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Prelude Geological Survey and Evaluation of Au, Cu Bearing Rock Using Energy Dispersive X-Ray Fluorescence Analysis: A Case of Shuwa, Madagali

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Authors' contributions

This work was carried out in collaboration among all authors. Authors UZM, MAB and SOI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors UZM, MAB and SOI managed the analyses of the study. Authors SA and AA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A prelude geological study have been carried out for the evaluation of gold (Au) and copper (Cu) bearing rock formation of Shuwa District in Madagali LGC and its environs, Adamawa State. Samples were collected and analysis using Energy dispersive X-Ray Fluorescence analysis. The results obtained from the study location reveals that the most prominent mineral formation within the study area is copper oxide (CuO) which accounted for about 42.05% of the mineral presence within the rock sample with 8.80% of $Ti0_2$ mineral deposit in association with other minerals occurring as trace elements including gold with 0.04% presence. This research shows that the dominant mineral in terms of economic potential for exploration is copper while gold may not be of any economic viability within the investigated area.

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1. INTRODUCTION

Energy Dispersive X-Ray Fluorescence (EDXRF) challenges the customary fire assay process for assessment of valuable metals. X-Ray Fluorescence (XRF) offers a simple methodology for determining the elemental constituents within a material, as well as to measure the thickness and composition both solid and liquid samples. In other situations, XRF can also sometimes be used to determine the thickness and composition of layers and coatings [1]. It is rapidly becoming the preferred method in the metal sector as it is a nondestructive method and thus used for applications where is an essential to maintain the samples veracity [2,3,4]. Gold in the schist belt of Nigeria occur as alluvial and elluvial deposits. Only 5-10% of Nigeria's 12,000kg of reported gold production has come from vein deposits, while the greater part has been from modern alluvial derived from basement rocks. Element with high atomic numbers have better detection limits than lighter element. The precision and accuracy of XRF analysis is very high when significant standard are available for instrument calibration. The total measurement time for a single XRF analysis depend on the number of elements to be determined and the required accuracy and variety from 2000 to 5000s. However, XRF are sensitive technique and samples must be contaminated free [5]. As such a finger print can affect the analysis of the result obtained. For accurate results, the spectrometer conditions (e.g., the excitation energy of the X-ray generator) are tuned to the element to be analyzed. Inappropriate settings can lead to poor results. In EDXRF a whole spectrum is measured simultaneously and the area of the peak profile is an alternative, but information can lost because the area of peak profile is less sensitive to noise than is height of the same peak. Several authors studied the gold mineralization and the host rocks in Nigeria, e.g. Woakes and Bafor [6] and Garba [7,8], Garba [8] suggested that the gold mineralization is present in alluvial and eluvial placers and primary veins from several parts of supra crustal (schist) belts in the northwest and southwest of Nigeria. Copper (Cu) is a transition element that is an important non-ferrous metal (as cable and electrical and electronic components and building materials, etc.). The grade of Cu in the earth's crust is approximately 0.01%. in nature, Cu is found primarily in the form of compounds with sulphur [9]. The accurate analysis of Au, Cu and other precious metals has become progressibly significant because of the value of these precious metals. This is particularity important for processors and resellers of these metals. The product is either resold to the consumer or processed to recover the precious metal for use as a raw material in the manufacture of other products. The main target of this project is to demonstrate the utility of EDXRF to determine and give insight into the mineral potentials of Au, Cu composition/distribution by analyzing geological sample from mountain rocks catchment of shuwa, Madagali Adamawa, Nigeria. Result of analyses reported here will provide a basis for developing protocols to aid in detection, evaluation of minerals and provide a robust for economic evaluation of Nigeria's natural resources.

1.1 Site Description and Geology of the Study Area

This site is accessible from main road of Michika community, Michika/Madagali Local Government area of Adamawa State. It lies between latitude N 010 42 31.3 to N 010 42 31.4 and longitude E 013 32 53.8 to E 013 32 53.4 (Fig. 1). The study area ranges in altitude from 475 m to 769 m above sea level, scope are varying between vertical on granite pegmatite and quartz vein. Right from the top of the hill, copper, gold, quartz and iron ores are detected, and it depth is slow as 6ft to 200ft, its tend move on straight line formation from up of the hill down to its stream where the Copper and Gold is eagled within quartz vein. Part of the formation has high amount of copper and quartz with traces of silicate along the hilly region within the border of Tokyal and Shuwa villages. The basement rocks rise to a wide variety of soil change in texture with depth and have sand topsoil with high clay contents. Quartz gravel is commonly featured of the soil. The geology of the area is relatively simple. Basically an old amphibolites schist complex is intruded by large granite plutons. The plutons from highland and the amphibolites schist complex from the plains with numerous slightly elevated areas are underlain by pegmatite bodies.

2. METHODOLOGY

Field assessment of selected rock samples was carried out at some locations using systematic method with aid of the global positioning system

(GPS). The rock samples were brought to the National Metallurgical Development Centre laboratory Jos, Nigeria and model analysis of minerals were carried out using the polarizing microscope, ED-XRF analysis. The rock sample mainly quartizes, granite and gneisses were sent for analysis (Fig. 2a-e) which was grinded to a fine talc-like powder by rock Labs hardened steel "masher'', the procedures include; crushing the sample, sieving and transferred to a labeled glass bottle, soaking the sample in 3% H_2O_2 for at leat 24 hours in a beaker to digest organic matter, digestion in 250 ml of Na-hexametaphosphate solution (concentration of 4 g/1000 mL). The beakers were inserted into an ultrasonic bath for several minutes to promote

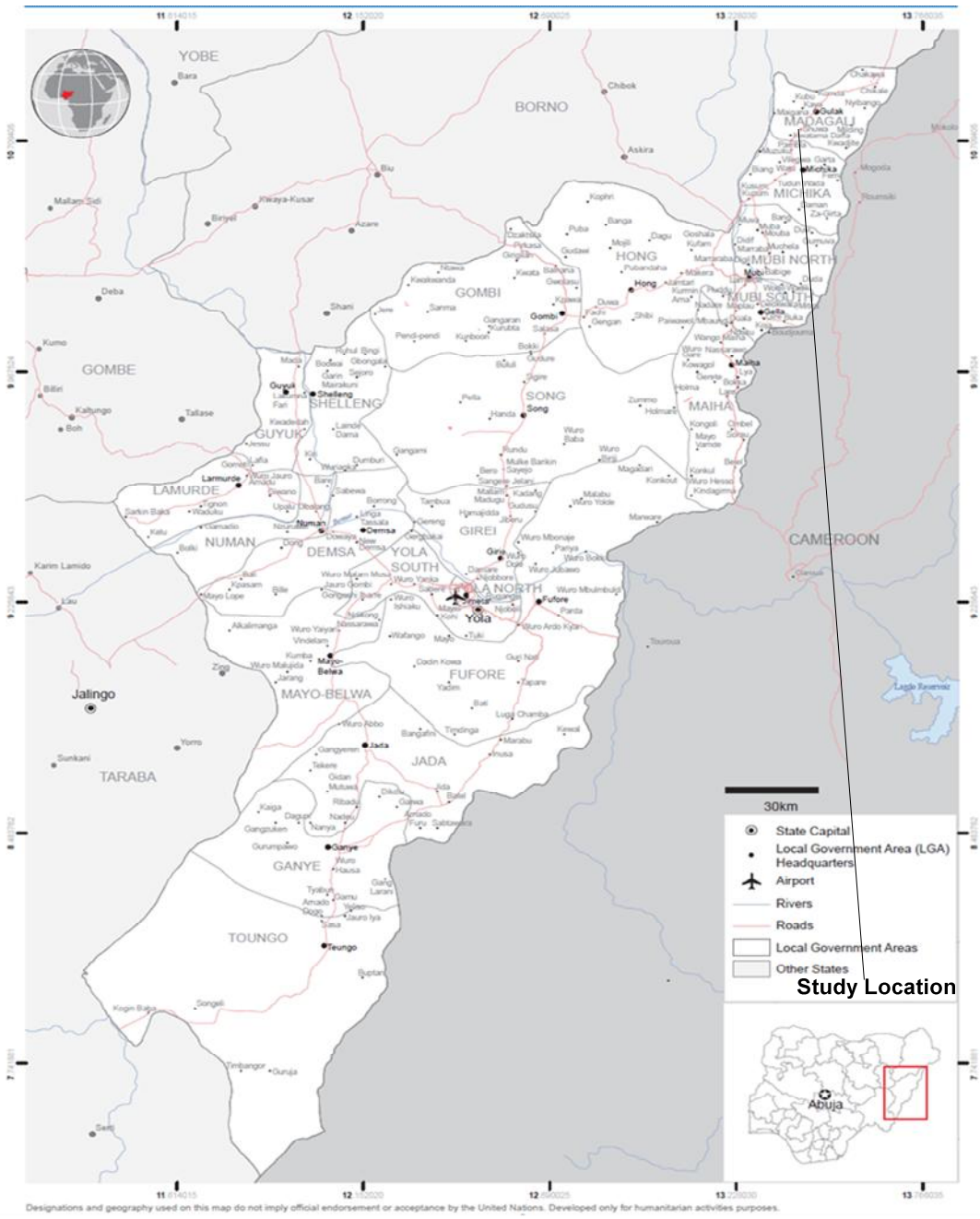
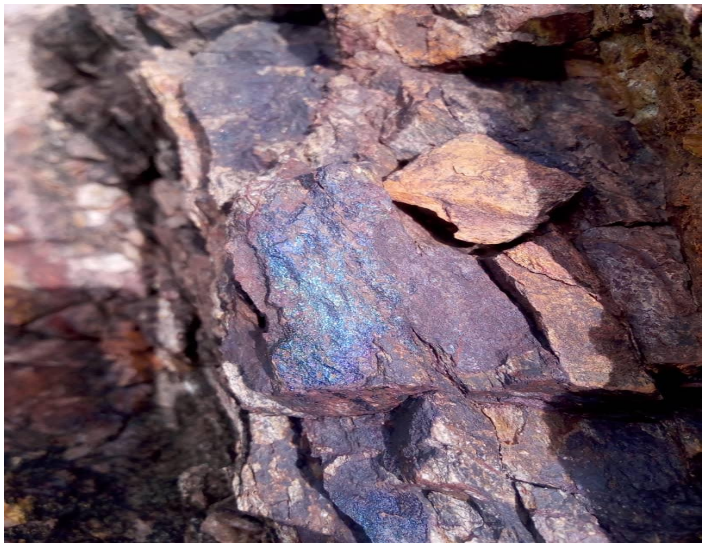


Fig. 1. Map showing the study location

disaggregation and deflocculation. This step (additional soaking) was repeated until visual inspection indicated complete disaggregation. Washing consisted of two passes through a centrifuge (8200 revolutions per minute (rpm) for 25 min;~ 6000g) with re-suspension in distilled water after each pass. After transferring the suspended sediment to a 60-mL plastic bottle, each sample were re-suspend by vigorous shaking and a 2-min application of a sonic cell probe, the small size of clay-size particles (<2 µm equivalent settling diameter) were then separated by centrifugation (1000 rpm for 2.4 min; ~320g). Oriented aggregates were prepared using filter peel method and 0.45- µm membrane [10], the small size aggregates were saturated with ethylene glycol vapor for at least 24 hour prior to XRD analysis, using a closed vapor chamber heated to 60° C in an oven. Finally, the sample was analyzed as soon as the glycol was uniformly absorbed on the sample mount and the sample was later scanned in XRD machine.

(a)



(b)

(c)

(d)

(e)

Fig. 2. (a-e) Showing different rocks samples

Table 1. Chemical ED-XRF Result Parameters in (%)

S/No	Sample	Al_30_3	SiO_2	SO_3	K_2O	CaO	Sc_2O_3	TiO_2	V_2O_5	Cr_2O_3	Au
1	Soft	6.68	7.20	ND	0.16	1.22	ND	8.80	0.56	0.19	0.04
		Fe_2O_2	NiO	CuO	ZnO	SeO_2	Rb_2O	ZrO_2	Ag_2O	Nb_2O_5	Ta_2O_5
		15.43	0.003	42.05	0.01	ND	0.04	0.02	0.58	2.46	0.68

Key: % = Percentage
ND = Not Detectable
Loss on Ignition (LOI) was not determined

3. RESULTS AND DISCUSSION

3.1 Concentration of Gold and Copper in Shuwa District

The Following are the geological sample analyzed using energy dispersive XRF. From the sample, Gold was obtained with trace of impurities as shown in Table 1. Copper ore was obtained from the suspected ore sample with some silica and trace of impurities. The results obtained characterized the mineral presence/deposit within the study area as follows; CuO; 42.05 %, Fe_2O_2; 15.43 %, TiO_2; 8.80 %, SiO_2; 7.20 %, Al_3O_3; 6.68 %, Nb_2O_5; 2.46 %, CaO; 1.22 %, Ta_2O_5; 0.68 %, V_2O_5; 0.56 %, Cr_2O_3; 0.19 %, K_2O; 0.16 %, Au; 0.04%, Rb_2O_4; 0.04 %, NiO; 0.03 %, ZrO_2; 0.02 % and ZnO with 0.01 %, indicative that the dominant mineral in terms of economic potential for exploration is copper with a percentage of 42.05 % while gold with a percentage of 0.04 % may not be of any economic viability within the investigated area (Table 1). Therefore, in term of exploration / exploitation of mineral for development, copper oxide with the largest deposit remains the most promising within the study area in terms of economic potential.

4. CONCLUSION

The investigated area is rich with copper by the random sampling carried out. The results obtained from the study location reveals that the most prominent mineral formation within the study area is copper oxide (CuO) which accounted for about 42.05 % of the mineral presence within rock sample with 8.80 % of $Ti0_2$ mineral deposit in association with other minerals occurring as trace elements including gold with 0.04% presence. This research shows that the dominant mineral in terms of economic potential for exploration is copper while gold may not be of any economic viability within the investigated area. Finally, the minerals can easily be mined by mechanized open cast method of mining or underground mining by experts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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