Regia Extraction analysis. The concentration of heavy metal in the soil samples ranges as follows (ppm): Cd (0.001 trace), Cu (0.01 – 8), Nm (12 – 60), Ni (Trace), Pb (0.01 – 8), Zn (0.001 – 6), Al (0.65 – 2.50), Cr (Trace), Fe (0.02 > 10). In percentage, the degree of metal concentration is comparable in the two study areas, except for some non metals. Significant positive correlations were observed between and among the metals. The geo accumulation index order for brine in Fe > Cu > Zn > Mn > Al > Pb > Al > Cd > Ni > Sn. Evaluation of chemical analysis results revealed that there are significant variations between metals. The major salts identified were HCO_3^{2-} , SO_4^{2-}, Cl^-, and NO_3^{2-}., The high conductivity value recorded in the HCO_3^- is as a result of high concentration of brine water in the study areas.

Keywords: Physico-Chemical Properties, Oxisol, Trace Metals, Hydromorphic And Under Ground-Water.

INTRODUCTION

A number of occurrences of brine are known in the NE-SW sedimentary belt of Nigeria, mostly within the Benue trough. Significant outcrops or occurrences which currently support local salt production are found at Okpanta, Ishiagu, Abachor, Iyegu, Gabu and Woda (Cross River State), Mol Igor and Oku, Lake (Benue State) and Keana, Awe, Azara and Akiri (Nasarawa State). Brine occurs as an extension spring in small pounds and in dug wells and has electrical conduction of about 10,000 S/cm. The equivalent salt concentration is about 0.5% to over 8%. The higher concentration values are over two times the concentration of sea water. This makes the brine more attractive for commercial development than sea water in Nigeria.

It is however worthy to note that the discovery of brine dates back to the origin of the associated villages or settlements where brine has been the traditional source of edible salt. Saline water is as old as Keana and Awe towns. Some of the Fulani herdsman who were early settlers in the area have remained in these towns called Keana and Awe today due to prevalence of saline water which they tagged as been spiritual. They believe that saline water can cure many internal and external diseases. In recent times, the level of derivate table salt from saline water has reduced, so also its elemental derivatives. People of the area (Keana) and are lamenting that because of resettlement at the upper part of the stream which rechanneled the movement of saline water to their traditional pond, the saline concentrates reduced with little or no salts now in the traditional pond.

There are however over 25 documented saline springs where salts are locally processed with unknown reserve across the middle Benue valley with their sources remaining at point of argument among so many authors, where more than 10 different minerals are been mined. Among the minerals mined, only Barite's reserve has been estimated to be about 730,000 tones. Other mineral deposits include Lead, Zinc. Limestone, Coal and Copper. In order to reduce the over dependency of the country on oil as the major source of revenue generation, there is need to evaluate other mineral resource potential of the middle Benue valley to boost the revenue generating capacity of the country..

Currently, active exploitation of these minerals resources is going on within this region but with no adequate data on their quality, reserve and the effects of such exploitation on the environment. This study attempts to provide information that

THE STUDY AREA

The southern landscape of the study area forms part of the low plains of the Benue trough. These plains are believed to be tectonic in origin. Others are composed of undulating lowlands and a network of hills developed on granites, migmatites, pegmatites and gneisses'. Around the mining village of Awe are a number of worn out volcanic cones.

However, around the salt-bearing areas of Awe and Keana are detached synclinal areas formed by localized folding. The brine spring of Awe is associated with anticlinal axis along which salt – bearing beds with the synclines approach the surface.

The Awe formation was deposited as passage (transitional body) during the late Albion Early Cinemania Regression. This formation overlies the ASU River group. Lying above the ASU River are about 100m of Flaggy, pale coloured and medium to fine grained ulcerous sandstones, carbonaceous shales and clays. The sand stones become the fined grained and more micaceous towards the base with fine beddings. Ofodile, (1976) described the Awe formation as "passage beds of Falconer".

The Keana formation resulted from the cenomanian regression, which deposited fluvio-deltaic sediments. In the Lafia-Awe area, the Keana formation could be traced south ward into the Makurdi formation and it is believed to be a lateral equivalent. The Keana formation consists mainly of thin-bedded, cross-bedded, fine to very coarse-grained, sometimes conglomeratic gritty arkosic sandstones of infrared fluvial or deltaic origin (Mural, 1972: Ofodile, 1976). Ofodile (1976) and Reyment (1977) described the Keana formation as places lying below beds referred to the Aku formation and elsewhere inter-lingering with them.

The study areas are characterized by a tropical sub-humid climate with two distinct seasons. The wet season lasts from about the beginning of May and ends in October. The dry season is experienced between November and April. Annual rainfall ranges from 1100mm to about 2000mm. About 90% of the rainfall between May and September (the wettest months), begin around July and August. The rain comes in thunderstorms of high intensity.

could inform policy decision on the management of other mineral deposits.

Soil is a dynamic mixture of water, air, minerals and organic materials that include decaying plant or animal's tissue. It spreads out as a thin layer over the earth surface. It is a natural body consisting of layers (soil horizons) of primarily mineral constituent of variables thicknesses which differ from the parent materials in their texture, structure, consistence, colour, chemical, biological and other physical characteristics. The major soil units of the area belong to the category of oxisols or tropical ferruginous soils. The soils are derived mainly from the Basement Complex and old sedimentary rocks. Laterite crust occurs in extensive areas on the plains, while hydromorphic soils occur along the flood plains of major rivers.

The soils of Awe and Keana are lateritic, which may be referred to as "INCEPTISOLS" (These soil types occur on recently accumulated alluvial sediments of flood plains). These soils have a common property of being moist and poorly drained, almost throughout the year and with the soil water table being very high. Drainage and oxidation of these soils lead to the formation of large concentration of sulphates in subsoils. More so, the availability of iron (Fe) has made the colour of the soil generally reddish. The soil units found in the study area belong to the category of oxisol tropical ferruginous soils (Nyagba, 1995). The soils are derived many from the basement complex and old sedimentary rocks. Laterite crest occurs in extensive areas on the plains while hydromorphic soils (humicinceptisols) occur along the flood plains of major rivers. In Awe, loamy soils of volcanic origin are found around the volcanic cones or crater.

The study areas fall within the southern Guinea Savanna zone. However, clearance of vegetation for farming, fuel wood extraction, for domestic and cottage industrial uses and saw milling has led to the development of re-growth vegetation at various levels of seral development. Dense forests are few and apart. Such forests are found in lowland areas.

Temperatures are generally high during the day, particularly between the months of March and April. The mean monthly temperature ranges between 20°C and 34°C, with the hottest months being March and April and the coolest months being December and January. Figure 1, 2 and 3 shows the location of the study area.

Figure 1: Map of Nigeria; Showing Nasarawa State (source: Federal Survey Department, Abuja)

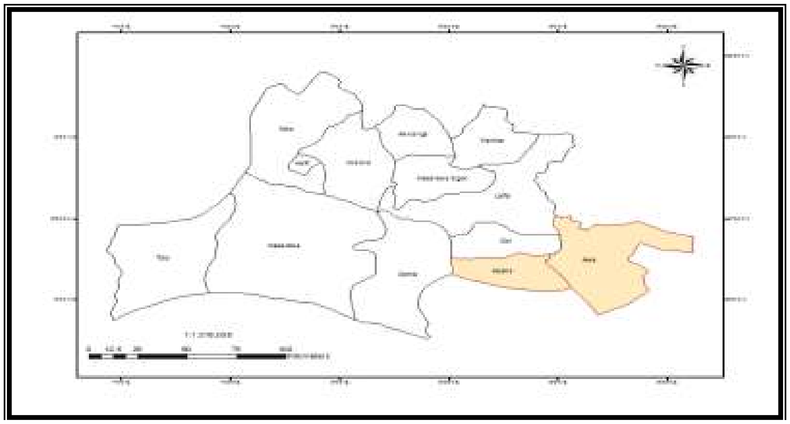

Figure 2: Map of Nasarawa State showing the Study Areas (source: Federal Survey Department, Abuja)

MATERIALS AND METHODS

Field work in the study area (Awe and Keana) was undertaken at several points of Saline spring and ponds in Awe and Keana since February 2013. . The study areas were mapped and soil 40 samples were collected. At the field, basic physico-chemical properties of the saline waters, like temperature, pH, conductivity were determined, while others were determined in the laboratory. In all, 25 elements and minerals were determined for the brine water analysis.

Sample Collection, Treatment and Preservation in Study Areas

Soil samples were collected in the months of February and August during the peak of dry and raining season respectively.

A total number of 80 water samples were collected for physico-chemical analysis of drainage system within the study Area Samples were collected in 2-litre plastic containers which had been adequately washed and rinsed with distilled water for sampling. About 1 litre of each of the samples collected was filtered and the volumes were used for the analysis of metals with acidified nitric acid to prevent the metal from adhering to the wall of containers. For further purposes, the entire samples collected were refrigerated at 10^oC before eventual analysis.

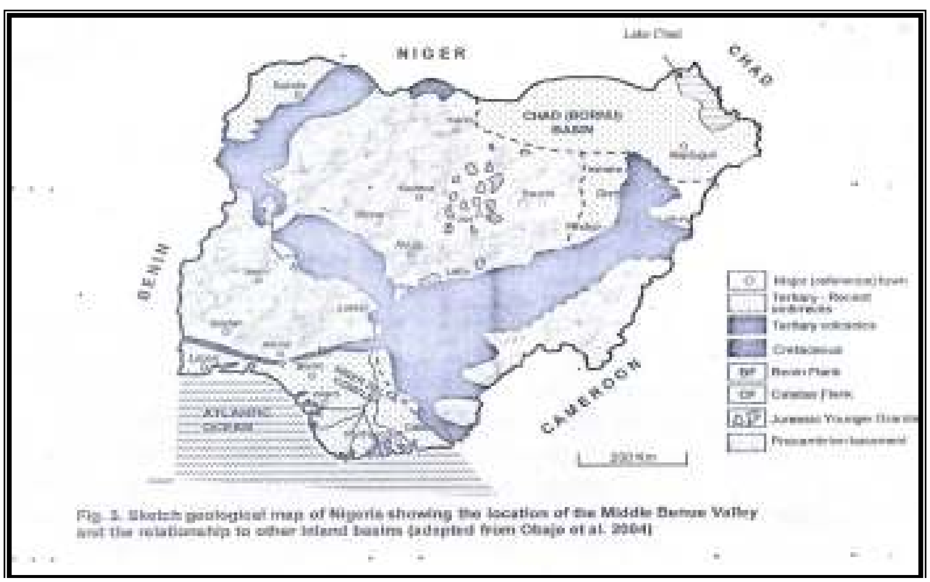

Figure 3: Location of the Middle Benue Valley

Mineral Analysis

All the analyses were carried out in the laboratory in accordance with American Public Health Association (1939) standard methods for examination of water. The elemental analysis was done in the water sample using Perkin Elmer and Oak Brown, atomic spectrophotometer. The instrument setting was described by Atolaye *et al* (2006) and Aremu et al (2008). Sodium and Potassium were determined by using a flame photometer (Model 405, corning UK) as does by Aremu and Inajoh (2007).

Physico-Chemical Analysis

Temperatures were measured using a mercury thermometer while pH was done using a BNC pH meter. Conductivity measurement was done using conductivity meter model

NATOPPS while alkalinity and total hardness were done by titremetry (APHA, 1995). Chloride was measured by chloride ions water (Model KRKC1-sz Japan). Phosphate (Molybodonphosporis blue colour method in H_2SO_4 system) and nitrate ions were estimated using PYE UNICAM visible spectrophotometer in NAFDAC, in Lagos. Total dissolved solves were determined by gravimetric method and chemical oxygen demand (COD) by APHA method (APHA, 1995).

Colour

The colour of the superficial materials in Keana and Awe were determined in the laboratory using simple Munsell colour chart. The colour analyses were determined by distinguishing different texture and structure of the water.

Exchangeable Cations (Calcium, Magnesium, Sodium and Potasium)

The level of exchangeable cations in the water sample not only indicates existing nutrients status, they can be used to assess the balance amongst cations. This is of great importance because exchange cations have many effects on water structure and nutrients uptake by vegetating consequently determining the nutrients status of the water. Soil extracts containing the nutrients cations were obtained by leaching the lake with N neutral ammonium acetate. The concentrations of calcium, magnesium, potassium and sodium were determined with the help of an atomic absorption spectrophotometer.

Cation Exchangeable Capacity

Cation exchange capacity (CEC) measurements are commonly made as part of the overall assessment of the potential of water turbidity and a possible response to chemical application. Soil cation exchange capacity was determined by the summation method; that is, the sum of exchangeable calcium, magnesium, potasium, sodium and exchangeable acidity.

pH

PH is a good indicator of water acidity or basicity (Miller and Donahue, 1992). The water pit greatly affects the solubility of minerals. It also influences plant growth by the pH effect on activity of beneficial microorganism. Water pH was determined potentiometrically on a 1:2:5 ratio. Water suspension and measured with a combination electrode using KCl gel (Hesse, 1971).

Available Phosphorus

Available soil phosphorus is low in many muddy lakes (Miller and Donahue, 1992). Available phosphorus extract in Kean and Awe lakes were obtained by leading the lakes with Bray P-1 extracting solution (0.025 N HCL+0.03N NH_4+). The concentration of available phosphorus was determined calorimetrically with a spectronic 20 spectrophotometer after the colour had developed with Murphy and Riley reagent (Bray and Kurtz, 1945).

Soil Organic Carbon

Soil organic carbon derived from living or dead plant and animals remains is a very active and important component of the soil and also determined the presence of animal on stone-like formation (Johnson, 1998). However, high amount of water organic carbon at level of the horizon determine the extent by which small mammal and animals carried out reworked activities within the superficial deposits. It is the nitrogen reservoir, also the main source of water phosphorus and sulphur. Subsequently, it protects the lake against erosions by supplying the cementing substances of describable aggregate formation. It also loosens up the soil to provide better aeration and water movement (Miller and Donahue, 1992). Organic in the soil samples taken was determined by the Walkley Black Dichromate method (Hesse, 1971).

Total Nitrogen

Nitrogen is one of the essential nutrients for plants growth and also a compliment of soil organic matter. The higher the level of soil nutrients, the higher the level of nitrate of nitrogen in a soil horizon. It is a constituent of plant proteins, chlorophyll nuclei, acid (the regenerative portions of the living cell), and other plant substances. Nitrogen in the soil samples of Keana and Awe were determined by the micro-Kjeldahl method (Hesse, 1971).

Micro-Nutrients

In addition to the macro elements mentioned above, soils also have small quantities of other elements known as trace elements or micronutrients. Six micronutrients, which are considered essential in soil analysis, were also determined. These are copper, iron, manganese, zinc, boron and molybdenum (London, 1991). The first four are known to be soluble in acid solutions.

In strongly acid soil, manganese, zinc and copper may dissolve to form toxic concentrations that hinder plant growth and further catalyse the oxidation state of ferruginous stone materials in the tropics. Manganese, Zinc and iron are also the micronutrients most often deficient in soil of arid and semi-arid regions.

The concentrations of molybdenum, boron, zinc, iron, copper and manganese were determined by the hydrofluoric acid (0.1M, HCL) extraction method with the atomic absorption spectrophotometer.

The water samples were analyzed in the laboratory using a number of selected water chemical reagents and following standard procedures outlined in the previous chapter. The analysis were carried out with the objectives of finding out the variation of distribution in the chemicals within and between each sides and from there to understand the quality of water, soil and quantity of various element (chemicals) and heavy metals that are more in proportion in the salt lake in the two study areas. A total of 25 micro and macro elements and heavy metals were investigated in the laboratory. For each sampling point, analysis was done for water samples taken at two study points. In this way, one can determine if there is any significant relationship between each point and the control site area.

Simple Correlation Analysis

The simple correlation analysis was used to establish the level of correlation between salt lake formations in the different geological regions of Keana and Awe. Simple correlation analysis deals with association or relationships between two variables providing measures of strength of their association and statistical test of their significance. The simple correlation analysis is a measurement of closeness of association between two ordinal variables.

The coefficient of correlation (r) was computed using the actual values of dependent (X) and independent (Y) variables. The correlation was applied to test the null hypothesis regarding the nature and occurrence of spring line in Keana and Awe.

Simple bivariate correlation results and dispersion were focused primarily on those relationship with a minimum correlation coefficient of 0.312 ($P<0.05$) based on the sample size of the water contents.

RESULTS AND DISCUSSION

Physico-chemical Analyses Of Mining Areas

The physic-chemical parameters analysed are shown in Tables 1 and 2 and Figures 1-7.. From the two Tables and the Figures, the temperature of the salt water varies from 34-48^{0}c in Awe to 38 to 20^{0}c in Keana.

The electric conductivity of various elements in the Awe and Keana salt water respectively are 6910.30mm and 11375.67mm, which means that the mean average of total dissolved salt in Keana is more than that of Awe salt lake.

PH: - The average mean acid varies between Awe and Keana. However based on Ezeigbo (1989), grouped pH varies as follows:

5	–	Acidic
5 – 6	–	lightly acidic
7	–	Neutral
7.5 – 8.5	–	Alkaline

The analysis of salt belt in Awe and Keana runs from weak acidic solution in Awe to slightly Alkaline in Keana. Based on this classification which is injurious to health, the water is not fresh and the pH is above World Health Organization standard for drinking waters (see tables 1, 2 and 3.) the salt solution is affecting the water quality.

Chemical Properties Of An Iron In The Mining Area

Na^+ ion (sodium): Generally, the amount of Na^+ with the various activities of usages in the brine pond is every high and this has been expressed and shown in tables 1, and 2.

K^+ ion (potassium: Like NA, the actual amount in brine pond during the dry season is relatively high as shown in tables 1 and 2, because of its high electronegativity which means that the reactive activities with other salts and elements are very high, Keana salt lake has the highest with 105.15 followed by Awe pond respectively during the dry season. This shows the high level of rock salt dissolution in water to create water salt in these areas.

Ca^+ ion: It is a divalent element which forms parts of the salt in the brine water body. Quality water needs low calcium salt. The highest amount is deserted as the Keana pond (261.15mm) then lower volume is found in Awe area (103.33mm) during the dry season respectively (tables 1 and 2). The high alternation of the $Ca2^+$ may affect the skin ligament which can lead to skin rashes and pigments.

Mg^{2+} ion (Magnesium): Like calcium magnesium is a divalent element which forms the salt, it is also needed in a small quantity for good quality water. The Keana pond has the proportion amount of 39.10 followed by Awe which is 29.20mm, which is explained in tables 1 and 2 above.

Mn^{2+} ion (Manganese): Generally, the highest amount of **Mn^{2+} ion was** recorded at Keana (0.14) and Awe recorded a lower amount (0.09). The level of Mn is within WHO standard maximum allowable amount surface water, which allowed discolouration with taste.

Fe^{2+} ion: The amount of iron in brine pond is quite low even as various activities are being carried out within the water body of river. The amount at Keana is 1.98, which is above WHO limit, while Awe's iron is 0.55, however, below the limit of World Health Organisation allowable amount in surface water, which allowed taste discoloration, turbidity and growth of iron bacteria.

Ba ion (barium): Barium is a microelement that exists with ion of Na and K as trace element. At certain level, they are inimical to certain gastro diseases. The leachate of the brine ponds in Keana salt lake has level of barium that is above the WHO (2004) maximum allowable amount in surface water.

Nitrate Compound (NO_3¯): Same as Sulphate. No_3¯ compound is buffer to major salt and relatively consumed in very small quantities. The mostly form part of organic matter or artificial fertilizer. The amount found in Keana is very lower (0.20) compared to Awe brine pond which is 13.88. The amount at the two sites are within the limit of World health Organisation standard (Tables 1 and 2) These shows the extent at which organic fertilizer of nitrate supplement is added to the soil and washed away as a leach ate into salt pond (Table 2).

$HC0_3$¯:- The carbonate compound is very common with brine and it's found to be very low if the parent tock is not a limestone, but at the two sites in tables 1 and 2, they are relatively high. Awe has the highest volume of 487.46 while Keana recorded 433.90 in general, they are needed for the extraction of pure edible salt.

CL (Chlorine):- It is an electronegative element which reacts quickly with monovalent elements like Na and K+ to form salt. Most salt compound contain chlorine are high during the dry season, however, the amount of chlorine in tables 1 and 2 at Keana salt pond was very high in volume (6343.75) while Awe is relatively lower than Keana salt pond.

Sulphate (SO_4¯):- Sulphate compound found at the two brine ponds are as a result of usage of fertilizer and the leachate into the ponds. During reconnaissance survey, farming activities were found within and around the salt ponds in these two areas. The amounts are very low compared to chloride ions at the pond. Keana has the lower amount of 0.10 while Awe area has 12.38(see Table 1; 2 and figure 1,2,3,4 and 5).

The Pearson Moment Product correlation examines the relationship between pairs of soil chemical nutrient at Awe and Keana study sites. The values soil properties (moisture contents, organic carbon content, Exchangeable base content, total nitrogen ratio, cation exchange capacity, reactive pH level, potassium, sodium, phosphorus, calcium, magnesium, iron, zinc, copper, and manganese) of the minerals in each site were subject to the ANOVA analyses. Table 3 shows the significance of the relationships between the water nutrients in Awe and Keana.

From the results of the Pearson Moment Bi-variate correlation, the seasonal variation of nutrients content in the brine water has low level of disparity. Moreover the nutrient element of brine water during the rainy and dry season in Awe has 1 correlation level which is significant at 95 and 99% level of

significance, which is not the same as Keana rainy and dry season nutrient level. Furthermore, the level of correlation of the two seasons is .756 at 2- tailed test of significant which is lower than what is obtained in the Awe area.
The correlation of Awe rainy season nutrients and Keana rainy season nutrient level is (.866) which is significant at 95 and 99% level of significant for the 25 nutrient minerals of brine water.
Invariably, the result of correlation during the dry season at the two study areas (Awe and Keana) is higher than the rainy season, due to high concentration of nutrient and evapo-transpiration of surface brine water. The correlation result is .978 which highly significant at 2- tail test.
In conclusion, the general outlook of the quantitative analysis shows the result of the correlation between both the dry and rainy season at the two study areas is significant at the 2- tail test of Pearson product moment correlation and it does not fall short of the results recorded by Aliyu (2007) and Boye, (2010).

Table 1: Mean average of elements and compounds in Awe

Elements	Mean (Dry season)	Mean(Raining season)	WHO Standard (2004)
Temp ^{o}C	34.48	20.34	<40
pH	6.82	4.09	6.9
Dissolve salt	13225.00	7935	500
Ca	103.33	62	<1
Mg	29.10	17.46	<1
Na	2635.27	1581.16	200
K	64.88	38.92	<1
Fe	0.55	0.33	<1
Mn	0.09	54	<1
Ba	2.03	1.21	<1
HCO_3	487.46	292.47	50
Cl	3570.00	2142	600
SO_4	12.38	7.42	250
NO_4	13.88	8.32	20
Br	1.80	1.08	<1
Mg/Ca	0.2816	0.17	<1
Ca/Na	0.0392	0.02	<1
Ca/Cl	0.289	0.02	<1
Na/K	40.6155	34.37	<1
Na/Cl	40.6155	0.44	<1
(Na+K)Cl	0.7563	0.46	600
HCO_3/Cl	0.1309	0.08	<1
So_4Cl	0.0035	0	250
TDI	6910.299	4146.18	500
Conductivity	6910.30	4146.18	1000

Table 2: Mean average of elements and compounds in Keana

Elements	Mean(Dry season)	Mean (Raining season)	WHO Standard (2004)
Temp ^{o}C	38.20	12.41	<40
pH	7.50	2.45	6.9
Dissolve salt	3400.00	4761	500
Ca	261.15	37.2	<1
Mg	39.10	10.48	<1
Na	4042.15	948.7	200
K	195.15	23.35	<1
Fe	1.98	0.2	<1
Mn	0.14	32.4	<1
Ba	30.57	0.73	<1
HCO_3	433.90	175.48	50
Cl	6343.75	1285.2	600
SO_4	0.10	4.45	250
NO_3	0.20	4.99	20
Br	5.50	0.65	<1
Mg/Ca	0.1497	0.1	<1
Ca/Na	0.0646	0.01	<1
Ca/Cl	0.04212	0.01	<1
Na/K	20.7130	20.62	<1
(Na+K)Cl	0.6679	0.26	600
(HCO_3+Cl)	0.0684	0.05	<1
TDI	11375.665	6825.6	500
Conductivity	11375.67	6825.6	1000

Source Field work 2013

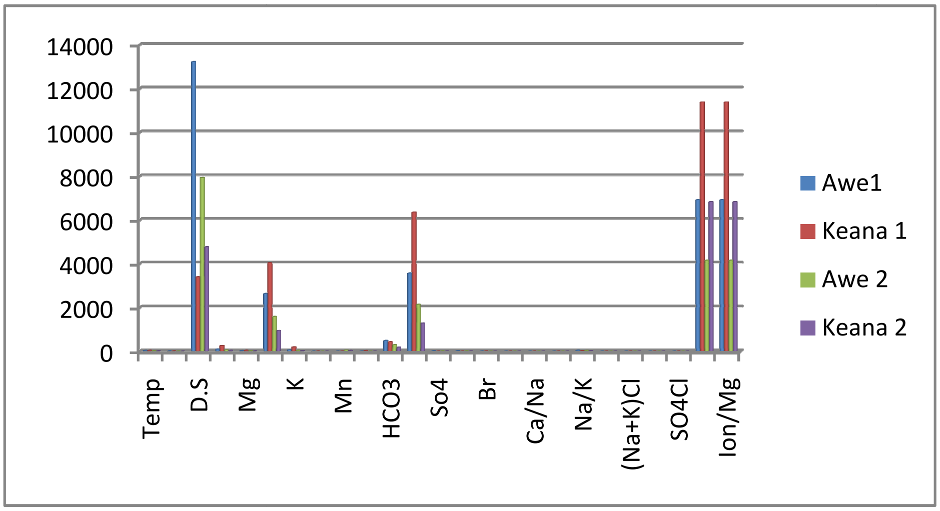

Figure 4: Mean Average of Variables and Element in Dry and Wet Season
Awe1: dry season; Awe 2: raining season; Keana 1: dry season; Keana 2 raining season

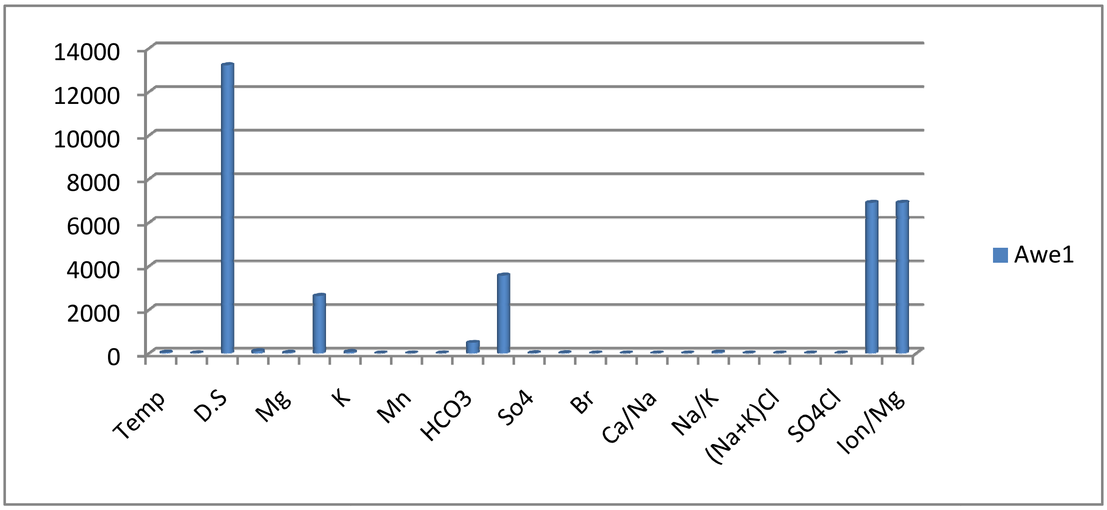

Figure 5: Mean Average of Variables and Element in Dry Season
Awe1: dry season; Awe 2: raining season; Keana 1: dry season; Keana 2 raining season

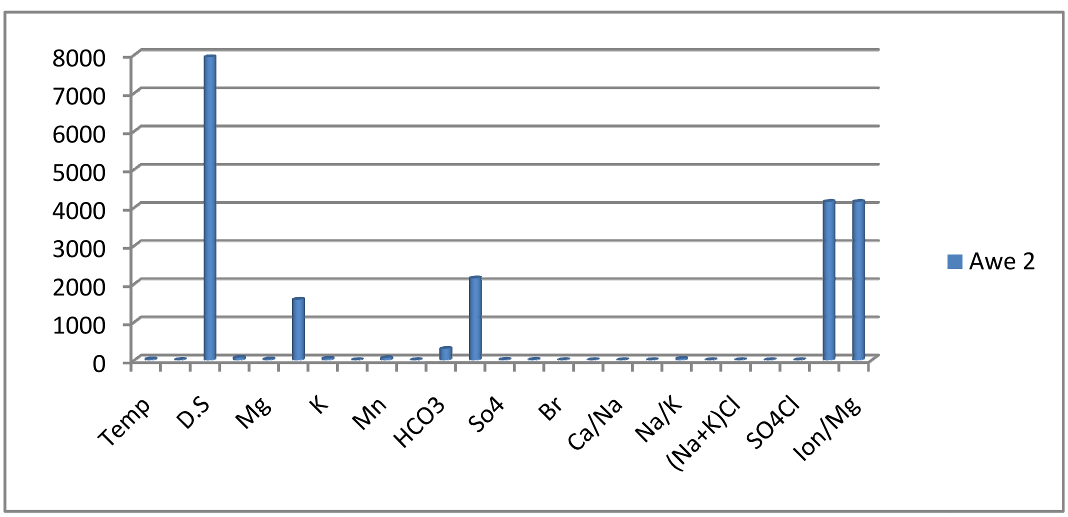

Figure 6: Mean Average of Variables and Element in Raining Season
Awe 2: raining season;

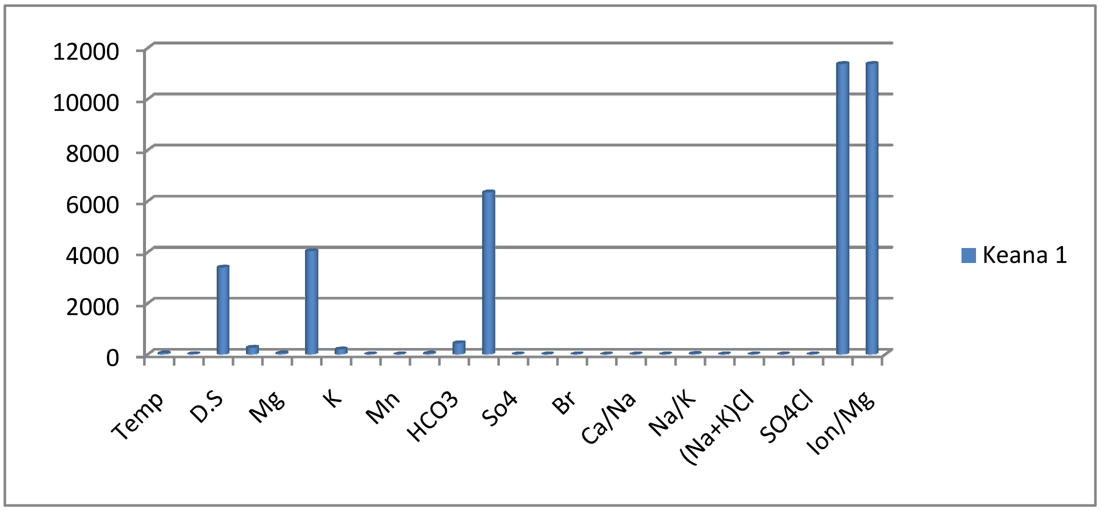

Figure 7: Mean Average of Variables and Element in Dry Season
Keana 1: dry season.

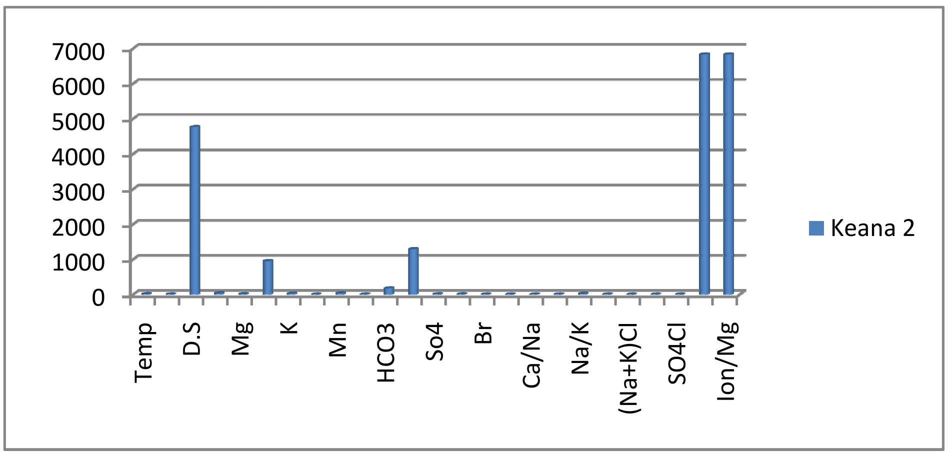

Figure 8: Mean Average of Variables and Element in Raining Season
Keana 2 raining season

Table 3: Summary The Pearson Moment Product Correlation For Awe And Keana Study Areas

	Dry Season (AWE)	Dry Season Keana	Rainy Season Awe	Rainy Season Keana
Awe (Dry season)	1.000 .000 25	978 xx .000 25	1.000xx .000 25	.867 000 25
Keana (Dry Season)	.978 000 25	1.000 - 25	.978 000 25	.765 000 25
Awe (Rainy Season)	1.000 000 25	.978 000 25	1.000 --- 25	.866 000 25
Keana (Rainy Season)	.867 .000 25	.756 .000 25	.866 000 25	1.000 --- 25

XX - Significant at two tail, X – significant at one tail

CONCLUSION

Minerals mining in Nigeria over the years have brought a lot of benefits which range from the provision of minerals necessary for industrialization and thereby enhancing national development. Nevertheless, it has left a scare of countless and complex environmental and environment related problems being experienced today by the Nigeria state. The environmental and environment related problems range from pollution of various forms as well as land degradation of Nations dimensions.

The security and restiveness in some part of Nasarawa State coupled with the activities of salt producing youths in the region can be seen as an environmental related problem than political. The issue of resource control being propagated today is an issue mainly concerned with the environment. The proponents argues that, areas of salt producing regions be allowed to take charge of the resources of their region so that they can be able to control the environmental degradation caused by this mining on their environment and thereby enhancing their environmental quality and development generally.

REFERENCES

1. Aga T. Resources Exploitation and Environment Pollution. The Nigeria Standard. Tuesday, May 9, 2000; pp 12.
2. Akintola FO, Mineral and Energy Resources. Oguntoyinbo, J.S Areola and Funlani M. (Eds) A geography of Nigeria Development. Ibadan. Henemann Educational Book Ltd, 1998; pp 90-92.
3. Alexander MJ. Soil Characteristic and the factors influencing their Development on the Mine Spoil Soil of Jos Mastery, 1986; pp 126.
4. Ajaegbu HI, the Jos Plateau Mining Region. Paper Presented to the 24th Annual Conference of Nigeria Geographical Association. 1981; pp20.
5. Alexander MJ. Soil Development on Mining Spoil and Reclaim are of the Jos Plateau. Soil Profile Description. FPRDP. Interm Report, 1984; 1: 78.
6. Alexander MJ. Soil Characteristic and the Factors Influencing their Development on Mine Spoil of the Jos Plateau JERDP. Interm report No.11, 1986.
7. Aliyu A. Citation on the Mineral resources of Nasarawa State. Obaje et al (2006) Geology and Mineral Resources of Nasarawa State, 2007.
8. Allaby, M. Dictionary OF Environment, the Camelot. 1977.
9. Asiku Brown ME. The Dangers poised by the Burdened Mine pond and Lotto Mines on the Jos Plateau. Journal of Environmental Sciences. 1999; 3(1): 258-265.
10. Bukley GD. The Forest Resource of the Jos Plateau and the Role of Eucalyptus Plantations “interm report” No7 JPERDP, 1986.
11. Bengtson GW.et al “Lime and Fertilizer use in Land Reclamation in Hund Region in Schaller et al, Reclamation of Drastically Disturbed loud. Pp 655-650. American Society of Agronomy. Madison U.S.A, 1981.
12. Boye H. Seasonal Variation of Brine Water in Keana Local Government of Nasarawa State. Unpublished BSc. Degree thesis, Dept., of Geography Nasarawa State University Keffi, 2010.
13. Burton I. Reading in Resources Management and Conservation, Chicago pp150-7.
14. Bauer A. and Decker R.S. Physical Analysis of Over Burden Material and Mine Land Soils” in Shaller et al Eds. R edemption of the Drastically Disturbed Land pp 655-650. American society of Agronomy Madison U.S.A, 1981.
15. Brashow & Support; The Restoration of Land. Black well Publisher, Studies in Ecology, 1984; l: 67-130.
16. Dabi DD, Federal Ministry of Solid Mineral Development Abuja, journal on the mining sector in Nigeria, 2001; pp21-26.
17. Danald P.B Open Pit Mining in Daniel N.1 et al Ads Encyclopedia of Environmental Science pp338-34 MC Grows Hill Book Company New York. U.S.A, 1974.
18. Eniolorunda PA. State of Environmental Report of Kogi State in National Seminer for States Environmental Protections Agency Director, 1995; pp.175-180
19. Encarta® Encyclopedia, (©1993- 2000 Microsoft Corporation, 2001.
20. Ezieachi AS. Barrier to and Suggestion Towards Management of the Degraded Tin Mine Land on the Jos Plateau Journal of Environmental Science of, 2005; pp. 41-48.
21. Susan M, Oxford Dictionary of Geography Oxford University Press, New York, 1997.
22. Evan J. Management of Solid minerals and solid waste. Graw hill book Company publisher New York, 1980; pp 294-304.
23. Eunice JG Oxford / Philip Atlas for Nigeria. Oxford University Press, 1979.
24. Horriton, In Sight, A.N (2002) Plantation as a Toll for Mine Spoils. Restoration Review Article, London, 2002.
25. Howard H. Mining Engineering, Willey and Son Publisher New York.US AID (2003): http//www.Usaid.cgov, 1987.
26. Ikyermum A Mineral mining and the Nigerian Environmental Today. The Africa journal of Environmental Law and Development studies, 2005; pp 207-211.
27. Kalumba Mining Company, Company’s Private Report unpublished, 2000.
28. Kwa YB. Nasarawa State Ministry for commerce and industry Annual Reports, 2006.
29. Knowles MA Economic and Social Geography Mad Simple, 1976; pp 300-20.
30. Ofodile, M. E. The geology of the middle Benue, Nigeria. Publication from the Palaeontological Institution of the University of Uppsala special vol. 4, Doctoral thesis at Uppsala University, 1976.
31. Ogezi AE. Mineral Raw Material and Nigeria Industries Post Graduate Open Lecture Series No. And Vol.11 Jos University pressLtd Jos, 1985.
32. Ogunmola JK, Exploration, viability and utilization of Nigerian Gypsum Resources. A seminer paper presented to the Department of Geology and Mining University of Jos, Jos –Nigeria, unpublished seminar paper. Environ Facts (1999) Colorado Press, 2003.
33. Okabgue Co. Evaluation of strength Properties of Mine Spoils” in Nigeria Journal of Mining and Geology, 1982; 1, 2 (22): 92-95.

34. Paone Nigeria News Magazines November, Effect of Mining Activities – Case study of Plateau State, 2000; 13-19
35. Reuban KU. Geographical Regions of Nigeria, 1972; pp 2066-20.
36. Rywerson FJ. Exploration and Mining for Gems and Gold in the west. Happy Comp. Califonia: Natural Publishers Inc., 1967; 204.
37. Seaker and Sopper Importance of Soil Organic Matter Accumulation, Deposition, and Minimum level of Organization Carton Nigeria Content for productive Mine Soils, 1988.
38. Singh AN. and Ragbubanshi J.S. Plantation as tool for Mine Spoil Restoration Department of Botany, Bananas Hindu University, Varanasi 221005, India, 2002.
39. Siyan Awareness for Mining Resources Exploration and Exploitation Dated Back to the Late 19th century and 20th century, 2007.
40. Stocking Soil Erosion and Land Degradation in O' riodan T(ed)'Environmental science, Environmental Management, Longman England p.224. International Mining strategy b (1999) unpublished, 1997.
41. Swoboda ER, Tourmaline Queen Case Files (1968-2001) Personal Communication with sott L. Ritchie, SDNYc. Beverly Hills Los Angeles Country, C.A, 2001.
42. United Nations Environment Programmes, for Development, 2003, http://www.Unep.org/
43. WHO, Health Problem in Developing Countries, 2004.

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