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Assessment of Mineral Oxides Composition in Rocks of Hong Local Government Area of Adamawa State, Nigeria

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Abstract: The mineral resource potential of an area is a measure of the likelihood within forescale. It was against this background that the mineral compositions in rocks of Hong Local Government Area were investigated. The un-weathered rock sample was chiseled, dried for 12 hours and pulverized. X-ray fluorescence spectrometer (XRF) was used for the mineral oxides determination. Considerable amounts of SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, SO_3, K_2O, Na_2O, TiO_2 and MnO were recorded in the 10 locations. The mean values of SiO_2 contents were comparably higher (72.51 %) among the locations. The mineral oxides revealed in the study have potentials for industries.
Keywords: Minerals, locations, amount, determination, Hong.

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Introduction

Solid mineral is a crystalline solid of inorganic origin formed as a result of geological processes and have well defined chemical composition (Dexter, 2002). They constitute rocks that are formed in the earth and exist together with the naturally occurring radioisotopes in the earth crust (Avwiri *et al.*, 2010). Most rocks contain silica and oxygen that forms 74.3% of earth's crust. This material forms crystals with other compounds in the rocks. The proportion of silica in rocks and minerals is a major factor in determining their names and properties (Wilson, 1995). Over the course of time, rocks can transform from one type into another as described by the geological model called the rock cycle.

The majority of the rocks of the earth's crust consist of Quartz, Fieldspar, Mica, Chlorie, Kaolin, Epidote, Olivine, Augite, Hornblende, Magnitite, Heamatite and Limestrone (Badmus *et al.*, 2013). Two rock masses may have same bulk composition and yet consist of entirely different assemblages of minerals. Granite is created by consolidation of molten magma at high temperatures and great pressures with its mineral component stable under such conditions. Exposed to moisture, carbonic acid and other agents at ordinary temperatures of the earth surface, some of these original minerals, such as quartz and white mica are relatively stable and remain unaffected; others weather or decay and are replaced by new combinations. These changes are accompanied by disintegration, and the rock falls into a loose, incoherent, earthy mass which may be regarded as sand or soil (Badmus *et al.*, 2013).

The search for mineral deposits and hence the art of mineral exploration continued to advance because of the economic benefits derived from mineral deposit to man. This advancement, from early year of twentieth century provided a good opportunity for explorers to look for more effective, less risky and more economical methods of sub-surface mineral exploration. This lead to discovery of different methods of mineral exploration often referred to as geophysical surveying or geophysical exploration techniques.

The method is concerned with the investigation of the interior of the earth's surface that are influenced by the by the distribution of the earth's underground masses. Analysis of the measurements will reveal various properties of the earth's surface (Abubakar and Idowu, 2014). It is against this background that the researcher was motivated to investigate the abundance and the quality of solid mineral compositions in rocks of Hong Local Government Area of Adamawa State, Nigeria.

Materials and Methods

Sampling and Sample Preparations

Sampling Locations

Table 1. Hong Local Government Area Rock Sampling Location Coordinates

Location	Latitude	Longitude
Hildi	$10^o24.456''$	$013^o10.622''$
Mijili	$10^o20.499''$	$013^o10.016''$
Garaha	$10^o24.151''$	$012^o53.071''$
Sigalmi	$10^o23.671''$	$012^o43.062''$
Gaya	$10^o25.847''$	$012^o59.759''$
Kwambila	$10^o16.245''$	$013^o06.181''$
Hong	$10^o13.739''$	$012^o55.857''$
Dzuma	$10^o10.051''$	$012^o57.177''$
Uding	$10^o09.794''$	$012^o55.131''$
Pella	$10^o09.241''$	$012^o56.377''$

Sample Collection

A Germin Dakota 10 Global positioning System (GPS) was used to locate the coordinates of the sample sites. About 400g of the rock sample was collected from the four coordinate points using hammer and chisel to break the un-weathered rocks as described by Migili and Maina (2010). The samples were kept in polythene bag and taken to the laboratory for further processing.

Sample Preparation

The rock samples were dried in air for about 12 hours and crushed into smaller pieces and then ground to fine powder using pestle and mortar and sieved. The representative samples for analysis were obtained by coning and quartering technique as explained by Crosby and Patel (1995). This method involves making a cone shape of the sample, flatten it and divide it into four equal parts; take the opposite two quarters and discard the other two quarters. This was repeated until the sample was reduced to the size required for final analysis and stored in an air tight container.

Analysis of Samples

Energy Dispersive X-Ray fluorescence (EDXRF) spectrometer of model “Minipal 4” was used for the analysis of major and minor elemental oxides in rock and soil samples as described by Alexander et al., (2011). About 2.0g each of powdered rock and soil samples were fused with 0.40g of stearic acid in 20 mL platinum crucibles and pressed with hydraulic press to form the pellets. These fused buttons were X-rayed and counted, and the major and minor elements were determined. The specimen is excited with the primary x-radiation. In the process, electrons from the inner electron shells are knocked. Electrons from outer electron shells fill the resultant voids emitting a fluorescence radiation that is characteristic in its energy distribution for a particular material. The fluorescence radiation is evaluated by the detector.

Statistical Analysis

Data generated were subjected to statistical analysis (analysis of variance, ANOVA) at 5% (0.05) level of probability using statistical tool for agricultural research (STAR) International Rice Research Institute (IRRI, 2013) and significant means comparison was carried out using Tukey’s Honest Significant Difference (HSD) Test. Graphical comparison of variability in mineral composition of the different locations were designed using Microsoft Office Excel (2010).

Results and Discussion

Elemental Oxide Compositions in Rocks

The mean distribution of major elemental oxide of rock samples in ten locations of Hong local Government area are presented in Table 2. The mean values of silicate (SiO_2) recorded in the location was 72.51% with highest amount from Uding (78.27%) which was significantly different at $p \leq 0.05$ among the locations. The amount of aluminum oxide (Al_2O_3) recorded ranged between 9.3 % to 14.30% with a total mean value of 12.62%. There was significance difference observed ($p \leq 0.05$) among the locations in terms of Al_2O_3 contents. Iron oxide (Fe_2O_3) was recorded in the entire locations with an average value of 3.76% having highest amount from Gaya area (79.7%). Fe_2O_3 contents differ significantly among the locations at $p \leq 0.05$. The amount of calcium oxide (CaO) obtained in the sample ranged between 0.48 % to 3.10% with total means of 1.41%. There was no significant difference observed in terms of CaO in Hildi, Pella, Kwambila and Dzuma locations. Considerable amount of magnesium oxide (MgO) was recorded in the entire sample varies from 0.04% to 0.85% with a total mean value of 0.42%. There was no significant difference ($p \leq 0.05$) in amount of MgO in Hildi, Sigalmi and Dzuma areas.

Sulphur oxide (SO_3) was found in the entire samples with exception of Kwambila area which was below the detectable limit (<0.001) of the instrument used. The mean values of SO_3 recorded were 0.59% with highest amount in uding location (0.77%). There was no significant diffrerence in terms of SO_3 content among Hildi, Mijili, Garaha, Sigalmi, Hong and Dzuma locations at $p \leq 0.05$. The mean concentration of potassium oxide (K_2O) found in the studied area was 2.41% ranged between 1.06% to 4.01%. There was no significant difference ($p \leq 0.05$) of K_2O contents in Garaha, Kwambila, Sigalmi and uding areas. The total average value for sodium oxide (Na_2O) revealed in the samples investigated was 1.26% with highest value (3.0%) from Mijili area. There was significant difference in terms of Na_2O contents among the locations at $p \leq 0.05$ with exception of Sigalmi and Uding areas. Titanium oxide (TiO_2) was found in the entire samples investigated in the studied area.mThe concentration of TiO_2 ranged between 0.50% to 2.29% with highest value observed in Garaha (2.29%) area. The amount of manganese oxide (MnO) found was considerable ranging between 0.072% to 0.18%. There was no significant difference ($p \geq 0.05$) among the locations in terms of MnO contents.

Table 2. Major Elemental Oxides Composition of Rock Sample in Hong Local Government Area (%)

Locations	Elemental Oxide									
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	Na_2O	TiO_2	MnO	LOI
Hildi	76.00ab	12.06h	0.90j	0.99e	0.42e	0.70ab	2.28d	1.30d	0.72de	0.072a	1.17c
Mijili	74.22ab	12.64e	2.65i	0.61g	0.04h	0.71ab	2.04f	3.00a	1.27bcde	0.094ab	1.20c
Garaha	62.11c	13.30d	5.08b	1.90c	0.85h	0.71ab	3.71b	2.01b	2.29a	0.18cd	5.06a
Sigalmi	72.25abc	12.30g	4.62c	3.10a	0.35f	0.63ab	2.45c	1.05e	1.65abc	0.13c	1.04e
Gaya	66.40bc	14.30a	7.97a	0.48h	0.13g	0.76a	2.03f	1.50c	0.50e	0.16cd	4.21b
Kwambila	76.49ab	12.66e	2.91g	1.09d	0.49d	<0.001	2.16e	0.76f	1.42abcd	0.17cd	0.87f
Hong	73.37ab	12.46f	3.09f	3.01b	0.75b	0.68ab	1.06g	0.49h	2.08ab	0.12c	0.81g
Dzuma	73.84ab	13.45c	3.92d	1.06d	0.61c	0.56ab	2.29d	0.76f	1.21bcd	0.083a	1.08d
Uding	78.27a	9.35i	2.79h	0.84f	0.49d	0.77a	4.01a	1.06e	0.96cde	0.08a	0.51i
Pella	72.20abc	13.69b	3.64e	0.97e	0.08g	0.41b	2.04f	0.64g	1.23bcde	0.074a	0.72h
Mean	72.51	12.62	3.76	1.41	0.42	0.59	2.41	1.26	1.33	0.15	1.67
SE	2.68	0.024	0.015	0.016	0.012	0.091	0.019	0.015	0.22	0.165	0.008
CV (%)	3.7	0.19	0.4	1.15	2.76	15.28	0.83	1.2	16.79	106.28	0.52

Mean with the same letter in the same column are not significantly different ($p<0.05$) according to Tukeys's Honest significant Difference (HSD) Test. SE = Standard Error, CV = Coefficient of Variance, LOI = Loss on Ignition

Comparison of Major Elemental Oxides in Hong Rocks

Figure 1 presents the comparison of major elemental oxide for different locations of Hong rocks. Going through the chart, it is evident that SiO_2 was the most abundant mineral oxide found in the area studied followed by Al_2O_3, K_2O, NaO_2, CaO, Fe_2O_3, TiO_2, SO_3, MgO and MnO in Hildi rocks. The compositions of mineral oxides in Mijili location was comparable having highest amount in SiO_2 followed by Na_2O, Al_2O_3, Fe_2O_3, K_2O, TiO_2, SO_3, CaO, MnO and MgO. The pattern of occurrence of mineral oxide in Garaha location was SiO> Al_2O_3> Fe_2O_3> K_2O> TiO_2> Na_2O> CaO> MgO> SO_3> MnO. The order of major mineral contents in rocks of Sigalmi was: SiO_2> Al_2O_3> Fe_2O_3> CaO> K_2O> TiO_2> Na_2O> MnO. The values for SiO_2 were highest in Gaya rock followed by Al_2O_3 and then Fe_2O_3, K_2O, Na_2O, CaO, TiO_2, MnO and MgO. The sequence of occurrence for elemental oxide in Kwambila rocks was: Si_2O> Al_2O_3> Fe_2O_3> K_2O> TiO_2> CaO> Na_2O> MgO> MnO. SO_3 was below the detectable limit the instrument used. The trends of major elemental oxide contents in the rocks of Hong follow the sequence: SiO_2> Al_2O_3> Fe_2O_3> CaO> TiO_2> K_2O> MgO> SO_3> Na_2O> MnO. The order of occurrence of mineral oxide compositions in rocks of Dzuma was SiO_2> Al_2O_3> Fe_2O_3> K_2O> TiO_2> CaO> Na_2O> MgO> SO_3> MnO. The amount of Si_2O was found highest in Uding rock followed by Al_2O_3, Fe_2O_3, K_2O, Na_2O, TiO_2, CaO, SO_3, MgO and MnO. The pattern of mineral oxide contents in rocks of Pella was in the following order: SiO_2> Al_2O_3> Fe_2O_3> K_2O> TiO_2> CaO> Na_2O> SO_3> MgO>MnO. Considerable amounts of minor elemental oxides were recorded in soils of Membila plateau by Idris *et al.*, (2004) and Isaac *et al.*, (2019).

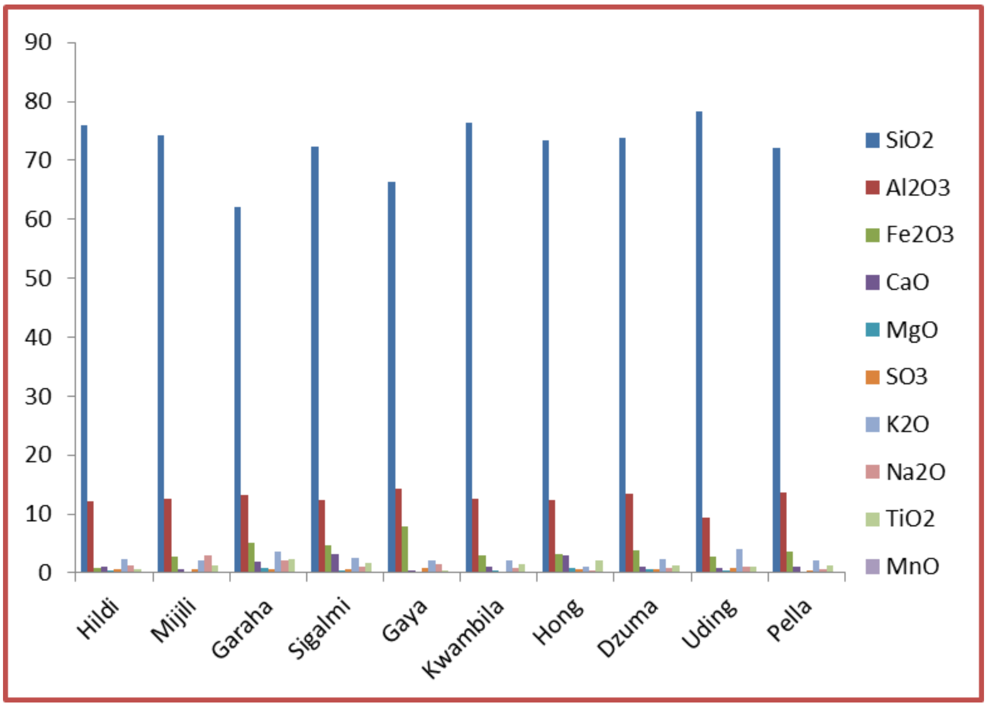

Figure 1. Comparison of Major Elemental Oxide for different locations of Hong Rocks

Conclusion

The mean distributions of mineral oxides observed in rocks at different locations of Hong Local Government Area were: SiO_2 (72.71 %), Al_2O_3 (12.62 %), Fe_2O_3 (3.76 %), CaO (0.42 %), MgO (0.42 %), SO_3 (0.59 %), K_2O (2.41 %), Na_2O (1.26 %), TiO_2 (1.33 %), MnO (0.15 %). The quantities of minerals identified in the study area are quite appreciable and their potentials could be relevant to several manufacturing industries and agricultural production.

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