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PRELIMINARY STUDY OF LEAD MINERALIZATION AT TAUNG GAUNG AREA, MADAYA TOWNSHIP, MANDALAY REGION, MYANMAR

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Abstract

Taung Gaung area is situated in Madaya Township, Mandalay Region, Myanmar. It is located approximately 30 km to the northeast of Mandalay, and 26 km northwest of Pyin-Oo-Lwin. The study area, falling in the Shan-Thai Block, lies in the eastern margin of Mogok Metamorphic Belt (MMB) and between the Sagaing Fault in the west and the Shan Scarp Fault in the east. Ordovician limestone is the main ore host rock in the Taung Gaung area. The regional trend of the rocks is generally N-S with dips either to the east or west forming asymmetrical anticlines and synclines. The major faults also trend N-S following the regional trend. The Ordovician limestone unit trends N-S and is broadly folded into a major anticline. The colour of limestone along the mineralization zone changes from pale blue to yellowish brown due to the effect of alteration. The mineralization follows the anticlinal axis of the major anticline, characterized by shearing and brecciation. The dominant alteration is dolomitization accompanied by minor silicification. Others are pyritization and limonitization. The principal ore mineral in Taung Gaung lead deposit is galena associated with sphalerite and minor amounts of anglesite, cerussite, jalpaite, marcasite and pyrite. In a separate paragenesis, copper as chalcopyrite, tetrahedrite - tennantite, covellite, chalcocite and azurite-malachite are also found in this area. The gangue minerals include limonite, siderite, ankerite, barite, dolomite, calcite and quartz. By the field observation and under microscopic study, several styles of mineralization were found to have formed under variable conditions, such as lead-zinc minerals occurring as disseminations, replacement ore, fracture - fillings and mineralized solution collapse breccias.

Keywords – Taung Gaung, Ordovician limestone, anticline, dolomitization, galena, tetrahedrite-tennantite.

Introduction

This paper is mainly based on the first author's third year field work and laboratory studies for his Ph.D Degree. Taung Gaung area is situated in Madaya Township, Mandalay Region. It is located approximately 30 km to the northeast of Mandalay, and 26 km northwest of Pyin-Oo-Lwin. The area lies west of the Shan Plateau where the topography is of rolling hills with the elevation around 270 m above mean sea level. The area is drained by parallel Yechi Chaung and Kyauk Kwe Chaung flowing from south to north. Location map of the study area is shown in Fig.1. The panoramic view of the Taung Gaung Taung is shown in Fig. 2.

Aim and Methods of Study

The major purpose of the study area is to determine the mineralogical characteristics of the ore minerals, alteration and mineralization. This study consists of two main stages, field work and laboratory work. During the field work, ore samples were collected randomly and selectively from the mineralized area at Taung Gaung lead deposit. The laboratory work consists of ore microscopy and Scanning Electron Microscopy (SEM) - Energy-Dispersive X-ray Analyzer (EDX) analysis.

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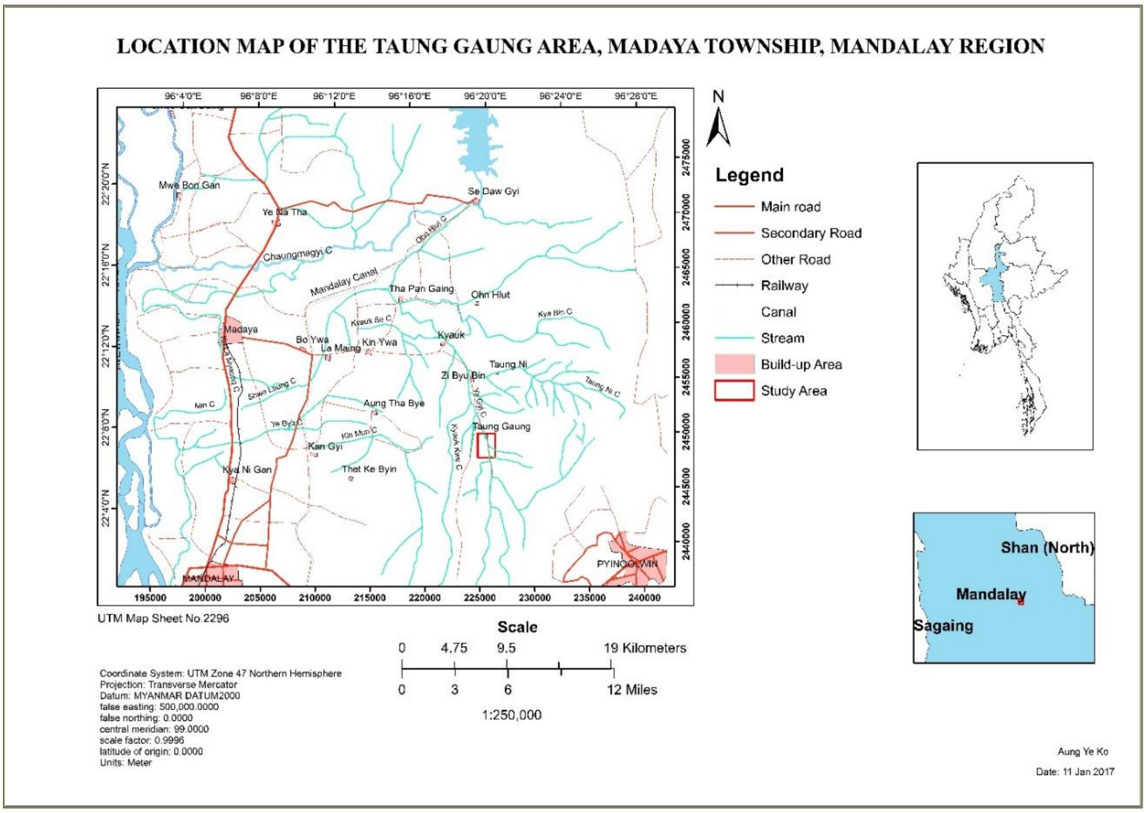

Figure 1 Location Map of the Taung Gaung Area, Madaya Township, Mandalay Region

Geological Background

With increased knowledge in plate tectonics, it is now generally accepted that Myanmar (Burma) is geologically built up of two main parts, the Eastern Part or Shan-Thai Block (Bunopas & Vella, 1983) or Sibumasu Terrane (Metcalfe, 1984) (Kachin Highlands, Shan Pleateau, Tenasserim Ranges, East Himalayan Syntaxis, Mogok Metamorphic Belt, etc.) and the Western Part or Burma Platelet or Burma Microplate (Curray et al., 1979) or West Burma (Searle et al., 2007) with its accretionary prism of Indo-Burman Ranges or Western Ranges (Naga and Chin Hills and Arakan Yoma). Sagaing Fault, a major right lateral strike-slip fault of 1500 km length (Win Swe, 2013. Soe Thura Tun & Watkinson, I.M.2017) geotectonically separates these two parts from the middle. Both parts belong to the larger Asian Plate. India Plate is subducting beneath Burma Microplate, and thus, in the Andaman Sea, forms an east-dipping curvilinear oblique subduction zone that continues onshore along the Western margin of the Indo-Burman Ranges.

The study area, falling in the Shan-Thai Block, lies in the eastern margin of Mogok Metamorphic Belt (MMB) and between the Sagaing Fault in the west and the Shan Scarp Fault in the east. It occupies the western marginal zone of Shan Plateau to the east of the Central Myanmar Basin (Fig.3). The MMB consists of metamorphosed sedimentary sequences of Precambrian to Carboniferous age. Basement sediments are intruded by Jurassic to Tertiary age granitoids. Regional stratigraphy of the research area and its environs is shown in Fig. 4. Stratigraphic rock units include Mogok Group, Chaungmagyi Group, Pangyun Group, Naungkangyi Group and Upper Plateau Limestone.

The geology of the Taung Gaung area is quite simple. It is composed of the Chaungmagyi Group of Mauk Kaw quartzite trending North-South and Ordovician limestone, comparable to the Wunbye Formation of Southern Shan State (Khin Maung Shwe, 1973). It mainly consists of limestone and dolomitic limestone with a general trend N-S. The limestones are fairly crystalline and grey to bluish grey in colour. Burrow textures are abundantly observed on both weathered and fresh surfaces of limestone. Dolomitic limestones are usually medium- to thick-bedded. Geological map of the Taung Gaung area and its environs is shown in Fig.5. The regional trend of the rocks is generally N-S with dips either to the east or west forming asymmetrical anticlines and synclines. The Ordovician limestone unit trends N-S and is broadly folded into a major anticline. The western limb of the anticline has been eroded away. The major faults also trend N-S following the regional trend. The dip amounts vary from (32˙ and 46˙).

Figure 2 Panoramic View of the Taung Gaung Taung
Location: 96°20'2.372" E and 22° 07' 24.425" N (Facing: South)

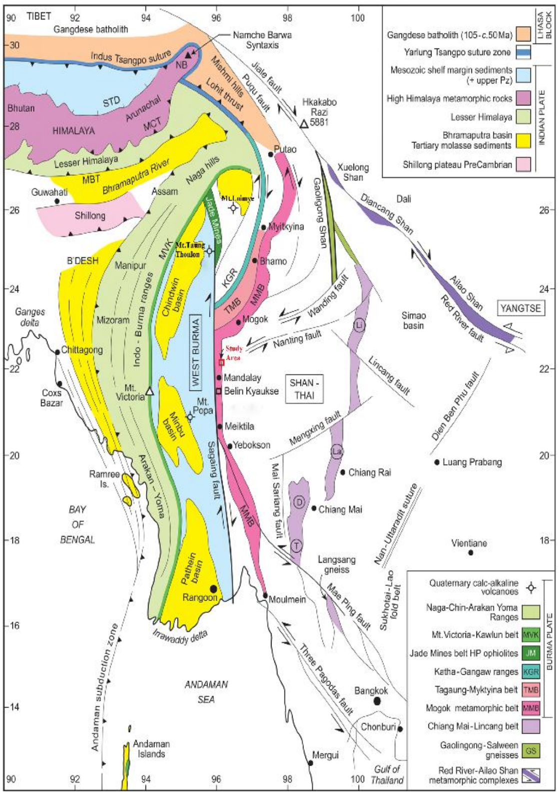

Figure 3 Geological map of Myanmar and surrounding areas showing major structures, faults and Terrane boundaries

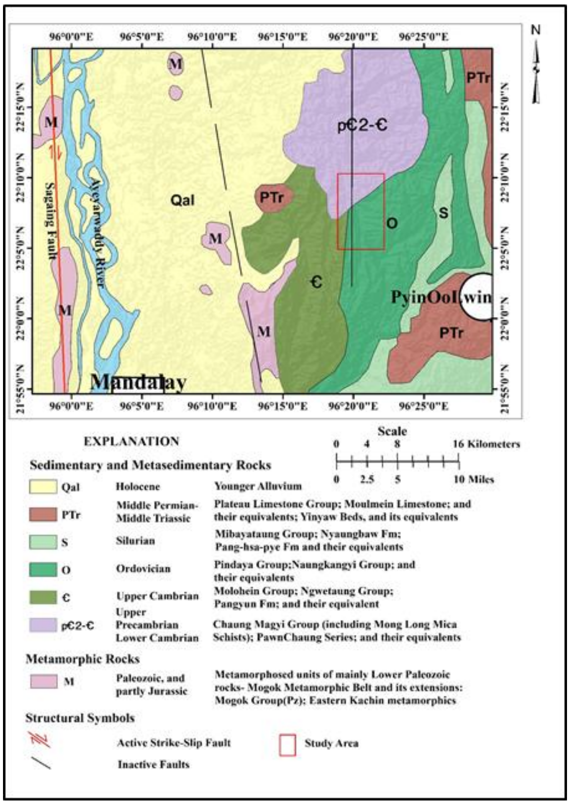

Figure 4 Regional geological map of the study area and its environs (After MGS, 2014)

(Modified after Searle et al., 2007)

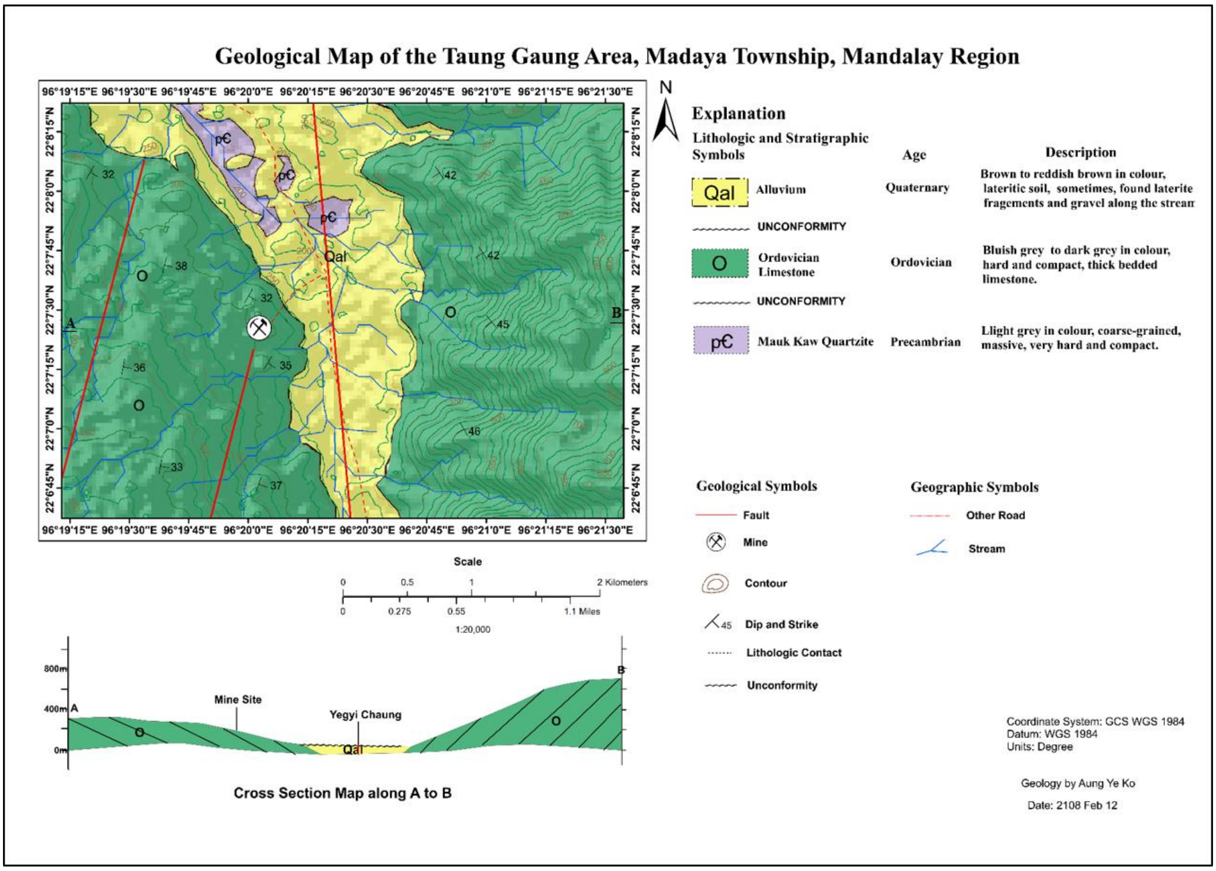

Figure 5 Geological Map of the Taung Gaung Area and its environs, Madaya Township, Mandalay Region, Myanmar

Alteration

Ordovician Limestone is the main ore host rock in the Taung Gaung area. The mineralization of the galena is observed to occur in the oolitic with dolomitic limestones (Fig.6,7,8 and 9). By the field study and microscopic study, the dominant alteration is dolomitization accompanied by minor silicification. Others are pyritization and limonitization.

Figure 6 Highly jointed, brecciated, and criss-cross joint pattern in dolomitic limestone, **Location:** 96°20'7.372" E and 22° 07' 28.425" N (Facing : East)

Figure 7 Grey coloured, medium- to thick-bedded, and highly- jointed dolomitic limestone, **Location:** 96°20'7.372" E and22° 07' 28.425" N (Facing : East)

Figure 8 Outcrop nature of oolitic limestone with oolitic texture,
Location: 96°21'5.3"E and 22° 08' 27.425" N (Facing : East)

Figure 9 Grey coloured, thin-bedded oolitic limestone
Location: 96°21'5.37"E and 22° 08' 27.425" N (Facing : East)

Dolomitization

Dolomitization is the process by which limestone is altered into dolomite; when limestone comes into contact with magnesium-rich water, the mineral dolomite, calcium and magnesium carbonate, $CaMg(CO_3)_2$, replaces the calcite (calcium carbonate, $CaCO_3$) in the rock, volume for volume.

In the Taung Gaung area, most of the mineralized limestones are oolitic as well as dolomitic limestones. The lead mineralization in the oolitic, dolomitic limestone is later than the secondary dolomitization. The dolomitization is mainly associated with lead mineralization. The dolomitization with Pb mineralization of the study area is shown in Fig. 10 and 11.

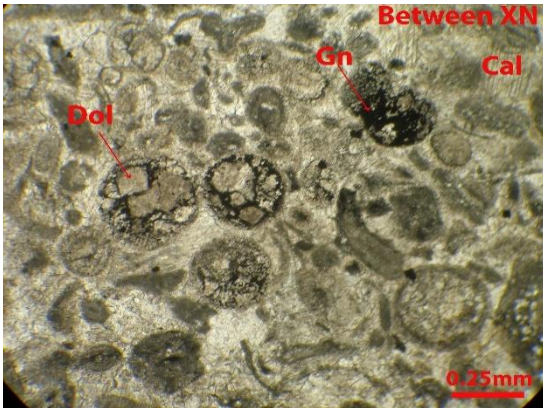

Figure 10 Dolomitization with Pb mineralization in oolitic limestone (Thin-section) (Gn = Galena, Dol = Dolomite, Cal = Calcite)

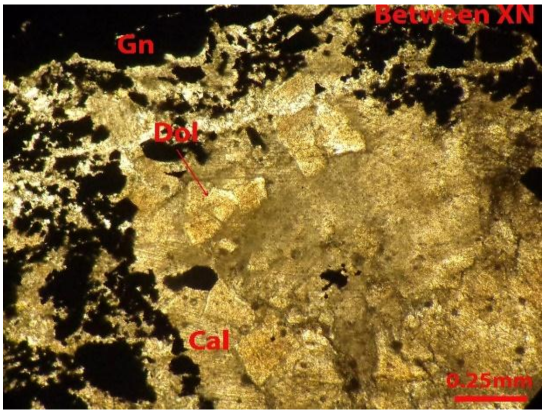

Figure 11 Dolomitization with Pb mineralization in dolomitic limestone (Thin-section) (Gn = Galena, Dol = Dolomite, Cal = Calcite)

Silicification

Silicification is another type of wallrock alteration in Taung Gaung area. The silicification of carbonate rocks is a diagenetic process that involves the major replacement of carbonate minerals by silica minerals. A general geochemical and thermodynamic requirement for the silicification of carbonates is the existence of pore fluids that are supersaturated with respect to the silica phase precipitated, and undersaturated with respect to the carbonate mineral dissolved (Hesse, 1989).

In the study area, silicification is commonly associated with the mineralization. The smaller or minute quartz grains occurring as intergranular grains are anhedral and show wavy extinction. The silicification and mineralization in the carbonate rocks is shown in Fig. 12 and 13. The silicification is not dominant in my study area.

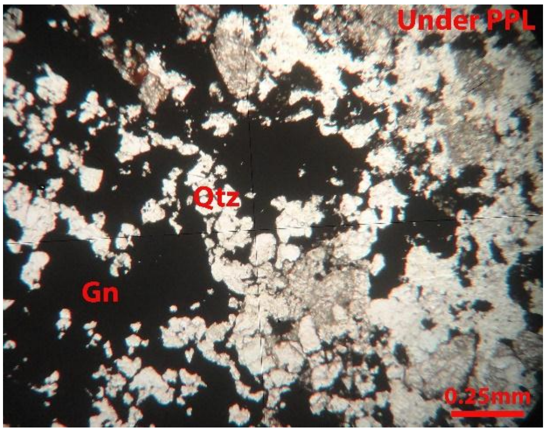

Figure 12 Silicification with Pb mineralization in carbonate rock (Thin-section) (Gn = Galena, Qtz = Quartz)

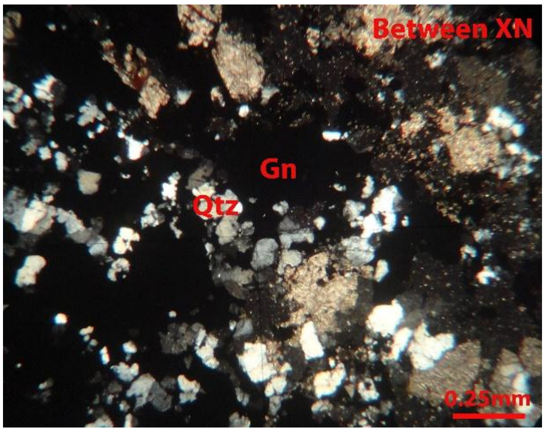

Figure 13 Silicification with Pb mineralization in carbonate rock (Thin-section) (Gn = Galena, Qtz = Quartz)

Pyritization

Pyritization is also another type of wallrock alteration in Taung Gaung area. The pyritization of carbonate rocks is a diagenetic process that involves the major replacement of carbonate minerals by pyrite mineral. Pyrite forms as rounded to elliptical crystals, disseminated in the host rock and ores. The earliest pyrite was probably formed during late diagenesis of the host rock and late pyrite was formed during the hydrothermal stage associated with galena and sphalerite (Fig.14 and 15).

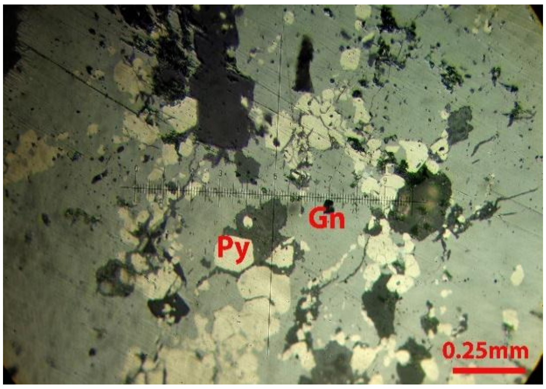

Figure 14 Pyritization with Pb mineralization in oolitic and dolomitic limestone(Polished-section) Gn = Galena, Qtz = Quartz)

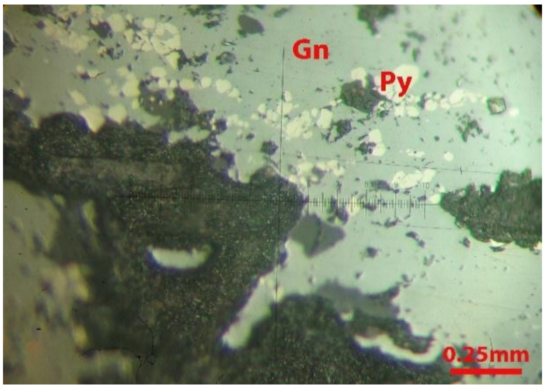

Figure 15 Pyritization with Pb mineralization in oolitic and dolomitic limestone (Polished-section)(Gn = Galena, Qtz = Quartz)

Limonitization

Many lead-zinc sulphides deposits when exposed to weathering undergo oxidation. They are inclined to break down forming new minerals and compounds or go into solution either whole or in part. Pyrite (FeS_2) is a common hypogene sulphide associated with lead-zinc ores and upon oxidation, it generates sulphuric acid and generally leaves limonite as gossans. A gossan capping at Taung Gaung orebody is shown in Fig. 16, 17, 18 and 19. Oxidation and mineralization at Taung Gaung orebody is shown in Fig.20 and 21.

Figure 16 A Gossan capping the Taug Gaung orebody (Location: 96°20’2.0" E and 22° 7’ 27.982" N) Facing: East

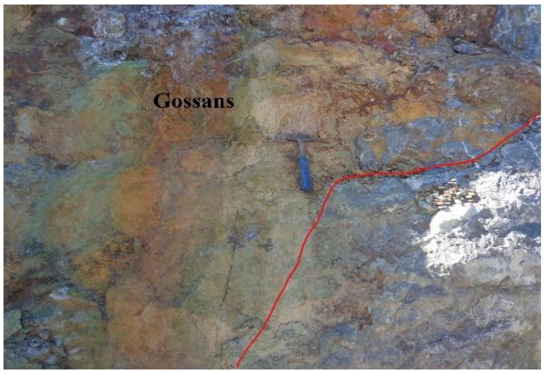

Figure 17 Pseudomorphs and coatings on the walls (Location: 96°20’2.049" E and 22° 7’ 27.982" N) Facing: East

Figure 18 Gossans in Taung Gaung orebody

Figure 19 Azurite-malachite associated with limonite

Figure 20 Oxidation and mineralization in Taung Gaung orebody (Location: 96°20’2.079" E and 22° 7’ 27.282" N) Facing: East

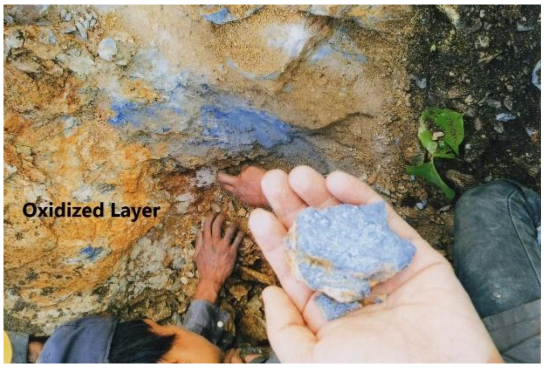

Figure 21 Oxidation and mineralization in Taung Gaung orebody (Location: 96°20’2.019" E and 22° 7’ 27.582" N) Facing: East

Mineralization

The Ordovician limestones are the host to mineralization. The colour of limestone along the mineralization zone changes from pale blue to yellowish brown due to the effect of alteration.

The mineralization follows the anticlinal axis of the major anticline, characterized by shearing and brecciation. Mineralization is in the form of disseminations and as thin strangers of fine galena in the shear planes. The geology and mineral occurrence map of the Taung Gaung area is shown in Fig.22.

Two local workings have exposed the mineralization at Taung Gaung Lead deposit. One at Bawdwingyi, about 1000 m south of Taung Gaung village. One old adit driven along the mineralized zone (7 m wide 3 m high and 30 m long) have exposed thin stringers of galena occupying the entire exposure of the adit. Fig.23. Bawdwinlay is situated about 150 m south of Bawdwingyi. The mineralization of Bawdwinlay is similar to that at Bawdwingyi. One old adit in Bawdwinlay is shown in Fig.24.The lead deposit is said to have been worked before World War- I by German brothers.

In Bawdwingyi, galena associated with barite, siderite, azurite, malachite, etc. occurs as vein and veinlets in the Ordovician limestone beds. The veins are about 7 to 14 centimetres thick and about 30 meters long. Well bedded grey limestone with speckles of disseminated galena and flakes of pyrites have low grade. Such speckles and stringers are found at the lower part of the section of Bawdwingyi tunnel. The upper part has coarsely crystalline white calcitic bands just above which are small stringers of rich galena, especially along the contact with the overlying altered zone. Galena is more coarsely crystalline than in fresh limestone. Other metallic deposits include stains of azurite and malachite occurring in small amounts in the oxidized zone. The mineralized lead ore area at Bawdwingyi mine is shown in Fig.25 and 26. Lead and copper ore samples at Bawdwingyi mine are shown in Fig.27 and 28.

In Bawdwinlay, galena associated with copper ore traces occurs as vein and veinlets in an old adit along the mineralized zone (4 m wide and 2 m high). Barite, quartz and calcite occur as gangue minerals. This type of deposit may be designated as fissure-filling, because the mineralization is observed only along the joints of massive limestone. The lead ore samples at Bawdwinlay mine are shown in Fig. 29 and 30.

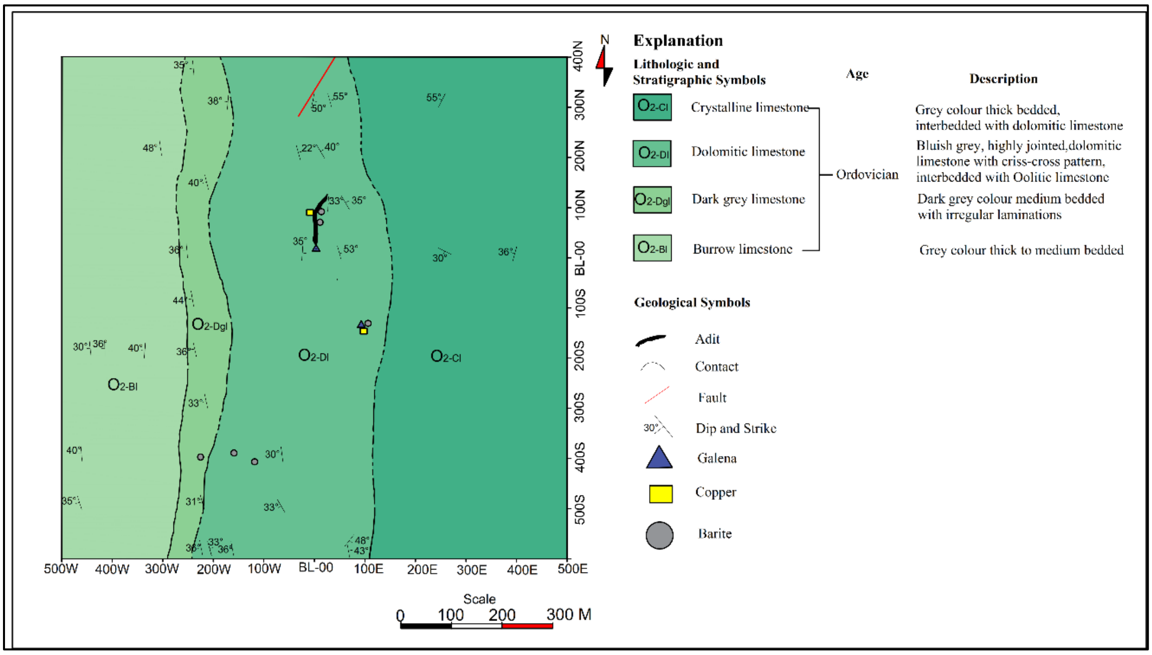

Figure 22 Geology and Minerals Occurrence Map of Taung Gaung Area (Modified after San Thu, Aung Pwa and Kyi Shwin,1980)

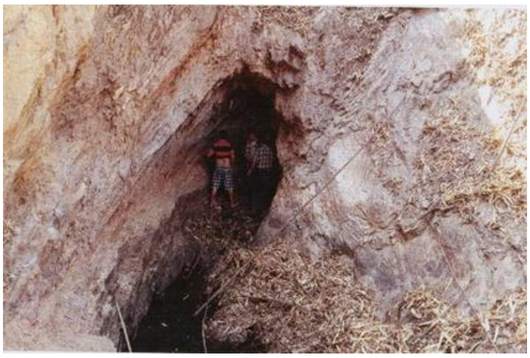

Figure 23 Adit at Bawdwingyi Mine (Location: 96°20’2.048" E and 22° 7’ 27.982" N) Facing: East

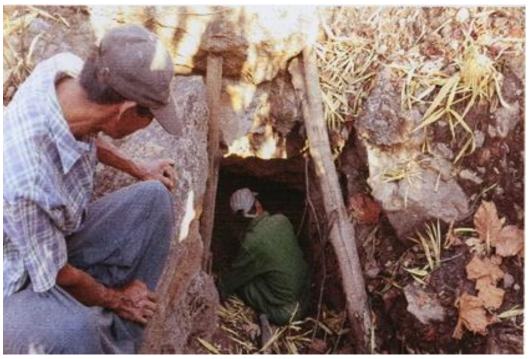

Figure 24 Adit at Bawdwinlay Mine (Location: 96°20’2.745" E and 22° 7’ 23.448" N) Facing: East

Figure 25 Mineralized lead ore zone at Bawdwingyi Mine (Location: 96°20’2.0”E and 22° 7’ 27.982" N) Facing: SE

Figure 26 Mineralized lead ore zone at Bawdwingyi Mine (Location: 96°20’2.0” E and 22° 7’ 27.982" N) Facing: SW

Figure 27 Lead ore samples at Bawdwingyi Mine

Figure 28 Copper ore samples at Bawdwingyi Mine

Figure 29 Lead ore samples at Bawdwinlay Mine

Figure 30 Lead ore samples at Bawdwinlay Mine

Ore Mineralogy

The ore mineralogy of the study area is rather simple, and the principal ore mineral is galena associated with sphalerite and minor amounts of anglesite, cerussite, jalpaite, pyrite and marcasite. In a separate paragenesis copper as chalcopyrite, tetrahedrite-tennantite, covellite, chalcocite and azurite-malachite also occur in this area. The gangue minerals include siderite, ankerite, barite, dolomite, calcite and quartz. The ore minerals of Taung Gaung lead deposit are shown in Fig.31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 and 46.

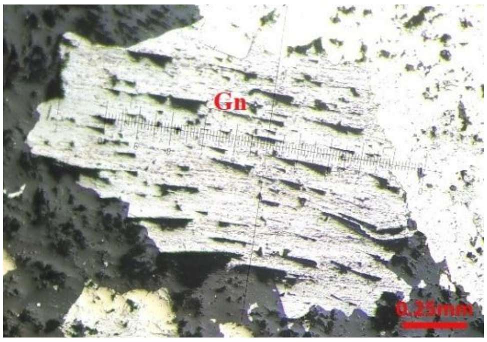

Figure 31 Perfect triangular cleavage pits of galena (Polished Section)

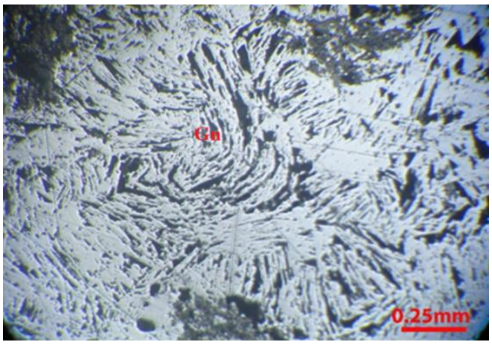

Figure 32 Extremely wavy,curved and displaced triagular cleavage pits of galena due to deformation (Polished Section)

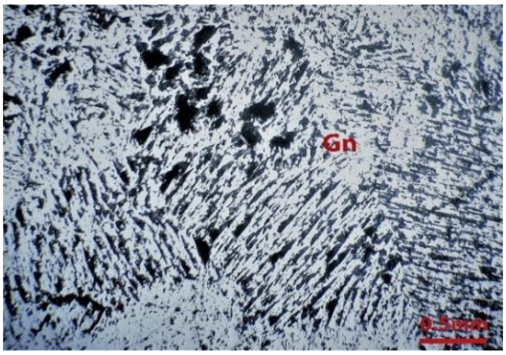

Figure 33 Dendritic patterns of galena (Gn = Galena) (Polished Section)

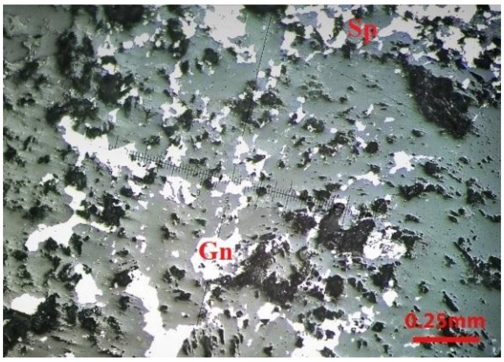

Figure 34 Disseminated patterns of galena in calcite (Gn=Galena) (Polished Section)

Figure 35 Galena is replaced and rimmed by intergrown anglesite (Gn = Galena, Ang = Anglesite) (Polished Section)

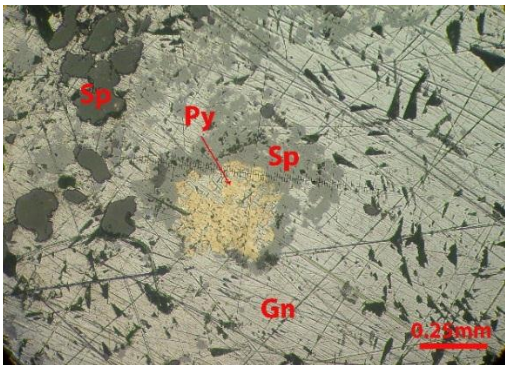

Figure 36 Pyrite isolated grains are formed as inclusions in galena and sphalerite (Gn = Galena, Sp = Sphalerite, Py = Pyrite) (Polished Section)

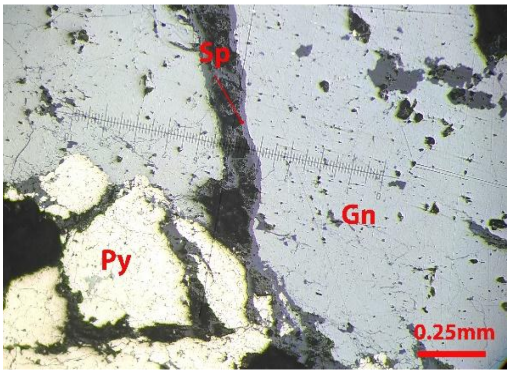

Figure 37 Sphalerite occurs as vein along the grain boundaries of galena (Sp=sphalerite, Gn=galena, Py= Pyrite) (Polished Section)

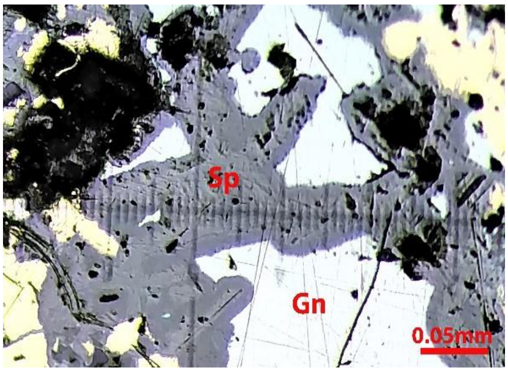

Figure 38 Skeletal structure of sphalerite in galena (Sp = sphalerite, Gn = galena) (Polished Section)

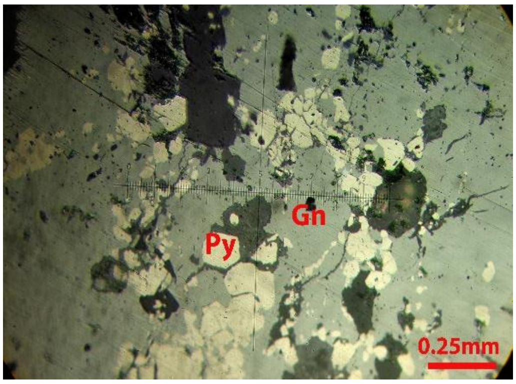

Figure 39 Disseminated pyrite in galena (Py = Pyrite, Gn = galena) (Polished Section)

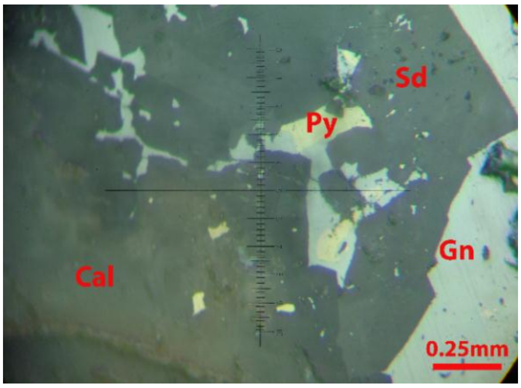

Figure 40 Siderite associated with pyrite, galena and clcite (Sd =Siderite, Py = Pyrite, Gn = galena) (Polished Section)

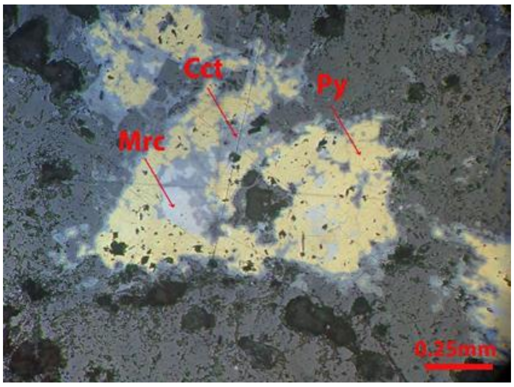

Figure 41 Marcasite embedded in pyrite, pyrite is enclosed by chalcocite and they are replaced by gangue-calcite and dolomite (Py = Pyrite, Cct = Chalcocite, Mrc = Marcasite) (Polished Section)

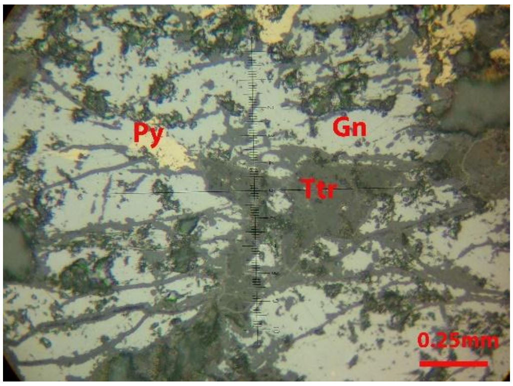

Figure 42 Tetrahedrite veins and veinlets are formed as inclusions in galena (Gn = galena, Ttr = tetrahedrite, Py = Pyrite) (Polished Section)

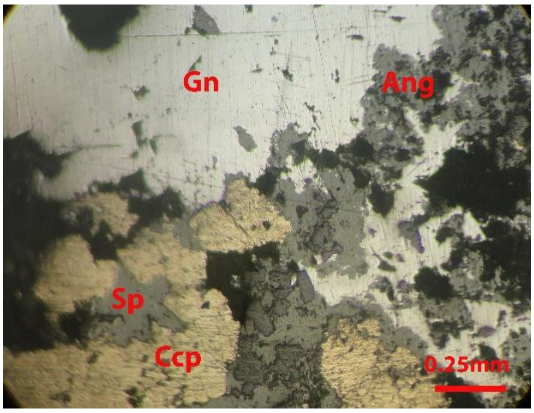

Figure 43 Galena associated with angelisite, sphalerite and chalcopyrite (Gn = Galena, Ang = Anglesite, Sp= Sphalerite, Ccp = Chalcopyrite) (Polished Section)

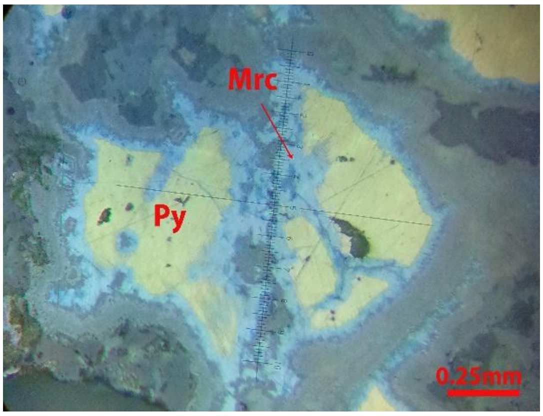

Figure 44 Marcasite is replaced and rimmed by pyrite which occurs zonal replacement texture (Mrc = Marcasite, Py = Pyrite) (Polished Section)

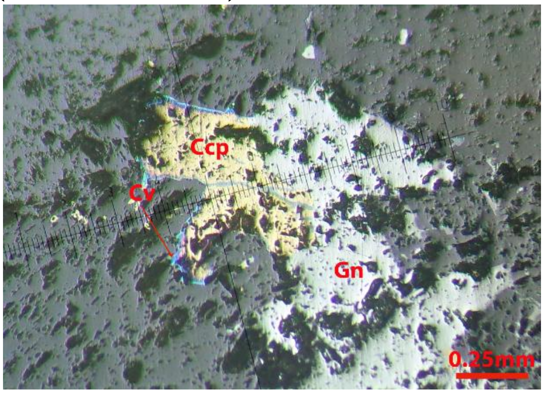

Figure 45 Covellite associated with galena and chalcopyrite (Cv =Covellite, Gn= Galena, Ccp= Chalcopyrite (Polished Section)

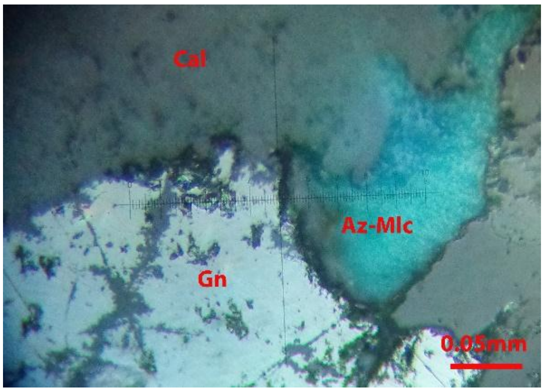

Figure 46 Galena associated with azur-malchite and gangue- calcite (Gn = Galena Az-Mlc = Azur-Malchite, Cal= Calcite) (Polished Section)

SEM-EDX Analysis of Ore Minerals

Scanning Electron Microscopy (SEM) provides detailed high resolution images of the sample by rastering a focused electron beam across the surface and detecting secondary or backscattered electron signal. An Energy Dispersive X-Ray Analyzer (EDX) is also used to provide elemental identification and quantitative compositional information. Back scattered electron imaging by Scanning Electron Microscope was used in order to attempt to explain the characteristics of gold and associated ore minerals.

Analysis of TGO-01 ore sample

In TGO-01 ore sample from Taung Gaung area, spectrum-1 is quartz, spectrum-2 is galena and spectrum-3 is sphalerite which are classified based on their chemical composition and ratio of constituent elements (Fig.47). Sphalerite and quartz formed as inclusions in the galena that formed the replacement texture. Table.1 shows the elemental composition of constituent elements of all spectra of the TGO-01 ore sample (using EDX). The SEM-EDX data graphs of the TGO-01 ore sample are shown in (Fig.48,49 and 50).

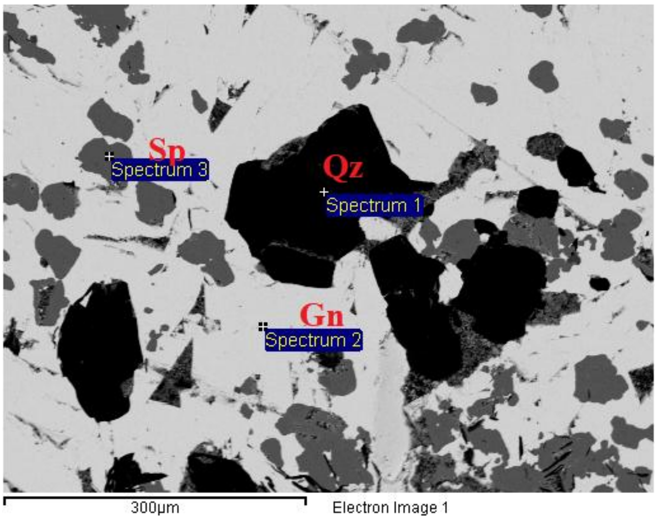

Figure 47 Back Scattered Images of galena, sphalerite and quartz of the TGO-01 ore sample

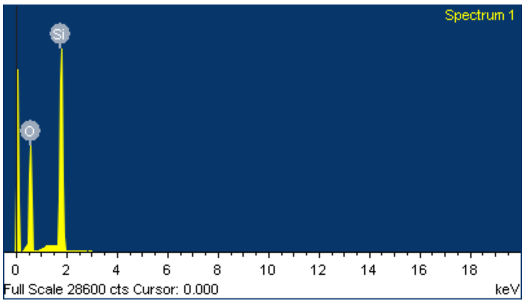

Figure 48 SEM-EDX Data Graphs of the Quartz

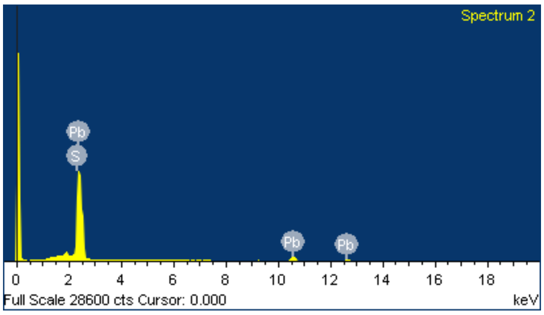

Figure 49 SEM-EDX Data Graphs of the Galena

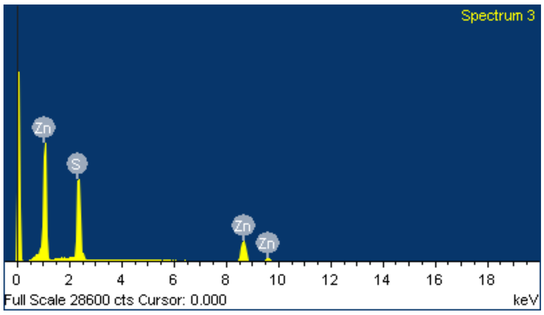

Figure 50 SEM-EDX Data Graphs of the Sphalerite

Table 1 Chemical composition of the TGO-01 ore sample (using EDX)

Spectrum	O	Si	S	Zn	Pb	Total	Mineral
Spectrum 1	62.00	38.00				100.00	Quartz
Spectrum 2			13.41		86.59	100.00	Galena
Spectrum 3			36.24	63.76		100.00	Sphalerite

Analysis of TGO-02 ore sample

In TGO-02 ore sample from Taung Gaung area, spectrum-1 is galena, spectrum-2 is anglesite, spectrum-3 is cerussite, spectrum-4 is barite and spectrum-5 is also anglesite which are classified based on their chemical composition and ratio of constituent elements (Fig. 51). Galena is closely associated with the anglesite, cerussite and barite which show the intergrowth texture. Table. 2 shows the elemental composition of constituent elements of all spectra of the TGO-02 ore sample (using EDX). The SEM-EDX data graphs of the TGO-02 ore sample are shown in (Fig.52,53,54,55 and 56).

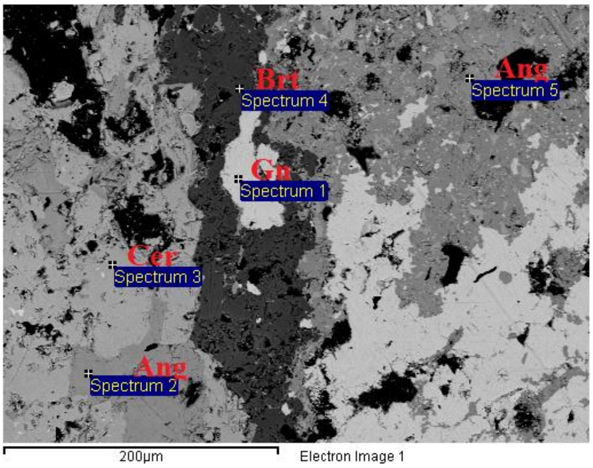

Figure 51 Back Scattered Images of galena, anglesite, cerussite and barite of the TGO-02 ore sample

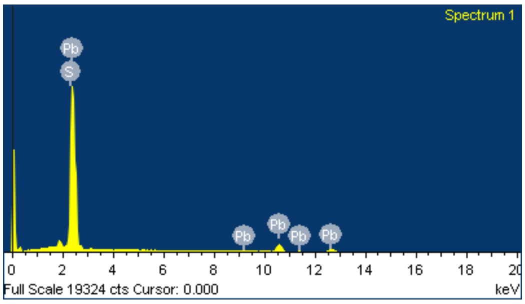

Figure 52 SEM-EDX Data Graphs of the Galena

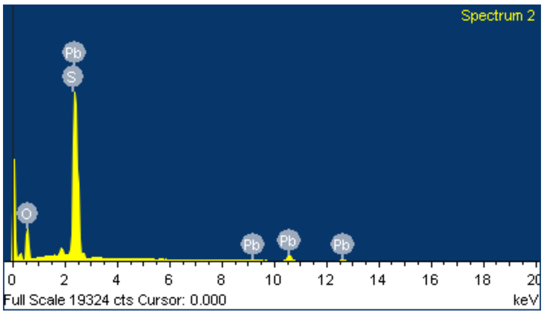

Figure 53 SEM-EDX Data Graphs of the Anglesite

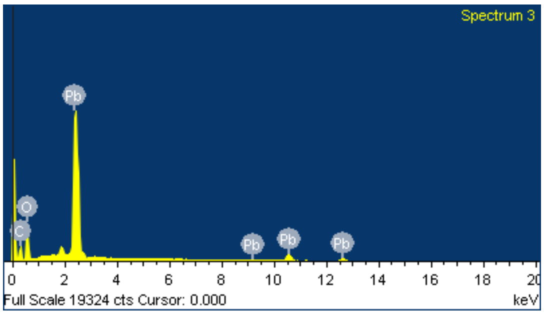

Figure 54 SEM-EDX Data Graphs of the Cerussite

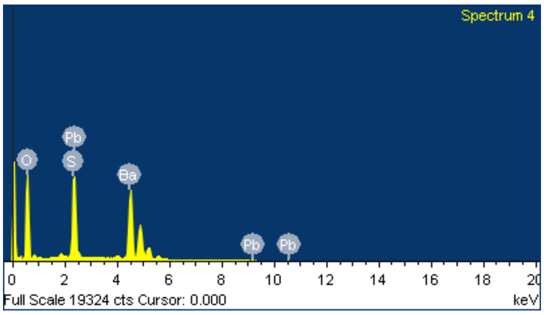

Figure 55 SEM-EDX Data Graphs of the Barite

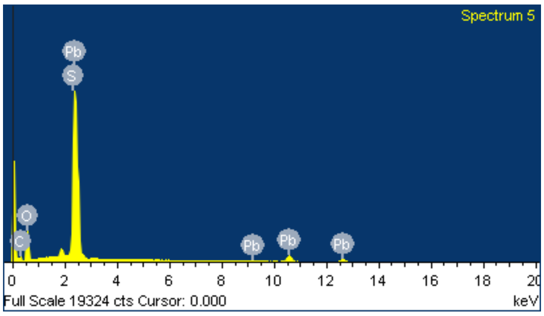

Figure 56 SEM-EDX Data Graphs of the Anglesite

Table 2 Chemical composition of the TGO-02 ore sample (using EDX)

Spectrum	C	O	S	Ba	Pb	Total	Mineral
Spectrum 1			15.7		84.3	100	Galena
Spectrum 2		26.64	11.43		61.93	100	Anglesite
Spectrum 3	11.85	21.32			66.83	100	Cerussite
Spectrum 4		29.56	13.64	55.36	1.43	100	Barite
Spectrum 5	7.24	23.84	10.72		58.2	100	Anglesite

Analysis of TGO-03 ore sample

In TGO-03 ore sample from Taung Gaung area, spectrum-1 is jalpaite, spectrum-2 is tennantite, spectrum-3 is calcite and spectrum-4 is tetrahedrite which are classified based on their chemical composition and ratio of constituent elements (Fig. 57). Jalpaite occurs along the grain boundaries of tetrahedrite- tennantite which formed the zonal texture. Jalpaite and tetrahedrite-tennantite are replacement of calcite that formed the replacement texture. Table. 3 shows the elemental composition of constituent elements of all spectra of the TGO-04 ore sample (using EDX). The SEM-EDX data graphs of the TGO-03 ore sample are shown in (Fig. 58,59,60 and 61).

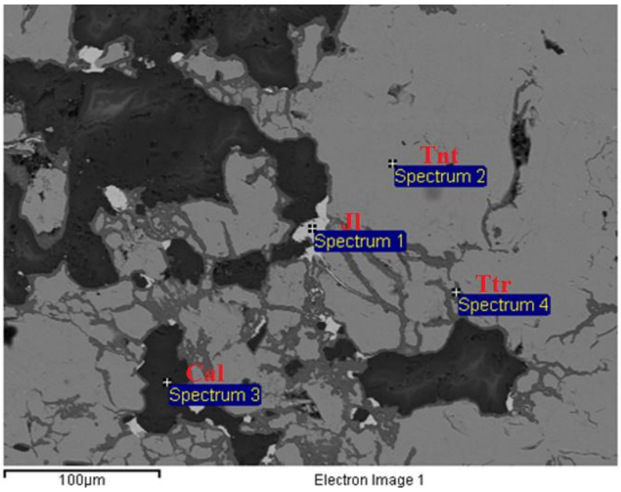

Figure 57 Back Scattered Images of jalpaite, tennantite, calcite and tetrahedrite of the TGO-03 ore sample

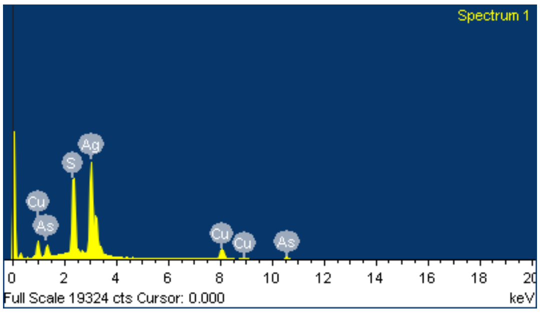

Figure 58 SEM-EDX Data Graphs of the Jalpaite

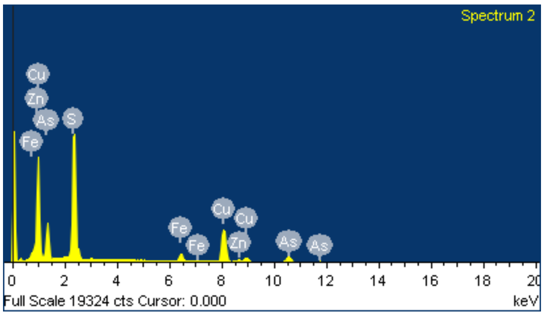

Figure 57 SEM-EDX Data Graphs of the Tennantite

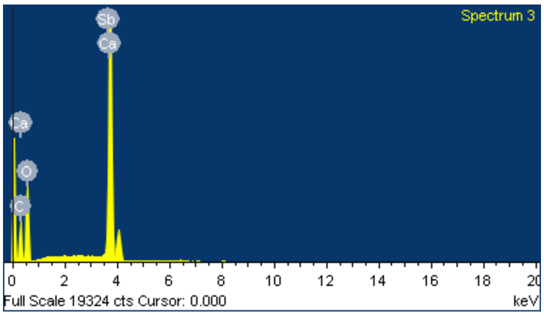

Figure 58 SEM-EDX Data Graphs of Calcite

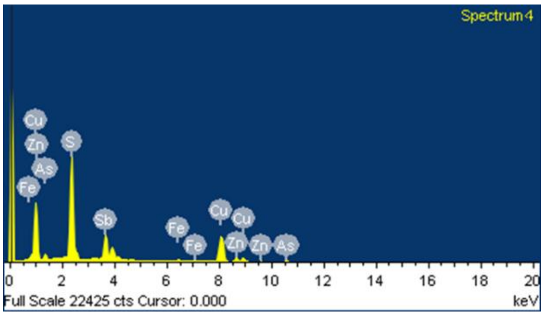

Figure 61 SEM-EDX Data Graphs of Tetrahedrite

Table 3 Chemical composition of the TGO-04 ore sample (using EDX)

Spectrum	C	O	Ca	Cu	Sb	Ag	Zn	As	Fe	S	Total	Mineral
Spectrum 1				14.0		61.41		6.52		18.07	100.00	Jalpaite
Spectrum 2				42.08			2.85	20.06	4.43	30.57	100.00	Tennantite
Spectrum 3	12.18	51.59	33.61		2.62						100.00	Calcite
Spectrum 4				37.55	24.15	4.10	5.58		1.03	27.40	100.00	Tetrahedrite

Deformation after Mineralization

In ore microscopic study, most of the galena display deformed structures (Fig. 32 and 33). Their growth zones and the cleavage sets are curved.

In SEM-EDX study, the calcite mineral grains are observed to be large. The other mineral grains nearby are seen as mostly fine-grained. Recrystallization is inferred to be caused by the orogeny producing the large calcite crystals. It may be partly due to metamorphism (Fig.51 and 57).

Ore Texture

The ore textures were examined under an ore microscope referring to the description of Edwards, A.B., (1954), Cameron (1966), Craig & Vaughan (1981) P.Picot and Z.John (1982) and Roger Taylor (2009).

Polished sections of ores from the Taung Gaung lead deposit were studied under the reflecting microscope and SEM-EDX analysis in order to identify the minerals and determine their texture and sequence of deposition. Textures observed in polished sections and SEM-EDX analysis may indicate the order in which the minerals were deposited and lead to inferences regarding the origin of the ore deposit. Ore textures vary with the type of deposit, structural controls, wallrock alterations and the physical and chemical conditions of the ore fluids.

The common ore textures found in the galena are dendritic pattern in (Fig.33), disseminated pattern in (Fig.34) and replacement texture in (Fig.35). The prominent cleavages sets are clearly seen in galena in (Fig.31).

In the sphalerite, rimmed replacement and disseminated structures are observed. The sphalerite grains are rimmed by the galena and the disseminated patterns of the sphalerite are dispersed in the galena in (Fig.36) and (Fig.47). The vein or veinlet textures of sphalerite are formed in the grain boundaries of galena and gangue-calcite in (Fig.37). The skeletal structure of sphalerite is observed in the galena in (Fig.38). In other minerals, the replacement textures, the disseminated patterns and the veins or veinlets textures are commonly observed.

Generalized Mineral Paragenetic Sequence

The time sequence of deposition of minerals in a rock or mineral deposit is known as its “paragenetic sequence” (Anthony, 1987). The information obtained on the consistence of textural relationships, field observations, both microscopic studies and SEM - EDX studies, such as intergrowth, replacement and cross-cutting features of associated minerals and their assemblages in the study area, provide a basis for interpreting and determining the generalized mineral paragenetic sequence for ore and gangue minerals of Taung Gaung lead deposit as shown in (Fig.62).

In gangue minerals, calcite, dolomite and quartz were deposited in all stages while siderite, ankerite and limonite were formed in post-mineralization (stage-iv), and barite was formed in both main mineralization (stage-iii) and post-mineralization (stage-iv).

In ore minerals, galena, sphalerite and chalcopyrite were deposited in main mineralization (stage-ii and stage-iii) while anglesite, cerussite, jalpaite, covellite, chalcocite, azurite- malachite, tetrahedrite – tennantite and marcasite were formed in post- mineralization (stage-iv), and pyrite was formed in all stages.

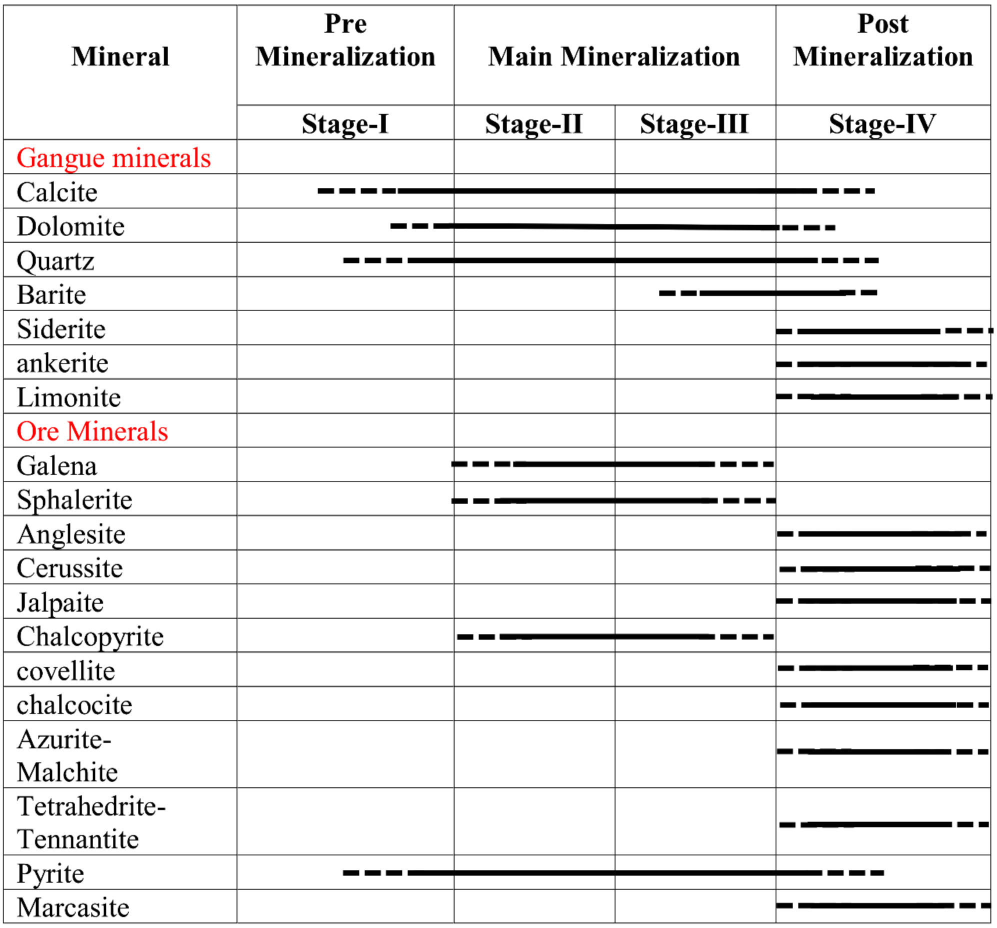

Figure 62 Generalized Mineral Paragenetic Sequence for Ore and Gangue Minerals of Taung Gaung Lead Deposit

Style of Mineralization

By the field study and microscopic study, several styles of mineralization were formed under variable conditions, with lead minerals occurring as;

1. Disseminations
2. Replacement ore
3. Fracture-fillings and
4. Mineralized solution collapse breccias

Disseminated ore are widespread with euhedral galena grains in the host rock (Fig. 63 and 64).

Replacement ore is the commonest style of mineralization where the pore spaces of the rock have been replaced by fine-grained galena. The replacement ores carry good grades having a potential for mining (Fig.66).

Fracture-filling ores usually accompany the replacement ores where small fractures and joints in the bedding planes are filled with coarse-grained galena (Fig.65).

The style of mineralization associated with the solution collapse breccias of open-space filling. Galena is found as open-space filling between angular dolomite fragments in the ore-hosting breccias. Open-space mineralization is characterized dominantly by pink sparry dolomite and euhedral galena, minor pyrite and calcite (Fig.67 and 68).

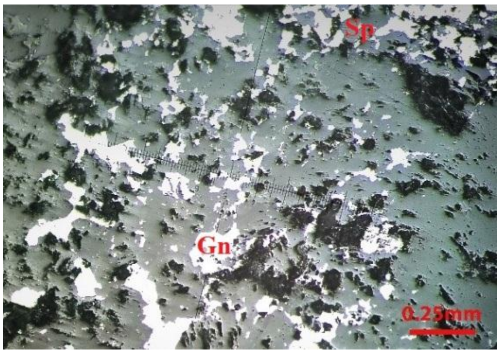

Figure 63 Disseminated lead ore in Bawdwingyi Mine

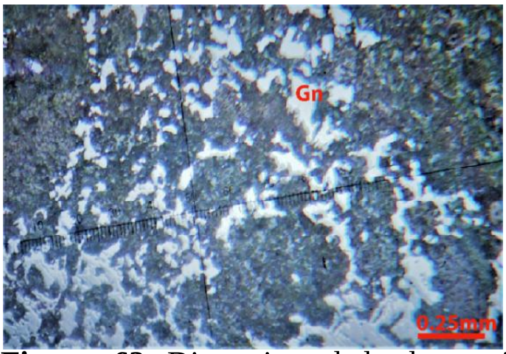

Figure 63 Disseminated lead ore in Bawdwingyi Mine

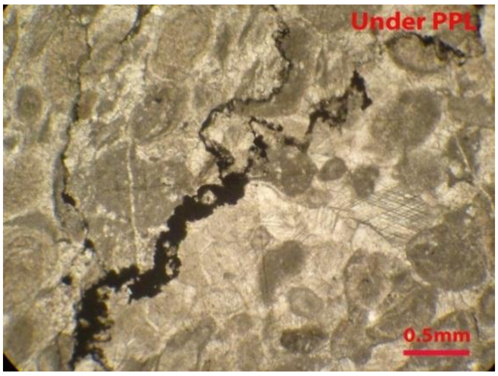

Figure 65 Fracture-fillings Style of lead ore

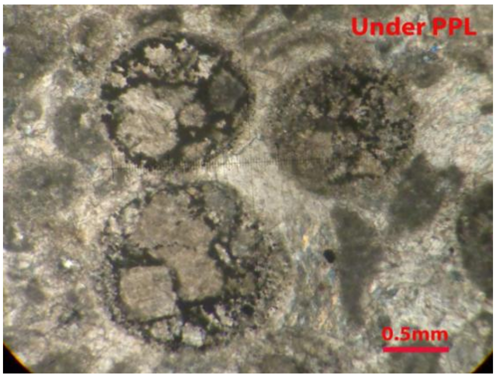

Figure 66 Replacement Style of lead ore

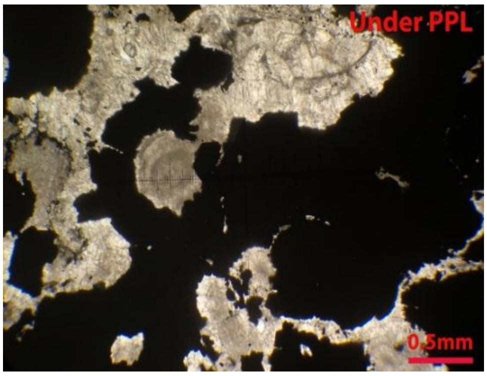

Figure 67 Mineralized solution collapse breccias of open space filling

Figure 68 Mineralized solution collapse breccias of open space filling

Conclusion and Discussion

Taung Gaung area is located in central Myanmar, 37 km to the northeast of Mandalay. It mainly consists of Ordovician limestone and dolomitic limestone with a general trend of N-S. The principal ore mineral is galena associated with sphalerite and minor amounts of anglesite, cerussite, jalpaite, pyrite and marcasite. In a separate paragenetic sequence, copper occurs as chalcopyrite, tetrahedrite - tennantite, covellite, chalcocite and azurite-malachite. The gangue minerals include limonite, siderite, ankerite, barite, dolomite, calcite and quartz.

In ore microscopic study, most of the galena display deformed structures. Their growth zones and the cleavage sets are curved. In SEM-EDX study, the calcite mineral grains are observed to be large. The other mineral grains nearby are seen as mostly fine-grained. It may be partly due to metamorphism. The common ore textures found in the galena are dendritic pattern, disseminated pattern and replacement texture. In sphalerite, rimmed replacement texture, disseminated structures, vein or veinlet textures, skeletal structure and network texture are observed. In other minerals, the replacement textures, the disseminated patterns and the vein or veinlet textures are commonly observed.

In gangue minerals, calcite, dolomite and quartz were deposited in all stages while siderite, ankerite and limonite were formed in post-mineralization (stage-iv), and barite was formed in both main mineralization (stage-iii) and post-mineralization (stage-iv). In ore minerals, galena, sphalerite and chalcopyrite were deposited in main mineralization (stage-ii and stage-iii) while anglesite, cerussite, jalpaite, covellite, chalcocite, azurite- malachite, tetrahedrite – tennantite and marcasite were formed in post- mineralization (stage-iv), and pyrite was formed in all stages.

By field observation and under microscopic study, several styles of mineralization were found to have formed under variable conditions, such as lead-zinc minerals occurring as disseminations, replacement ore, fracture - fillings and mineralized solution collapse breccias.

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