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Research Paper

Petrographic Character of the Debo Gold Prospect, Gagnoa, South-Western Côte D'ivoire: Consequence For The Mineralization.

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ABSTRACT: *The present study characterizes the petrography of the gold prospect of Debo in the Gôh-Nawa region, Côte d'Ivoire. The objective is to dive deeply into its geological knowledge by clarifiying its host rocks, hydrothermal alteration and deformation history. This study has been carried out on the description of the drill cores resulting from the company coreshed and also sample described and taken during the field work at Debo. The second core logging and data synthesis have been done at the University of Man. The petrography of the prospect is composed of magmatic and metamorphic rocks. The magmatic rocks are mafic volcanics and pegmatite whereas the metamorphic rocks are dominated by schists (sericite to chlorite). The hydrothermal alteration types include silicification and sulphudation. They are noticeable in the schistosity planes by the occurrence of quartz associated with sulphides (pyrite and chalcopyrite). In sericite schists, sulphides are both disseminated and controlled by the schistosity, whereas in chlorite schists, sulphides are particularly observed in zones where hydrothermal alteration is strong. The quartz and sulphide veins appear to have been controlled by the schistosity planes before undergoing ductile deformation that led to their folding. The mineralization would be related to hydrothermal alteration that occurred after the deformation of the mafic volcanic. The mineralization is therefore post-tectonic and syn-intrusion.*

KEYWORDS: *Birimian, Petrography, gold, Debo prospect, Côte d'Ivoire.*

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I. INTRODUCTION

The successes of the mineral exploration projects in Côte d'Ivoire has increased the gold production of the country from 23 t Au in 2015 to almost 42 t in 2021 [1]. Most of these discoveries have been made in coherence with the birimian furrows. In Côte d'Ivoire, seventeen birimian furrows of NNE orientation are known for their gold endowment [2]. It becomes evident that for the search of gold, these Paleoproterozoic formations appears as the main target [3]. Given that the characterization of the deposits of Agbahou [4] and also Bonikro [5] [6] has consolidated two main gold controls i.e the magmatic events and their deformation through shear zones, it is essential that the petrographic and deformation knowledge can serve during the exploration stages. Their understanding support the boom of the exploration projects is observable in the whole country. It is the situation of the Gôh-Nawa region where different activities are undertaken on the Debo prospect and include the geological surveys, regional mapping and ground studies. The proeminent results led to declare a prospect and distinguished interesting anomaly grids, which were subsequently drilled to consolidate the mineralization extension (Jefoma oral com.). Considering the positive results obtained before, questions remain about the petrographic nature of the mineralization's host formations and the type of control related to the emplacement of this mineralization. It is thus with the aim of improving the knowledge on the petrography and the setting of the mineralization of the Debo that this work is initiated. To fulfill the objective of this

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investigation, we describe successively the prospect and specially its rocks, hydrothermal alteration, deformation and their influence in the setting of the gold ore.

II. GEOLOGICAL CONTEXT

The Debo site laid within the Côte d'Ivoire Paleoproterozoic domain. The geological history of this region is related to the Baoulé-Mossi domain located on the Man Ridge belonging to the West African craton (figure 1) [7]. This proterozoic age domain was structured during the eburnean orogenic cycle dated between 2.5 and 1.6 Ga which corresponds to the establishment of the Birimian formations [8] [9]. The site corresponds to a golden prospect around which different birimian furrows are. According to the Daloa map, geologically, the formations found in the immediate environment of the site are migmatitic gneisses and migmatites with biotite and/or amphibole, which were emplaced during the Liberian orogeny and on the other hand, formations that were emplaced during the Eburnian orogeny with notably pyroclastic formations including tuffs. We also find two-micas and tuffaceous feldspathic sandstones and finally a granitic rock with two-mica granites and granodiorites with orthogneissified facies. On the Soubré map, the geology is made of pegmatite, two-mica granite, biotite granite, biotite gneiss. In some places, we note the presence of amphibolite and migmatite. According to the map of [10], the Gagnoa area does not have enough structural data. However, others observations have allowed us to identify two families of supposed faults. One family oriented NW-SE and the other oriented NE-SW. The Bonikro and Agbahou gold deposits are located near the Debo prospect and are recognised as affected by different hydrothermal alterations including sericitization, carbonatation, epidotization, chloritization and sulphudations [11] [12] [4].

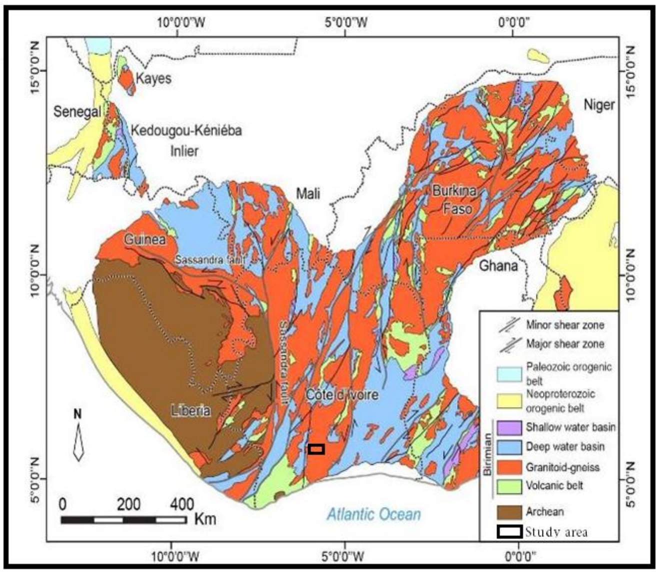


Figure 1: Geological map of the Man shied from [7] and the Debo golden prospect.

III. MATERIALS AND METHODS

The methodology employed to characterize the petrography of the Debo prospect was carried out in two phases. The first phase was run during the fieldwork. The outcrops that we encountered were systematically described. This description was completed by the logging of diamond drilling samples and those from the company coreshed. The second phase is the laboratory work undertaken at the School of Geological and Mining Sciences, University of Man. During this step, all of the samples were described again with emphases to their petrography, deformation and hydrothermal alteration. The interpretation arises from these two phases was able to understand the rocks setting history associated with their deformation and mineralization deposition.

IV. RESULTS

4.1 PETROGRAPHY OF THE DEBO GOLDEN PROSPECT

Two types of rocks are encountered: magmatic and metamorphic rocks.

4.1.1 Magmatic rocks

These rocks are shown by the boreholes.

- **Volcanic rock**

It is a massive found in the Box 20 at the depth (97 to 97.1m), melanocratic rock of microlithic texture. Its mineralogy is composed of pyroxene, biotite in a matrix of chlorite and carbonate (figure 2a). It is likely a massive mafic volcanite with biotite phenocrysts: basalt.

- **Filonian rock**

Leucocrate with a pegmatitic texture in the Box 37 from 171.4 to 172.5 m, the rock is made of k-feldspar, quartz, plagioclase and chlorite (figure 2b). It represents the pegmatite.

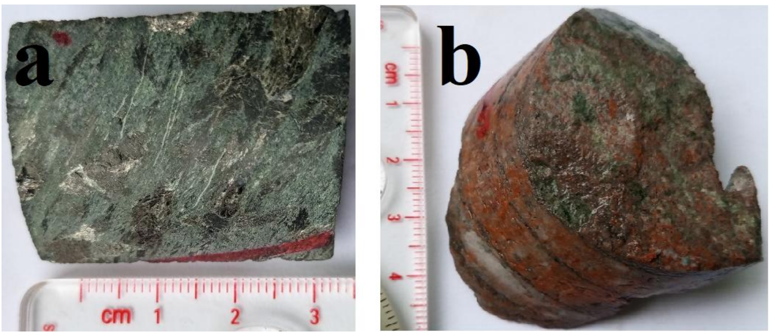


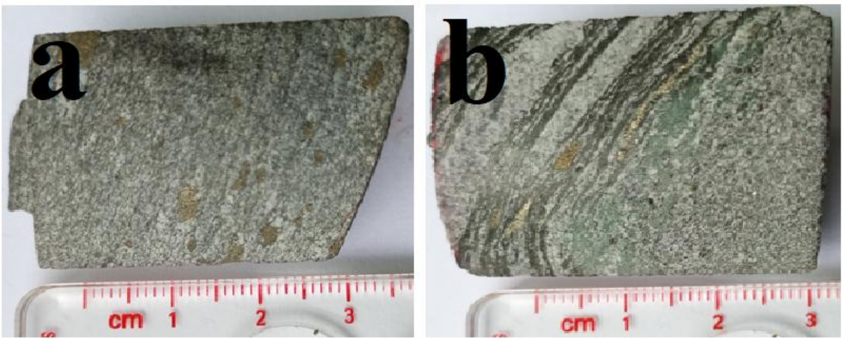
Figure 2: Macroscopic view of the magmatic rocks at the Debo prospect. a: Basalt, b: Pegmatite

4.1.2 Metamorphic rocks

These rocks are widespread in the field and also through the diamond drilling campaign, we encountered within different boreholes.

- **Sericitoschist**

The rock has been described through different samples. In the Box 19 at the depth from 76.6 to 76.7 m, (figure 3a) the sample is massive, grey in color with a schistose structure. It is magnetic and present a mineralogy made of biotite, chlorite, quartz and sericite. Locally, the matric shows a greenish coloration which could be due to schistose facies metamorphism and comes from alteration of biotites to chlorite. Also, we notice small yellow particles with metallic aspects. Also, these seem to be affected by rust in certain places, probably pyrite. In the Box 24 from 98.6 to 98.7 m, (figure 3b) we observe a massive sample with colors ranging from metallic gray to black due respectively to biotite and chlorite, and white (feldspars and quartz). It has a schistose structure and shows a stronger magnetism in the metallic grey colors than in other colors. The paragenesis is biotite, chlorite, quartz, feldspars, pyrite and sericite. This sulphide occurs as a yellow mineral with a metallic sheen and is automorphic in the grey areas. The rock is showing the relics of the initial bedding of schistosity. The spaces between these bedding are occupied by black bands, suggesting the impacts of the hydrothermal alteration (silicification). The Box 34 shows from 142.7 to 142.8 m that the sericite schist has greyed colors (figure 3c). It has a schistose structure. However, the rock presents two types of structures: the first is identical to the schist of Box 32, the second is the schist having recorded the rise of quartzo-feldspathic fluids giving a metallic gray aspect followed by sulfides. The paragenesis is biotite, chlorite, quartz, feldspars, pyrite and sericite. The sample is magnetic especially in the grey zones. When observed in the Box 41 from 177.1 to 177.2 m), the rock is massive, grey in color with a schistose structure (figure 3d). The paragenesis is biotite, chlorite, quartz, pyrite and sericite. The sulfides minerals are abundant and indicating two types: disseminated in one hand and in other hand slightly controlled by the schistosity.



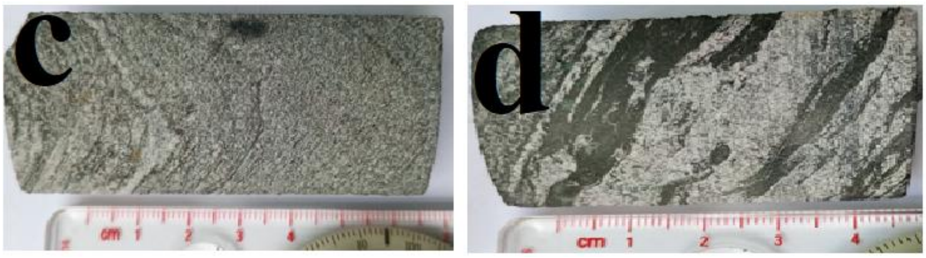


Figure 3: Macroscopic observations of the sericite schists facies from the Debo prospect.

- **Chloritoschist**

In the Box 19 at the depths started from 76.6 to 76.7 m), the sample is massive, of green color with a schistose structure (figure 4a). It has a paragenesis of chlorite, quartz and sulfide. The rock appears in a zone of a lithological contact where chlorite, quartz and sulfide (pyrite) are also expressed. The sample is massive in the Box 32 with depths 133.2 to 133.4 m, weakly magnetic, green in color with an incipient schist structure (figure 4b). Its mineralogy is obviously chlorite, quartz and biotite. The structure of the rock is marked by a primary lineation of chlorites minerals indicating that the rock is likely a chloritoschist. According to the Box 40 at depth (172.4-172.5 m), the sample is massive, colors ranging from grey to black with a schistose structure. The paragenesis is of biotite, chlorite and quartz. It is locally made of small grains of pyrite. It is likeky the schist before the hydrothermalism activity and showing the contact between sericite and chlorite schists. The sericite schists have disseminated and controlled sulphides in places, whereas the chlorite schists have sulphides in areas of pronounced hydrothermal alteration.

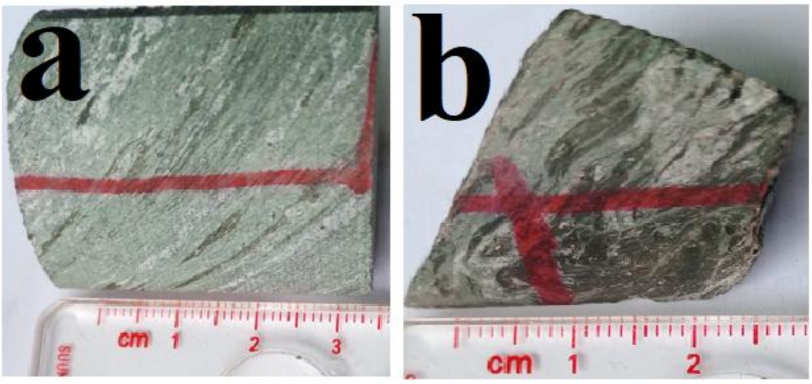


Figure 4: Macroscopic observations of the chlorite schists facies at the Debo prospect

4.2 Discussion

❖ **On the petrographic level**

Gold mineralization on the Debo prospect is found in quartz veins and silicified zones of magnetite, biotite, quartz and schist. On naked eyes, the petrography shows the area is affected by magmatic rocks (basalt and pegmatite) and metamorphic rocks (chloritite schist, sericite schist). Given that gold is the main focus of this prospect, this petrography is similar to that of Bonikro, Agbahou and Dougbafla (respectively [13] [14] [15]). In these deposits, the mineralization shows chlorite or mica schists forming chloritoschists and micaschists with constituent minerals aligned and parallel to the schistosity planes of the rocks in presence. These rocks being the result of the general metamorphism and the intensity of the shearing [16] [6]. The metamorphism of the rocks of the Debo project is materialized by variations in chlorite and sericite levels and by hydrothermal fluid circulation, which is similar to the work carried out on the mineralization of fettèkro [16]. Sericitization would therefore be a good tracer of mineralized zones, chloritization, on the other hand, is mainly induced by epizonal metamorphism (greenschist facies) manifested at the level of biotite crystals [12]. Some mineralization or gold deposits are related to quartz lenses and disseminated sulphides developed in different strongly hydrothermalized lithologies such as the mafic volcanics at Agbahou [14] which explains the quartz veins, and the layers affected by fluid circulation in the Debo prospect. They are proofs of the effective hydrothermal alteration that hane provided the gold mineralization in the birimian and may be also the same event in the Debo prospect.

This distribution of surface units (volcanosedimentary unit) recall the existence of birimian formation related to birimian volcanism. The alteration paragenesis and the composition of the alteration minerals depend on the

nature of the hydrothermal fluid, especially on the nature of the initial rock [17]. Thus the main traces of the hot fluid system circulating in brittle-ductile transition zones are vein systems, mineralized bodies, and hydrothermal alteration [18]. Lode gold deposits, regardless of the genetic type to which they relate, occur in belts of metamorphosed and deformed rocks [19]. Therefore, the schists present result from sedimentary formations and the breccias are from volcanic formations, both metamorphosed [15] (Ouattara et al., 2017).
The studied realized on West African gold mineralization help to confirm that the mineralization observed in shear zones in emplaced under structural control following the action of deformation [3].
These types of mineralization and lithologies related to lithological and structural control are also encountered in the Dougbafla [15] and Bobosso [20] mineralizations. They are related to quartz veins associated with structural control and hydrothermal affiliation. The minerals are oriented in a preferential direction (NE-SW) identical to the mineralization of Tighza [21], different from that of Agly in France [22] and [23]. The Debo permit (Figure 1) covers the southern part of the Divo unit consisting of birimian lithologies and ancient gneisses and migmatites intruded by granitoids, alaskites, and syenites; all cut by dolerites and granophyres. Other lithologies are observed on grids 3 North and South such as magnetite, biotite, muscovite, chlorite and quartz schists. Gold mineralization on the permit is found in granitoids (quartz veins and veinlets) where it is often associated with tourmaline but also with hematite and rutile. It is also represented in quartz-biotite, muscovite schists bearing magnetite. Grid 3 South, which is the subject of this study, extends over 1400 m. The mineralization is orogenic in style and occurs in quartz veins in silicified magnetite-biotite-quartz schist zones with variations in chlorite and sericite.

❖ **On the timing of the gold mineralization**

Considering the facts that in the Debo prospect, the metallic paragenesis is mostly observed in the deformed basalt and the schists. Also, taking in hand the facts that sulphides are widespread either disseminated and controlled. We can understand that gold has been deposited in the area after the metamorphism and the tectonic event, clearly post-deformation. Also, looking that gold is associated with the intrusion, we can also admit it has a syn-intrusion behaviour. These behaviours are associated with gold in the birimian rocks of Côte d'Ivoire in Bonikro [6], Bobosso [20] and Agbahou [4].

V. CONCLUSION

The petrographic study carried out at the Debo prospect is consistent with the magmatic and metamorphic rocks. It admitted that a greenschist facies metamorphic has affected the magmatic rocks and also a deformation event associated with hydrothermal alteration. As a consequence, the area is affected by an intrusion and gold deposition simultaneously. The metamorphism has provided various schists which endergone a NE-SW deformation. The hydrothermal activity includes silicification, chloritization, sericitization, epidotisation and sulphudation. The golden main event appears as syn-intrusion and post- deformation which is clearly what is observed in the birimian furrows around the Debo prospect.

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