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EDXRF ASSESSMENT OF GOLD SOLID MINERAL DEPOSIT OF YARGALMA, ZAMFARA STATE, NORTH-WESTERN NIGERIA

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ABSTRACT

The gold solid mineral deposit of Yargalma area of Zamfara state, Nigeria was analysed for the elemental composition by energy dispersive X-ray fluorescence (EDXRF) spectrophotometry. Also, physical properties and anionic composition of the gold bearing rock was studied using standard methods. The result indicated high concentration of Haematite iron oxide Fe_2O_3 (3.295% ± 0.40), Lead (II) Oxide pbO (3.04% ± 0.72) Aluminium oxide Al_2o_3 (2.2%± 0.4) other valuable oxides such as manganese (ii) oxide MnO (0.914%±0.23) Tungsten trioxide WO_3 (0.16%±0.46) and the hunted metal by the local community "Gold" detected in elemental form Au (0.065%±0.31). The results of the physical properties tested revealed positive loss on ignition (LOI 2.8%) and low alkalinity (8.23), yellow colour, specific gravity range (6.7-7.2) and average size of (0.14 mm). This analysis showed that sample was generally rich in Gold, Haemitite, Manganese, Aluminium and Tunsten, hence it is economically valuable for exploitation.
Keywords: Gold, EDXRF, Solid Minerals, Yargalma, Anions, Loss on Ignition

INTRODUCTION

The mining regions of Northern Nigeria have been known since the colonial era. The popular among them is the Jos and in the late 70s, the Zamfara mining belt. The Zamfara mining region of Northern Nigeria has deposit of precious mineral like tantalite and gold among others (Alhassan *et.al,* 2010). Gold is the most important mineral form of the state exploited mainly for commercial purposes illegally by local farmers. Others include Tantalum and Niobium oxides respectively, which are major compositions of tantalite ore and columbite. The mining industry has contributed in the development of many countries that have vast deposits of solid minerals; it plays a significant role in creation of jobs in most developing countries like Nigeria. However, mining activity is always associated with deposition of heavy metals into the environment as reported by many authors (Tsafe and Alhassan, 2012). Large deposits of gold solid mineral exist across the African continent and the world, namely in South Africa, Guinea, Namibia and Germany, Sweden, Norway (Rosaline et. al, 2018).

This paper studies the elemental composition of Gold solid mineral deposits of Yargalma area, Zamfara state, Nigeria using Energy Dispersive X-ray Fluorescence (EDXRF) spectrophotometric analysis. Also, physical properties such as colour, pH, LOI, specific gravity and average size were studied. The anionic composition of the solid mineral was also studies with the aim of identifying the mineral potential for exploration and exploitation.

MATERIAL AND METHOD

All glass wares in the analysis were initially washed with liquid soaps, rinsed with distilled water and soaked in 10% HNO_3 overnight; cleaned with distilled water according to Babale *et. al* (2011). All the reagents used were analytical grade, samples were collected at different area under study. They were packed in plastic containers, manually crushed and sieved with a 355mm electric shaker.

Study Area

The solid mineral samples were collected from the lead (pb) poisoned village called Yargalma. The village is located about 6km off Gummi-Anka road in Bukuyyum local government area of Zamfara state at latitude 12° 3N and Longitude 5° 51 E in the tropical Sudan savannah zone of Northern Nigeria. The area mainly consist of tropical laterite, alluvian brown and red soils of the basement complex. The soil forming materials are rocks and sand. It is a small community of not more than 8,000 people. The inhabitants of the villages are predominantly Hausa/Fulani whose major occupations are farming, animal rearing and illegal mining of rare earth metals (MSF and WHO, 2010).

Sample Preparation for (EDXRF) Analysis

This was conducted at the center for Energy Research and Training Ahmadu Bello University Zaria, Nigeria. The procedure was reported (by Hassan and Umar, 2004). The sample from the analysis was pulverized (0.3g) homogenized with 3 mg of an organic binder (polystyrene dissolved in toluene). This was pressed at 10 tons with a hydraulic press to form a pellet of (19mm) diameter. The pellet was loaded into the sample chamber of the spectrometer and a voltage (30kv maximum) and current (1ma maximum) where applied to produce the X-ray to exite the sample for a preset time (10minutes in this case). The spectrum from the sample was analysed and elemental concentrations of the sample determined (Alhassan and Tsafe, 2020).

Table 1: Result of Percentage Oxides and Percentage Elements (EDXRF) Analysis.

Elements	% Element	Oxide	%Oxide
Al	1.164	Al_2O_3	2.2±0.4
Si	40.170	SiO_2	86.0
P	0.653	P_2O_5	1.5
Au	0.065	Au	0.065± 0.31
K	0.273	K_2o	0.33
Pb	2.819	PbO	3.04±0.72
Ca	0.175	CaO	0.245
Zn	0.016	ZnO	0.021
Cr	0.024	Cr_2O_3	0.036
Mn	0.708	MnO	0.914±0.23
Fe	2.863	Fe_2O_3	3.295± 0.40
Ni	0.0715	NiO	0.091
Cu	0.0567	CuO	0.071
Mg	0.0512	MgO	0.085
Mo	0.00607	MoO_3	0.0091
Co	0.0204	CoO	0.026
W	0.107	WO_3	0.16±0.46
Hg	0.0012	HgO	0.0015
Ir	0.0068	IrO_2	0.0058
Cd	0.0209	CdO	0.024
Os	0.0068	OsO_4	0.0077

± Indicated limit of detection

Table 2: Result of Physical Test of Solid Mineral

Physical property	Quantity
Loss on Ignition	2.8
pH	8.23
Colour	Yellow
Average Size	0.14
Specific Gravity	6.7-7.2

Table 3: Result of Confirmatory Determination of Anions

Sample	Cl^-	SO_4^-	HCO_4^-	NO_3^-
mg/l	260	210	14.5	520

Loss on Ignition

The pulverized solid minerals sample (2.0g) was placed in platinum crucible and fired in a muffle furnace operated at 1000° for 2 hours, then cooled in a desiccators for 10 minutes before the final weights taken. The loss on ignition was calculated as: LOI= *Weight* before firing- *Weight* after firing

$LOI = W_1 - W_2$ (Alhassan and Tsafe, 2010).

p^H TEST

The grounded samples (10.0g) was weighted, dissolved in a 10cm^3 of distilled water, and then stirred vigorously to ensure homogeneity. The pH was measured after calibration.

Determination of Anions

The following anions as listed in table 3 above were determined using standard methods as reported by (Ademoroti, 1996).

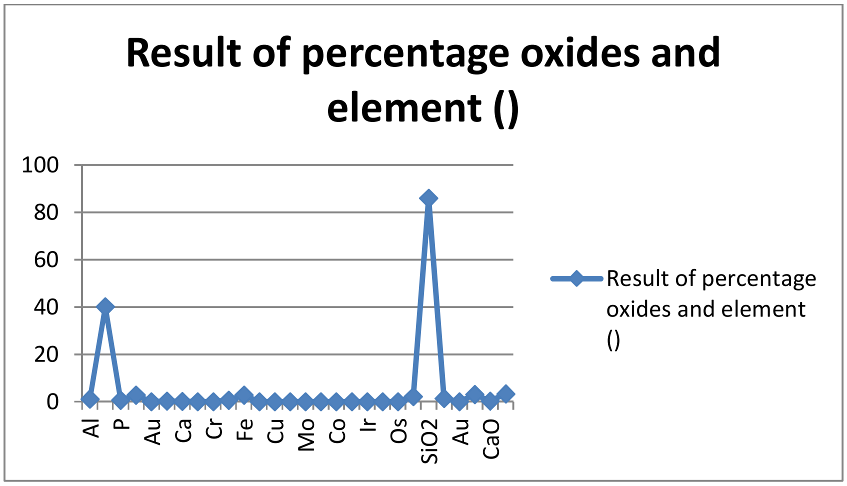

Fig 1 Results of percentage of Oxide and elements (EDXRF) Analysis

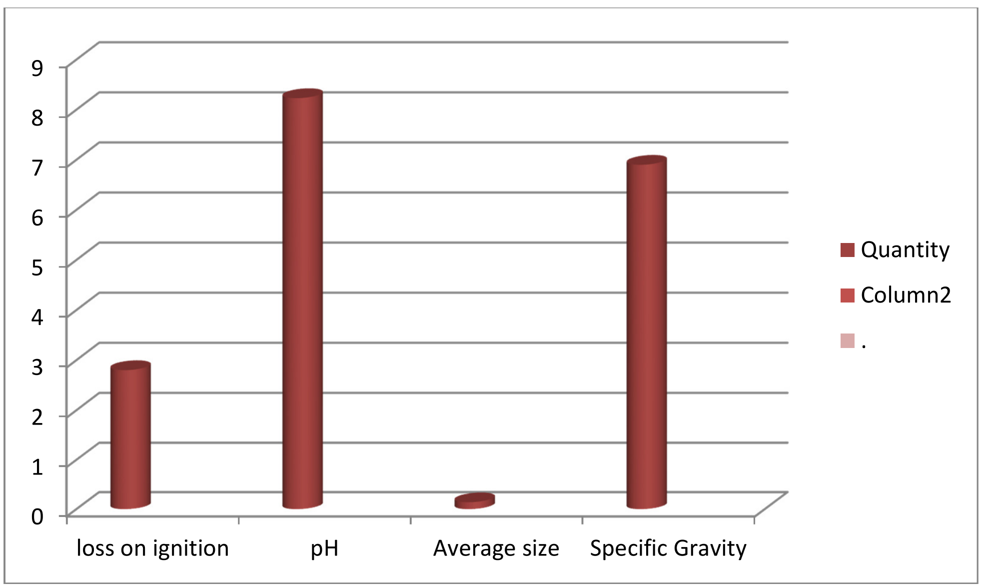

Fig 2: Results of Physical Test of Solid Mineral

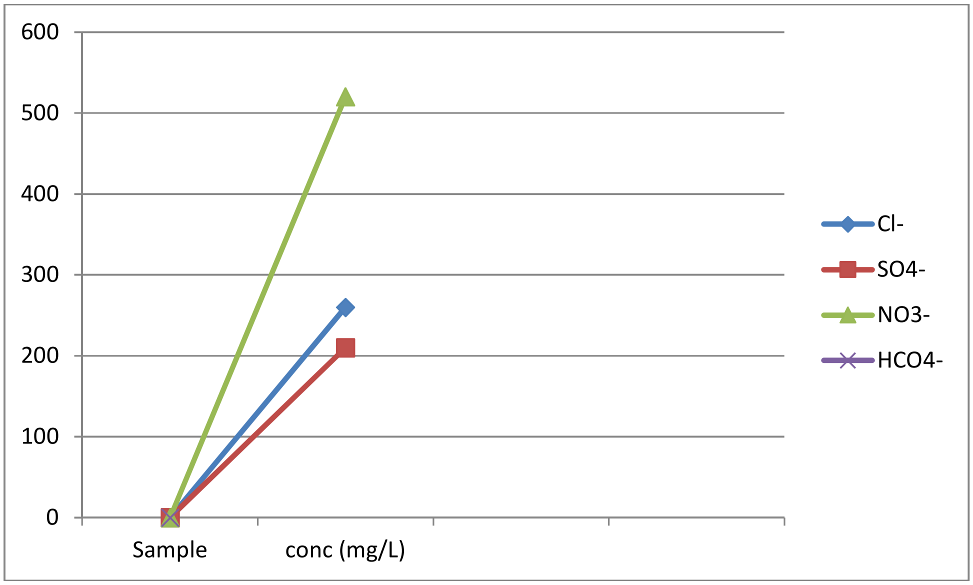

Fig 3: Result of confirmatory determination of Anions

RESULT AND DISCUSSION

The result of percentage elements and oxide compositions detected using EDXRF analysis of the Yargalma gold solid mineral samples are indicated in table1 and figure 1. The study showed high percentage of iron (2.863%) followed by lead (2.819%), this result indicated the lead poisoning of the communities in illegal mining areas of Zamfara state as reported by (MSF and WHO, 2010) was real, since solid mineral from the region contained high concentration of the heavy metal. The third percentage element detected was Aluminium (1.164%), the result also showed that Gold is present in the mineral sample in elemental form Au (0.065%) along with economically important elements such as Tungsten and Manganase with percentage oxides of less than (1%).

Table 2 and figure 2 shows the important physical properties for the mineral identification and industrial characterization. Table 3 and figure indicated the result of the confirmatory determination of anions constituents of the solid mineral samples.

Analysis of the solid mineral deposit of Yargalma area, Zamfara state showed different composition of important compounds. The following were found as major composition of the ore: % Fe_2O_3 (3.294±0.40),

%PbO (3.04 ± 0.72), %Al_2O_3 (2.2 ± 0.4), %MnO (0.974 ± 0.23), %WO_3 (0.16 ± 0.46) and Au (0.065). This result in table I is within the range of high mineralogy deposits of gold ores in Nigeria considering the fact that the %Au found is in elemental form (Ruiz, 2004). The level of heamatite found in this sample is within range of five iron ore samples across Nigeria, reported by (Adetunji et al; 2015) which had ranges as follows: %Fe_2o_3 (3.620), % La_2O_5 (4.01), % Fe_2O_3 (4.23) Funtua, (2014) %Fe_2O_3 (5.39) and % Ta_2O_5 (3.34) (Funtua, 2014). It was discovered that the level of % Al_2O_3 (2.2 ± 0.4) discovered in this study was very low compared to the other samples above, this could be due to high purity hematite deposit of the area and the variation of the mineral ore from one ore vein to another (Adetunji et. al 2015). The high level of lead (ii) oxide in this study %pbO (3.04±0.72) is also indicating the presence of another mineral of high toxicity as well as economic importance. Lead is a very good component of many vehicle batteries and a number of electric cells. The common car battery or accumulator usually consists of lead cells. Another important component of the ore is Tungsten, although the %WO_2 discovered was low compared to other components, it is an important transition element that is used in various alloys, especially high-speed steel (for cutting tools) and in lamp filaments (Rosaline et al, 2018).

Physical properties are important in mineral characterization. The yellow colour of the mineral ore in Table 2 shows it has similar physical properties with tantalite and some columbite deposit reported by (Ruiz et al, 2004). The LOI entails low volatile matter, thus greater percentage of the material was retained after excessive heating at 1000°C, while the pH in table 2 showed low alkalinity close to neutrality. In the laboratory the elements were isolated from the sample by absorption using methyl Isobutyl-ketone (MIBK).

The anionic composition of the mineral reveals the presence of high nitrate (520 mg/l) and low bicarbonate (14.5 mg/l), this has assisted in adjusting the pH to 10 during isolation of the metallic components in NH_4OH (Rosaline et al 2018).

CONCLUSION

The compositions of the solid mineral deposit of Yargalma Zamfara state was determine using EXDRF analysis and was found to contain high concentration of Heamatite Fe_2O_3 (3.295%), pbO (3.04%), Al_2O_3 (2.2%) and Gold Au(0.65%) within accepted limit of rich ore deposits across the world. Other mineral oxides were also determined in the samples such as WO_3, MnO, NiO that have some important economic and commercial applications. Physical properties tested showed low composition of volatile matter and anionic composition. The solid mineral is generally suitable for exploration and exploitation.

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