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Preliminary Gold Mineralization Potential Assessment of a Site Covering Parts of Gwagwalada and Abaji Area Council, Federal Capital Territory (Abuja)

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Abstract: *Gold producing areas in Nigeria are located within the western part of the basement where the schist belts are best developed because there is a spatial relationship with some schist belts even though gold also occurs in quartz veins and in gneisses. However, there are also occurrences of gold in other areas that are not part of the major schist belt but are partially associated with them, such as those in the Federal capital of Nigeria. The various vein mapped on the field ranges in thickness from a few cm to 1 m amongst others. Most of the main gold bearing veins found in the site are highly associated with fracturing, faulting and shearing, this ductile deformation was accompanied by brittle deformation and infiltrated by hydrothermal fluids leading to silicification, carbonatisation, sericitisation, pyritisation of second and third generations and gold mineralisation along such crevices, and these localised occurrences orientation are concordant with the main mineralisation trends which is NNE-SSW occurrences associated within the main schist belts, and these mineralised veins, stringers, lenses, reefs and similar bodies of quartz, quartz-feldspar and quartz-tourmaline rocks occurs in both the supracrustal rocks and the Migmatite-Gniess complex basement rock underlying the area. The study area is also highly rich in alluvial gold as most of the main river channels in the area yield some specks of gold when properly sampled. The main method used for this survey was different forms of geological field investigation including alluvial and eluvial soil sampling, panning and vein trenching to describe the gold potentials over Gwagwalada and Abaji local government area, located within the FCT, Abuja area in the central region of Nigeria, underlain by the basement rock of the Migmatite – Gneiss complex., the main recommendation on the area is about 80% of alluvial prospect that can be harnessed and the 20% for primary deposits type which was strategically mapped and identified ad these will involve a full detailed exploration to be carried out ranging from Geological to geochemical, geophysical and drilling.*

Keywords: *Gold, minerialization, maturity, Abuja*

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1.0 Introduction

Gold occurs in different geologic settings and its classification into deposit types is complicated. However, the two basic types of occurrences or deposits (prim0000-0002-9589ary and secondary) rely on the similarities of the chemical and physical processes to produce economic concentrations of gold ore. Primary deposits form where gold precipitates during chemical reactions between hydrothermal (hot fluids) mineralizing solutions (metal-bearing) and rocks in the Earth's crust. Secondary deposits form later during the chemical and mechanical processes of weathering and erosion, and the physical re-concentration of gold-bearing sediment into placer deposits.

Though precious metals are not essential for industrialization, they are a valuable source of foreign exchange and their exploitation to a large scale promotes the establishment of ancillary industries. In Nigeria traces of gold have been found in every area underlain by the Basement Complex and mining on a small scale has taken place in many areas. Nigerian gold contains varying amounts of silver. Small amounts of silver are also present in the lead-zinc ores and this could probably be recovered as a by-product if the ore is mined on a sufficiently large scale.

About 90% of Nigeria's total gold production has been from alluvial deposits derived from primary gold mineralization in the basement rocks (Obaje 2009). All the producing areas have been in the western part of the basement where the schist belts are best developed and there is a spatial relationship with some schist belts although gold quartz veins also occur in gneisses (e.g. Malele, Diko and Iperindo). Four goldfields can be outlined, Ilesha-Egbe, Minna-Birnin Gwari, Sokoto and Yelwa (Woakes and Bafor, 1983), and each covers several thousand square kilometers. Gold mining reached its peak in the period 1935–1941 but since 1950 has been generally limited to very small-scale alluvial workings. In recent years the defunct Nigerian Mining Corporation did some extensive exploration work and planned production from alluvials in the Ilesha area. Typically, gold bearing quartz veins carry some sulphides, galena and pyrite being the most common. The veins are very often conformable with the general N–S to NNE–SSW structural grain of the basement and occur in a variety of geologic settings which suggests that there was more than one period of mineralization. Regionally it was observed by Woakes and Bafor (1983) that primary gold deposits are associated with some schist belts (e.g. Ilesha, Maru, Anka, Kushaka) but not with others (e.g. Wonaka, Karaukarau, Iseyin-Ogun River), and that they are often spatially related to amphibolites and regional NE–SW to N–S fault or shear zones, with no specific relationship to the Older Granites or BIF. In the Ilesha (Elueze, 1981) and Egbe (Garba, 1985) areas, gold occurs in the amphibolites in amounts above the average primary gold content for similar rocks and is sufficient to provide the source of some of the alluvial deposits. The alluvial deposits throughout the goldfields are found not only in the present river channel deposits but also in older buried placers which in places have been eroded by the modern drainage system and are the source of modern placers. Russ (1957) also reported small quantities of gold in the basal conglomerates of the Cretaceous Nupe Sandstone in several localities fringing the Mid-Niger Basin. No similar deposits have been reported from the Benue Trough where the Cretaceous and later sediments are derived from basement areas with only very minor schist occurrences.

1.1 Location accessibility, drainage and physiography

The site Area of investigation covers some part of Gwagwalada, Abaji local government area of the FCT and some part of Gurara area of Niger State and it is bounded by latitude 9^o 4'15" to 9^{o}14' 45" and longitude 6^o 51'15" to 6^o 56' 0" of Nigeria (Figs. 1 and 2), the area is well-drained by the Gurara river which is the major source of water for the area. The major part of the rivers runs in the North-south direction which is also the trend of the mineralization and faulting in the area.

The area is undulating terrain with high hills and valleys, and flood plains giving rise to a dendritic drainage npattern for the area (Fig.s 3 and 4). The areas are accessible through a network of roads through Izom road, Dewu to Gawu, through or through Gwoyi and to wumi village, or Gasakpa as seen in Fig. 5.

Fig. 1: The map of Nigeria showing the 36 states and the FCT

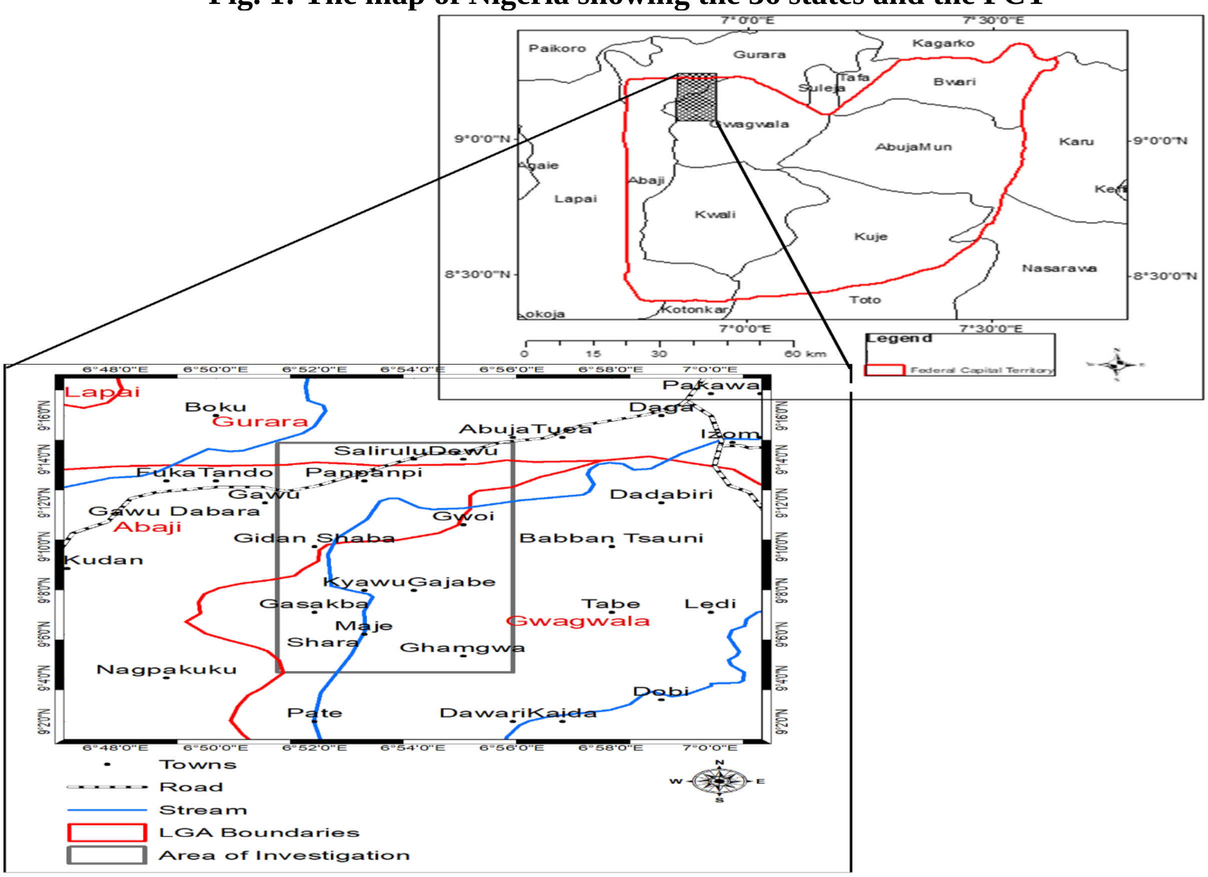

Fig. 2: The Map of Federal Capital Territory relative to the location of the Area of investigation

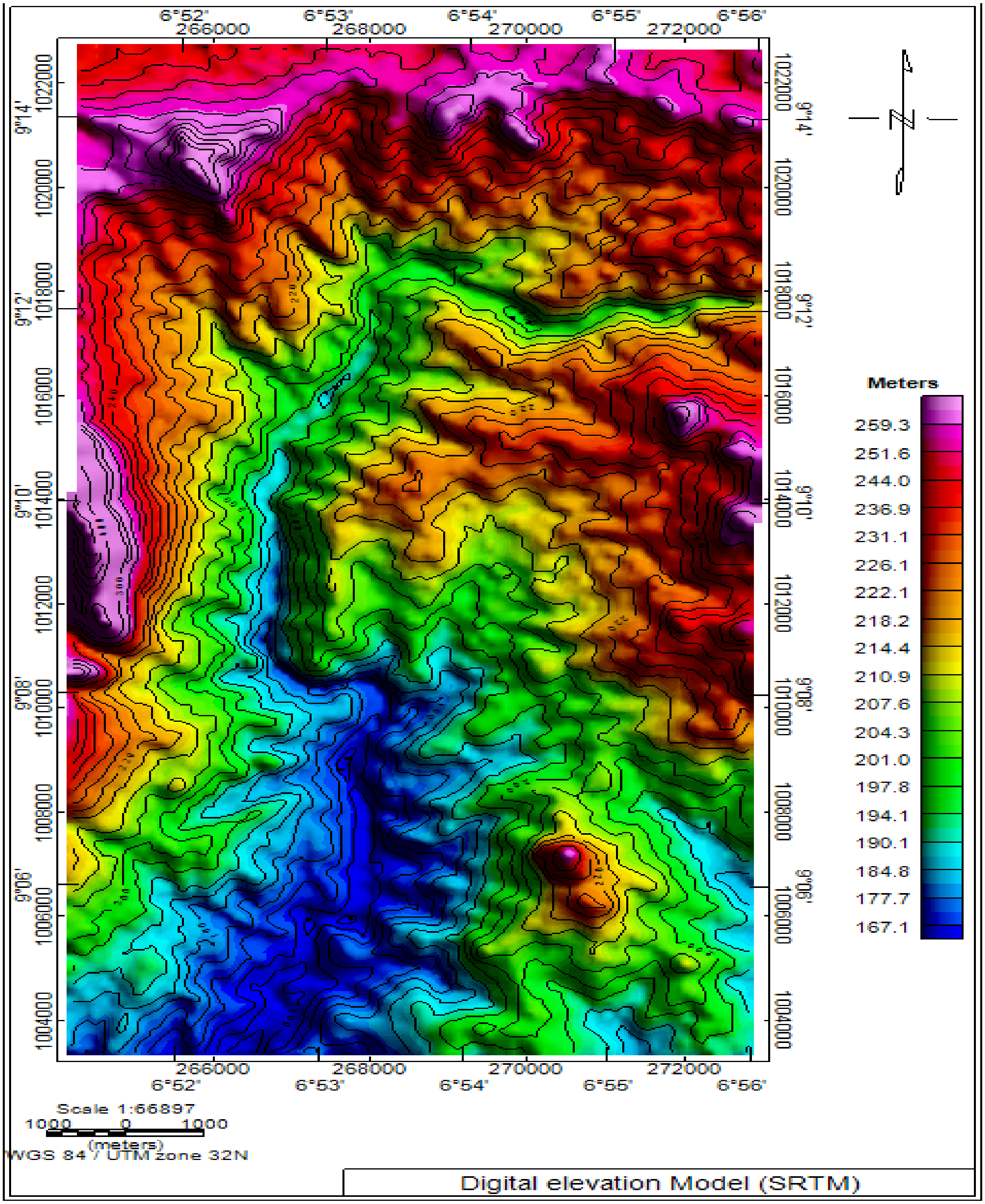

Fig. 3: The Digital Elevation map of Area of investigation showing the Variation in topography

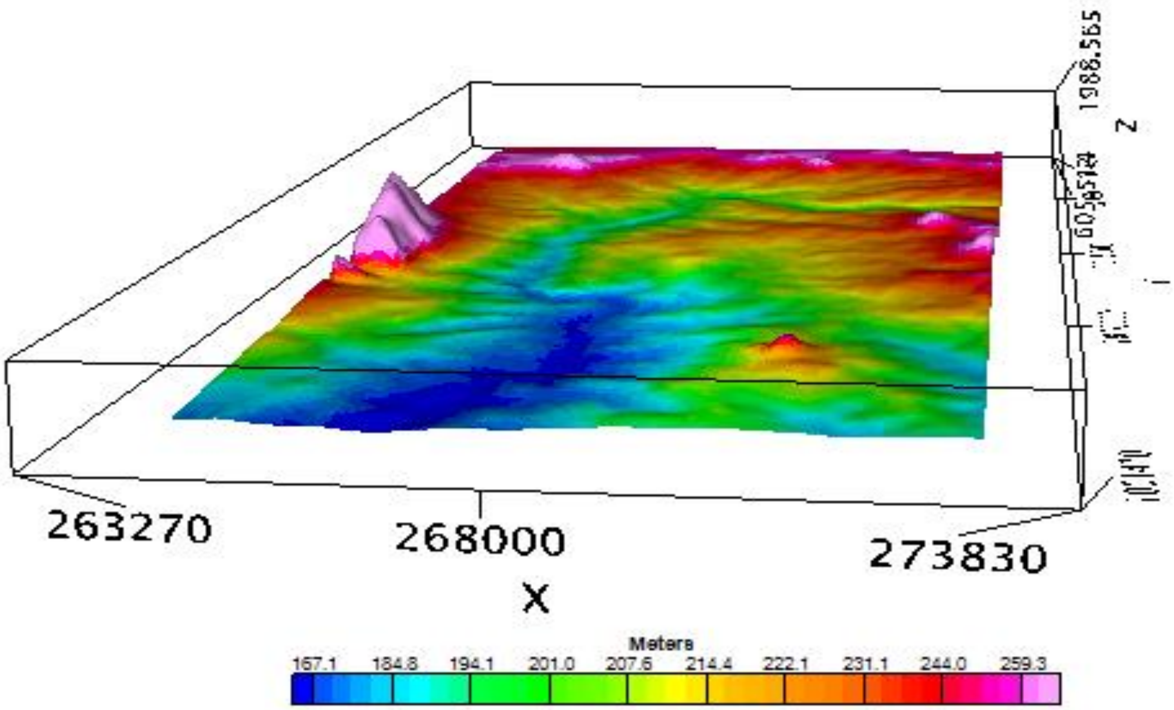

Fig. 4: The 3D Digital Elevation Model of Area of investigation, showing areas with high and low topography

1.2 Geology of area of investigation

Area of investigation covering some part of the FCT and Niger state falls within the basement complex rock of the country, and it consists mostly migmatite, migmatitic gneiss, granite gneiss, quartzite and banded gneiss, in northern Nigeria, the abundance of Pan-African granites appears to increase eastward. In the area west of Zaria these occur as isolated intrusions (McCurry, 1973), whereas in the region between Rahama and the Mesozoic-Cenozoic cover the intrusive granites and related rocks envelope remnants of Migmatites. McCurry (1973) working mainly west of Zaria divided the granites into two main groups according to their field relationships. The first "syntectonic" group comprised elongate batholithic sheets that are partly concordant, and foliated. The second group "late tectonic" is made up of poorly foliated discordant bodies, rich in mafic xenoliths and had a lower proportion of potash feldspar. The late granites are considered to be the products of widespread mobilisation and reactivation of older basement rocks during the Pan-African orogeny. The Older Granites occur intricately associated with the Migmatite-Gneiss Complex and the Schist Belts into which they generally intruded. Older Granite rocks, occur in most places where rocks of the Migmatite-Gneiss Complex or the Schist Belt occur. However, Older Granites are particularly noteworthy in and around Wusasa (Zaria), Abuja, Bauchi, Akwanga, Ado-Ekiti and Obudu areas. The Older granite range widely in age (750–450 Ma) and composition. They represent a varied and more durable (750–450 Ma) magmatic cycle associated with the Pan-African orogeny. The rocks of this suite range in composition from tonalites and diorites through granodiorites to true granites and syenites. Charnockites form an important rock group emplaced during this period. They are generally high level intrusions and anataxis has played an important role (Rahaman, 1984). The Older Granites suite is notable for its general lack of associated mineralization although the thermal effects may play a role in the remobilization of mineralizing fluids.

Figure 5 shows the geologic map of the Area of investigation, three major rock types are found within this area and all the parts of the Basement complex region. The Migmatite is part of the migmatite gneiss complex and is usually associated with the Older Granite rocks, the Older granite occurs as intrusion within the Migmatite gneiss complex as seen in the area, the coarse and medium Biotite and Hornblende granite area part of the Older granite and these rocks are responsible for the mineralization within these areas. Older Granites are the most obvious manifestation of the Pan-African orogeny and represent significant additions of materials (up to 70% in some places) to the crust (Rahaman, 1988). From field evidence and observations, most of the productive area and gold bearing veins in these areas are granitic (mainly Quartz vein) and they follow a N-S or NE-SW trend, which is the general trend for Gold mineralization in the schist belt of the county especially in the Western part of the south and that of the North. The Nigeria Archean to lower paleozonic basement rocks consist of a mignatite-gneisis-quartzite complex, adding that they bear imprints of Liberian, Eburnean and Pan-African tectonic events which erewere responsible for Gold mineralization within veins not directly associated with the schist belt Gold in Nigeria, however, they are also found in alluvial and eluvial places which are the secondary deposit types both in the schist belt or the areas close to it and some areas within the migmatite gneiss complex within Quartz veins such as we have in areas around Area of investigation and its environs. However, the primary veins occur within the several parts of supracrustal (schist) belts in the northwest and southwest of Nigeria. Various pictures of these rocks in field observation are displayed in figure 6 to 12.

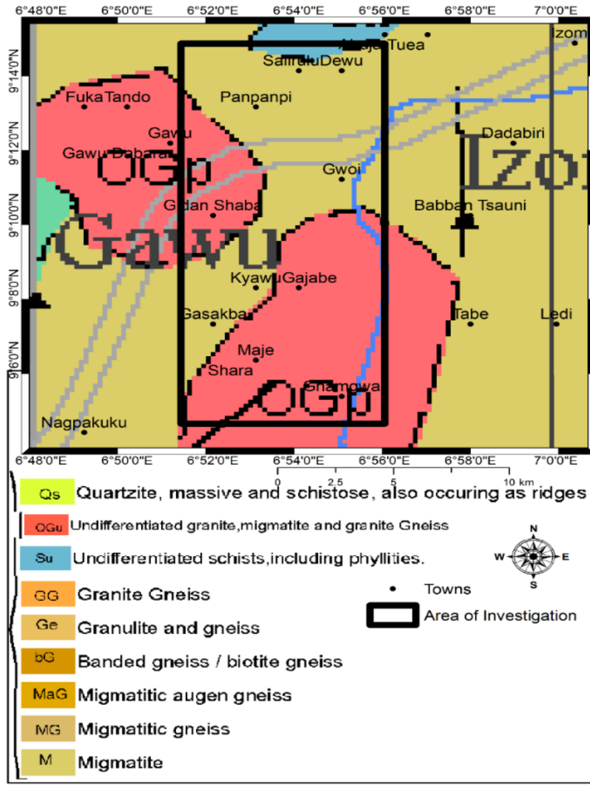

Fig. 5: The Geologic Map of Area of investigation showing the Migmatite rock and the coarse and medium grained biotite, Hornblende granite. (Modified after NGSA 2010)

Fig. 6: A stream channel Migmatite gneiss rock exposure (N9.16879º E 6.9157º)

Fig. 7: A highly weathered Migmatite gneiss rock occurring as a stream channel exposure within ELV023753 (N 9.20694^{O}, E 6.90810^{O})

Fig 8: A highly weathered migmatite rock,the competence of the quartz within it can be seen as they are highly resistant to weathering, while the Feldspar component has weathered completely (N 9.16913 ^{O}, E 6.91379^{O}).

Fig 9: Quartzite rock exposed along the stream channel (N9.22055º, E6.91827º)

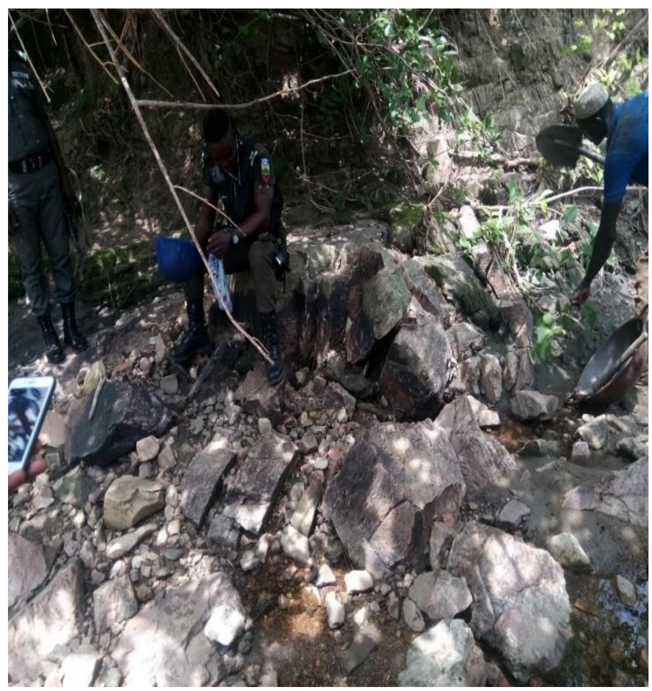

Fig 10: A highly weathered quartzite component of the migmatite exposed along a stream channel within the area of investigation (N 9.16880 ^{O}, E 6.91327^{O})

Fig. 11: A rock highly resistant to exposure along the Gurara River.

Fig. 12: A highly fractured boulder discontinuous granite, most of these granites occur as plugs within the area and are highly resistant and thereby form the highest mountain ranges within the area.

2.0 Methodology and Procedures

Methodology and procedures include those techniques used in the prospect evaluation of the site, they are based on geological inferences and some physical parameter utilization (such as the physical property) of the mineral we are prospecting for, identification of their source and host body.

2.1 Geologic Mapping

Gold mapping was carried out through in-situ observation of various rock contacts and identification of key markers which are likely indicators. Such as lithological identification, fault identification, Contacts mapping, Vein and structural mapping.

2.2 Trenching

Trenching is the process that involves the creation of a trench or the digging of pits to get subsurface geological information, especially in the area where the overburden is shallow, trenches and pitting can be quick and they are successfully employed in exploration programs to gain access to mineralized rock for detailed mapping.

Trenches were created in the area of investigation to trace a suspected mineralized vein exposed along a stream channel, the trench was dug perpendicular to the trend of the vein, and the observed vein has a trend in the of 170 to 180^o (N-S Trend), so a trench was dug in the east-west direction to a depth of about 1.5 meters and a width of 1 m and a length of 15 to 30 meters from place to place at four different point at a distance of 150 meters apart along with the trend of the vein (170^O to 180^o) to determine the extent of the vein and the vein's length.

The observed vein seems to extend towards the southern part from where it was first encountered and it did not extend towards the northern part, the total length of the vein can therefore be estimated to be about 150 meters, and a thickness between 1 to 1.4 meters and occurring at a depth of about 1 to 1.5 meters from the surface.

Fig. 13: 14 meters long Trench 1 was created perpendicular to the vein for sampling at the first contact point with the vein at the stream channel. (N 9.167856303^{O}, E 6.911962193^{O})

Fig. 14: Showing the First contact of the suspected mineralized vein occurring at a stream channel, the vein has a thickness of about 1 meter and a width of about 1 meter, the trend in a North-South direction (N 9.167856303^{O}, E 6.911962193^{O})

Fig. 15: The trenched point two, falling along a river channel, here the vein seems to occur at greater depth and hence was not seen even after a 1.3 meters trench was dug. However, another smaller quartz vein body was encountered. (N 9.165715227^{O}, E 6.911619072^{O})

Fig 16: The second contact of the vein at the third Trench point here the quartz vein occurs at shallow depth and appears to have some sulphide some iron oxide component, gold accessory minerals. (N 9.168968976^{O}, E 6.912066118^{O})

Fig. 17: A hand size sample of the quartz vein at trenched point 3, here the quartz samples are bigger compared to the place where they were first seen and they have the impression of iron oxide and some sulphide. (N 9.168968976 ^{O}, E 6.912066118^{O})

Fig. 18: Showing the quartz vein samples at trenched point 3

Fig. 19: Showing the Trench dug at point 4 to establish the extent of the quartz vein, here the vein was not seen and meaning the vein did not extend to this point or it is occurring as very great depth here. (N 9.170473734^{O}, E 6.912067875 ^{O}).

Fig. 20: The trenched point 5, here the vein was also not encountered after 1.5 meters trenched was dug (N 9.171792838^{O}, E 6.911844155^{O})

2.3 Panning

Panning, in mining, simple method of separating particles of greater specific gravity (especially gold) from soil or gravel by washing in a pan with water. Panning is one of the principal techniques of the individual prospector for recovering gold and diamonds in placer (alluvial) deposits.

In the On-site Area of investigation, soil panning was done at various points to be able to evaluate the sand to know if there is a presence of alluvial gold deposits, especially along the river channels and the areas where the trenches were dug.

2.4 Geochemical sampling

This involves the process whereby samples were taken from the site and sent to the laboratory for analysis especially in areas where the Gold is not visible during the panning process, some samples were taken at strategic places across the site for lab analysis to examine the potential and the distribution of the gold in the area to be able to know areas with high occurrence relative to others within the same site.

Table 1: Table showing the coordinate of the five trenched points

Trenched_points	POINT_X Deg Dec	POINT_Y Deg Dec
T1	6.911962193	9.167856303
T2	6.911619072	9.165715227
T3	6.912066118	9.168968976
T4	6.912067875	9.170473734
T5	6.911844155	9.171792838

Fig. 21: The panning process being employed, washing of sample taken at the stream channel for gold specks (N 9^{O} 10’ 4.28”, E 006^{O} 54’ 43.06”).

Fig. 22: The panned residue being examined for gold specks.

Fig. 23: The sample being taken for the panning process. (N9^{O} 09' 48.67", E 006^{O} 54' 35.18")

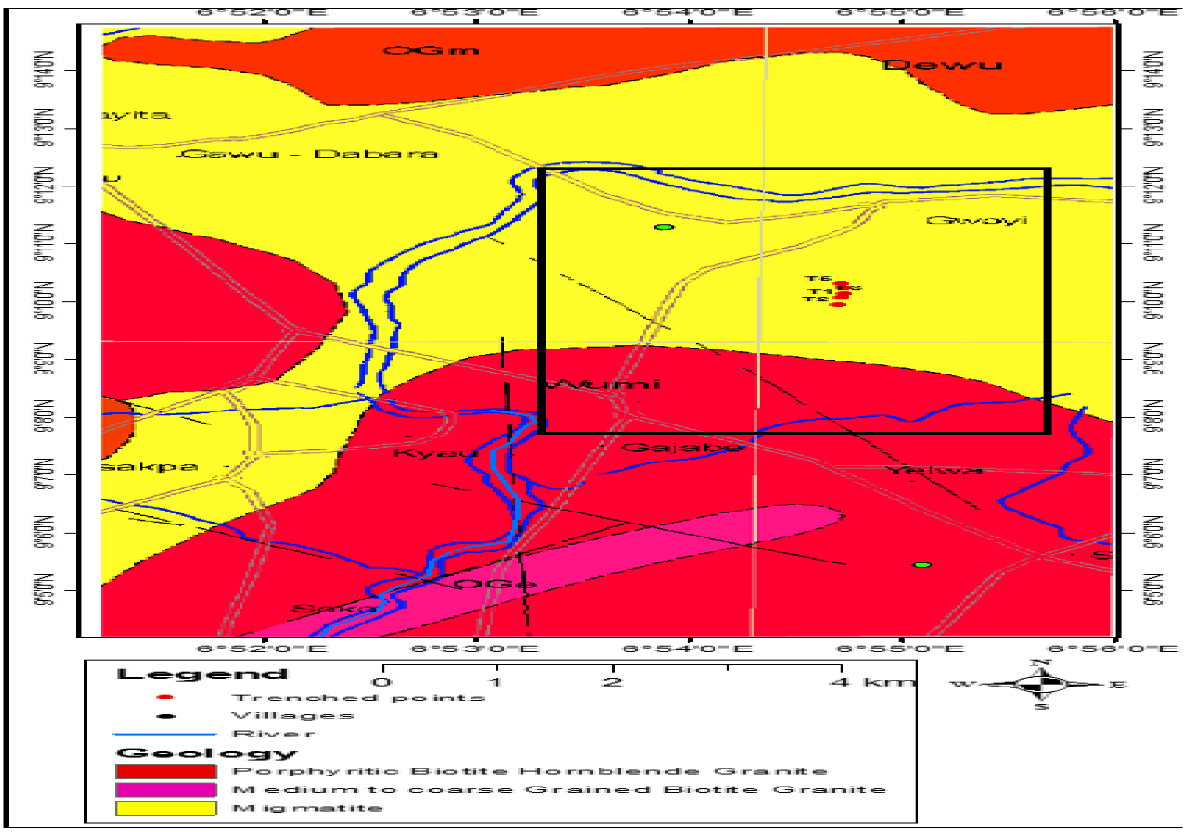

Fig. 24: The geologic map of the area of investigation showing the area where the suspected mineralized vein was trenched, the vein extends from T1 point to T3 and therefore its length is about 150 m.

The result of the field observation and sampling that shows that the trenched vein extends from the trenched point 1 to trenched point 3 (Figure 24 and 25), and therefore its total length can be estimated to be about 150 meters and a width of about 1 to 1.4, however, the potential of the vein is of low values as the in-situ soil was panned and there was no evidence of visible Gold specs found especially at point 3, but some specs were found at the point around the first trenched point, however, a lab analysis might have a different result outcome, but it is worthy of note that the material in prospect for is not microscopic, that means they are visible especially in areas where they occur abundantly. The samples from the vein were taken to the crushing centre, where about three (3) bags of samples which is equivalent to a sample weight of about 150 kg was crushed and the gold within them was extracted with mercury, these results yield a gold weigh-off about 0.4 grams, which is equivalent 2.66 gram (0.09383 Ounce) per Tonnage of the ore body.

The alluvial sediment panning however show good prospects as most of the areas where the panning was done gave a positive response with few exceptions, the areas where the specs were found is shown in figure 26 and 27, their coordinates in Table 2.

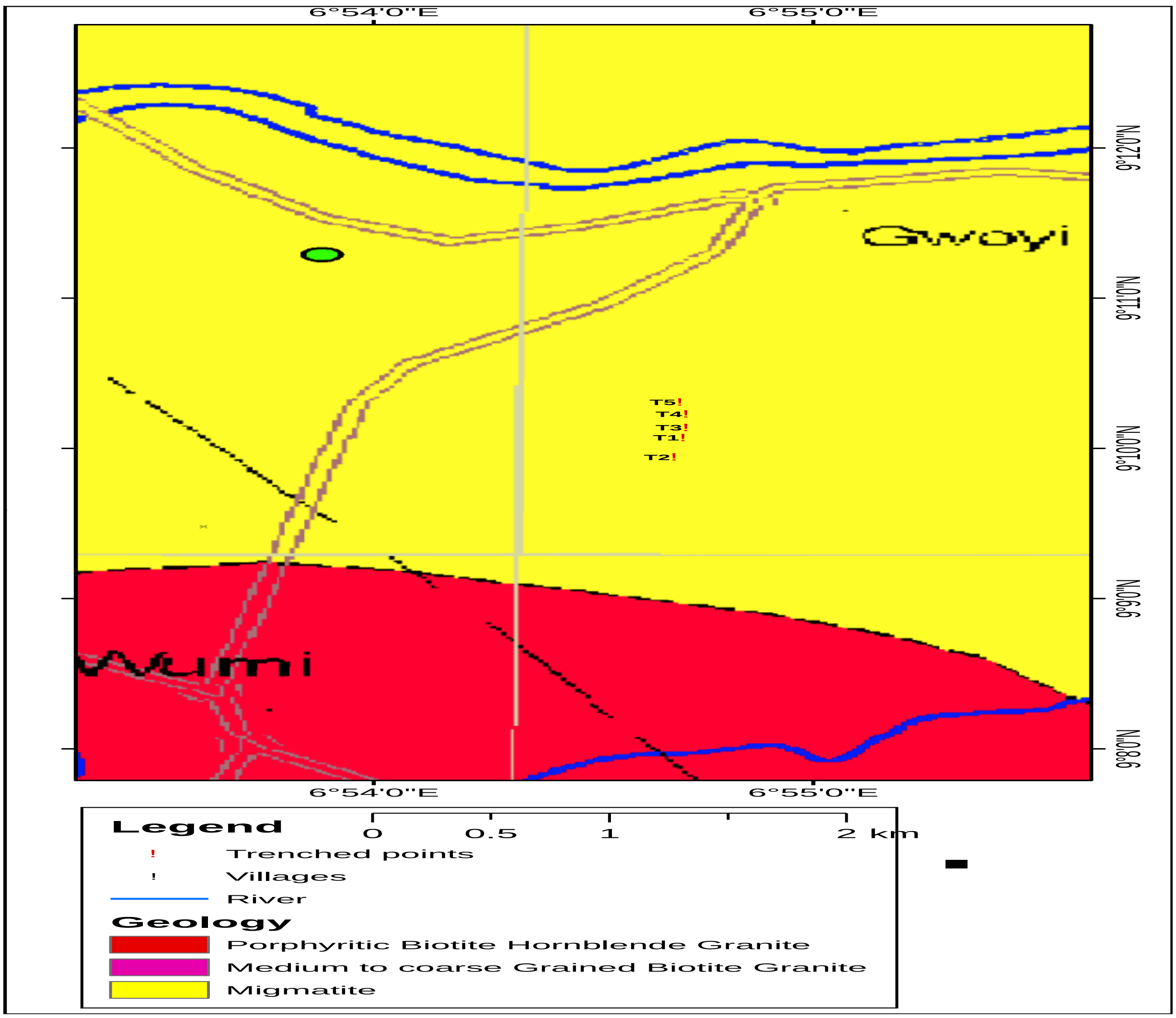

Fig. 25: The geologic map of the area showing where the trenching was done, the vein extends from T1 point to T3 and therefore its length is about 150 m and its length varies from 1 to 1.2 meters and the component is quartz.

Fig. 26: The residue of the panned sample showing the gold specks enclosed in the black polygon. (N 9.16850 ^{O}, E 6.91242^{O})

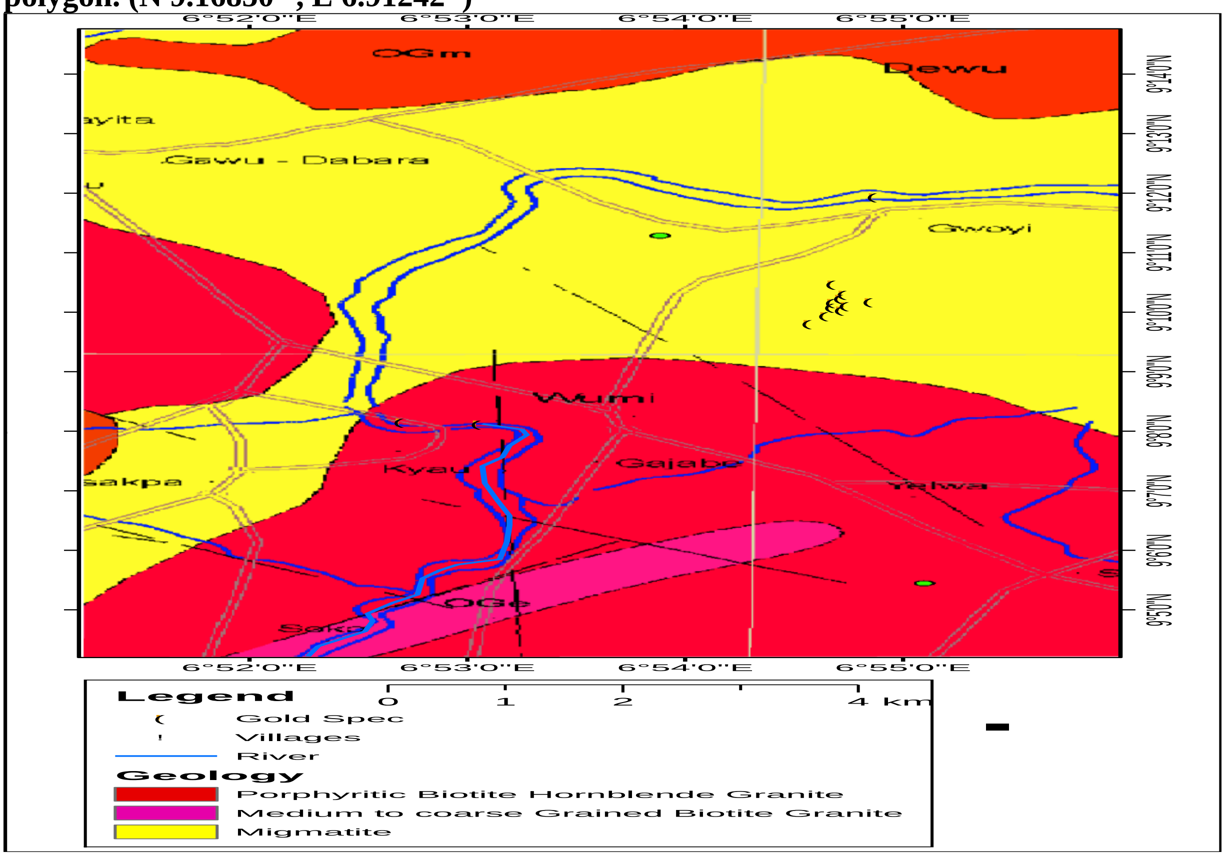

Fig. 27: The Geologic map of the site area of investigation showing the area where gold specks was found after the panning process was done.

Table 2: The coordinate of the areas where gold specs were found after the panning process.

S/N	Longitude (deg.dec)	Latitude (deg.dec)
1	6.912633024	9.16852352
2	6.911516376	9.168094039
3	6.912461232	9.171701673
4	6.912203544	9.170585024
5	6.914436841	9.169640168
6	6.914780425	9.199016609
7	6.884475607	9.135350279
8	6.911063924	9.165721475
9	6.912266469	9.167267603
10	6.9115793	9.169415004
11	6.909775484	9.163488178
12	6.878595226	9.135915554
13	6.911601121	9.174568136

4.0 Conclusion

The study reveals that the studied area has some prospects for gold mineralization, especially in the alluvial soil deposits, where gold specks were found in most of the surrounding

Consequently, the implementation of further researches and detailed exploration works on the geology and mapping of the studied area is recommended.

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Data plotting and Maps were produced using the ArcGIS and the Geosoft Oasis Montaj software.

Consent for publication

Not Applicable

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The publisher has the right to make the data public

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Author's contributions

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