GEOLOGICAL AND GEOCHEMICAL PROSPECTING FOR GOLD MINERALIZATION IN BODE-SAADU AXIS, SOUTHWESTERN BASEMENT COMPLEX, NIGERIA

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ABSTRACT

Geological and geochemical studies of gold mineralization in Bode-Saadu axis, Southwestern Basement Complex, Nigeria have been conducted in order to study their mode of occurrence, structural settings, pattern of distribution and potential. Geological studies reveal that granite and gneiss granite are the prominent rocks in the area and exist in the north-eastern, north-western and southwestern part of the area whereas mica and amphibole schist occur as low-lying exposure. Petrographic studies reveal spatial association between gold mineralization and the fractured zones. Geochemical studies show that the gold concentration in rocks and stream sediments from the region is low with the exception of a few areas with high values and is related to the occurrence of fissure in the northeast-west direction. The distribution pattern of gold in the region is skewed NE-SW, indicating that gold mineralization is structurally controlled.

Keywords: Geochemical prospecting; Geological studies; Gold mineralization; Structurally controlled.

1 INTRODUCTION

A major source of raw materials which drive industrialization globally is mineral resources. Mineral resources such as gold, iron ores, tins, marbles, limestone are essential in the manufacturing, cosmetic and construction industries to mention a few. Some decades ago, in Nigeria, solid mineral resources were the mainstay of the economy. In later years, the discovery of crude oil shifted the focus from solid minerals to crude oil, making the later the highest contributor to Nigeria's Gross Domestic Product (GDP). The solid mineral sector has, however, in recent years gained significant attention leading to increased exploration and development of metalliferous deposits and gemstones. This became inevitable since crude oil is non-renewable and the need for diversification of the economy.

The importance of gold in driving the economy of any nation is well known, thus, the necessity for its search globally. Geologically, in several parts of the world, native gold is relatively ubiquitous in oxidized zones of sulphide and hydrothermal deposits. Also, in gold-quartz veins, streams and rivers. They have also been reported to be in association with stocks, batholiths, intermediate to acidic igneous intrusions [1]. Precambrian to Late Tertiary orogenic belts are known to host hydrothermal gold deposits [1]. In Western Australia, the Precambrian granitoid-greenstone terrains (ca 2700 to 2500 Ma) of the Yilgarn Craton are the most mineralized with world-class nickel and gold deposits including mineralized pegmatites [2].

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pp. 64–76, ISSN 1802-5420
DOI 10.35180/gse-2021-0053

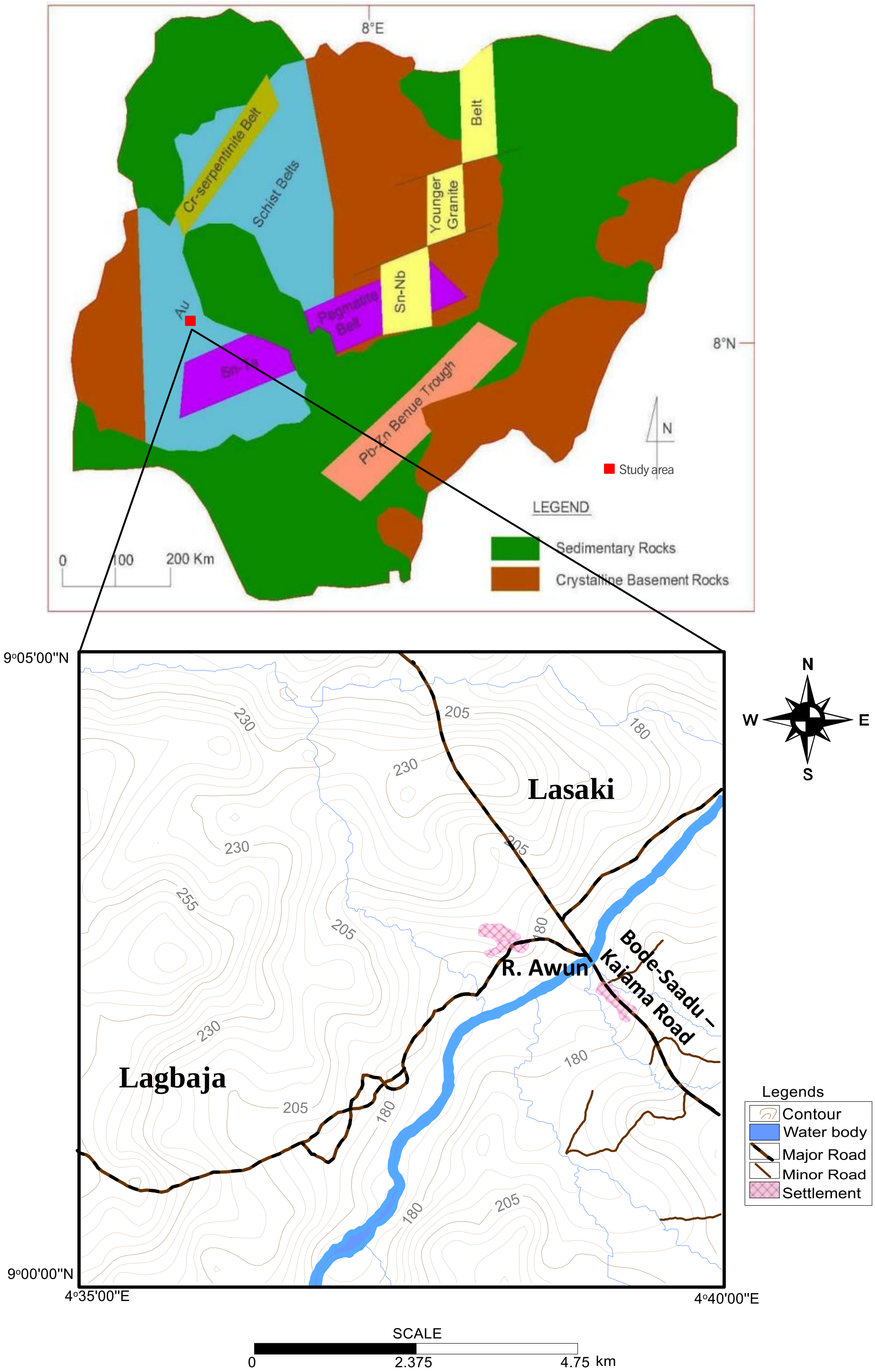

Figure 1. *Major mineral belts of Nigeria Modified from [3]*
(Au = Gold; Cr-serpentinite, Sn-Ta belts = Pan African; Sn-Nb, Pb-Zn belts = Mesozoic to Early Cenozoic)

According to the study of [4], Nigeria's schists belts contain world class potential gold reserves and are the principal targets for exploration. The schist belts in Nigeria constitute an integral part of the Nigerian basement complex, and are noted for gold, iron, tin, tantalum, niobium and marble mineralization [5]. The Nigerian schist belts, which have been described as Archaean greenstone belts [6], cover over 400 km^2 along a N-S trend confined prominently to the western half of Nigeria [5]. In Nigeria, gold is known to occur as both primary vein deposit and

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placer deposit i.e. alluvial and eluvia within the schist belts of northwest and southwestern Nigeria. Areas associated with gold mineralization in Nigeria's schist belt are shown in Figure 1.

The schist belts have attracted the attention of several authors because of their potentials in hosting metallic minerals, chiefly gold. Authors in [4] conducted geological, geophysical and geochemical studies for gold exploration in Kwakuti, North-central Nigeria. The study aimed to produce geological and structural maps that can help in identifying possible areas of gold mineralization. The work of [7], on the geology and genesis of gold bearing quartz vein in Bin Yauri and Okolom in the Pan-African domain of western Nigeria suggests that gold mineralization in the two localities and in the Nigeria schist belts in general may have evolved as a result of the metamorphic dewatering of thick sequences of clastics sediment, metamorphic shales and their associated volcanic rocks within the Precambrian to Lower Palaeozoic Basement Complex. Research in [1] suggested that the Gold deposits in Anka Schist Belts, a part of North-western Nigeria, were of metamorphic origin from geochemical analysis using Na_2O/Al_2O_3 – K_2O/Al_2O_3 discrimination plots and inter-elements ratios of lithophile elements such as K, Rb, Ba, Rb and Sr. Some other works on gold mineralization within the Nigerian schist belts include [8], [9] and [10].

Determination of appropriate structural patterns and hydrothermal processes needed to transport gold liquids and deposition is important in gold prospecting. Research in [11] show that the occurrence of gold deposit in the Main Reef Complex (MRC), South Africa has been reported to be structurally controlled and hydrothermal in origin and associated with sulphides. Research by [12] combined geological and geophysical methods to delineate and model gold mineralization zone in Sefwi Belt, Ghana, and showed that gold mineralization strikes in the north-east direction, thus is structurally controlled.

The potential for gold mineralization in the present study area (Bode-Saadu axis), which is a part of the schist belt within the Southwestern Basement Complex of Nigeria, is however yet to be explored. The combination of geological mapping and geochemical data can help identify and delineate lithological units and boundaries, fractures and mineral accumulations more accurately. Thus, this study incorporates geological and geochemical methods to explore for gold.

This study will help to delineate lithological contacts, structural settings and possible alteration zones as that can serve as a preliminary guide for further gold exploration in the study area.

2 METHODOLOGY

Geological field mapping was conducted by traversing along foot paths and mostly cutting through the bushes to an outcrop. In the field, each outcrop has been observed and described on the basis of its mode of occurrence, macroscopic features, structural elements and the field relationship with adjacent outcrops. The hand specimens were described on the basis of the following macroscopic characteristics: colour, texture, mineralogy and carefully labelled and georeferenced on the base map at the appropriate locations where the samples were collected using (GPS) and geographic coordinates of the base map. The lithological boundaries were mapped out based on changes in rock units, nature of soils, vegetation, thickness of overburden soil and topography. With the aid of the compass clinometers, the description and measurement of structural attitudes (strike, dip amount and dip directions) were carefully made. Fresh rock samples and stream sediments were collected to confirm the mineralization of the area. Mineralogical and textural observations of the different rocks sample were first carried out on the field using magnifying lens, which provided a preliminary insight into determining the nomenclature of the rocks. Four fresh representative samples (rocks) were taken with a sledge hammer for petrographic analysis. Petrographic studies involved thin-section preparation of each rock samples at Geology and Mineral Science Department’s Thin-section Laboratory, University of Ilorin, Nigeria. The petrographic analysis of the thin section was carried out using a petrological microscope in both Plane polarized (PPL) and Cross polarized (XPL) mode. For the rock geochemical analysis, the samples were crushed and powdered using a stainless Jaw crusher and grained to obtain a grain size less than -63 μ. The samples were quarted in order to get a statistically representative fraction and powered. A mass of 25 g of the powered samples were subjected to attack by a mixture of concentrated HCl and HNO_3 acid in a crucible flask. This process is commonly referred to as aqua regia digestion. Aqua regia is used to typically describe a 1:3 mixture of concentrated nitric (HNO_3) and hydrochloric (HCl) acids. The digestion of the samples was continued by heating the mixture for over an hour after which it was left to cool for few minutes. They were thereafter transferred to a mechanical shaker for about 30 minutes. A sponge was added to the mixture, later removed and placed in a 1 g ammonium nitrate, then mixed thoroughly, and roasted for one hour in a muffle

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furnace. The foam was then washed and taken to the Atomic Absorption Spectrophotometer (AAS). The Aqua regia is particularly useful for the dissolution of gold (Au); neither nitric acid nor hydrochloric acid alone will keep Au in solution. Combining the two acids performs the necessary steps to dissolve Au and keeps it in solution. Nitric acid and reaction products in combination with HCl (e.g. nitrosyl chloride, NOCl) are strong oxidants, forming gold ions (Au^{3+}) in solution after dissolution of Au-bearing minerals. Hydrochloric acid forms the source of Cl- ions, which form strong aqueous chloroaurate ($AuCl^{4-}$) complexes, removing Au solution and allowing dissolution and oxidation reactions to progress Au i.e. [13]:

$$Au(s)+3NO_3^-(aq)+6H^+(aq)\rightarrow Au_3+(aq)+3NO_2(g)+3H_2O(l)\ Au_3+(aq)+4Cl^-(aq)\rightarrow AuCl_4^-(aq) \qquad \textbf{(1)}$$

Five stream sediments were collected and the sites for the sampling coincided with drainage channels. Samples were taken at about 0.3 m from the surface of the stream. The stream sediments were taken for analysis in the Central Research Laboratory, University of Ilorin, Nigeria and Kursi Laboratory. Four major elements were analysed, namely zinc, copper, lead and Au. The geochemical composition of stream sediments was obtained using an Atomic Absorption Spectrophotometer.

3 RESULTS AND DISCUSSION

3.1 Geology of Bode-Saadu Area

The study area lies within the Iseyin-Oyan Schist belt, covering the southwestern part of Jebba sheet 181. It falls within the Precambrian basement of Southwestern Nigeria, dated to be of late Proterozoic to early Palaeozoic [9]. The major rock types identified include schist (Amphibolite and Mica Schist), granite gneiss and granite (Fig. 2). The major structures in the study area include joints, faults, foliations and minor folds. Most of the structural elements are not represented on the map due to scale.

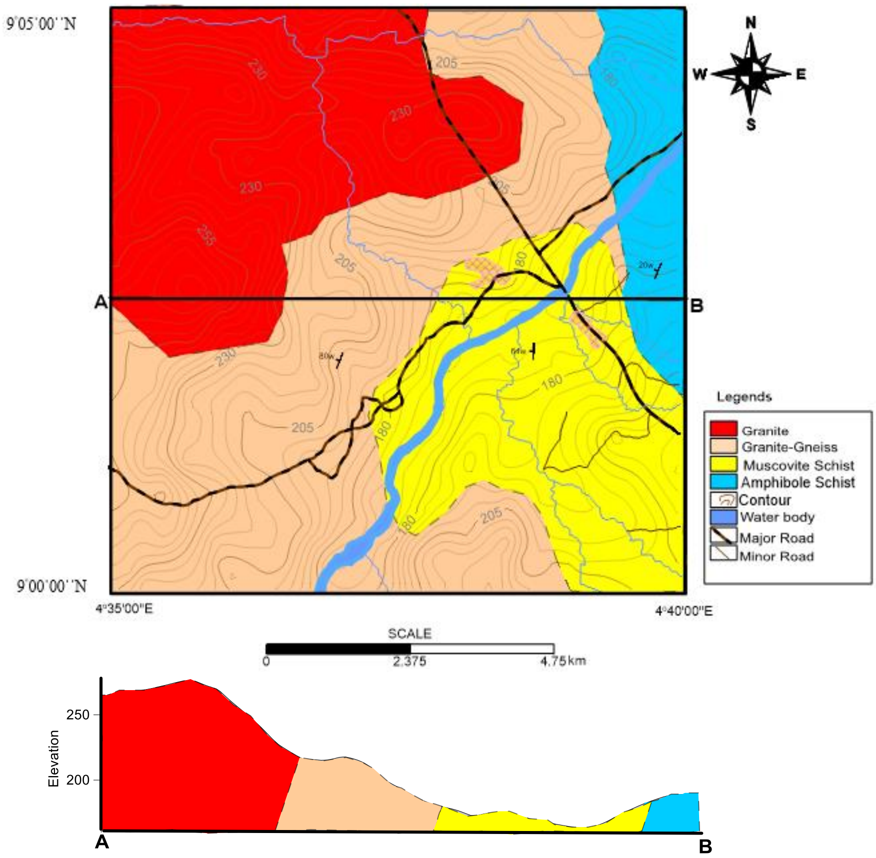

__Figure 2.__ Geological Map of Study area [14]

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3.2 Field Description

3.2.1 Schists

Different schists encountered on the field include the mica schist and the amphibole schist. They cover a significant part of the north-eastern and south-western part of the study area. However, the exposures are scarce and where found they occur as low-lying outcrops due the intensity of weathering and denudation or isolated hills and are conspicuous along river channels. The Mica schists are generally characterized by their conspicuous, very high and well-defined schistosity with basic mineral compositions comprising of biotite, muscovite and feldspar. Similarly, the amphibole schists are seen in contact with the mica schist and the exposures of this schist is low lying and often fragmented along the river channels. However, some of the amphibole schists are seen to be unperturbed and unweathered. The general strike of the rock is in the N-S direction, there are minor quartz veins which intrude the rock through its weak foliation planes. Strike and dips values include: 180^0/64^{0}W, 186^0/66^{0}W, 182^0/64^{0}W and 180^0/60^{0}W. The mineralogy includes quartz, muscovite and minor tourmaline.

3.2.2 Granite Gneiss

Granite gneiss occupies the NE-SW part of the study area although intruded by granite. It is a pinkish, medium-grained rock containing quartz, k-feldspar, oligoclase, minor biotite and muscovite along with accessory ilmenite, epidote, sphene and chlorite. There are a number of laterally continuous quartzo-feldspar veins. Some of these veins have been displaced into strike-slip faults (a prominent dextral fault was observed on the outcrop). Structurally the granite gneiss is marked by heterogeneous strain producing rocks from weakly deformed granite to mylonitic granitic gneiss. Mineralogy of the mesocratic granite gneiss include quartz, feldspar and some occasional tourmaline.

3.2.3 Quartzite

Along the Bode-Saadu- Kaiama road there is a locally exposed low-lying quartzite which trends in the N-S direction. The low-lying exposure of quartzite hosted in the amphibole schist has an area extent of about 25 x 10 m. Near the contact with the metagreywacke, the sequence is marked by 3cm to 5m thick lenses of pebbly quartzite containing white and smoky quartz as well as small grain of microclines in a matrix of finer quartz and muscovite grains interpreted as representing a matrix-supported conglomerate. The quartzite locally shows preserved cross-stratification and locally occur as thinly-bedded, flaggy units. Strike and dip values include 024^0/50^{0}W and 020^0/060^{0}W.

3.2.4 Granite

The hand specimen of the rock is light grey in colour and leucocratic. The texture of the rock ranges from fine to medium grain with variable amounts of quartz, microcline, plagioclase, biotite and minor hornblende and are the youngest in the study area as they intrude the gneisses and the schists.

3.2.5 Petrographic Analysis

Thin sections were prepared from four representative rock samples collected in the field, (granite, gneiss, amphibole and mica schist), and petrographic analysis of the thin section was done in both the PPL and XPL mode using a petrological-type microscope. The analysis was carried out in Geology and Mineral science Department, University of Ilorin, Ilorin, Nigeria.

3.2.6 Mica Schist

The hand specimens of the mica schist are mostly light brown. Flakes of dark mica, lined up parallel to each other, and separated by light-coloured material, which are mostly millimetre-centimetre sized quartz/feldspar crystals with schistose texture. Under the microscope, the rocks show euhedral and anhedral crystals of dark and light-coloured minerals. The mineral assemblages of the rock include quartz (10 %), feldspar (plagioclase 30 %), biotite (30 %), microcline (25 %) and opaque minerals (5 %) (Fig. 3).

3.2.7 Amphibolite Schist

From the thin section observation, the rock is dominantly composed of amphibole (35 %), quartz (20 %), biotite (20 %), myrmekite (25%). Basically, the rock shows anhedral crystals of light and dark coloured minerals. Amphibole is grey to dark brown and possess a vitreous lustre. Quartz is colourless to light yellow and shows no cleavage. Biotite occurs as an elongated crystal and in form of lath (Fig. 4).

3.2.8 Granite Gneiss

Thin section study indicates the presence of the following minerals: quartz (35 %), biotite (10 %), Microcline (30 %), Plagioclase (20 %), opaque mineral (5 %). Quartz is colourless to yellow with conchoidal fracture and no sign of alteration. It has low relief and shows no pleochroism. Biotite is brown with strong pleochroism, pleochroic and cleavage. It shows yellow colour and interference colour of second order. Opaque minerals remain dark both in plane and cross polarized light (Fig. 5).

3.2.9 Granite

The thin section of the rock indicates that microcline (40 %), quartz (20 %), biotite (15 %), muscovite (15 %) and opaque (10 %). In thin section, the rocks are porphyritic in texture, with phenocrysts of microcline in a groundmass made up of quartz, biotite and muscovite (Fig. 6).

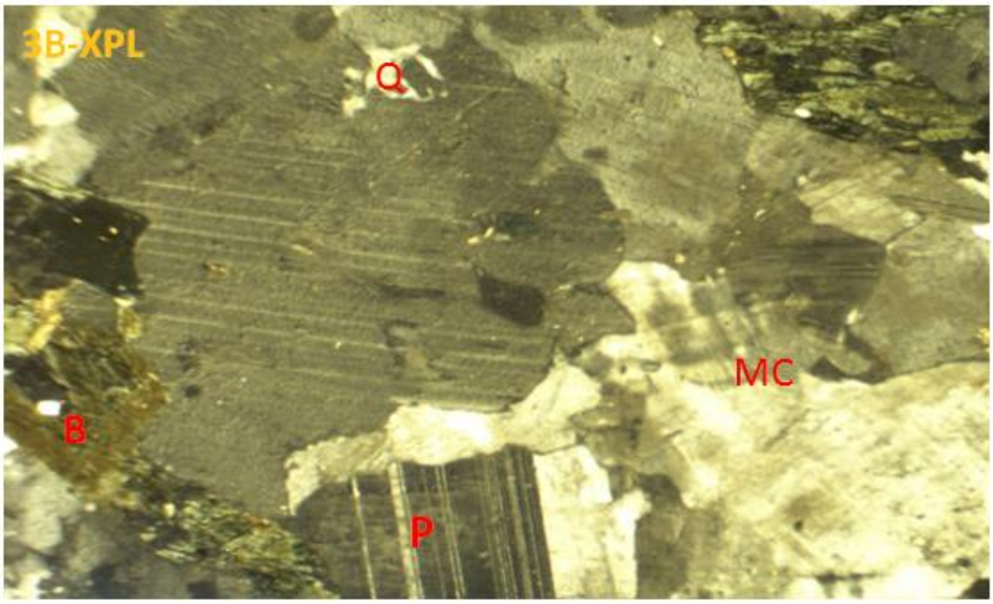

Figure 3. *Photomicrographs of Mica Schist (B – Biotite, P – Plagioclase, Q – Quartz, MC – Microcline); magnification MG-X4*

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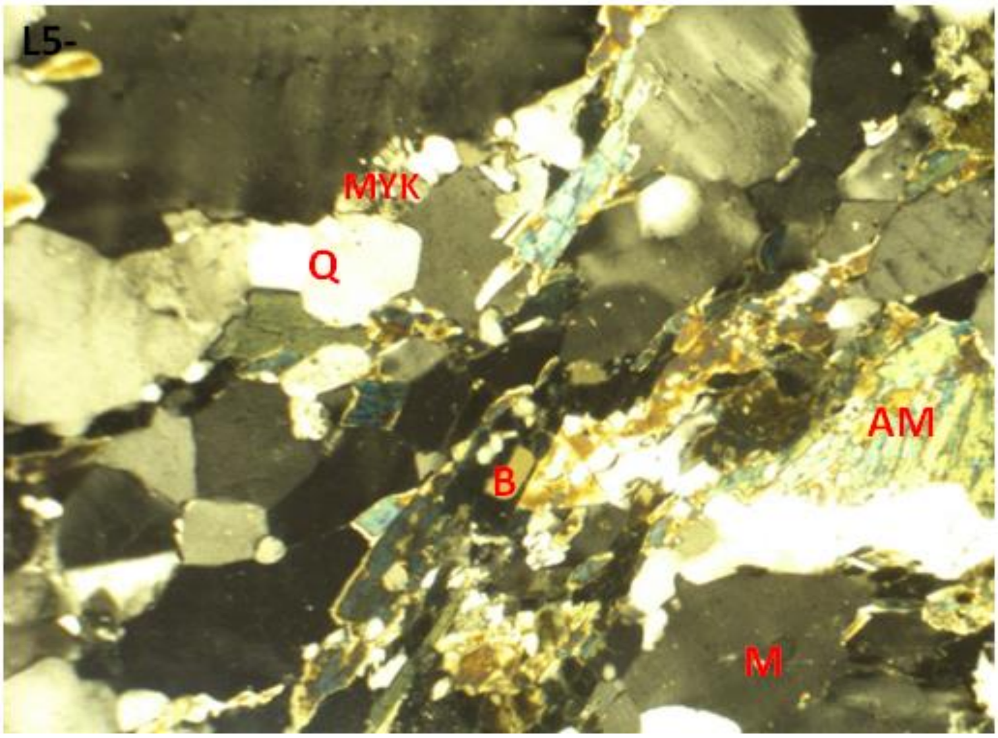

Figure 4. *Photomicrograph of Amphibole schist (B – Biotite, Amp – Amphibole, Q – Quartz, Myk – Myrmekite); MG-X4*

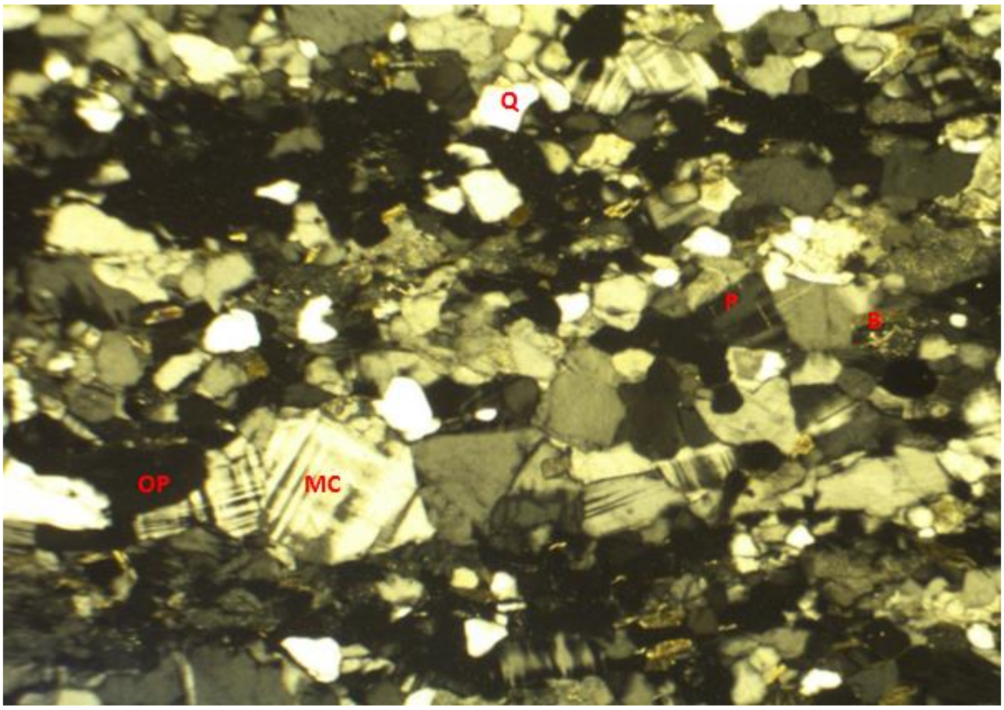

Figure 5. *Photomicrograph of Granite Gneiss (B – Biotite, P – Plagioclase, Q – Quartz, Mc – Microcline, Op – Opaque); MG-X4*

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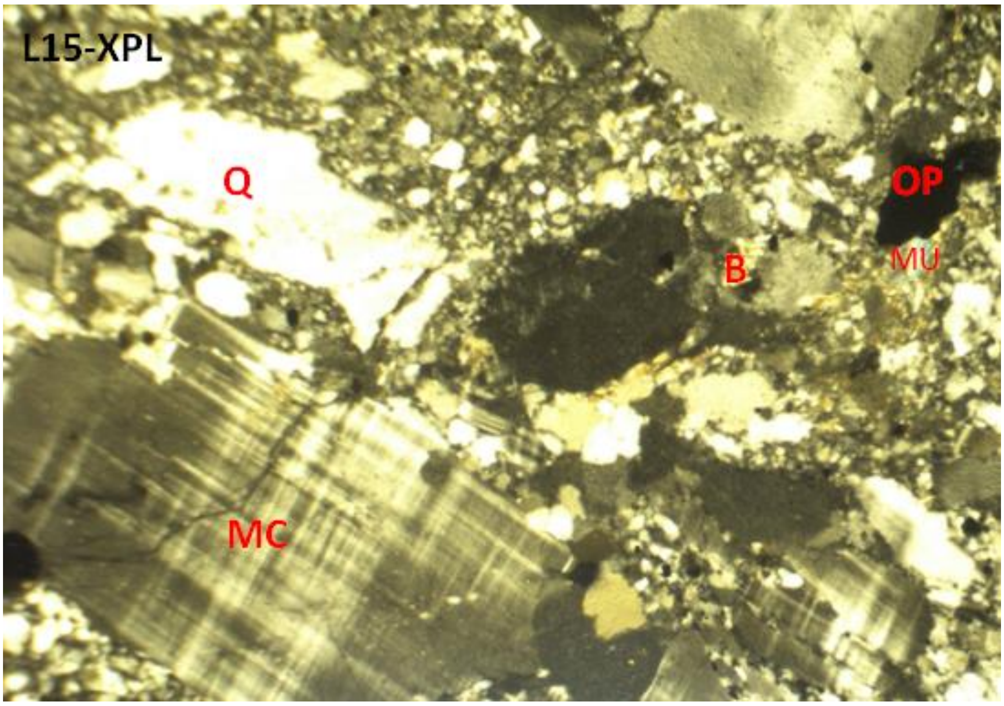

Figure 6. *Photomicrographs of Granite (B – Biotite, MU – Muscovite, Q – Quartz, MC – Microcline, OP – Opaque); MG-X4*

3.3 Geochemical Data Analysis and Interpretation

The results of the geochemical composition of stream sediments and statistical relationships are presented in Tables 1 and 2, respectively.

Table 1. *Concentration of elements in the study area*

Location	Latitude	Longitude	Sample type	Zn (ppm)	Pb (ppm)	Cu (ppm)	Au (ppm)
1	N 9° 2' 18.58"	E 4° 38' 8.25"	Stream Sediment	0.02	0.00	0.02	0.00
2	N 9° 2' 18.03"	E 4° 38' 7.45"	Stream Sediment	0.08	0.00	0.00	0.00
3	N 9° 2' 34.43"	E 4° 38' 59.29"	Stream Sediment	0.00	0.00	0.00	0.00
4	N 9° 0' 10.31"	E 4° 40' 43.64"	Mica Schist	0.05	0.03	0.21	0.00
5	N 9° 0' 12.03"	E 4° 40' 43.47"	Amphibolite Schist	0.05	0.00	0.08	0.00
6	N 9° 0' 12.79"	E 4° 40' 44.48"	Granite	0.00	0.00	0.03	0.00
7	N 9° 01' 24.86"	E 4° 39' 54.31"	Stream Sediment	0.01	0.00	0.03	0.00
8	N 9° 01' 37.75"	E 4° 39' 37.08"	Stream Sediment	0.12	0.00	0.04	0.00
9	N 9° 02' 37.75"	E 4° 38' 30.30"	Granite	0.11	0.00	0.01	0.00
10	N 9° 1' 31.78"	E 4° 37' 11.52"	Amphibolite Schist	0.80	8.00	2.50	2.04
11	N 9° 1' 30.28"	E 4° 37' 11.63"	Amphibolite Schist	12.0	6.40	26.20	2.40
12	N 9° 1' 41.21"	E 4° 37' 11.28"	Granite	28.0	12.0	13.40	3.48
13	N 9° 1' 42.02"	E 4° 37' 13.83"	Granite	12.4	18.0	5.20	4.00
14	N 9° 1' 54.52"	E 4° 37' 14.15"	Granite	20.00	10.4	10.50	6.20
15	N 9° 1' 32.74"	E 4° 37' 52.58"	Granite Gneiss	5.04	8.00	22.10	4.38

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Table 2. *Statistical Presentation of Concentration of elements in the study area*

		Zn (ppm)	Pb (ppm)	Cu (ppm)	Au (ppm)
N	Valid	15	15	15	15
	Missing	0	0	0	0
Mean		5.2453	4.1887	5.3547	1.5000
Median		.1100	.0000	.0800	.0000
Std. Deviation		8.84444	5.86726	8.73383	2.10283
Minimum		.00	.00	.00	.00
Maximum		28.00	18.00	26.20	6.20

The lowest values of gold of 0.00–2.04 ppm were recorded in the stream sediments, higher values (0.00–4.00 ppm) at the aureole contact between the amphibole schist and medium-granite batholith while the highest values (4.38–6.20 ppm) were recorded in granitic rocks. The results obtained from stream sediments and rock samples show that there was substantial evidence of mineralization in the area indicating background enrichment to moderate enrichment. Evidence from field relationships, petrographic, geochemical studies of the rocks and stream sediments show that gold in the study area is closely associated with Zn, Cu and Pb. Au, Zn, Cu and Pb elements in the mineralization area are represented by wide anomalies when compared with their relative abundance in average crustal rocks.

Using the Independent T test, an analysis was carried out to compare the mean of each of the geochemical substance, and their estimated level of significance was compared to 0.05. As seen in Table 4, the sig. (2-tailed) Zn, Pb, Cu, Au were all less than the standard level of significance 0.05 for this test, indicating that there is a significant difference in each of the geochemical substance.

Table 3. *One-Sample Test*

	Test Value = 0					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Zn (ppm)	2.297	14	.038	5.24533	.3474	10.1432
Pb (ppm)	2.765	14	.015	4.18867	.9395	7.4378
Cu (ppm)	2.375	14	.032	5.35467	.5180	10.1913
Au (ppm)	2.763	14	.015	1.50000	.3355	2.6645

3.4 Areal distribution of the elements

Contour diagrams (Figs. 7–10) were prepared to determine the element distribution in the field. Contour diagrams using the percentage values of gold indicate that Au forms a strong anomaly which trends in the NE-SW part of the area. In the contour diagrams of the various elements, it may be inferred that the elements are strongly and positively correlated as the pattern for the anomalies maintained the same trend throughout the study area except for Zn which maintains a low anomaly trend in the North-South part.

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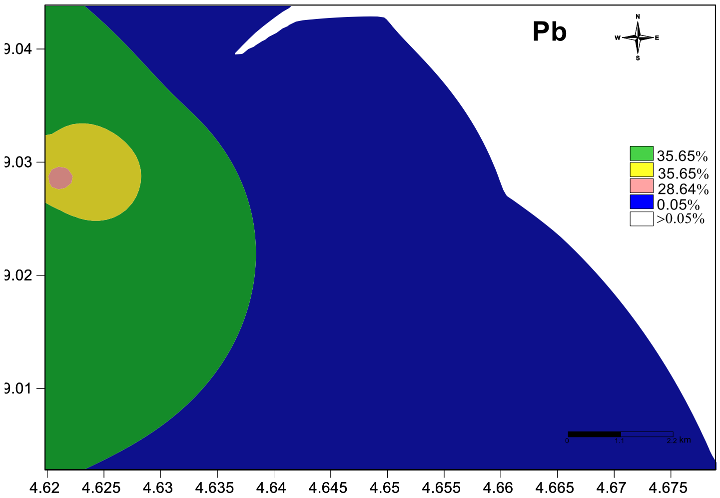

Figure 7. *Contour diagram for Pb mineralization in the study area*

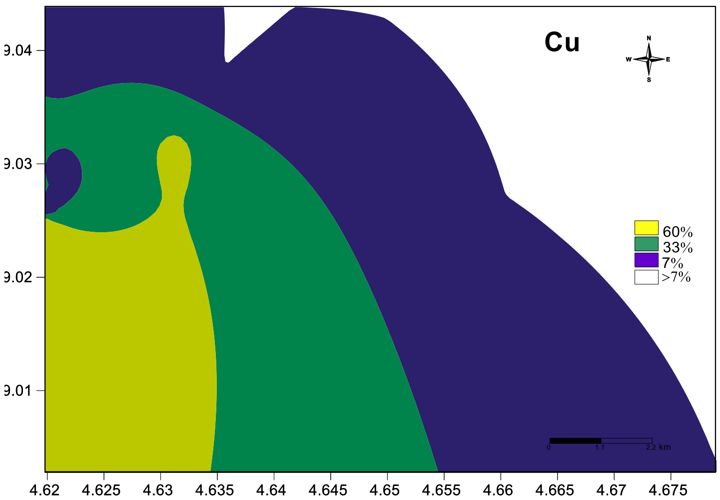

Figure 8. *Contour diagram for Cu mineralization in the study area*

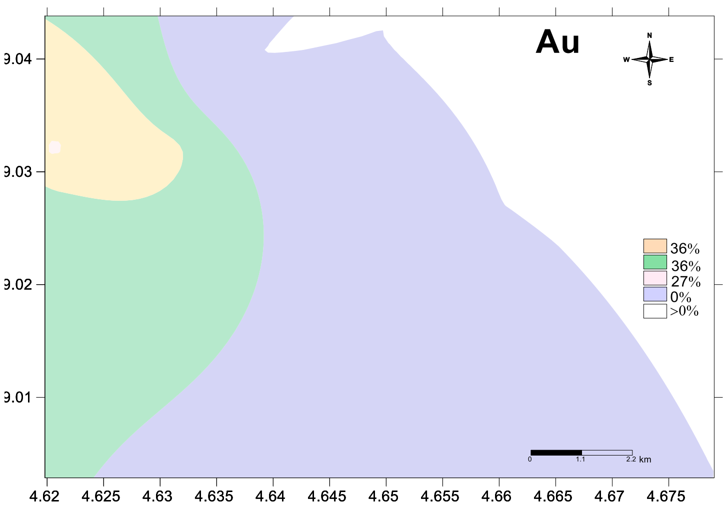

Figure 9. *Contour diagram for Au mineralization in the study area*

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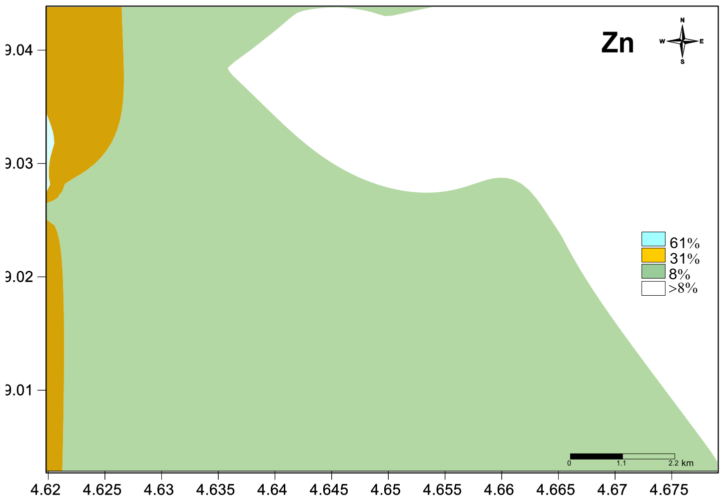

Figure 10. *Contour diagram for Zn mineralization in the study area*

By carefully comparing or superposing the element distribution diagrams on lineament map in Fig. 11 shows that mineralization is clearly associated with NE-SW trending fracture systems. Elements (Au, Zn, Cu, and Pb) show wide anomalies at the junction of major fracture systems and the contact zones.

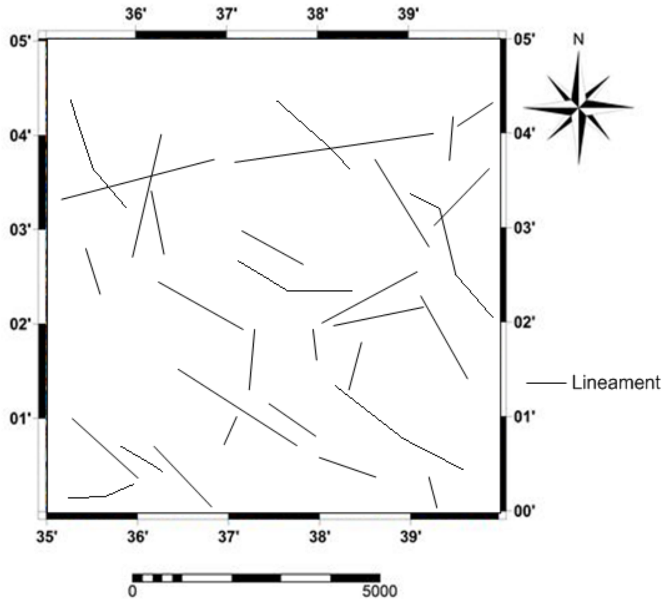

Figure 11. *Lineament map of the study area*

3.5 Mineralisation

Gold mineralization in the study area is hosted by the biotite granite, granite gneiss, mica schist and the amphibole schist with NE–SW trending shear structures (Fig. 10). The gold mineralization is probably formed by hot circulating connate fluid which leached out metals from the wall rocks. The hot metalliferous fluid then convects upward under pressure through fractures and faults into cooler areas in the upper levels of the earth where it was precipitated within quartz filled fractures under favourable physico-chemical conditions. Gold mineralization in the study area usually occurs in parallel N-S trending quartz veins and reefs which rarely exceed few centimetres

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in thickness. The slight anomalous concentration in major streams might have resulted from disintegration and denudation of these lithologies which host the gold, thus resulting in remobilization of the gold and reconcentration in alluvial sediments. The gold mineralization process in the study area is possibly related to a hot circulating underground fluid system, which leached out metals from the wall rock as it convects upward through fractures and shear zones into the upper parts of the earth where the metalliferous fluid precipitates gold in quartz veins and reefs.

4 CONCLUSION

From the field observations, structural studies and geochemical analyses, it can be concluded that the gold mineralization is structurally controlled. The NE-SW and the NNW-SSE trending fractures served as conduit for disseminating the mineralized fluid in the Bode-Saadu area. The primary source of mineralization is suggested from the detrital gold and metal ions leached from the wall rock. Degassing of mantle volatiles might have contributed to the gold mineralization solutions that produced the gold deposit. The statistical studies and data evaluations show that gold in Bode Saadu axis is closely associated with lead, copper and lead. Hence, lead, copper and zinc could be used as pathfinder elements in the gold exploration. The association of these pathfinder elements could also indicate the presence of sulphide mineralization, hence the possibility for galena, sphalerite or chalcopyrite ore deposit. Comparing the element distribution diagrams and the lineament map reveal that mineralization is closely related to NE-SW and the NNW-SSE trending faults system. The contacts between different geological units, the intersections between linear features, sheared and fractured zones are potential traps for gold mineralization and therefore give a significant exploration vector. Further geochemical and geophysical surveys as well as exploratory drilling are recommended to confirm the results of this study and for mineral prospecting.

REFERENCES

[1] DANBATTA, U.A., Y.I. ABUBAKAR and A.A. IBRAHIM. Geochemistry of Gold Deposits in Anka Schist Belt, Northwestern, Nigeria. *Nigerian Journal of Chemical Research*. 2008, vol. 13, pp. 19–29. ISSN 1119-0221. Available from: https://www.ajol.info/index.php/njcr/article/view/73774/64466

[2] GROVES, D.I., M.E. BARLEY and J.M. SHEPHERD. Overviews: Geology and mineralisation of Western Australia. *ASEG Extended Abstracts*. 1994, (1), pp. 1–28. ISSN 2202-0586. DOI: 10.1071/ASEGSpec07_02

[3] EISENLOHR, B.N., D. GROVES and G.A. PARTINGTON. Crustal-scale shear zones and their significance to Archaean gold mineralisation in Western Australia. *Mineralium Deposita*. 1989, vol. 24, pp. 1–8. ISSN 0026-4598.

[4] EJEPU, J.S., C.I. UNUEVHO, A.T. AGBOR and S. ABDULLAHI. Integrated geosciences prospecting for gold mineralization in Kwakuti, North-central Nigeria. *Journal of Geology and Mining Research*. 2018, vol. 10(7), pp. 81–94. ISSN 2006-9766. DOI: 10.5897/JGMR2018.0296

[5] OYINLOYE, A.O. Metallogenesis of the Lode Gold Deposit in Ilesha Area of Southwestern Nigeria: Inferences from Lead Isotope Systematics. *Pakistan Journal of Scientific and Industrial Research*. 2006, vol. 49(1), pp. 1–11. ISSN 0030-9885.

[6] WRIGHT, J.B. and P. MCCURRY. A Reappraisal of Some Aspects of Precambrian Shield Geology: Discussion. *Bulletin of the Geological Society of America*. 1970, vol. 81(11), pp. 3491–3492. ISSN 0016-7606. DOI: 10.1130/0016-7606(1970)81[3491:AROSAO]2.0.CO;2

[7] AKANDE, S.O., O. FAKOREDE and A. MÜCKE. Geology and genesis of gold-bearing quartz veins at Bini Yauri and Okolom in the Pan-African domain of western Nigeria. *Geologie en Mijnbouw*. 1988, vol. 67(1), pp. 41–51. ISSN 0016-7746. Available from: https://drive.google.com/file/d/0B7j8bPm9Cse0TndwdXlDdU41RnM/view?resourcekey=0-iR2vHekiPAxniXGOIAp7kQ

[8] SALAU, S.L., U.A. DANBATTA and Y.S. AGUNLETI. The Interpretation of Aeromagnetic and Satellite Imagery for Structures in Coincident with Gold Mineralization in Anka Schist Belt, Northwestern Nigeria. *IOSR Journal of Applied Geology and Geophysics*. 2016, vol. 4(5), pp. 29–34. ISSN 2321-0982. Available from: http://www.iosrjournals.org/iosr-jagg/papers/Vol.%204%20Issue%205/Version-2/E0405022934.pdf

[9] NNABO, P.N., S.S. DADA and A.O. SOLOMON. Geochemical control of mineralization in Egbe-Isanlu tantalite-gold fields, South-West (SW) Nigeria. *Scholarly Journal of Scientific Research and Essay (SJSRE)*. 2014, vol. 3(8), pp. 100–111. ISSN 2315-6163. Available from: https://scholarly-journals.com/sjsre/publications/2014/September/pdf/Nnabo%20et%20al.pdf

[10] ADEKEYE, J.I.D., J. AJADI, A.D. ADEDOYIN, O.S. BAMIGBOYE and A.G.F. ALABI. Origin and Structural Control of Gold Mineralization in Bishewa Area, Central Nigeria. *Centrepoint Journal (Science Edition)*. 2015, vol. 21(1), pp. 13–34. ISSN 2141-3819.

[11] SCHOUWSTRA, R.P. and J.P.R. DE VILLIERS. Gold mineralization and associated wallrock alteration in Main Reef Complex at Sheba mine, South Africa. *Transactions of the Institutions of Mining and Metallurgy, Section B: Applied Earth Science*. 1988, vol. 97, pp. 158–170. ISSN 0371-7453.

[12] TAKYI-KYEREMEH, K., D.D. WEMEGAH, K. PREKO and A. MENYEH. Integrated geophysical study of the Subika Gold Deposit in the Sefwi Belt, Ghana. *Cogent Geoscience*. 2019, vol. 5(1), pp. 1–16. ISSN 2331-2041. DOI: 10.1080/23312041.2019.1585406

[13] RAMESH, S.L., P.V. SUNDER RAJU, K.V. ANJAIAH, R. MATHUR, T. GNANESWARA RAO, B. DASARAM, S. NIRMAL CHARAN, D.V. SUBBA RAO, D.S. SARMA, M. RAM MOHAN and V. BALARAM. Determination of gold in rocks, ores, and other geological materials by atomic absorption techniques. *Atomic Spectroscopy*. 2001, vol. 22(1), pp. 263–269. ISSN 0195-5373.

[14] ADEBAYO, S.A., P.I. OLASEHINDE, D.O. OBASAJU, O.V. FATOYE and E.A. ALEJOLOWO. Investigation of structurally controlled mineralisation in Bode-Saadu axis, southwestern Nigeria – a case study using magnetic data. *Arabian Journal of Geosciences*. 2021, vol. 14. ISSN 1866-7538. DOI: 10.1007/s12517-021-07635-w

Vol. 67 (2021), No. 3
pp. 64–76, ISSN 1802-5420
DOI 10.35180/gse-2021-0053