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GRANODIORITE-HOSTED GOLD DEPOSIT IN THE MAGYIBIN-KABA AREA, PINLEBU TOWNSHIP, SAGAING REGION

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Abstract

The research area, granodiorite-hosted gold deposit, is situated within the Pinlebu Township, Sagaing Region, Northern Myanmar. It is bounded by latitude 24° 3' 30"to 24° 12' 30"N and longitude 95° 32' 00"to 95° 40' 00"E and falls in UTM map 2495-12. The research area consists chiefly of the various igneous rock types which form a batholith and sedimentary units. Ore deposits of gold are hosted in the Kanzachaung batholith (Wuntho massif) especially as granodiorite and diorite body. Five gold deposits were observed at Magyibin and Kaba area, productive gold deposits are MG-1, MG-2, KB-1, KB-2 and KB-3. Most of mineralized quartz veins, fracture filling, are recognized in the fracture zone of granodiorite body and diorite body. Quartz veins in the research area contain gold (Au), lead (PbS) and copper ($CuSO_4$). The mineralized quartz veins show lenticular and banded nature. In some places, pinch and swell structures are noted. Economically the main ore mineral is gold. The mineralogy of the vein is relatively simple and can be recognized into three paragenetic stages. Stage-1 and stage-2 are main mineralization stages and stage-3 is post- ore forming stage. Ore deposit of the research area is hydrothermal origin source of hydrothermal ore fluid is considered to be meteoric water and magmatic water. It is reasonable to conclude that mineralization in the present area might have been formed at the late stage of or after the intrusion.

Keywords: Granodiorite, fracture filling, hydrothermal origin

Introduction

Location, Size and Accessibility

The research area is situated within the Pinlebu Township, Sagaing Region, Northern Myanmar. It is bounded by latitude 24° 3' 30"to 24° 12' 30"N and longitude 95° 32' 00"to 95° 40' 00"E and falls in one-inch topographic map 83 P/12 (Fig. 1 and 2). It covers approximately 80 square miles. The research area can be reached from Kawlin by car, which is situated on Mandalay-Myitkyina railway line, 155 miles from Mandalay and 180 miles from Myitkyina. Road connecting the area with Pinlebu can be used during the dry season only.

Geological Background

The research area lies on the northerly trending Central Volcanic Line (Volcanic Arc) related to the subduction zone of the collision of India and Eurasian plates. Along the line are the Upper Cenozoic volcanoes, volcanic and plutonic rocks (pre-Oligocene) and igneous rocks (probable Upper Mesozoic to Lower Tertiary) (Chhibber, 1934).

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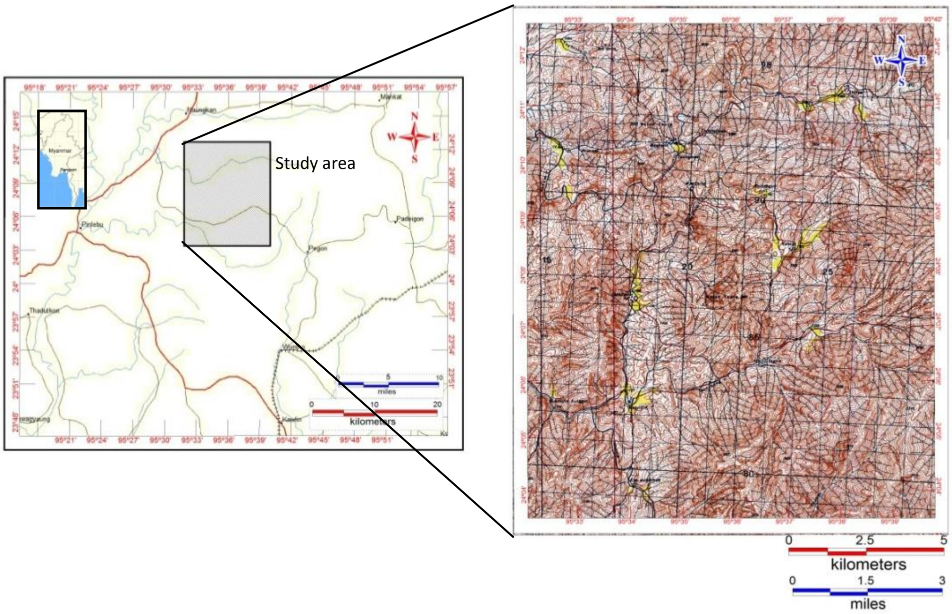

Figure 1 Location map of the research area

The western part of the research area includes part of the eastern limb of the Chindwin syncline. A well-known major fault, Sagaing Fault (Win Swe 1970) is situated to the eastern part of the research area. The Geological Survey and Exploration Project (BUR.72.002) of the United Nations (UN project), and the Development of Geological Survey and Mineral Exploration (DGSE), of the Ministry of mines carried out reconnaissance survey and geological mapping in this area.

Methods of study

The present research includes field methods and laboratory investigations and employs the three methods to achieve the objectives of the research. The three methods are (a) landsat image and aerial photographic interpretation were made before doing field trip, (b) detailed studies of outcrops and sampling applying the GPS II Plus method and (c) using the ore microscope to analysis the ore texture and mineral paragenetic sequence.

General Geology

Geomorphologically as well as tectonically, Myanmar can be subdivided into four North-South trending major tectonic domains from west to east. They are the Arakan (Rakhine) Coastal Area, Indo-Burman Ranges, Inner-Burman Tertiary Basin, and the Sino-Burman Ranges (Bender, 1983). The study area occupies the Central Volcanic Line that is classically interpreted as the volcanic arc separating the fore arc basin in the west and the relatively thin back arc basin in the east.

Generally, the research area consists chiefly of the various igneous rock types which form a batholith and sedimentary units. The Kangon Formation occupies the north-western part, and the eastern part of the research area is mainly composed of igneous units of Kanzachaung batholith such as granodiorite and diorite. The north and north-western flank of the study area is formed of the Mawgyi andesite.

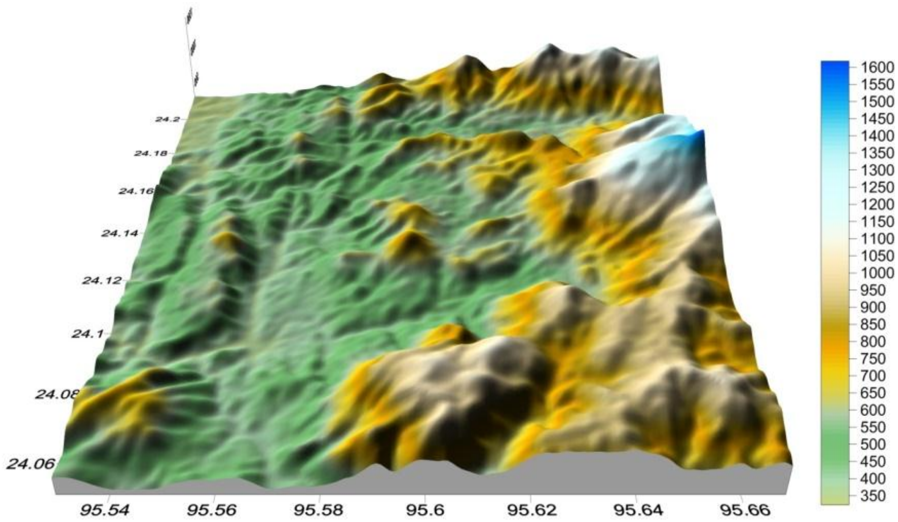

Figure 2 3D view of the study area (looking north)

The sequence of the rock units of the study area is described in the table (1) based on the field relationship, correlation and radiometric dating. The simplified geological map of the Magyibin-Kaba area is shown in figure (3) (Based on UNDP project, 1979).

Table 1 Rock sequence of the study area

Rock Unit	Age
Sedimentary Rock Units	
Alluvium	Recent
^^^^^^^^^^^^^^^^^^^^	Unconformity
Mansigale Group	
Kangon Formation	Early Eocene
Igneous Rock Units	
Kanzachaung Batholith	
Veins and dykes of aplite, pegmatite and andesite Granite Biotite granodiorite Hornblende biotite granodiorite Diorite	Late Cretaceous
Mawlin Formation	
Mawgyi andesite	Early Cretaceous

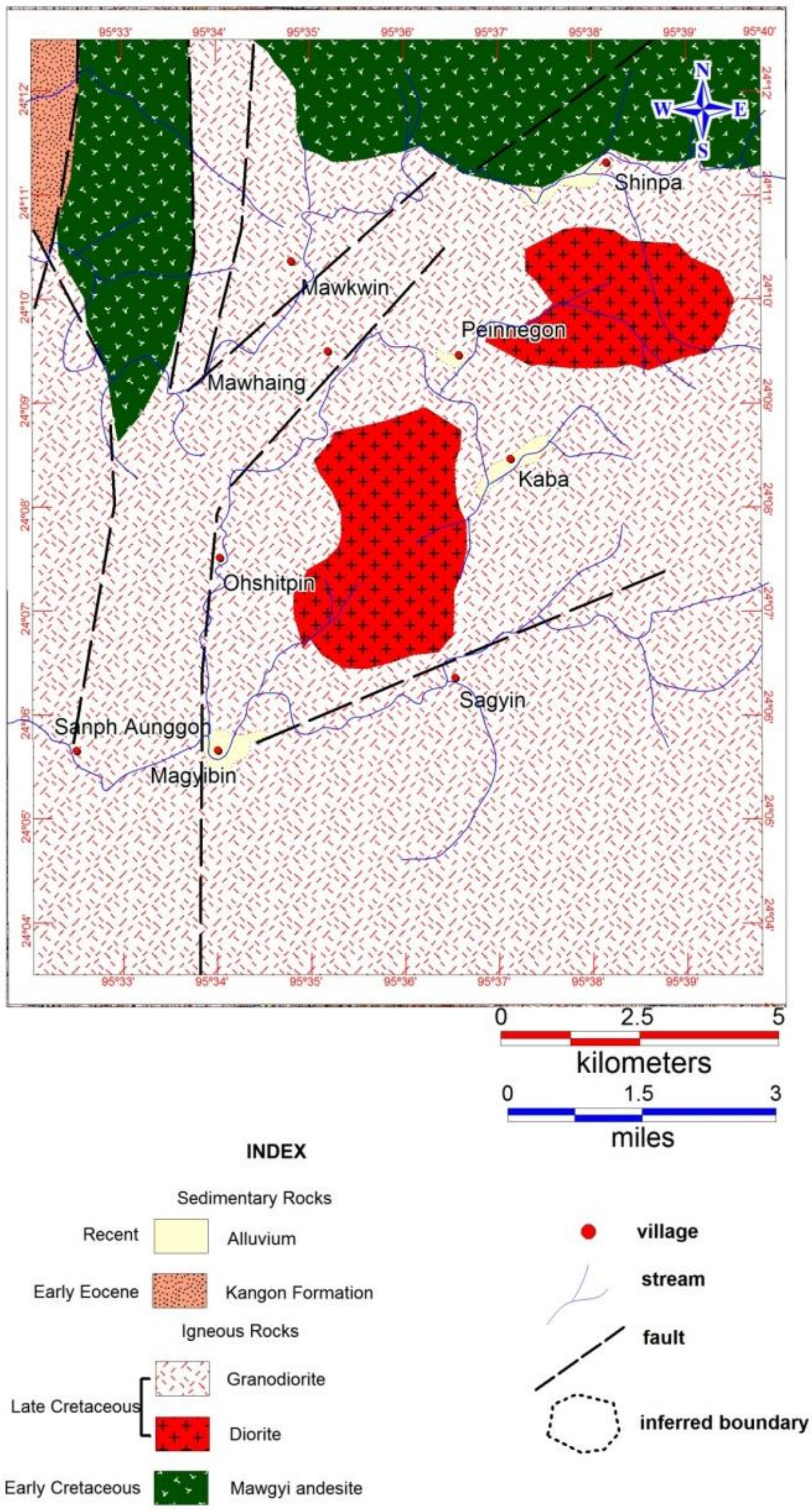

Figure 3 Geological map of the study area (modified after United Nations, 1978)

Occurrence of Gold Deposits

Distribution of Gold Deposit at the Magyibin-Kaba Area

Gold ore deposits in the research area are hosted in the Kanzachaung batholith (Wuntho massif). Five gold deposits were observed at Magyibin-Kaba area and their distribution is shown in figure (4). The mineralized gold vein occurrences are predominantly hosted in the granodiorite and diorite body. In many places, the veins follow the fracture filling. Some mineralized quartz veins are recognized in the fracture zone of granodiorite body. The most productive gold deposits in Magyibin-Kaba area are MG-1, MG-2, KB-1, KB-2 and KB-3.

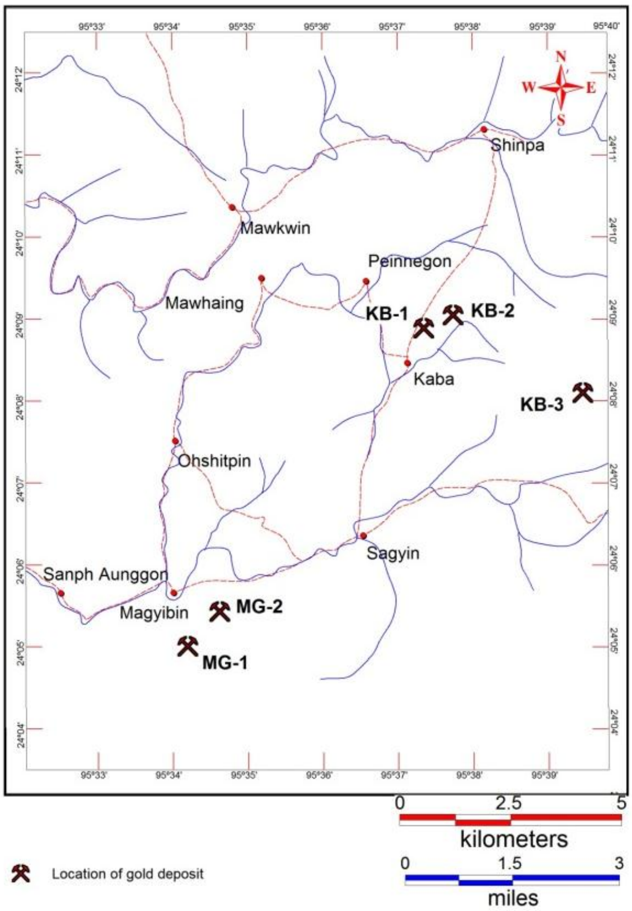

Figure 4 Location of gold mines and salt springs in the study area

Gold Mine of MG-1

This gold mine (KB-1) (N 24° 6' 02.22", E 95° 35' 21.3") is located at the ½ mile south-east of the Magyibin village and stands at the elevation of 1428 ft. The gold mineralization at MG-1 is related to 240° / 35° SW direction quartz veins and veinlets. At the second level of the main shaft (about 300 ft), the thickness of the quartz veins vary from a few centimeters to 90 cm and dip westward (Fig. 5). The quartz vein is associated with the pyrite, chalcopyrite, sphalerite, galena and other sulfide minerals. The MG-1 mine is run from the inclined shaft. The wall-rock is soft, friable and loose due to the alteration. Gossan zone occurs within 20-30 ft below the surface. The MG-1 gold mine is situated beside the Magyibin Fault which is trending NE. The vein related alteration is characterized by silification, sericitization and chloritization.

Gold Mine of MG-2

The MG-2 gold mine (N 24° 05' 28.9", E 95° 34' 39.9") is situated ½ mile south of the Magyibin village and stands at the elevation of the 1264 ft (Fig.6). The host rock of the MG-2 gold mine is hornblende biotite granodiorite. The mineralized quartz veins occur at the main shaft of 90 ft and is 1 - 3 cm thick. The strike of the quartz veins is 120° / 5°-10° SW direction. It occurs as a fracture filling type. The quartz vein is associated with the sphalerite galena and other sulfide minerals. It is characterized by the occurrence of gold flake in hand specimens (Fig. 7). The mineralized gold veins are found together with calcite and show vuggy texture. The clear microcrystalline quartz is relatively coarse compared to the milky quartz. The quartz vein is associated with the galena, sphalerite, pyrite and other sulfide minerals.

Gold Mine of KB-1

The KB-3 gold mine (N 24° 09' 04.10", E 95° 37' 29.9") is situated at the 1 mile north of Kaba village and stands at the elevation of 2014 ft. The mine is run by the inclined shaft. The host rock of the mineralization is the diorite body. It is soft, friable and brecciated. The strike of the veins is 216° / 20°- 27° NW direction and veinlets cross-cut the diorite body. The thickness of the veins varies from 5 to 20 cm and shows the wall-rock alteration. Some veins show lens-shaped or pinch and swelling structure (Fig. 8). Some veins and veinlets contain gold grains a few millimeters in diameter, gold is generally dispersed in sulfide minerals. Quartz veins display crustiform- colloform, drusy and comb textures (Fig. 9). A crustiform-colloform symmetrically banded quartz vein sample belongs at least 10 cm thick. The gold-bearing quartz vein is associated with the pyrite, arsenopyrite, galena and other sulfide minerals.

Gold Mine of KB-2

The KB-2 gold mine (N 24° 09' 03.10", E 95° 37' 50.0") is situated 1 mile north of Kaba village and stands at the elevation of 1980 ft. Host rock is dark grey diorite. It is mined by the inclined shaft. The strike of the vein is 190° and the dip amount is 20°-30° NW direction. The alteration halo occurs below and above the mineralized quartz veins (Fig. 10). Above the mineralized vein, gossans zone occurs in the form of the iron cap (Fig. 11). This vein is mainly composed of galena, sphalerite, pyrite and other sulfide minerals. The thickness of the quartz vein varies from 10- 20 cm. The alteration is characterized by silicification, sericitization and chloritization.

Gold Mine of KB-3

The KB-3 gold mine (N 24° 07' 39.8", E 95° 38' 49.6") is run at the site 3 miles east of Kaba village. This gold mine is operated by the inclined shaft along the fault plane (Fig. 12). Host rock is hornblende biotitegranodiorite and it is associated with the brecciated quartz vein. The thickness of the quartz vein is about 25 cm and trends 154° / 35° NW direction. The mineralized quartz vein is highly brecciated, brittle and hard. Wall-rock alteration is chracterized by the sericitization and clay alteration.

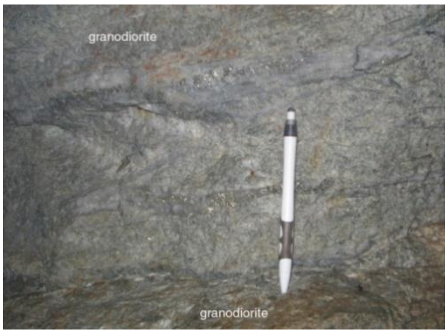

Figure 5 Photograph showing the bifurcate and lens-shape of auriferous veins at MG-1 (N 24° 6' 02.22", E 95° 35' 21.3") (west facing)

Figure 6 Exploration adit of No.2 gold deposit of MG-2 (west facing) (N 24° 6' 02.22", E 95° 35' 21.3")

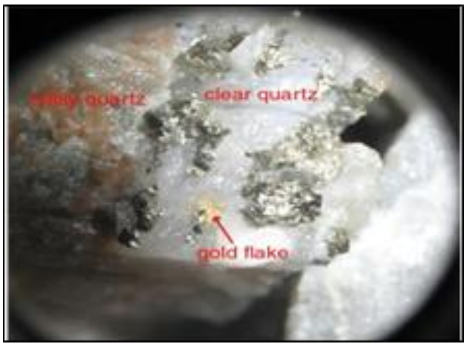

Figure 7 Photograph showing the gold flakes associated with the clear quartz, milky quartz and pyrite minerals of the MG-2 gold mine (10X)(N 24° 05' 28.9", E 95° 34' 39.9")

Figure 8 The pinch and swelling of auriferous quartz vein at KB-1 gold mine (N 24° 09' 04.10", E 95° 37' 29.9") (west facing)

Figure 9 Photograph showing the drusy and comb textures of the gold bearing quartz vein at KB-1 gold mine (N 24° 09' 04.10", E 95° 37' 29.9")

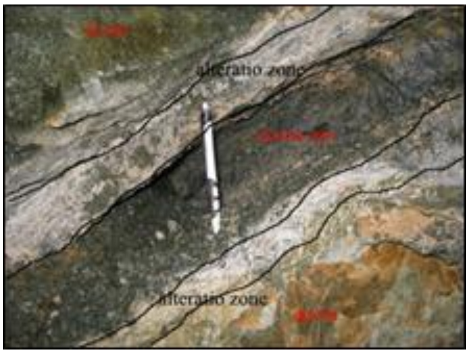

Figure 10 Alteration formed along the auriferous quartz vein at KB-2 gold mine(N 24° 09' 03.10", E 95° 37' 50.0") (north facing)

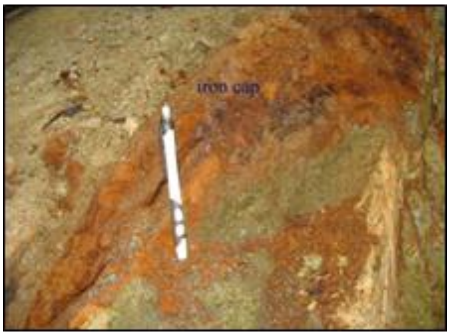

Figure 11 Photograph showing the yellow, earthy hematite gossan at KB-2 gold mine (N 24° 09' 03.10", E 95° 37' 50.0") (west facing)

Figure 10 Auriferous quartz vein along the fracture zone of granodiorite body at KB-3 gold mine (N 24° 07' 39.8", E 95° 38' 49.6") (east facing)

Ore Mineralogy

The major ore constituents of quartz veins in the study area are gold, lead and copper. The major ore minerals are pyrite, chalcopyrite, sphalerite, galena and arsenopyrite with lesser amount of chalcocite, bornite and arsenopyrite. Economically the main ore mineral is gold.

Therefore polished section and thin section of mineralized rock samples (15 double polished and thin sections) are prepared. The mineralizing veins at MG -1, MG -2, KB-1, KB-2 and KB-3 gold mines are composed of gold and sulfides minerals.

Sphalerite (Zn Fe)S

Grain size ranges from 0.5 mm to 2 mm and occurs as gray color irregular anhedral masses along with pyrite, galena and chalcopyrite. It contains randomly oriented grains of exsolved chalcopyrite. Late stage sphalerite veins are injected into quartz and pyrite minerals. In some specimens, the sphalerite minerals cross cut the galena, and enclose the quartz and galena minerals (Fig. 13).

Chalcopyrite (CuFe) S_2

It occurs as minor constituent of ore minerals in the study area. Anhedral patches of grain size ranges from 0.5 mm to 2 mm, yellow to brassy yellow colored chalcopyrite is formed in pyrite and apex of the galena minerals. It also occurs as inclusion and exsolved grains in pyrite and sphalerite (Fig. 13&14). Most of the chalcopyrites are found along the grain boundaries and within the galena minerals.

Gold (Au)

Bright yellow gold is observed as disseminated specks within the pyrite, chalcopyrite, sphalerite and galena. Some gold minerals occur along the grain boundaries of pyrite which is associated with the galena and gangue minerals (Fig. 15). Sometimes, gold flakes occur within the gangue minerals like quartz. It is characterized by its "golden" color, lack of fracture and very high reflectance and paleochroism. Some minute gold grains are encapsulated in pyrite which renders the gold ore refractory. Most of the visible gold is bright yellow in color, suggesting that it has a relatively high fineness.

Galena (PbS)

Galena occurs as anhedral to euhedral form. In some specimens, euhedral grains of galena are found associated with the gangue mineral quartz (Fig. 16). The perfect cleavage is usually visible and triangular pits (Fig. 16) are observed as characteristic feature. The average grain size is 0.5 to 2 mm. In some specimens, curved cleavage pits occur as a result of post depositional deformation. Galena associated with chalcopyrite is set in pyrite. Sometimes, galena and sphalerite minerals are replaced by the gangue minerals like quartz.

Pyrite (FeS_2)

Grain size of pyrite ranges from 0.1 mm to 2 mm and it occurs as yellowish white irregular coarse-grained and often euhedral crystals (Fig. 16). Small fractures of pyrite are partly replaced and filled by chalcopyrite. Discrete grains of pyrite occur in quartz vein. Pyrite is the most abundant sulfide mineral. In one section, annealed texture of recrystallized monomineralic pyrite is seen. Coarse pyrite is commonly fractured and cemented by sulfide minerals such as galena and sphalerite and by gangue minerals quartz and calcite (Fig. 14). The early formed pyrite cubes occur as relic crystals in anhedral chalcopyrite and sphalerite. Pyrite is also found as small disseminated grains throughout the vein and as aggregates of small cubes.

Arsenopyrite (FeAsS)

Arsenopyrite occurs as small white colored subhedral to euhedral grains margional to gold. It is embedded in pyrite. It is characterized by white color rhomb form and anisotropism.

Chalcocite (Cu_2S)

Chalocite occurs as blush white disseminated grains and veinlets in the pyrite. In some specimens, chalcocite is found replacing the cleavage and boundaries of the galena (Fig. 7.8).It is also found along the sphalerite, galena and chalcopyrite grain boundaries.

Bornite (Cu_5FeS_4)

Bornite has pinkish to purplish color. It occurs as irregular aggregates and as coating or lamella intergrowth with chalcopyrite. It is altered to covellite on grain boundaries and its core. It is also dispersed in sphalerite together.

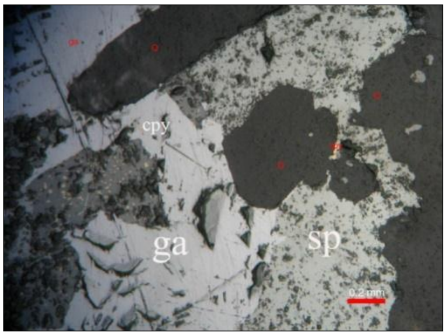

Figure 13 Photomicrograph showing sphalerite (sp), galena (ga) and quartz mineral (Q) from the KB -1 gold mine (N 24° 6' 02.22", E 95° 35' 21.3")

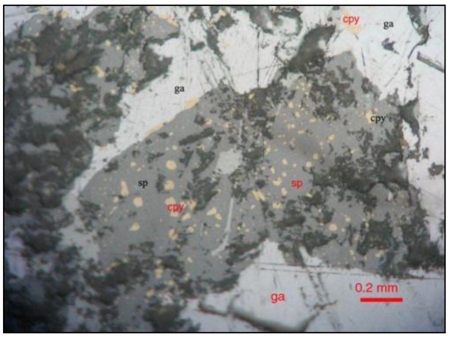

Figure 14 Photomicrograph showing chalcopyrite (cpy) diseases within the sphalerite (sp) and along the edges of galena (ga) from the KB -1 gold mine (N 24° 6' 02.22", E 95° 35' 21.3")

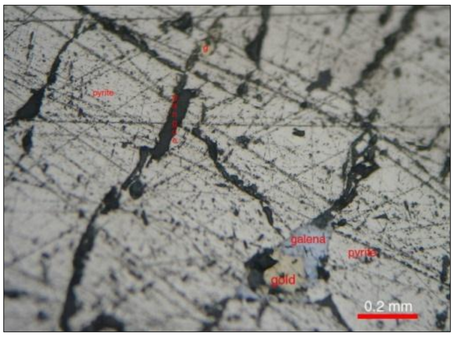

Figure 15 Photomicrograph showing fracture-filling of electrum (g) associated with galena (ga) and quartz within the pyrite (py) from the KB-1 gold mine (N 24° 09' 04.10", E 95° 37' 29.9")

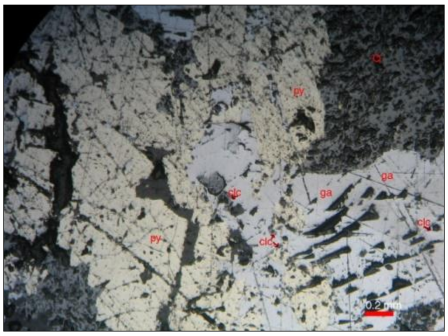

Figure 16 Photomicrograph showing chalcocite (clc) replacing galena (ga) along the grain boundaries and cleavages from the KB -3 gold mine (N 24° 6' 02.22", E 95° 35' 21.3")

Paragenesis

The mineralogy of the vein is relatively simple and can be recognized into three paragenetic stages. Stage-1 and stage-2 are main mineralization stages and stage-3 is post- ore forming stage. In stage-1 quartz and pyrite with minor amounts of sulfide minerals were formed. Precious metal and sulfide mineral are mainly precipitated stage-2. Generally, white to clear crystalline quartz is most abundant in stage-1 and stage-2. The vein width of the stage-1 is relatively in small comparison with the stage-2. Stage-2 is the most important paragenitic stage and thickness of the veins varies from 2 cm to 25 cm in the research area. Hydrothermal solutions are terminated in stage-1 and stage-2 by onset of fracturing and brecciation event along the mineralized veins. Finally, barren hydrothermal solutions were deposited lean or cross-cutting the stage-1 and stage-2. Generalized paragenetic sequence of the vein minerals of the study area is shown in Table (2).

Table 2 Generalized paragenetic sequence of ore and gangue minerals in the research area

Minerals	Stage 1	Stage 2	Stage 3
Quartz	———	———	
Adularia		———	
Sericite		——	
Calcite			———
Pyrite	– –	———	
Arsenopyrite		– – – ———	
Chalcopyrite		– ———	
Galena		———	
Sphalerite		– – – ———	
Gold		– ———	
Bornite		———	
Covellite		———	
Chalcocite		———	

Conclusion

In the research area, precious and base metal mineralization of is hosted by diorite and granodiorite units which were intruded by later intrusion of andesite dykes and apalite dykes. Therefore, these metals might be scavenged from hydrothermal solution which is probably as a result of late stage magmatic differentiation during the emplacement of intrusions

Therefore, the mineral deposit of the present area is of hydrothermal origin (both mesothermal and epithermal) and source of hydrothermal ore fluid is considered to have an igneous source combined with the meteoric water. It is reasonable to conclude that the precious and base metal mineralization of the study area might have been formed more or less associated with the intrusion.

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