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ELEMENTAL X-RAY FLUORESCENCE ANALYSIS OF HAYIN-NA'IYA ROCK DEPOSITS RAFIN-GUZA, KADUNA STATE-NIGERIA

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ABSTRACT: *The elemental composition of rock deposits of Hayin-Na'iya rocks Rafin-Guza, Kaduna was determined using X-ray Fluorescence spectroscopy . Moisture content analysis revealed 1.375%, indicating poor permeability of the rock deposits. The percentage composition of elemental oxides gave SiO_2 as the oxide constituting the highest percentage (56%) followed by dialuminumdioxide, Al_2O_2 (31%) and ferric oxide, Fe_2O_3 (9.49%) . Silicon oxide fell below the world nominal value of 70-77%. Other oxides found included the oxides of potassium, titanium, vanadium, chromium, manganese, Nickel, copper, gallium and silver as K(1.0%), Ti(1.18%), V(0.06%), Cr(0.022%), Mn(0.016%), Ni(0.011%), Cu(0.015%), Ga(0.024%) and Ag(1.3%), respectively. The results indicated that the rock deposits could be good sources of raw materials for glass and constructional industries as further sophisticated geological survey could reveal larger deposits of valuable oxides..*

KEYWORDS: Percentage Concentration, Elemental Oxides, X-Ray Fluorescence, spectroscopy

INTRODUCTION

Rocks are naturally crystalline formations that are made up of different types of chemical elements. Though viewed basically as rocks, they are scientifically considered as minerals. These natural deposits are known to be of economic value depending upon their composition. The composition of rocks is a function of the environment and constituents that make up the rocks and thus determine their economic importance and types [9]. In this vein rocks are classified as sedimentary, igneous or metamorphic. They can also be metallic, non-metallic or fuel minerals depending on their composition and uses. Silicon as an element is considered as one of the most abundant rock forming element that always exist in the form of quartz (SiO_2). Aluminium metal, produced from alumina Al (OH_3) is sourced from bauxite. Calcium commonly originates from limestone ($CaCO_3$) and magnesium from magnesite ($MgCO_3$) [2].

All of the aforementioned substances generally considered as rock, can be used for different economic purposes. Minerals such as iron ore, limestone, gypsum, talc, kaolin, among others, are found in the form of rocks and are used for metallurgical, pharmaceutical, cosmetics, and allied industries [7]. A rock is usually characterized by its chemical composition. Natural formations of rocks are always guided by chemical reactions and chemical changes resulting from such actions. Therefore, it has been identified that it is through analytical means that the elemental composition of the minerals are identified [8].

The two major types of mineral analysis are classical (wet chemistry) and instrumental methods. The former is the traditional approach where efficiency is relative to experience as it relies on an individual's exposure and accuracy, especially that it is manually handled. The

latter is the modern, sophisticated, accurate and reliable approach for which various equipment such as Atomic Absorption Spectrometer (AAS), X-Ray Diffractometer (XRD), X-Ray Fluorescence (XRF) and X-Ray Luminescence (XRL) are used to arrive at the quantitative and/or qualitative characteristics of rocks mineral [12]. The study attempts to employ theoretical knowledge and existing modern analytical methods to analyse Hayin Na'iya rock deposits in Rafin- Guza of Kaduna state.

Table 1*:* Nominal chemical composition of various oxides

S/N	Oxides	percentage (%)
1	Silica (SiO_2)	70-77
2	Alumina (Al_2O_3)	11-14
3	Potassium Oxide (P_2O_5)	3–5
4	Soda (Na_2O)	3–5
5	Lime (CaO)	1
6	Iron (Fe_2O_3)	1-2
7	Iron (FeO)	1–3
8	Magnesia(Mg0)	0.5-1
9	Titania (TiO_2)	< 1
10	Water (H_2O)	0.03

(Source: ANON, 2010 a)

EXPERIMENTAL

Study Area

Rafin Guza is a village located at the far end of Kawo New Extension in Kaduna North Local Government Area of Kaduna State, Nigeria. It is located at approximately longitude $10^0$35' N and latitude $7^0$28' E and between altitudes 550- 650m above the mean sea level. The geology of the area is typically basement complex rocks comprising of high-grade igneous and metamorphic rocks such as migmatite, mica and quartz-mica schists, granite-gneiss, biotite granite, porphyritic biotite granite and granodiorite.

Sampling and Sample Preparation

The samples collected at different locations within the area under study were subjected to the quartering and coning method of sampling so as to get a true representative sample. The rock sample was grounded to powder, which passed through 53 μm sieve. 10 g of the powdered sample was weighed and 3 g of binder (stearic acid) was mixed with it thoroughly. The mixture was transferred into 40 mm diameter mould and pressed into a pellet using hydraulic pressure press at 25 tons (Robin, 1997).

Moisture Content Determination

The powdered sample (4g) was weighed into a porcelain crucible, which was pre-heated at 200ºC. The sample and the crucible were kept in the ovum at 200ºC for one hour. The crucible was then removed and kept in a desiccator to cool. The content of the crucible was weighed by

finding the difference between the weight of the empty crucible and the crucible and sample. The percentage moisture content was also calculated.

Principle of X-ray Fluorescence

MiniPal 4 Energy Dispersive X-Ray Fluorescence (EDXRF) by PANalytical was directed via the secondary collimator into gas flow and scintillation detectors. These X-rays pass through a Mayor window on the back of the flow counter and out of vacuum chamber via another Mayor window. Radiation with intermediate wavelengths (e.g. The K radiation of elements) was converted into electrical pulse amenable to digital processing.

RESULT AND DISCUSSION

The results as percentage composition of the x-ray fluorescence analysis of Hayin Na'iya rock deposits as shown in Table 1 revealed that Silicon oxide (SiO_2) was the major component of the rocks (56%). This values was however less than the world wide average found in most deposits (70-77%), [3]. Silicon oxide is used in the steel industry as a source of silicon [4] and also as a component of Steel alloys as ordinary steel contains less than 0.03% of silicon [11]. Silicon steel containing between 2.5-4% silicon is used in making the cores of electrical transformers [10]. The alloy known as duriron, containing 15% silicon, is hard, brittle and corrosion resistant. More so, quartz (SiO_2), the major constituent of glass, can serve as an important resource for glass industries.

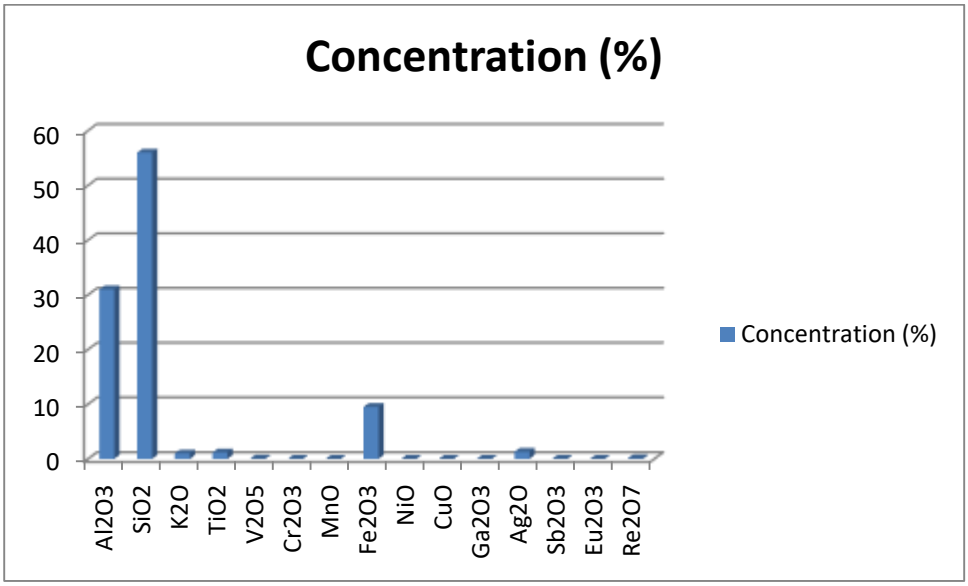
Aluminium oxide was the second highest oxide found in the analyzed rock deposits, 31%. The high strength to weight ratio of aluminium makes it useful in the aeronautical and automobile industries. The lightness of aluminium is of particular importance in long distance high voltage power transmission [1] The Hayin Na'iya rock deposits may be a good source of aluminium for the manufacture of building materials and household utensils. The percentage composition of Iron as Iron iii oxide was found to be 9.49% which is higher than the nominal composition shown in table 1. Iron is another metal of economic importance as it is a major component of steel. Other oxides in appreciable quantities were potassium (1.0%), silver (1.18%), and titanium (1.3%). All the oxide percentages fell within the nominal composition values (table1). Other oxides found in trace amounts were Vanadium (0.06%), Chromium (0.022%), Manganese (0.016%), Nickel (0.011%) and Copper (0.015%). Moisture analysis revealed 1.375%, which gave an indication of poor permeability of the rocks' texture [7]. The results which revealed the presence of numerous important minerals in substantive amounts therefore provided an insight to the suitability of the rocks for use in major industrial processes.

Table 2: XRF analysis of the oxides of Hayin Na'iya rock deposits.

S/N	Compound	Iraw (cps)	Inet (cps)	Concentration (%)
1	Al_2O_3	8.902	8.902	31
2	SiO_2	38.691	38.691	56
3	K_2O	51.484	51.484	1.0

4	TiO_2	200.958	200.958	1.18
5	V_2O_5	14.970	14.970	0.060
6	Cr_2O_3	10.427	10.427	0.022
7	MnO	11.404	11.404	0.016
8	Fe_2O_3	8319.161	8319.161	9.49
9	NiO	13.364	13.364	0.011
10	CuO	19.904	19.904	0.015
11	Ga_2O_3	27.327	27.327	0.024
12	Ag_2O	19.232	19.232	1.3
13	Sb_2O_3	1.014	1.014	0.03
14	Eu_2O_3	3.601	3.601	0.01
15	Re_2O_7	35.565	35.565	0.097

Fig.1: Graphical illustration showing percentage composition of the oxides analyzed in Hayin Na'iya Rock Deposits



CONCLUSION

X-ray fluorescence analysis carried out on rock deposits of Hayin N'iya Rafin-Guza Kaduna-Nigeria revealed high percentages of the oxides of silicon and aluminium, and a lower percentage of iron (III) oxide. The results indicated the economic viability of the rocks in major industrial processes.

RECOMMENDATION

Advance geological survey techniques should be routinely carried out on the rocks to monitor stability of the oxides and quantify minerals for possible use in large industrial applications.

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