

Quartz Veins Characteristics and Au Mineralization Within the Batouri Au District, East Cameroon

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Abstract: The Batouri south Au district of East Cameroon is hosted by biotite-amphibole meta-granites that belong to the Pan-African group of Pre-to Syn D₁ and D₂ Neoproterozoic granitoids. Hydrothermal activity and Au mineralization in this area is greatly enhanced by the presence of fractures, foliations, faults (sinistral) and vein splays hosted within a foliated meta-granite basement. Thirteen samples of 1.00 kg each of quartz vein were crushed and panned for Au-grain recovery. Fire Assay geochemistry was used to analyze eighteen samples for Au. Field results identified foliated and non-foliated GQV/BQV quartz vein varieties. The mineralization style in the area is mainly by fracture filled. Disseminated Au is common in the weathered wall rock envelop associated with mineralized veinlets. Au-grade from fire assay geochemistry varies from ~0.056 g/t to 2.844 g/t similar to 3-4 g/t Au-grade from field analysis associated with the GQV veinlets and weathered wall rock. The highest Au-grade was obtained from the foliated variety of GQV (QV₂). Recovered Au-grains varied in shape and sizes (102-392 μm).

Keywords: Quartz Veins, Au Mineralization, Batouri South-Cameroon

1. Introduction

Quartz vein systems in regions that have experienced deformation remain the main depository for primary Au [e.g. 1-2]. Such deformation occurs in stages and the fluxes of hot fluids from the subsurface (hydrothermal) into the resulting structures also follow the sequence of deformation. These fluids eventually precipitate material into these structures to form lodes and veins that differ in their characteristics [2-6]. Based on the pattern of deformation, different types of veins are produced including fault-fill-veins, extensional-veins and stock work-like veins [7, 8]. The composition of the fluids also determine the mineralogy of the formed veins such as tourmaline-Au veins, quartz-Au veins, epidote-sericite-Au veins and sulfide-Au veins [7]. However, most Au-bearing veins are usually the quartz veins type of polymetallic character [9, 10 - 13]. In quartz vein systems, different textural characteristics can be observed. Some of these textures are usually associated with the ore zones (mineralized veins) while others are linked to the barren zones [7]. Some of the mineralized textures include overprinting and modification textures including phantom veins, ribbon and /or brecciated quartz, laminated quartz and

comb quartz textures [7].

In addition to textures and structures, quartz vein systems commonly show alteration characteristics known as wall rock alteration [3, 14, 15]. The alteration is commonly related to hydrothermal processes and could also be formed from supergene activity. Generally, the boundary between alteration zones is often sharp [7, 16]. Most often, the intensity of the alteration envelope correlates positively with the thickness of the veins and veinlets [3]. In most cases of Au exploration, grade is easily assessed by crushing a quantity of the sample, weighing and panning to obtain the concentrate from which the Au-grains if present, can easily be recovered and weighed [e.g.17]. Therefore, vein systems (quartz veins) constitute a major tool in the study and understanding of hydrothermal processes as well as the geochemistry of ore deposits that serves as a guide in mineral exploration [e.g. 7, 17, 18-21].

2. Location and Geology of the Study Area

The Batouri gold district is found in the East Region of Cameroon bordered to the west by Bertoua the regional

capital and to the east by the Central African Republic. Geographically, the study area (Batouri south) consists of a semi tropical forest wet climate, characterized by gentle hills (≈ 600 m to 900 m high). This area shows a thick soil profile (≈ 30 m) that belongs to the Ferralitic class derived from the weathering of the granitoid basement rocks. These soils are highly leached leading to the development of a broad surface duricrust that hampers agricultural activities and artisanal mining. The study was limited around the Dimako and Kambele mining camps (Fig 1). Geologically, Batouri south belongs to the Pan African granitoids group of rocks whose emplacement spanned from the start of tectonic deformation to the late uplift of the Central African Orogenic Belt [22]. According to [23], the Pan-African domain of north western Cameroon shows complexity and diversity in the structural network. [23] Also identified three main geotectonic units belonging to the Pan-African: the Poli Group, the Adamawa domain and the Yaoundé Group. These Pan African

granitoids cross-cut both the schist belts and the Paleoproterozoic high-grade metamorphic complexes of the region and are broadly made of Pre-to-Syn-D1 granitoids (calc-alkaline metadiorites and Metagranodiorites), 2) Syn-D2 granitoids (plutons of S-types granites and porphyritic granites and granodiorites), 3) Post-tectonic granites [22]. [24] Indicated that the Central Cameroon Shear Zone (CCSZ) system is identified as a syn-D3 structure, characterized by thick mylonitic layers whose bands are defined by S1 and S2 foliations. This work focuses on Au-quartz vein system in the Batouri South Au district (Fig. 1). The general objective is to contribute to Au exploration and enhance the understanding of hydrothermal processes in Au mineralization in East Cameroon which would be realized by: the determination of structural and field characteristics of quartz veins, identifying evidences of wall rock alteration within and around quartz veins; assessment of Au-grade from the crush and pan technique, and also by fire assay geochemistry.

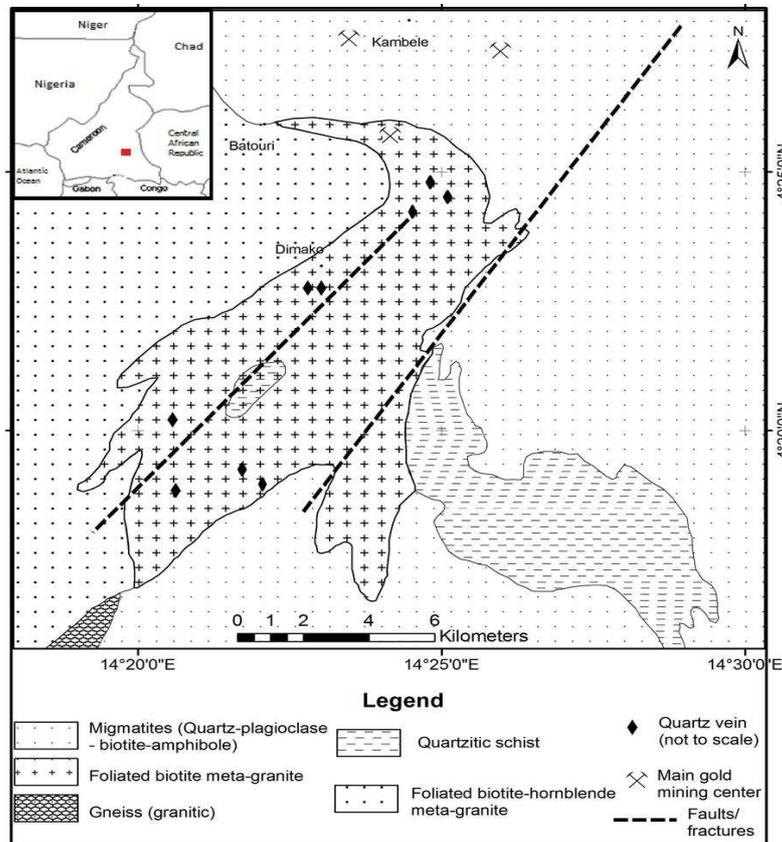


Figure 1. Geological map of Batouri Au district and associated mining camps (modified from Suh 2008).

3. Materials and Methods

This study was carried out in conjunction with the exploration phase of Africa Aura Resources Ltd (AAR) exploration programme. In this regard it serves as a contribution to the ongoing regional exploration survey of the Batouri Au district. During this study, investigated sites which constituted mining pits hosted by granitoids basement were identified with the use of the regional soil grid map. These pits were all artisanal mining pits randomly distributed

and also occurred in clusters at different parts within the study area. It was realized that within most of the pits, the quartz veins were already completely extracted leaving behind tunnels especially with the mineralized veins (Au-quartz veins). Most of the pits were abandoned and measured between 4-6 m depth, and at least 4 x 5 m wide.

a). Field surveying technique

Quartz vein and associated weathered margins exposed in pits constitute the main geological features investigated. Within every located mining pit, the vein(s) were identified

and described using attributes like change in color, texture, dimensions and structural orientations (lineation). Two selected pit walls with quartz veins showing evidence of wall rock alteration were described, logged and sampled systematically. Quartz veins were further logged separately by identifying the changes in their internal fabric: texture, structure, mineralogy, color and dimensions of each domain. Quartz vein description was done following the pattern presented in the flow chart (Fig. 2). The information obtained from logging was plotted on graph sheets and further digitized using MapInfo Professional 8.3 software (Fig. 5, 7ai & bii). Sampling of the veins and weathered wall rock material was also carried out following the same pattern used in logging. A total of thirty-one samples were collected. Thirteen of the samples used for field analysis weighed 1kg each and were made up of quartz vein material only. The eighteen remaining samples collected for laboratory analysis were a mixture of quartz veins and weathered wall rock material obtained by logging and each equally weighed 1 kg. Samples were logged from east to west on two pit walls.

b). Physical analysis

The thirteen quartz vein samples were crushed in powder using a metallic bowl and pestle. The powders were panned to obtain the concentrates made up of the heavy mineral fraction. These concentrates were initially observed in the field using a hand lens for the presence of Au. After the field observation, the concentrates were then sun dried and further

observed under a binocular microscope from which visible Au-grains were handpicked and weighed using a sensitive electronic balance in the laboratory at the University of Buea, Cameroon to determine the grade of Au.

c). Geochemical analysis

In the OMAC Commercial Laboratory, Dublin, 50 g of each pulverized sample were analyzed by fire assay geochemistry using lead collection and AA finish, In-house method. The detection limit for Au was set at 2 ppb. Randomly selected samples were analyzed twice for quality control. In-house blanks were used to correct for any aliquot impurity. International standards used in calibrating the equipment followed procedures indicated in [25]. Ore and scanning electron microscopy was used to analyze for minerals associated within quartz veins. To investigate these associations, a selected quartz vein sample was divided into three pieces in the laboratory. One piece was cut and polished to obtain thin sections which were subsequently studied under an ore microscope using reflected light. The second part was crushed and panned in the laboratory to obtain the heavy mineral concentrate and further observed under a Scanning Electron Microscope (SEM) fitted with an Energy Dispersive Spectrometer (EDS) following procedures described in [26]. The SEM identified the morphology of Au grains while the EDS provided geochemical patterns reminiscent of the chemical composition of each phase identified. The third part served as back up.

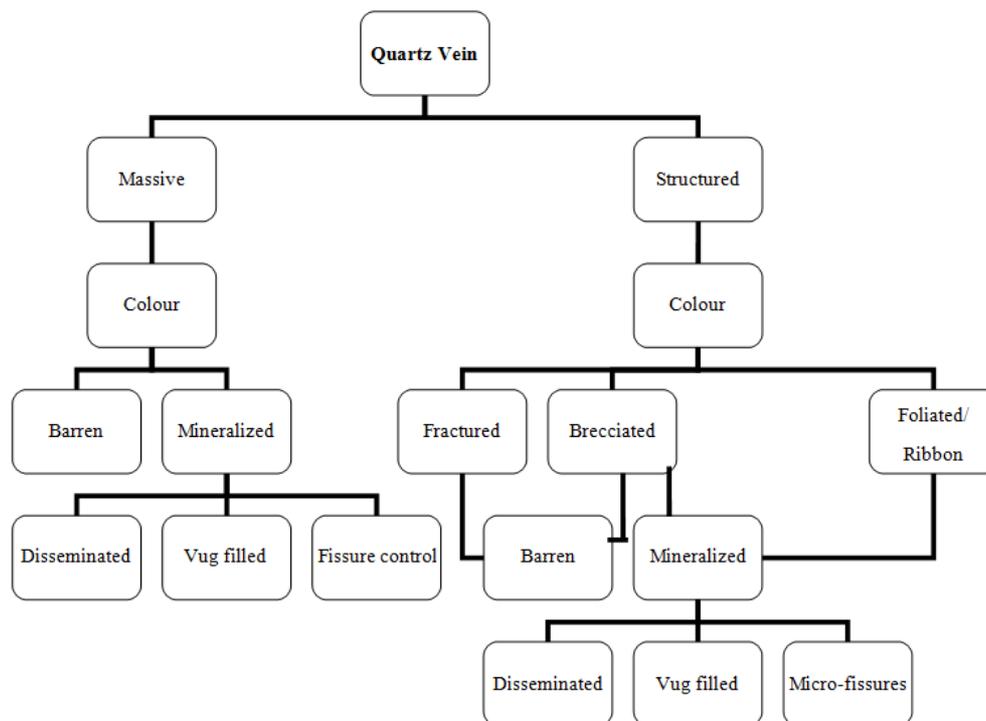


Figure 2. Flow chart describing quartz veins systems in the Batouri Au district.

4. Results and Discussion

4.1. Structural Control

The veins of the Batouri south Au district are hosted by a

foliated meta-granite and show variable orientations controlled by foliations and sinistral faults. Cross-cutting relationships among veins were observed implying different stages of veins emplacement in the area. The early formed veins trend mostly NNE-SSW, NE-SW NNW-SSE which are

being displaced in centimetric scale by the late ENE-WSW trending veins. Based on reports from [27], the late forming veins are probably associated with the D₃ deformation. The early formed veins have shallow dips between 15° – 35° as opposed to the late forming counterpart with high dips of >70°. A similar difference among the cross-cutting veins was observed in texture and Au mineralization. The later consist mainly of the mineralized veins with both categories occurring in spatial association. Such structural relationships are common in orogenic zones, particularly in shear related deformation [e.g.16, 28, 29]. According to [30], subsequent plutonism or metamorphism may cause the reactivation of these structures. A plotted stereonet for six selected veins (Fig. 3) indicate a NNE-SSW and NNW-SSE orientation for the veins. [27] Indicated that structures from D₁ and D₂ deformation host most mineralized veins in Batouri area while the D₃ event saw the emplacement of the barren quartz variety having a major ENE-WSW trend. Apparently, a large population of the mineralized veins had already been extracted by artisanal miners by tunneling and these tunnels mostly trend NNE-SSW, NE-SW and NW-SE. Fracture

cleavage and mylonitic foliations occur as the main planar features with the quartz mylonites showing intense stretching and fragmentation surrounded by dark hematite seams. Both foliations are concordant to the strike of the veins and are often cross-cut obliquely and perpendicularly by fractures. The presence of sinistral strike-slip faults; slickenside strae, intense foliation as well as mylonitic foliation collectively suggest intense shearing within an orogenic tectonic setting for the veins emplacement [31]. The laminated margins along veins also suggest localized shearing probably due to high fluid pressure that subsequently promoted fracturing [31, 32]. Nevertheless, shear movement alone cannot fully explain the system of evolution in these veins since some of the veins rather show intense fracturing. However, most mesothermal orogenic Au-regions around the world have experienced multiphase deformation similar to what was observed in the Batouri area [e.g. 4, 5, 8, 31, 32]. The spatial association of brittle and ductile structures (fractures, foliations, lineations) genetically suggests similar stress conditions of formation [33].

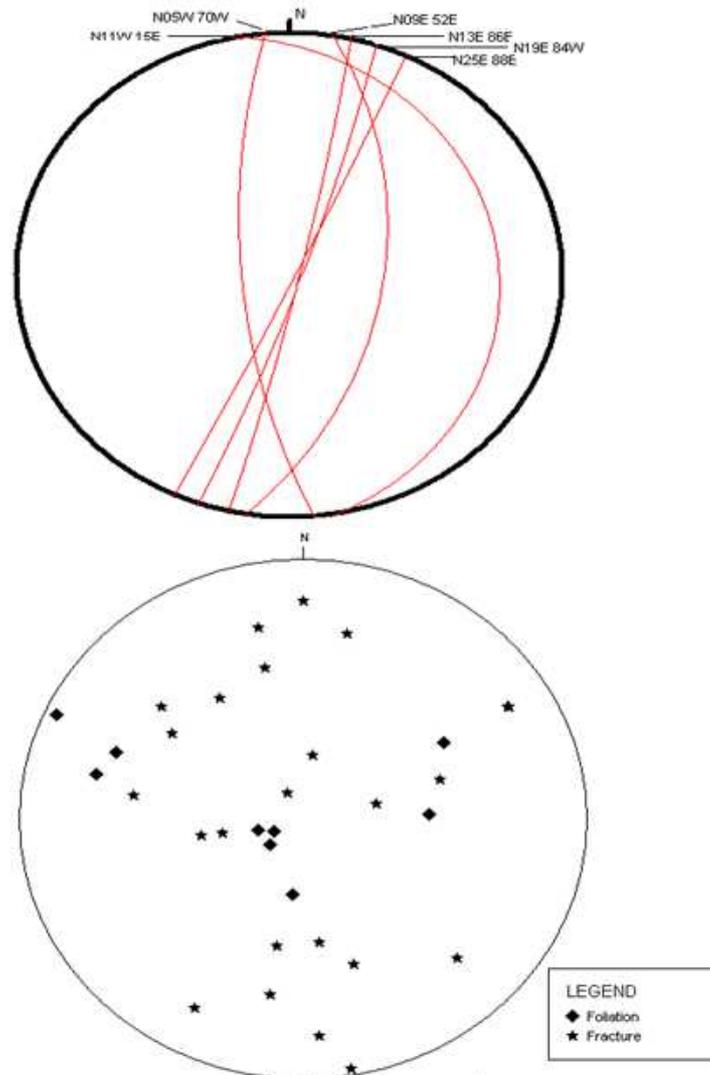


Figure 3. Stereographic plots of structural data for some veins and measured fractures. (a): beta diagram for barren and mineralized quartz veins showing (a) east dominant dip direction with . (b): π diagram showing irregular distribution of fractures and foliations in veins.

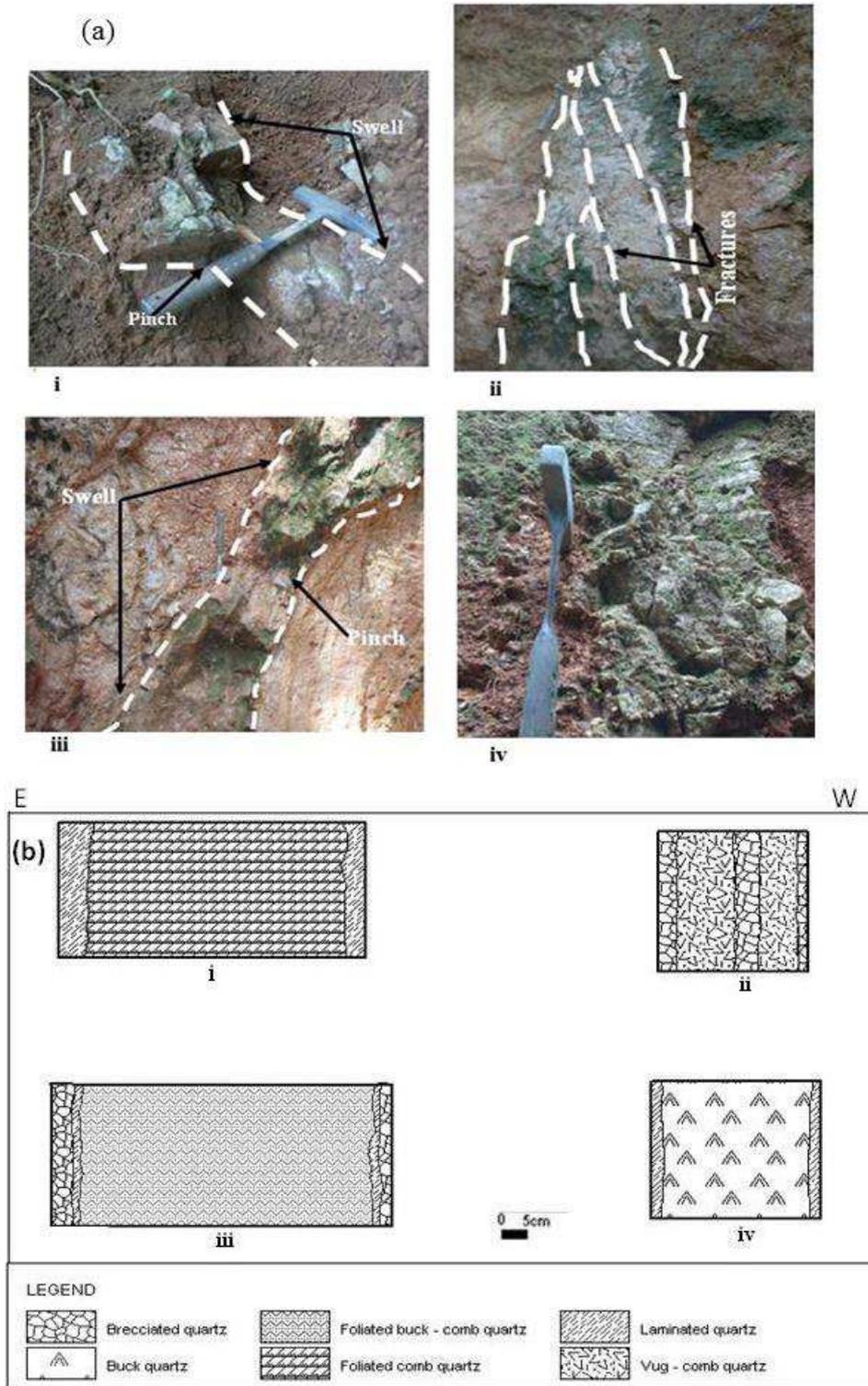


Figure 4. Batouri GQV and BQV showing a) field photographs of a foliated (ai) and a non-foliated anastomosed GQV (aia) indicated by the orientation of the fractures on the surface and b) cross sections of GQV/BQV veins showing textural zoning (bi) foliated GQV depicted in 4ai, (bii) non-foliated GQV depicted in Fig. 4aia. (biii) Foliated BQV depicted in 4aiii (biv) non-foliated BQV as depicted in 4aiv (note the intensity of fracturing).

4.1.1. Au-Bearing Quartz Veins (GQV)

The investigated veins in this area composed of quartz (70-90 vol%) sulphide minerals (10-20 vol%) and oxides (5-25 vol%). These quartz veins were grouped into two categories: Au-Bearing quartz veins (GQV) and the Barren Quartz Veins

(BQV) (Fig. 4aiii, a iv & 5). The GQV veins are the most common in this area. However, this study was able to identify just a few (4) reason being that most of them have been excavated by the local miners in search for Au. The GQV occur both as foliated and non-foliated varieties (Fig. 4ai, aia, bi & bii). The foliated variety have very low dip (<

25°) to the west. These GQV are also fractured and have an average thickness of 32 cm mostly with a characteristic pinch and swell outline. The vein margins are slightly laminated with weathered wall rock slivers interleaved with stretched quartz (Fig. 4bi). Quite commonly, the GQV bear saccharoidal pink to brown quartz. Along fractures, the quartz is stained with purplish hematite coating. Comb textures are also common within these foliated varieties. The non-foliated GQV veins on the other hand, have higher dips (70°-80°) to the east and are anastomosed (Fig. 4a_{ii}). These veins are smaller (6cm on average) and are highly fractured.

The internal structure of the veins depicts textural zoning (Fig. 4b_{ii}) with brecciated bands sandwiched by non-brecciated quartz variety. The quartz breccia consists of fragments of smoky and buck quartz cemented by dark hematite seams. Poorly developed comb textures and vugs are common within the non-brecciated zones. Pyrite (Sulphide minerals) together with hematite, Covellite and chalcocite occur within the brecciated bands.

4.1.2. Barren Quartz Veins (BQV)

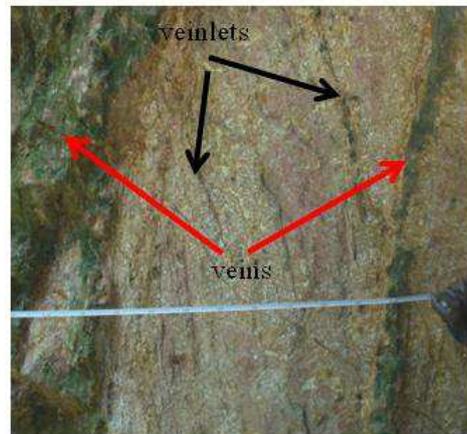
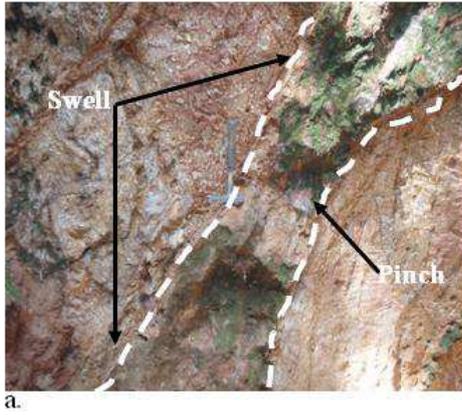


Figure 5. Field photographs of foliated and non-foliated BQV (a) foliated pinch and swell (b) foliated blocky pinch and swell (c.) brecciated pinch and swell (d) non-foliated smoky quartz vein (e) veins with associated veinlet.

The BQV veins show a characteristic pinch and swell outline dipped to the east. These veins fractured and also made of the foliated and non-foliated varieties (Fig. 4aiii, iv, biii, biv & 5 a-e). The foliated variety vary in width from 7cm to ~ 60cm. Based on the texture, the veins are weakly brecciated at the margins and become progressively laminated towards the center (Fig. 4biii). Foliated buck and comb quartz forms the center part of the veins. Quartz crystals defining the comb textures occur as long (0.3 - 2 cm) euhedral crystals. The color of the quartz varies from milky white at the center to rusty brown along the fracture and foliation planes. The non-foliated variety appeared to be more common showing intensely fracturing (Fig. 5b-d). Both saccharoidal and buck quartz are present showing white to rusty brown color. Vugs and comb textures present are

partially filled by quartz, hematite and sulphide minerals. Quartz crystals occur as subhedral to euhedral (hexagonal), exhibiting variable grain sizes with no preferential orientation. However, quartz grains in the comb show no sign of deformation but crystals crisscrossing each other. Generally along both vein categories, their associated quartz veinlets are oriented concordant to the veins. The mineralogical property of the veinlets is similar to that of the corresponding veins (Fig. 5e). According to [34], open space textures (vugs) with euhedral quartz crystals in veins suggest a situation where fluid pressure during vein formation has been equal or exceeded lithostatic conditions [35], as the preservation of such textures maybe ascribed to low confining pressure [36-38].

4.2. Alteration and Au Mineralization

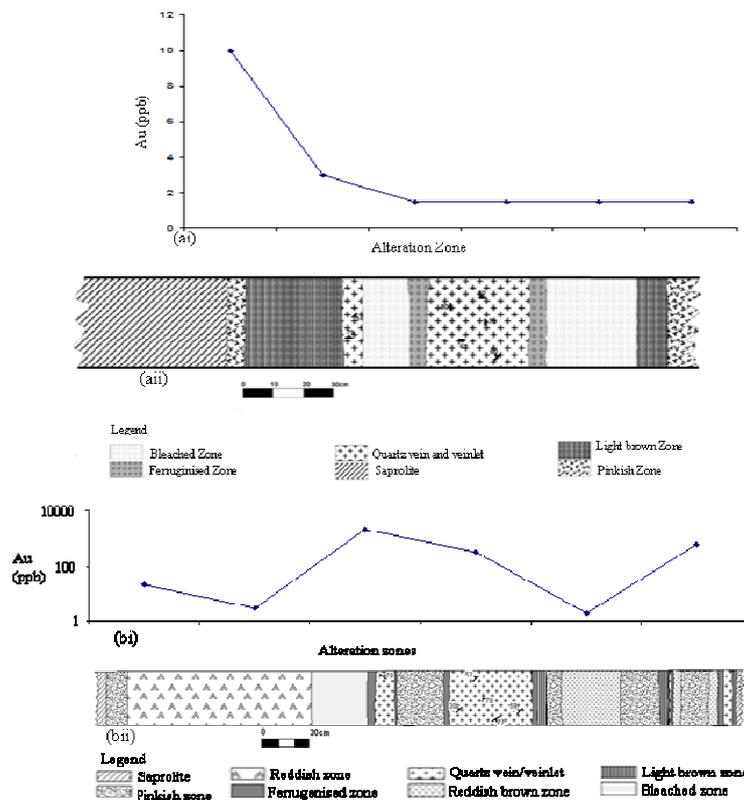


Figure 6. Zonation pattern along veins logged from East-West (a i) variation of Au concentration within the different zones on pit wall I (aii) weathered wall rock zonation along veins on pit wall I (bi) variation of Au concentration within the different zones on pit wall II (b ii) weathered wall rock zonation along veins on pit wall II.

The study area has a very thick soil profile (≥ 30 m) that provides limited access to the fresh meta-granitic (granitoid) basement. However, the relicts of hydrothermal wall rock alteration were observed within the regolith in mining pits. A symmetric alteration envelopes (Fig. 6a & b) surrounding veins in this area was observed and suggests situation of alteration process that commences the moment hydrothermal fluid entered the host structures [e.g.7]. The alteration halos observed show lateral zoning with partially preserved texture

of the weathered host rock. This was determined mainly by changes in mineralogy, color, texture and structure along and within the veins. Four main alteration zones were identified: ferruginized zone (FZ) that encloses the vein (Fig. 6). This zone grades out into a bleached zone (BZ), then to a light brown zone (LBZ) that is bordered by an outer pinkish zone (PZ) (Fig. 6a). The FZ occurs as a thin dark brown, well silicified and having a characteristic clayey texture. The BZ contains sugary quartz often associated with the GQV

(foliated and non- foliated). The bleaching may be due to K-feldspars replacement by residual Ti-oxide [16] or sericite [39]. According to [17], the bleached zone stands as a major indicator for hydrothermal alteration, even though it usually does not contain Au. In situation where two or more veins occur together, (Fig. 6b), the BZ is absent or replaced by the reddish-brown or a light brown zone. Even though geochemical analysis was not performed on the parent meta-granitic host rock, the gradual decrease and eventual absence of Au within the outer weathered wall rock envelop along GQV gives a strong indication that the parent rock itself lacks or is weakly mineralization.

4.2.1. Ore Mineralogy and Au Geochemistry

From the thirteen quartz samples analyzed from the field technique, three of the samples contain Au (Table 1). Amongst these three, two of the veins gave significant Au-grade which includes: quartz vein one (QV₁) and two (QV₂) that yielded 4 g/t and 3 g/t of Au respectively. In these veins, Au occurs in close association with hematite, pyrite, and chalcopyrite. For the geochemical analysis, varying Au-grades were obtained using fire assay geochemistry. QV₂ gave the highest Au-grade of about 2.84 g/t and 0.83 g/t from the associated veinlets (Table 2). QV₁ also gave 1.99 g/t of Au with about 0.32 g/t obtained from the veinlets associated with reddish-brown zone material. Meanwhile, relatively low

grades (<0.001 g/t) were obtained from most weathered wall rock material. [27] Reported Au-grades in quartz vein between 0.04 g/t - > 30 g/t and the fresh wall rock between 0.4 – 18.5 g/t. The Au-grade obtained for QV₁ and QV₂ (table 2; ADBREG-03 and 04) differed slightly from that obtained from panning (table 1). Reasons could be due to the differences in the sample sizes used in both analyses.

Photomicrographs obtained from polished sections for QV₁ and QV₂ show aspects of hydrothermal activity and ore mineralization (Fig. 7a, b). The sulphide minerals in QV₁ occur as subhedral to euhedral crystals buried in a fine-grained quartz matrix (Fig. 7a). Pyrite and chalcopyrite which occur as the most abundant sulphide were equally zoned. Covellite and chalcocine occur as part of the mineral associated with Au based on field observations. According to reports of [17] in this area, the covellite/chalcosite minerals are highly associated with Au ahead of chalcopyrite and pyrite. It is possible that these minerals resulted from supergene enrichment during which they were leached and reprecipitated. This is also supported by the occurrence of these minerals in association with colloidal hematite and clay minerals. Au was not visible in QV₁ (Fig. 8a), however, Au-grains in QV₂ follow micro-fissures in the quartz crystal (Fig. 8b).

Table 1. Au grade obtained from panning of equal amount of homogenized crushed quartz samples.

Vein type	Location(UTM)	Vein Description	Weight panned	grains	Weight(g/kg)	grade (g/t)
QV ₁	33N 0426936 0483780	Weathered, brecciated smoky quartz vein, oriented N175E,70W	1.00kg	4	0.004	4
QV ₂	“	Weathered foliated saccharoidal quartz. Very rich in hematite mineral. Oriented N169E,15E	1.00kg	20	0.003	3
QV ₃	“	Foliated buck quartz, rich in pyrite and chalcopyrite. Oriented N25E,88E	1.00kg	1	-	-

Table 2. Fire assay geochemical data for Au concentration (ppb) in quartz veins and weathered wall rock samples from the Batouri Au district, East Cameroon.

Sample N°	Sample Description	Location (UTM)	Grade (ppb)	Grade (g/t)	Replicate (ppb)
ADBREG-01	Pinch and swell, foliated veinlets associated with QV ₁ . Sample consists of buck quartz with open space texture.	33N0426936 0483780	<2	-	-
ADBREG-02	Quartz sample obtained from splays. Sample is a mixture of quartz and altered granitic weathered wall rock material along QV ₂ .	“	828	0.828	-
ADBREG-03	Quartz sample from a non-foliated quartz vein (QV ₃). Vein shows anastomosing structure, dipping west.	“	56	0.056	-
ADBREG-04	Quartz sample from a foliated quartz vein (QV ₂). Sample consist of saccharoidal quartz, rusty brown to purple in color	33N0426934 0483789	2844	2.844	-
ADBREG-05	Moderately oxidized weathered wall rock material obtained from a light brown zone within an alteration envelope along QV ₄ .	33N0427589 0486462	3	0.003	-
ADBREG-06	Feldspatic weathered wall rock material obtained from a pinkish zone within an alteration envelope along QV ₄ .	“	10	0.010	-
ADBREG-07	Silicified weathered wall rock material from a bleached zone along QV ₄	“	<2	-	-
ADBREG-08	Weathered granitic wall rock material obtained from a ferruginized zone along QV ₄ . Sample is dark in color and silicified.	“	<2	-	-

Sample N°	Sample Description	Location (UTM)	Grade (ppb)	Grade (g/t)	Replicate (ppb)
ADBREG-09	Quartz material from vein (QV ₄) mixed with the associated proximal thin ferruginized zone.	“	<2	-	-
ADBREG-10	Quartz material from non-foliated quartz vein. sample consists of comb and buck quartz with open space texture	“	<2	-	<2
ADBREG-11	Quartz material from veinlets mixed with reddish weathered granitic wall rock material.	33N0426934 0483789	2	0.002	-
ADBREG-12	Chipped sample from a non-foliated quartz vein dominantly made up of buck quartz. Visible quartz crystals are common and misoriented.	33N0426936 0483780	<2	-	-
ADBRE-13	Chipped sample from a foliated pinch and swell quartz vein. Sample consists of comb quartz, buck quartz and have pen space texture.	“	21	0.021	-
ADBRE-14	Oxidized weathered wall rock material obtained from reddish saprolitic zone along QV ₁ .	“	3	0.003	-
ADBRE-15	Oxidized granitic weathered wall rock material from reddish zone along QV ₁ .	“	1989	1.989	-
ADBRE-16	Quartz material from splay and associated weathered wall rock material.	“	316	0.316	-
ADBRE-17	Chipped sample containing quartz from QV ₁ and QV ₃ dipping west and east respectively. Sample mixed with reddish altered granitic material.	“	2	0.002	-
ADBRE-18	Chipped sample containing part of QV ₃ and reddish-brown altered granitic material.	“	582	0.582	-

NB: Sample 01-18: obtained from three different investigated sites; ADBREG: are grabbed samples collected from quartz veins and veinlets. ADBRE: are samples collected by lateral channel chip across veins and associated weathered wall rock. Samples 13-18: were sampled indiscriminately across veins and weathered wall rock in an interval of about 63cm E-W.

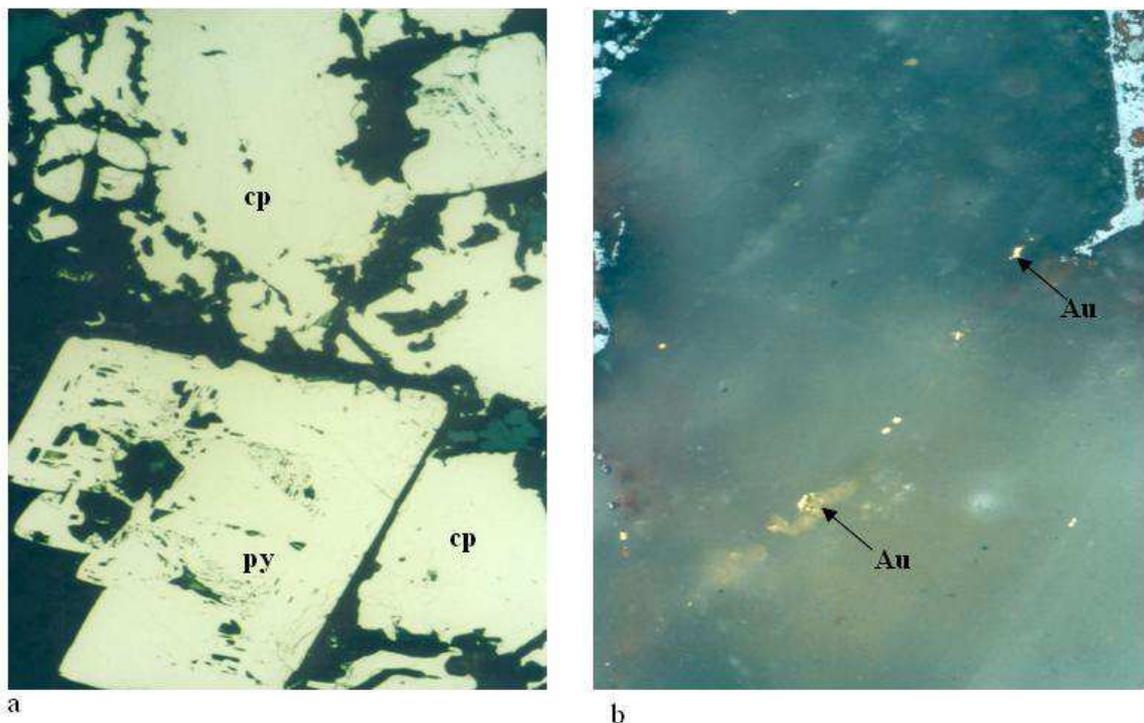


Figure 7. Photomicrographs for foliated and non-foliated GQV (a) pyrite (py) and chalcopyrite (cp) occurring in a zoned mineral assemblage (b) Au (yellow) occurring within micro fissures (fracture and foliation planes).

4.2.2. Morphology and Au Chemistry

Back Scattered Electro-microscopy (BSE) images for Au-

grains obtained from QV₂ show slight variation in the shapes and sizes of the grains (Fig. 8a-c). These grains vary from

sub-rounded through sub-equant to tabular. The sub-rounded grains (Fig. 8a) have corroded margins and pitted surfaces. The sub-equant and tabular grains have smooth surfaces with indented margins. Sub-equant grains (Fig. 8c) have larger grain sizes of 348-392 μm , while the sub-rounded grains have smaller sizes ($\sim 102 \mu\text{m}$). The chemistry of Au particles obtained from QV₂ is indicated on the EDS spectra (Fig. 9a-c). These spectra show that Au does not only occur as pure but also alloyed in small proportion with Ag as indicated by the presence of consistent small Ag peaks. The presence of O, Al and Si peaks indicates the presence of sericite around the grains as hydrothermal alteration phases. The Fe peak is reminiscent of hematite with which Au is associated. Rutile

particle also occur in the heavy mineral fraction (Fig. 9c). The association of Ti with Fe and Ag indicates a hydrothermal origin for Ti. This is explained by the presence of rutile grain in the heavy mineral fraction (Fig. 8d) with an EDS scan containing high peaks for Ti and Fe (Fig. 9c). The variation of mineral assemblage in GQV varieties suggests a situation of multiple deformation and fluid generation episodes. [13] Suggests that such a situation may indicate fluid immiscibility during Au deposition. However, the Au-rich veins that highly contain iron oxide (hematite) seem to be different from Au chemistry from other Au districts of the Birimian [e.g.13, 40].

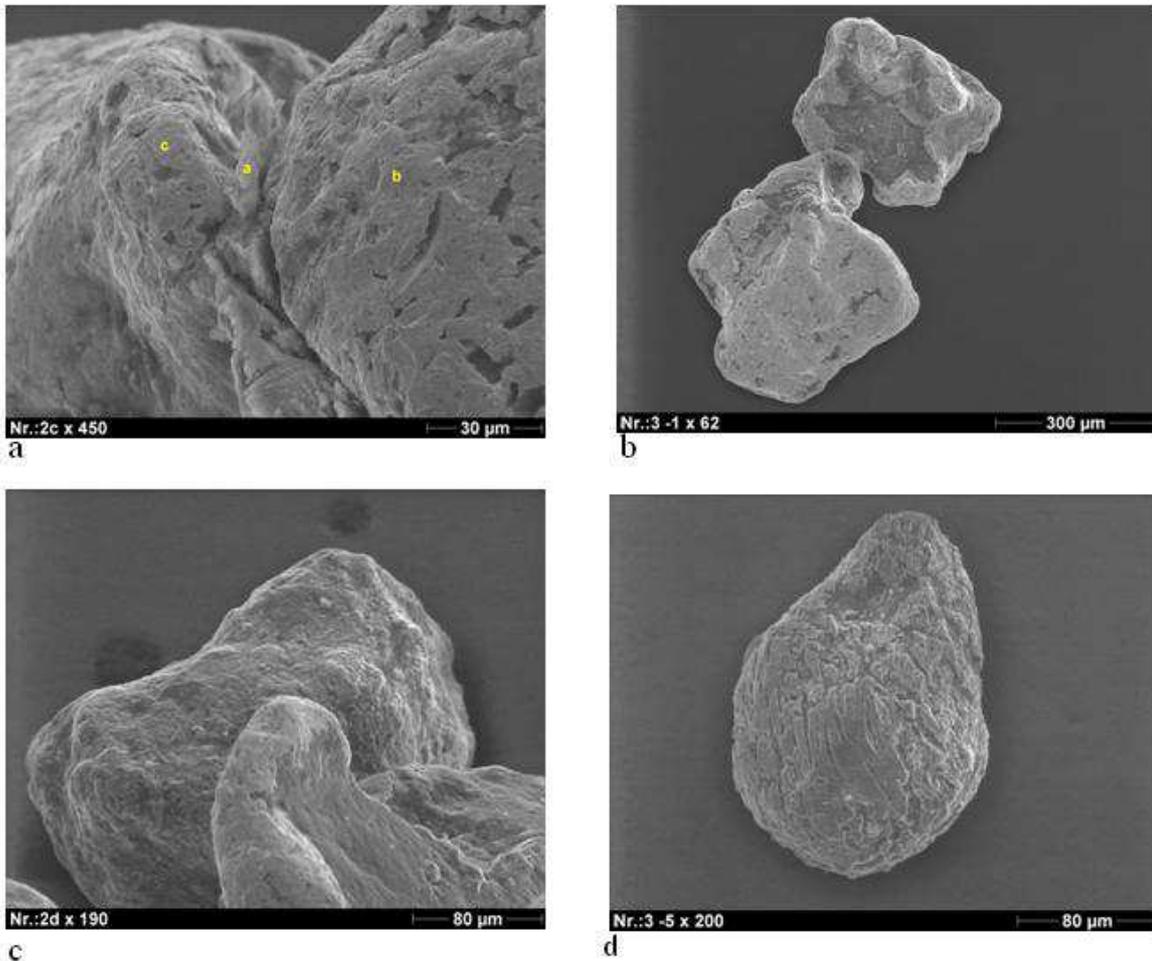


Figure 8. Photomicrographs of grains obtained from panning (a) sub-rounded grains with corroded margins and grain boundary located at point a (b) sub-equant grains with indented margins (c) tabular grains with indented margins and pitted surfaces (d) elongated rutile grain.

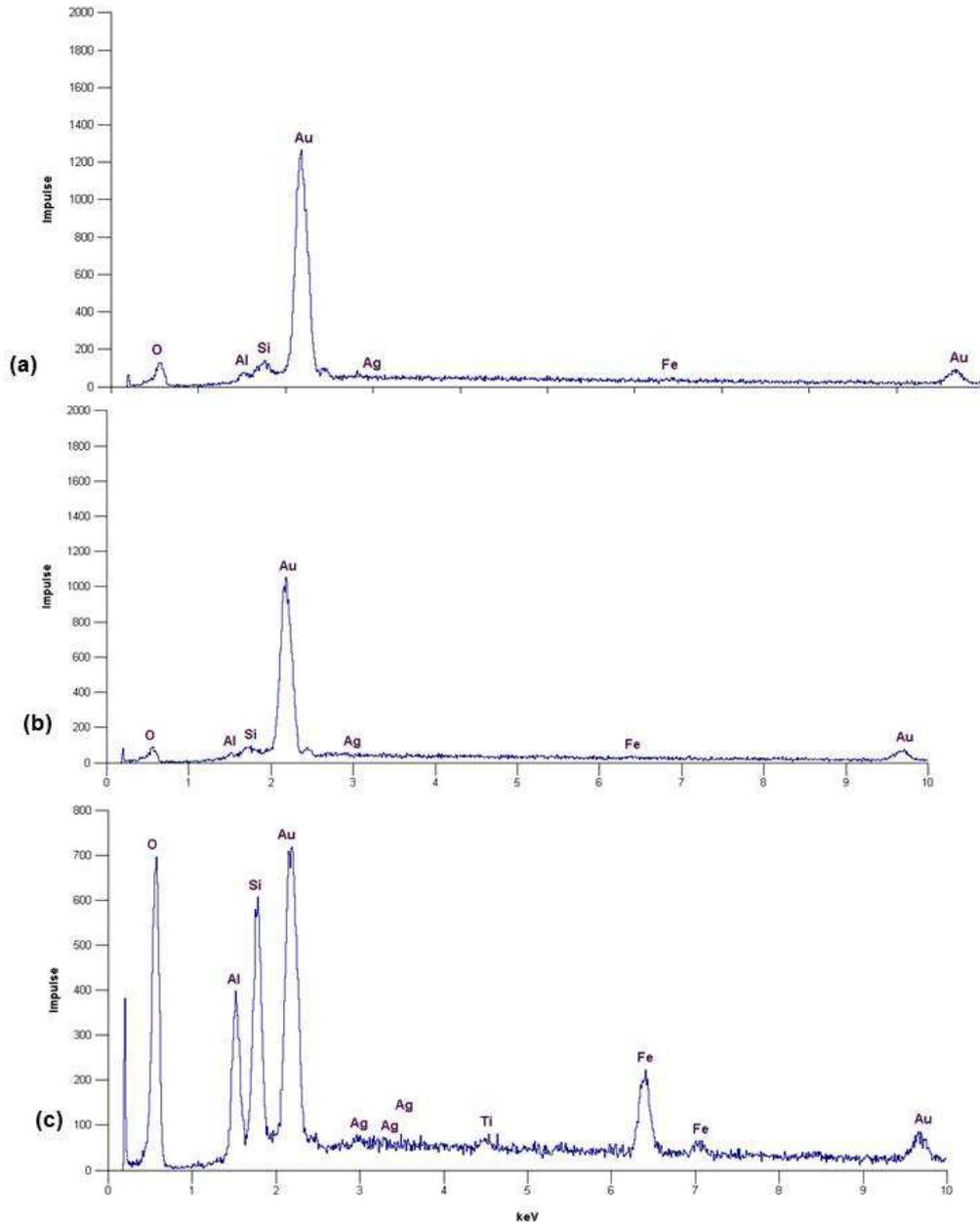


Figure 9. EDS pattern for Au particles (a) pattern for Au at spot b (b) pattern for same grain at spot c away from grain boundary (c) pattern at spot c that represents the grain boundary. Note small peaks of Ag Fe and Ti.

5. Conclusions

Au-bearing quartz veins in the Batouri south area are confined to a major NNE and partly NNW orientations. These veins are characterized by partially and completely filled fractures and foliation planes. This therefore constitute the main mineralization style within the area. Disseminated Au is common in sheared weathered wall rock associated with veinlets and vein splays. Both foliated and non-foliated quartz veins (barren and mineralized) varieties occur in this area. The investigated veins show evidence of multiphase deformation as indicated by the mineralogical, textural and cross-cutting relationships among veins. However, a distinctive relict of hydrothermal wall rock alteration occurs

along the quartz veins and veinlets that showing lateral zoning (weathered meta-granite >pinkish zone >light brown zone >reddish zone >bleached zone >ferruginised zone >quartz vein). Generally, the weathered wall rock envelope is poor in Au. The bleaching in the weathered wall rock does not indicate mineralization as the field results (Table 1) shows the association of the zone with veins devoid of Au. Accessory minerals include: rutile and/or ilmenite, with quartz and sericite as the most common gangue mineral. The mineralized veins are rich in hematite and poor in pyrite /chalcopyrite. The chemistry of Au particles indicates the presence of gold with metals (Fe, Mn, Ag, Al), O, S and Si derived from supergene enrichment (sericitization).

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