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THE MINERALIZATION STYLE AND ORE GENESIS OF MAGYIBIN AREA, PINLEBU TOWNSHIP, SAGAING REGION IN MYANMAR

[1] **Zaw Win**, [2] **Shwe Sin Nwe**
[1] Associate Professor, [2] Assistant Lecturer
[1] Department of Geology, Panglong University, Panglong, Myanmar
[2] Department of Geology, Yadanabon University, Mandalay, Myanmar
Email – [1] zawwingeol@gmail.com,

Abstract: *This paper presents the mineralization style and ore genesis of Magyibin area. The research area is situated within the Pinlebu Township, Sagaing Region, Northern Myanmar. The present research includes field methods and laboratory investigations and employs the three methods to achieve the objectives of the research. It consists chiefly of the various igneous rock types which form a batholith and sedimentary units. Gold ore deposits are hosted in the Kanzachaung batholith (Wuntho massif). Five gold deposits were observed at Kaba area, productive gold deposits are MG-1, MG-2, MG-3, MG-4 and MG-5. The mineralized gold vein occurrences are predominantly hosted in the granodiorite and diorite body. Some mineralized quartz veins are recognized in the fracture zone of granodiorite body. On the basis of the field criteria, petrology, mineralogy, structural features and tectonomagmatic events of the research area, two stages of mineralization may be assigned: (1) the early mineralization took place syn- and post intrusion of the Upper Cretaceous age and (2) the late mineralization deposited after the uplifting of granodiorite body near the surface in the Late Eocene. The mineral deposit of the present area is of hydrothermal origin (both mesothermal and epithermal).*

Key Words: *Mineralization style, ore genesis, field methods, laboratory investigations, Wuntho massif, gold deposit, hydrothermal origin.*

1. INTRODUCTION :

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). 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.

The Wuntho Mass Uplift, part of the research area, is bordered on the west by the Chindwin Basin and on the east by a N-S trending right lateral strike slip fault called the Sagaing Fault (Win Swe, 1970). The Wuntho Igneous Mass, batholithic in size, is an elongated body trending generally NNE-SSW. It consists of several types of igneous rocks. This area is traditionally known earlier as the Maingthon Hill Tract (Noetling, 1894) and then later known as the Wuntho Igneous Complex (Chhibber, 1934).

Figure 1 Location map of the research area

The metamorphic and pre-Batholithic stratigraphic units comprise the Hpyu Taung Metamorphics (schist and schistose quartzites of possibly pre-Triassic basement), Shwedaung Formation (laminated cherty, tuffaceous sediment, micritic limestone, tremoliteschists and andesite of Upper Triassic) and Mawgyi Andesite (black andesitic rocks or flow breccia, Lower Cretaceous). Plutonic rocks of basic, intermediate and acidic compositions occupy and consist largely of granodiorite, diorite, and quartz diorite, biotite adamellite with subordinate amounts of gabbro, dolerite and micro-leucocratic rocks.

2. METHODS OF MATERIALS:

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.

2.1 Distribution of Gold Deposit

Gold ore deposits in the research area are hosted in the Kanzachaung batholith (Wuntho massif). Five gold deposits were observed at research area and their distribution is shown in figure (2). 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 Kaba area are MG-1, MG-2, MG-3, MG-4 and MG-5.

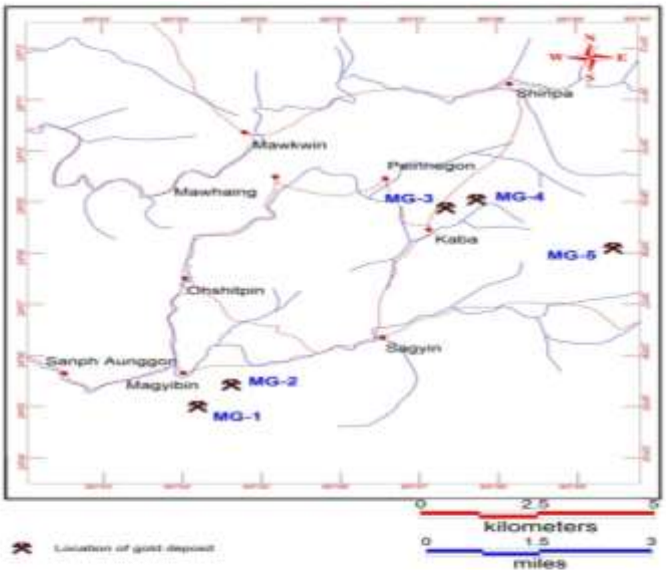

Figure 2 Location of gold mines in the research area

2.2.1 Gold Mine of MG-1

This gold mine (**MG** -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. 3). The gold-bearing quartz vein of this mine is banded and tabular. The mineralized quartz veins are hard and compact. Sometimes, it shows the bifurcate quartz vein and lens-shaped nature (Fig. 4). 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.

2.2.2 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. The host rock of the MG-2 gold mine is hornblende biotitegranodiorite (Fig. 5).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. 6). 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 (Fig. 7). The quartz vein is associated with the galena, sphalerite, pyrite and other sulfide minerals.

Figure 3 The banded nature of ore-bearing quartz vein injected in the hornblende biotite granodiorite of **MG** -1 gold mine (west facing)

Figure 4 Photograph showing the bifurcate and lens-shape of auriferous veins at **MG** -1 (west facing)

Figure 5 Exploration adit of No.2 gold deposit of **MG** -2 (west facing)

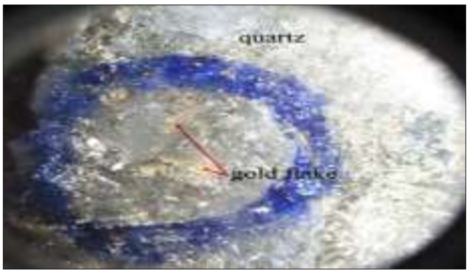

Figure 6.Photograph showing the gold flakes embedded in the crystalline quartz of **MG** -2 gold mine (10X)

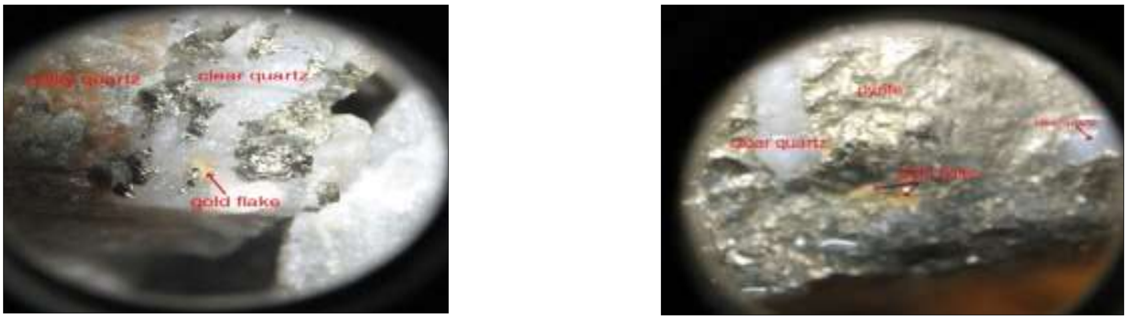

Figure 7 Photograph showing the gold flakes associated with the clear quartz, milky quartz and pyrite minerals of the **MG** -2 gold mine (10X)

2.2.3 Gold Mine of MG -3

The MG-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 (Fig. 8). 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. 9). 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. 10). A crustiform-colloform symmetrically banded quartz vein sample belongs at least 10 cm thick. In hand specimen, the sample shows a sequence, from the margin to the center, milky quartz associated with the pyrite (in contact with the wall rock), followed by 2 cm clear quartz, then milky quartz and at the center, iron oxide or sulfide minerals (pyrite?) (Fig. 11). The gold-bearing quartz vein is associated with the pyrite (Fig. 12), arsenopyrite, galena and other sulfide minerals.

2.2.4 Gold Mine of MG -4

The MG-4 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. 13). Above the mineralized vein, gossans zone occurs in the form of the iron cap (Fig. 14). 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.

2.2.5 Gold Mine of MG -5

The MG-5 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. 15). 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 associated with the galena, sphalerite, pyrite, chalcopyrite etc. The clear quartz is associated with banded milky quartz. The mineralized quartz vein is highly brecciated, brittle and hard. Wall-rock alteration is chracterized by the sericitization and clay alteration.

Figure 8 Portal and inclined shaft of the **MG -**3 gold mine (Shwedagar Company Lt.d) (west facing)

Figure 9 The pinch and swelling of auriferous quartz vein at **MG -**3 gold mine (west facing)

Figure 10 Photograph showing the drusy and comb textures of the gold bearing quartz vein at **MG** -3 gold mine

Figure 11 The auriferous quartz vein associated with sulfide minerals at **MG -**3 gold mine

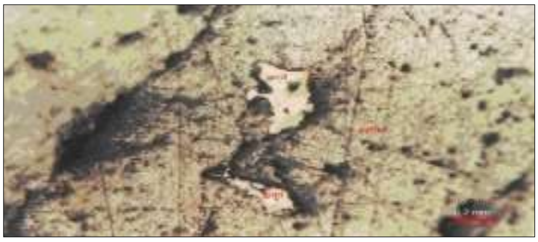

Figure 12 Photomicrograph showing electrum in the sulfide ores from the **MG** -3 gold mine

Figure 13 Alteration formed along the auriferous quartz vein at **MG -**4 gold mine (north facing)

Figure 14 Photograph showing the yellow, earthy hematite gossan at **MG -**4 gold mine (west facing)

Figure 15 Auriferous quartz vein along the fracture zone of granodiorite body at **MG -**5 gold mine (east facing)

3. MINERALIZATION STYLE:

The gold mineralization in the research area may have been controlled by regional scale structure. Mawhaing Fault and Gon Doungchaung Fault are occur in NE-SW trend, but Okshipin Fault is N-S trending. Along these fault lines, salt springs and yellow magnesium oxide water occur significantly. The local gold mines are mostly associated with the traverse fault.

Generally, the mineralized quartz veins are west dipping and N-S trending in direction. The veinlets are oriented in irregular direction. Some veins have a thickness of 2 cm to 25 cm, and pitch and swelling, pockets and lens-shaped ore veins are locally observed.

Gold veins in granodiorite and diorite are observed as fracture filling type by the hydrothermal solution ascending from the later stage of the intrusion. Some quartz veins are associated with aplite dykes, andesite dykes and pegmatite. Precious metal is usually bulky and voluminous, and is associated with Zn, Pb and sometimes Cu, almost invariably hosted in granodiorite and diorite.

Generally, gold-bearing quartz veins occur as hydrothermal breccia and fracture filling type. Auriferous veins are associated with chalcedony, clear quartz, clay and carbonate minerals. Electrum occurs as inclusions within chalcopyrite and pyrite associated with galena and gangue minerals. The mineralization veins are generally N-S trending and west dipping and are mostly associated with galena, sphalerite and other sulfide minerals. The gold mineralization in the area is associated with the milky quartz veins ranging in thickness from 2 cm to 90 cm or more. In some places, the ore veins are found as the lens-shaped or pinch and swelling structure. Some veins show the banded nature. At the deeper level of the mine, the mineralized quartz veins are hard and compact. Occasionally, the gossan zone is found in the upper part of the mineralized quartz vein. Silicification prevails along the quartz veins with the yellowish white color.

4. GENESIS OF ORE DEPOSITS:

4.1 Ore Texture

The ore is mainly comprised of pyrite, chalcopyrite, galena and sphalerite. Chalcocite, arsenopyrite, bornite and covellite are found in lesser amounts. Textural relationships indicate that early pyrite, commonly occurring as fractured, large crystals, is extensively replaced by chalcopyrite, and then by bornite silicate matrix. The chalcopyrite diseases occur within the sphalerite and galena grains due to the exsolution of the ore solution. The chalcocite is replacing the cleavage and boundaries of the galena in some polished sections. Pyrite minerals are mostly brecciated and associated with the sulfide minerals.

4.2 Wall-rock alteration

In the field, the mineralized vein system is bordered by the zones of alteration with variable intensity and thickness. The variation in alteration styles has been interpreted as a direct reflection of the depth of the formation of the deposits (Groves, 1993). At the deposit scale, distribution and intensity of the wall-rock alteration is a largely controlled by the composition and competence of the host rocks and their associated subsidiary structures. Further away from the vein, the alteration is characterized by various amounts of chlorite and calcite but the proximal parts of the vein haloes comprise biotite, epidote, albite, quartz, chlorite, sericite and carbonate. The dominant alteration types are silification, chloritization, sericitization and epidotization around the massive ores. Commonly, the sericitization and silicification that surround the sphalerite-pyrite veinlets are accompanied by the presence of copper and lead. The following are the general characteristics of these zones.

- Wall-rock alteration can be characterized by hydrothermal alteration minerals such as sericite, albite, epidote, chlorite and calcite.
- The vein-related alteration is characterized by silicification, sericitization, kaolinization and chloritization from inner to outermost zones.
- Once silicified, the rocks were more brittle, allowing the apparently late emplacement of the massive auriferous quartz – sulfides veins.
- Pale green to white color alteration is found in granodiorite and diorite bodies.
- In some places, alteration zones are not significant along the mineralized vein because the granodiorites are hard and compact character. The mineralized sulfide veins are associated with the iron oxide at the alteration zone.
- Generally there are two phases of silicification. The younger phase is marked by fine-quartz veinlets, cutting across the older phase of coarse white quartz veins in some places. It is found that coarse quartz vein contains low content of gold compared to the fine quartz veins which carry fair amount of gold.
- The alteration processes in the research are mostly sericitization, chloritization, silicification, pyritization etc.

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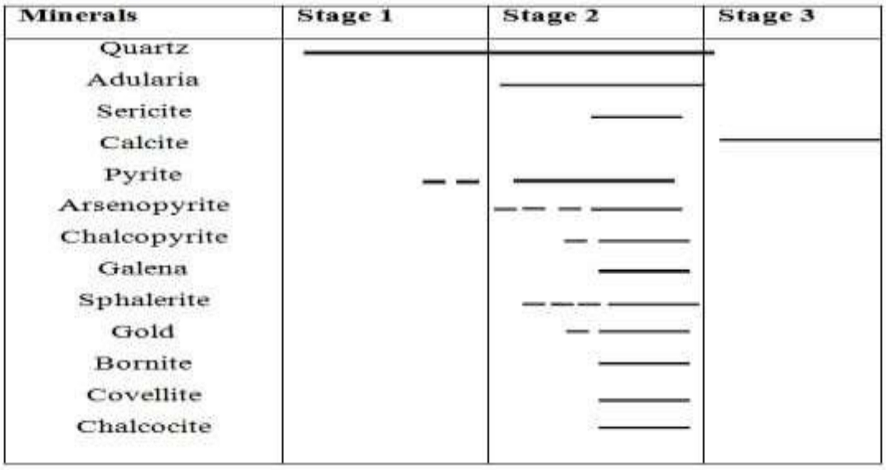
4.3 Paragenesis

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 research area is shown in table (1).

Table (1) Generalized paragenetic sequence of ore and gangue minerals in the research area



4.4 Age of Mineralization

The mineralization in the research area is hosted in intrusive rocks volcanics. Most of the gold-bearing mineralized quartz veins are within the granodioritic and dioritic rocks. On the basis of the field criteria, petrology, mineralogy, structural features and tectonomagmatic events of the research area, two stages of mineralization may be assigned: (1) the early mineralization took place syn- and post intrusion of the Upper Cretaceous age and (2) the late mineralization deposited after the uplifting of granodiorite body near the surface in the Late Eocene.

The timing of mineralization in relation to tectonic, metamorphic, sedimentation, and magmatic events is fundamental for understanding the genesis of mineral deposits. As there is no direct radiometric dating for gold-bearing mineralization, age of ore deposits. The relative age determination of the research area is mainly based on tectonic evolution associated with the graniodioritic intrusion, the dating of the host rock, any cross-cutting intrusions that may be closely associated with the mineralization. The textural relationships, host rocks, ore and gangue mineralogy, vein type and tectono-thermal events of the research area suggest that the gold mineralization took places two times with different age.

Firstly, the gold mineralization in the research area is related to the calc-alkaline magmatism, which could be used to constrain its age. K-Ar dating method of ages for biotite indicates that the emplacement age of the granodiorite rocks is 97.8 ± 3.6 to 93.7 ± 3.4 m.y (UN Technical report 2, 1978). Therefore, the main gold mineralization may be late Upper Cretaceous.

Secondly, the granodiorite reached near the surface due to the crustal thinning and extension associated the normal faulting in the Late Eocene to Middle Miocene. Therefore, the veins may be post Eocene age.

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 research area may have been formed more associated with the intrusion.

5. CONCLUSIONS:

Two stages of mineralization may be assigned: (1) the early mineralization took place syn- and post intrusion of the Upper Cretaceous age and (2) the late mineralization deposited after the uplifting of granodiorite body near the surface in the Late Eocene. 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 research area may have been formed associated with the intrusion.

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