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# ENERGY DISPERSIVE X-RAY FLUORESENCE SPECTROMETRY EVALUATION OF ROCK MINERALS IN GUJENI AND TSOHON BIRNIN GWARI LOCAL GOVERNMENT AREAS, KADUNA STATE, NIGERIA

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**ABSTRACT**
The elemental evaluation was carried out by Energy Dispersive X-ray Fluorescence Spectrometry. The Gujeni iron ore contained Fe (76.07%), Cu(0.039%), S(1.10%), Zn(0.061%), Au(5 x$10^{-5}$%), Hg(0.0012%), Ga(0.01%), As(0.0082%), Bi(0.058%), Si (20.05%) and Al(2.60%) and Tsohon Birnin Gwari gold ore contained Au(0.009%), Pb(0.045%), Ag(0.019%), Zn(0.053%), S(0.56%), Fe(90.44%), Cu(0.014%),Ga(0.043%), As(0.202%), Bi(0.25%), Hg(0.27%), Si(7.0%) and Al(0.25%). The results of the analysis showed a high percentage contents of Fe in both samples but low percentage of gold. The low percentage of gold might be due to interlocking of the gold with aluminiumsilicate phase which require high pressure and temperature to release the gold metal. The results also provide baseline information on anthropogenic impact on environmental information on the mining community and the basis for planning strategy by regulated bodies for better quality environment.

**Keywords**: Energy Dispersive X-ray Fluorescence Spectrometry (EDXRFS), Gujeni, Gold ore, Iron ore and Tsohon Birnin- Gwari,

## INTRODCTION

Minerals elements are a key parameter of a country's economy. Nigeria is blessed with abundant natural and human resource for industrial growth and development; however, current experience shows that mineral resources development particularly mining is largely carried out by informal and illegal miners using primitive techniques with no understanding of the environmental consequences or human health (Gyan and Ashano, 2010). Kaduna state is located in the north – west part of Nigeria and is endowed with both metallic and non-metallic minerals such as Gold, Silver, Platinum, Mica, Felspar, Kaolin, Kyanite, Iron, Manganese, Granite, Laterite, Tin, Columbite, Tantalite, Nickel, Colbate, Lithium (KDMC,2021). The activities of these miners or their practices are seriously affecting the communities where these minerals were located because majority of their operations are carried out by artisanal and small scale miners who lack the requisite knowledge and appropriate technology to implements bests and standard practices in their operations (Malomo, 2007). Mining operations especially open cast mines as well as underground mines affect the environment through their mode of operations which is surface operation that normally employed by illegal and artisanal miners. One of the biggest environmental challenges is the disposal of tailings generated from open cast mine, which entails issues such as loss of top soil, soil erosion and water and air pollution, ecological disturbance and health problems (Krishna,2020). Also, the most serious environmental problems associated with mining activities is the acid drainage which occurs in many mining operations. They are characterized by low pH values and increased concentration of dissolved heavy metals, the sulphuric acid easily dissolves metals such as iron, copper, aluminium and lead. Acid producing mine can have long term effects on surface and ground water bodies even aquatic life, rendering the water bodies unsafe for human consumption. Mining operations along with the sorting, grinding and clustering of ores, and open air disposal of tailings by wind and miners causes environmental pollution (Dhaliwal *et al.,* 2020). This leads to an increase in the heavy metals content within the area of mining sites as waste materials are discharged and disposed of in the environment in various forms such as elemental, organic and inorganic. (Druibe *et al.,*2007). Heavy metals are carcinogenic and mutagenic and can pose great threat to humans, plants and aquatic animals as well as water bodies (Sarwar *et al.,* 2017). Metal ions accumulate in the body cells, may interact with and cause changes to nucleic acids and proteins and eventually damage DNA and disrupt biological functions **(**Türkdoğan, *et al.,* 2003**)** Consumption of food contaminated with heavy metal can significantly reduce the amount of important nutrients in the body, leading to weakened immune defences, stunted growth and malnutrition ( Sardar *et al.,* 2013). In present study elemental evaluation of rock minerals in Gujeni and Tsohon Birnin Gwari area of Kaduna State was carried out by Energy Dispersive X-ray Fluorescence Spectrometry (EDXRFS) to evaluate the potential minerals and the toxicity of the mining environment in the areas. The result of this analysis will provide baseline information on anthropogenic impact on the environment.

## MATERIALS AND METHODS

Sample collection and Pre- treatment

The rock bearing ore samples were collected from Tosoho Birnin Gwari gold mining site and Gujeni iron ore mining site Kaduna State as shown in Figure 1. The samples were collected in a well labeled air tight Polythene bags and transferred to the laboratory for further treatment. The samples were air dried under laboratory conditions for a week, ground with mortar and pestle, then sieved with 2mm mesh and store in a clean and labeled container (Sholadoye *et al.,* 2020).

**Table 1:** Samples Identification and Coding for the Mineral ores

| S/N | Samples | Code |
|---|---|---|
| 1 | Birin Gwari Gold Mining site Kaduna | BG |
| 2 | Gujeni Iron Mining Site Kaduna | GI |

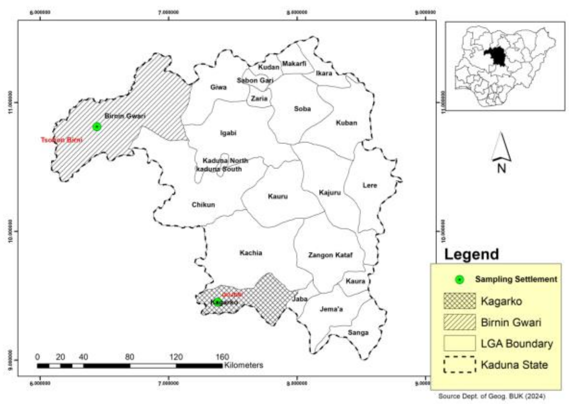


**Figure 1:** Showing Gujeni and Tsoho Birnin Gwari Sampling Sites. (Department of Geography, Bayero University, Kano (2024)

**Concentration of Ores Samples**

A 30g of the powdered sample was accurately weighed into 100cm$^3$container. 50cm$^3$ of bromoform was added to it and centrifuged at 4000 rpm for ten (10) minutes. The sample was removed and partially freeze the heavy minerals at the bottom part with liquid nitrogen while the light mineral was decanted. The sample was then warmed to unfreeze the frozen bromoform, and decanted and finally washed with 10cm$^3$ acetone. The washed sample was accurately transferred into a crucible and dried in an oven for about 12 hours at 56$^o$C. This procedure was carried out for all the samples, both concentrated and raw samples were subjected to EDXRF Spectrometer, model Lelyweg1, 760ZEA, Almelo, Netherland for elemental analysis (Jimoh, 2012)

**RESULTS AND DISCUSSION**

**Table 2**: Elemental results of raw and concentrated Iron ores samples (GI)

| Elements (%) | Raw Sample | Concentrated Sample |
|---|---|---|
| Ag | 0.00026 | 0.0082 |
| Au | ND | 5 x 10$^{-5}$ |
| Zn | 0.049 | 0.061 |
| S | 0.87 | 1.10 |
| Fe | 65.97 | 76.07 |
| Cu | 0.022 | 0.039 |
| Ga | 0.004 | 0.01 |
| As | 0.0063 | 0.00820 |
| Bi | 0.006 | 0.058 |
| Si | 27.05 | 20.05 |
| Al | 6.0 | 2.60 |

**ND = below detection limits**

**Table 3**: Elemental results of raw and concentrated Gold ores Samples for (BG)

| Elements (%) | Raw Sample | Concentrated Sample |
|---|---|---|
| Ag | ND | 0.019 |
| Au | 3.6 x 10$^{-5}$ | 0.0088 |
| Zn | 0.042 | 0.053 |
| Pb | ND | 0.045 |
| S | 0.42 | 0.06 |
| Fe | 84.10 | 90.44 |
| Cu | 0.086 | 0.094 |
| Ga | 0.020 | 0.043 |
| As | 0.168 | 0.202 |
| Bi | ND | 0.25 |
| Si | 13.10 | 7.10 |
| Hg | ND | 0.27 |
| Al | 2.0 | 0.85 |

**ND = below detection limits**

Table 2 presents the elemental composition of Gujeni Iron Ore samples. The results show that Fe, Si and Al were the predominant elements in the ore samples. The concentrations of the elements were Fe(65.97%), Si(27.05%) and Al(6.00%) in untreated samples while the concentrations in the treated samples were Fe(76.07%), Si(20.05) and Al (2.60%). Other associated elements such as Ag, Au, S, Bi, As, Ga and Cu were minor in the ore matrix. The preponderance of Zn, S, As in the results suggest the minerals are likely to be pyrite ($FeS_2$), arsenopyrite (FeAsS) and zinc blended (ZnS). The result of this studies agreed with Ambo *et al.,*(2013) which reported high concentration of Fe(57.70%), Si(2.51%) and Al(1.13%) along with other associated elements in their studied of cassiterite ore sample from Udege Beki. Also, Uduma *et al.*, (2016) reported high concentration of Fe(29.55%) and Si(24.68%) along with other associated element in their studied of Itakpe iron ore.

Table 3 present the elemental composition of Brinin Gwari Gold ore sample. The result presents Fe, Al and Si as the predominant elements in the ore sample. The concentration of the predominant elements were Fe(84.10%), Si(13.10%),Al(2.00%) and Au(0.009%) in the untreated sample and the concentration in the treated sample were Fe(90.44%), Si(7.10%) and Al(0.85%). Other associated minerals present in ore matrix were Ag, Pb, Zn, S, Cu, Ga, As, Bi and Hg. The presence of Fe, Cu, S and Pb suggest minerals like Chalcopyrite ($CuFeS_2$), Chalcocite ($Cu_2S$) and galena (PbS) which may predominant in the areas than gold being mined. Low concentration of gold mineral might be attributed to the presence of natural carbonaceous materials and minerals such as pyrite, copper, sulphides, quartz and silicate such as kaolin and illite are known for strong adsorbing properties i.e. pregrobbing effect, which may affect the availability of gold metal in the mining areas. Also, the presence of arsenic in the result of analysis may suggest arsenopyrite which may include gold. Arsenopyrite is insoluble to cyanide solution hence, affect the availability of gold. Sampling pattern may also affect the quantity of the gold metal present in the present work.

**Conclusion**

This study revealed the uses of EDXFS technique to obtain elemental composition of geological minerals as well as impact of illegal and artisanal miners on the mining environment. It also shows other potential minerals present in the mining areas which are not known to illegal miners. Mining operations are known for significant released of toxic metals into the surrounding

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environment through discharging of mined water to the environment and acid mined drainage. Some of the metals associated with mining operations include mercury, lead, arsenic etc. which are very difficult to convert to non-toxic harmless forms, hence they are carcinogenic, mutagenic and cytotoxic to the animals in contact with them. Also, acid mine drainage is another problem of mining activities which easily contaminate water bodies. Therefore, there is a need for regulatory bodies such as National Environmental Standards and Regulations Enforcement Agency (NESREA) and Standard Organization of Nigeria (SON) to create awareness on the effect of activities of illegal and artisanal miners as well as health implication of heavy metals on ecosystem and human begin at a large.

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