MINERALOGY OF THE METASEDIMENTARY ROCKS OF PIN-LE-IN AND NYAUNG-OK AREA, MADAYA TOWNSHIP, MANDALAY REGION, MYANMAR

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Abstract

The research area is situated in Madaya Township, Mandalay Region which lies on one inch topographic map No.93-B/3. This area is bounded between latitude 22° 11′ N to 22° 14′ N and longitude 96° 33′ E to 96° 35′ E. Pin-le-in and Nyaung-ok area is located between the Shan massif in the east and Tertiary sediment in the west. The regional trends of metamorphic rocks in present area are nearly north-south in direction. Yatkanzin Taung is occupied by metamorphic units, especially marble and calc-silicate rocks. Igneous rocks and metasedimentary rocks mainly distributed in the research area and granitic rocks partly intruded into metasedimentary rocks. Metasedimentary rocks are marbles, calc-silicate rocks and gneisses. Biotite granite is highly weathered in the research area. Hornblende granite is mainly occupied at the eastern part of Bodawgyi Taung range. Marbles can be subdivided into diopside marble, phlogopite marble and white marble. Calc-silicate rocks are interbedded with white marble at Yatkanzin Taung range and it is also interbedded with biotite-hornblende gneiss at Bodawgyi Taung range. Biotite-hornblende gneiss is well exposed at Bodawgyi Taung and it is partly in contact with hornblende granite. Minerals occurred the research area consist of calcite, alkali feldspar, plagioclase, quartz, hornblende, biotite, diopside, phlogopite, sphene, spinel, garnet and scapolite. Contact and regional metamorphism can be observed in this area. According to the mineral assemblages, the regional metamorphism of the research area took place under "amphibolite facies". The limited occurrences of some gems and industrial minerals can be encountered in the research area. The rough stones of spinel, garnet are found in some marble and pegmatite.

Keywords: Metasedimentary rocks, Mogok belt, Amphibolite facies

Introduction

Pin-le-inn and Nyaung-ok area is nearly by Bodawgyi Taung and Yatkanzin Taung range. The area interests for their gem minerals, ore minerals and geological features to study about gemology, mineralogy and petrology. The

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research area is bounded by N 22° 11′ to N 22° 14′ and E 96° 33′ to E 96° 35′ which is located in the Madaya Township, Mandalay Region, (Figure 1). One inch topographic map number is 93-B/3. The total area coverage is about 10 km^2 in extent, including Nyaung-ok and Pin-le-in village. The highest landmark of the area is Bodawgyi Taung, its highest peak is 447 meters above sea level. The drainage patterns of the area are radial in the southern part (Bodawgyi Taung) and dendritic in the rest of the region. Generally dendritic pattern can be divided into coarse-dendritic pattern and fine-dendritic pattern in some area which occur in metamorphic rocks.

Purposes of Research

This research attempts to constrain the mineralogical aspects of some gem minerals with the following objectives:

- To prepare detailed geological map
- To study the mineralogy of various rock types
- To carry out the relationship among the geology, petrography and mineralogy

Methods of Research

Rock samples were collected for the different rock types to carry out the mineralogical research in the laboratory. The field investigations were made along road cuttings, foot paths and streams, and locations were made by G.P.S. The representative samples were studied by detailed examination of various metamorphic rocks for better understanding of the mineralogy of the area. Good exposures and prominent panoramic views are taken as a photographic data. The laboratory methods are megascopic observation of the collected specimen and microscopic examination of thin sections from various rocks units.

Previous Works

Pin-le-inn and Nyaung-ok area is located within the Mogok Metamorphic belt. Many authors described about this area and its environs by several point of viewing. Thein Win (1980) and Yin Yin Nwe(1986) were investigated the research area at different fields of view.

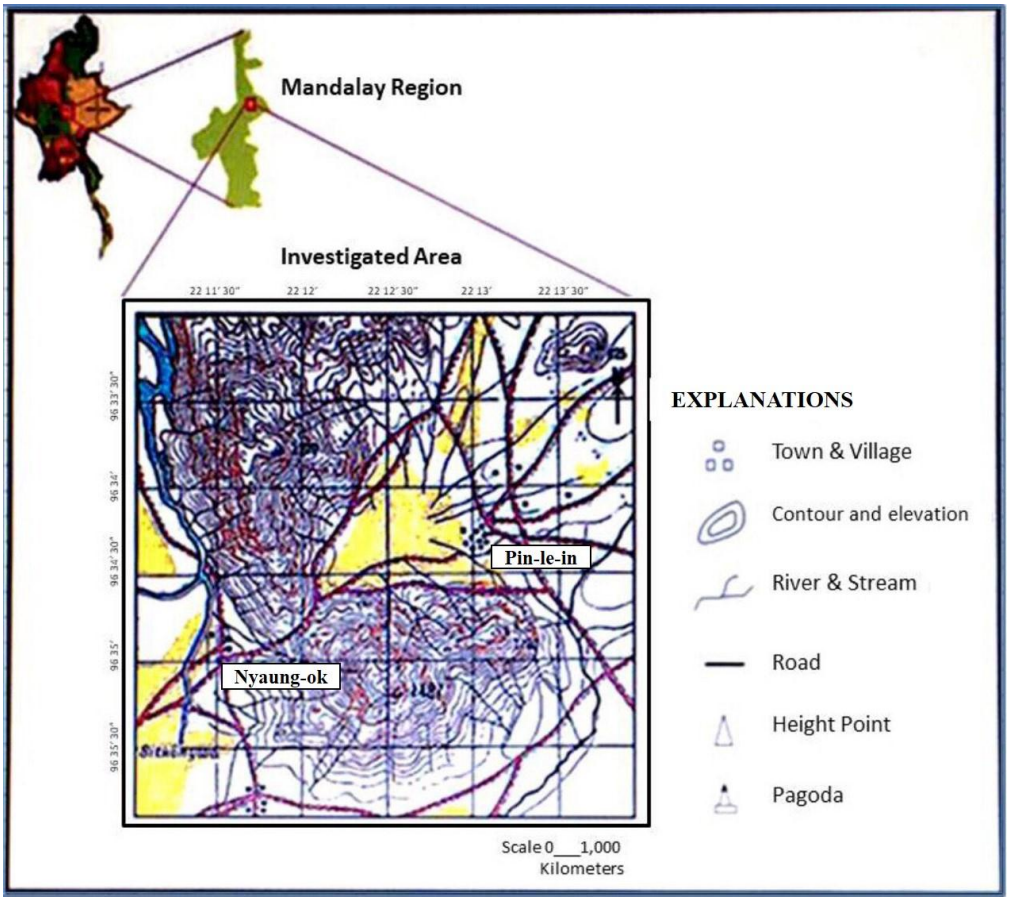

Figure 1: Location map of the research area

Regional Geologic Setting

The regional geology of the research area is situated in the complex of metasedimentary rocks and igneous intrusive lying between the Shan massif in the east and Tertiary sediments of "Central Burma Basin" in the west. The area also lies in the southern part of the "Mogok Belt" of Scarle and Haq (1964). These crystalline rocks or metasedimentary rocks are formed as a result of tectonic activity related to the Himalayan Orogeny (Figure 2). These crystalline rocks, phlogopite marble, spinel-chondrodite marble, white marble, calc-silicate rocks, garnet-biotite gneiss and biotite-hornblende gneiss are dipping generally to the east.

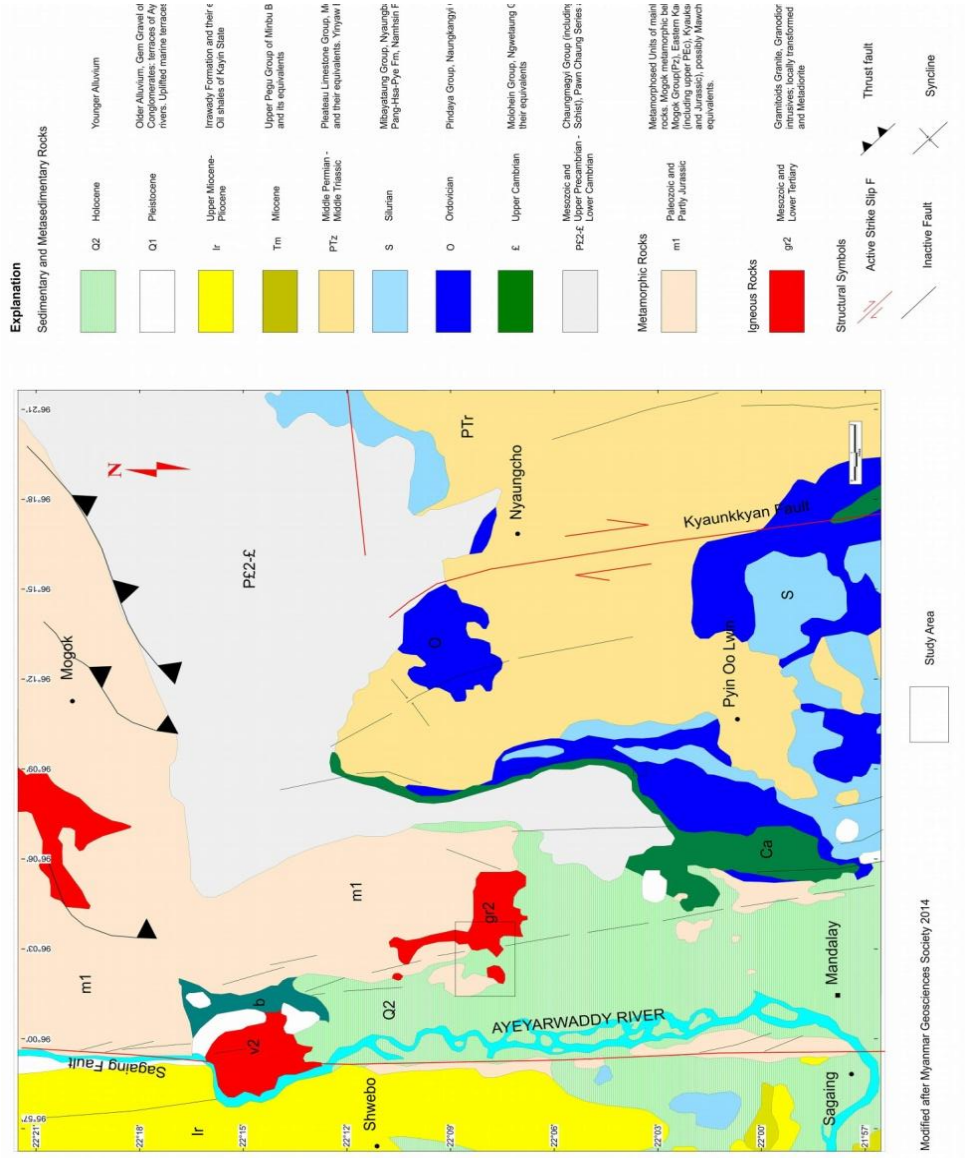

Figure 2: Regional Geologic Map of the Research Area (Modified after Myanmar Geosciences Society 2014

Sequences of the rock units

The rock units of the stratigraphic succession are described and mapped in the area. The rock succession established mainly on the basic of correlation and field relation (After Thein Win, 1980) is as follow;

Igneous rocks

Pegmatite
Leucogranite
Biotite microgranite
Biotite granite
Granodiorite — Tertiary
Hornblende granite

Metamorphic rocks

Biotite hornblende gneiss
Calc-silicate rocks
White marble fine to medium grained with some spinel
Phlogopite and graphite
Phlogopite marble — Upper Paleozoic to Mesozoic
Diopside marble

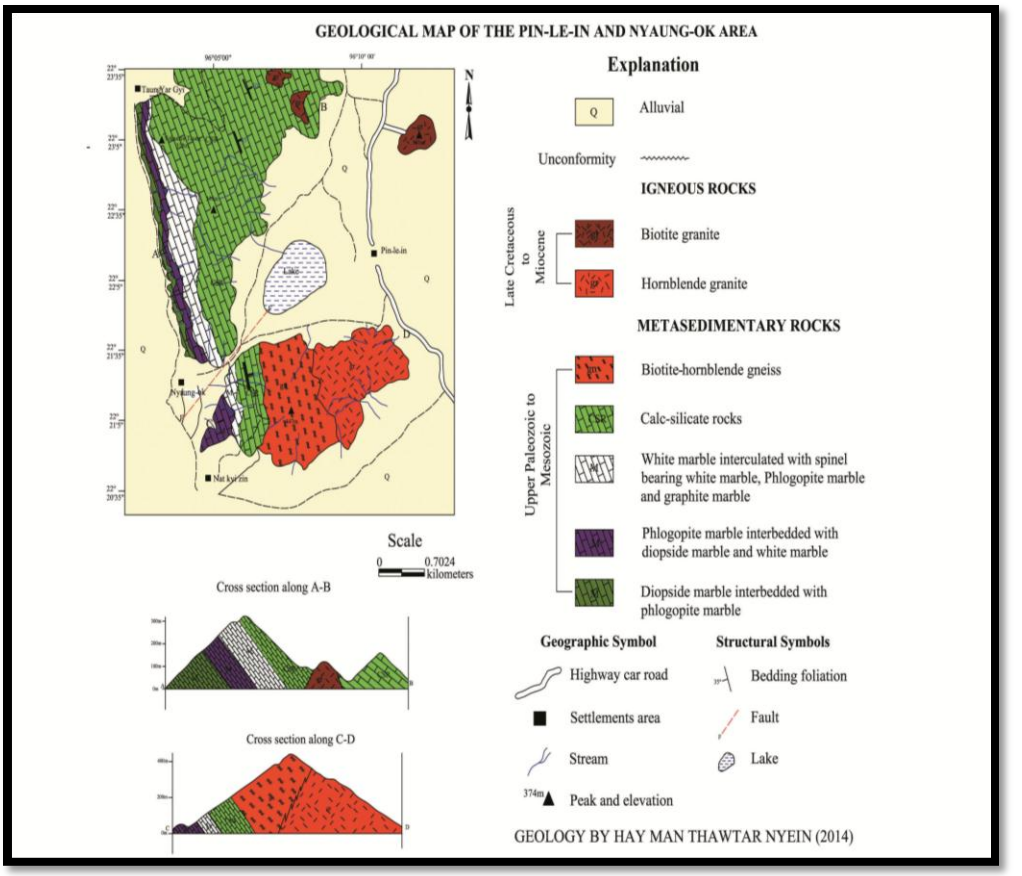

Figure 3: Geological Map of the Pin-le-in and Nyaung-ok area

Biotite hornblende gneiss

It is widely distributed throughout at Bodawgyi Taung range, (Figure 4). The rock is chiefly composed of feldspar, quartz, hornblende and biotite. Accessory minerals are sphene and opaque minerals. Hornblende presents more abundant than biotite **(**Figure 10a & b).

Calc-silicate rocks

Drag folded outcrop nature of Calc-silicate-rocks which are exposed in middle part of the Bodawgyi Taung area (Figure 5). The mineral composition is

calcite, diopside, scapolite, quartz, alkali-feldspar, and sphene, (Figure 11a & b). Alkali-feldspar sphene and opaque minerals are composed as accessory minerals.

White marble

White marble is distributed mainly at Yatkanzin Taung range, (Figures 6 & 7). It also occurs at the western base of Bodawgyi Taung. Major constituent minerals of the rocks are calcite. It shows coarse-grained granoblastic texture. Accessory minerals are graphite and spinel (Figure 12a & b).

Phlogopite marble

This unit is mainly distributed at Yatkanzin Taung range, (Figure 8). It also occupies at Bodawgyi Taung. It is mainly composed of calcite, phlogopite, and diopside (Figure 14a & b).

Diopside marble

This unit is mainly distributed at the western base of Yatkanzin Taung range, (Figure 9). Diopside marble chiefly consists of calcite and diopside as main minerals. Phlogopite is occurred as accessory mineral (Figure 15a & b).

Figure 4: Outcrop nature of biotite hornblende gneiss, it is well exposed at the middle part of the Bodawgyi Taung range, Location: N - 22° 21′ 19.0″, E - 96° 05′ 50.3″, Facing: 60°

Figure 5: Calc-silicate-rocks are exposed in middle part of the Bodawgyi Taung area, Location: N - 22° 22′ 13.3″, E - 96° 4′ 56.8″, Facing: 25°

Figure 6: White marble is well exposed at Yatkanzin Taung range, Location: N - 22° 21′ 34.4″, E - 96° 5′ 1.3″, Facing: 360°

Figure 7: Biotite granite intruded into white marble at Yatkanzin Taung range Location: N - 22° 21′ 34.4″, E - 96° 5′ 1.3″, Facing: 360°

Figure 8: Phlogopite marble is well exposed at Yatkanzin Taung range, Location: N - 22° 21′ 37.0″, E - 96° 05′ 00.3″, Facing: 130°

Figure 9: Diopside marble is well exposed at Yatkanzin Taung range, Location: N - 22° 21′ 37.0″, E - 96° 05′ 01.2″, Facing: 260°

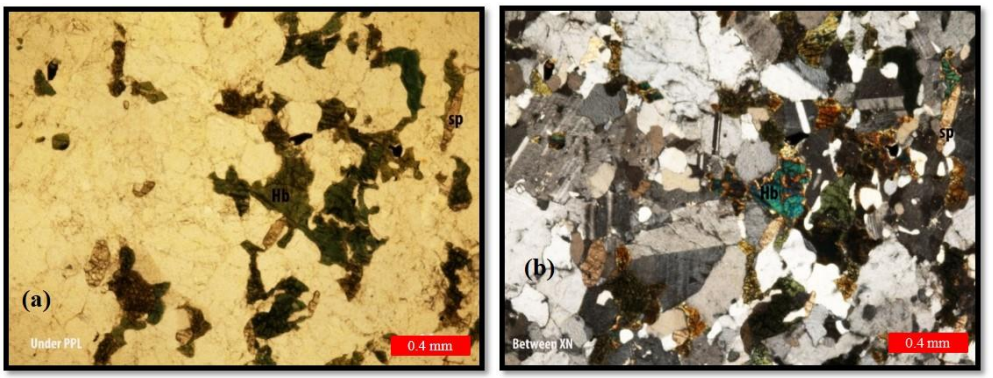

Figure 10: (a) (b) Photomicrograph of biotite hornblende gneiss: Hb=hornblende, sp=sphene

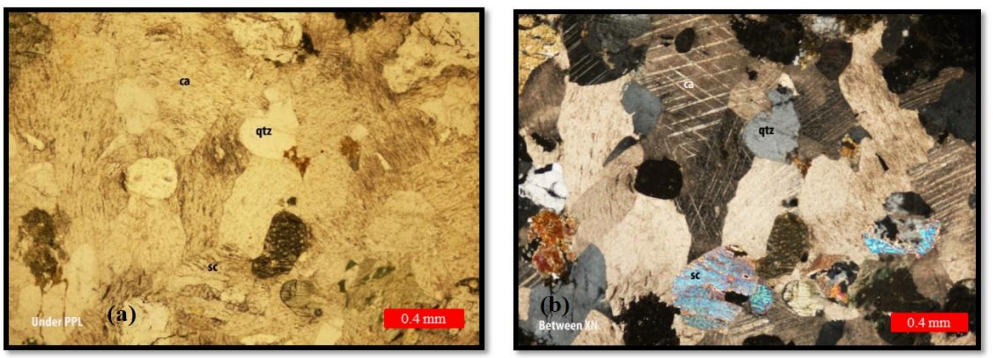

Figure11: (a) (b)Photomicrograph of calc-silicate rock: ca=calcite, qtz=quartz, sc=scapolite

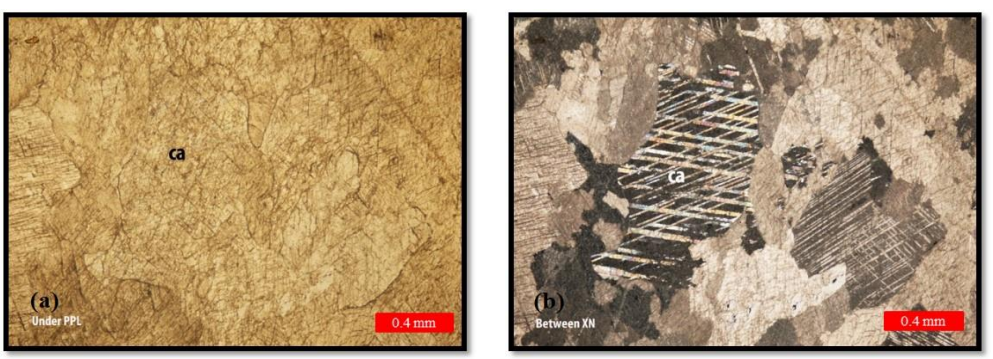

Figure 12: (a) (b) Photomicrograph of white marble: ca=calcite

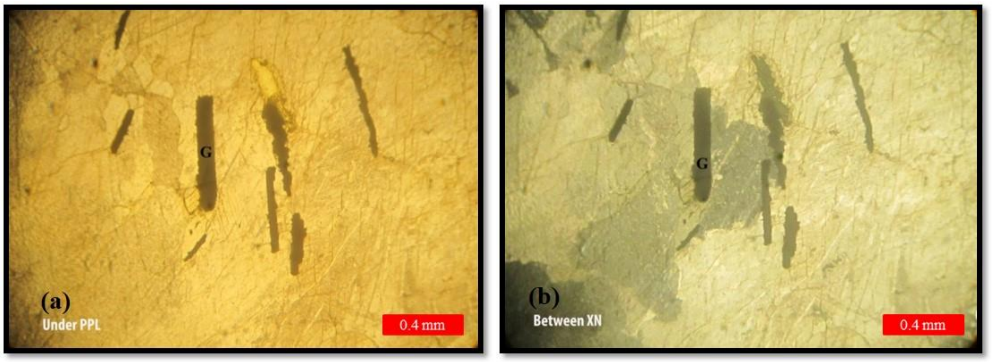

Figure 13: (a) (b) Photomicrograph of white marble: G=graphite

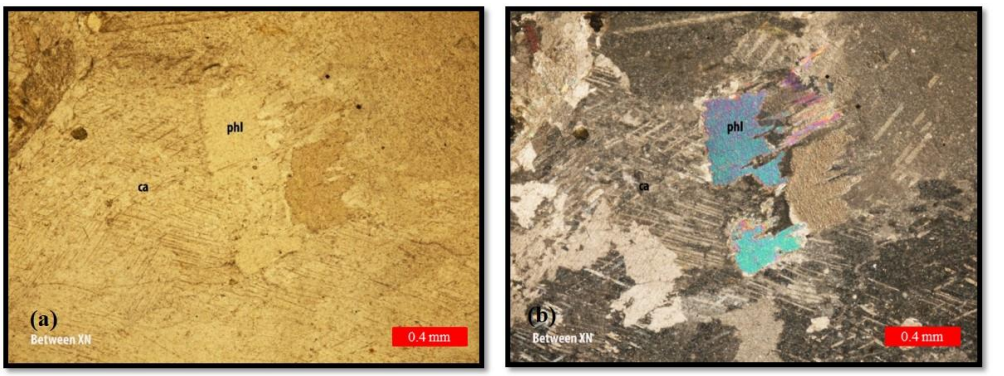

Figure 14: (a) (b) Photomicrograph of phlogopite marble: phl=phlogopite, ca=calcite

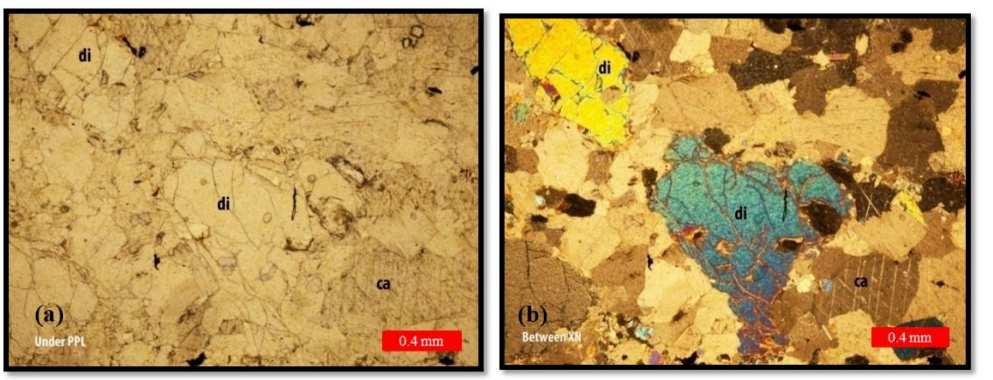

Figure 15: (a) (b) Photomicrograph of diopside marble: ca=calcite, di=diopside

Visual estimation of rocks in the research area

No	Minerals(%)	Rocks				
		Biotite hornblende gneiss	Calc-silicate rocks	White marble	Phlogopite marble	Diopside marble
1	Alkali feldspar	30	-	-	-	-
2	Plagioclase	15	-	-	-	-
3	Quartz	25	20	-	-	-
4	Hornblende	12	-	-	-	-
5	Biotite	10	-	-	-	-
6	Calcite	-	30	95	80	80
7	Phlogopite	-	-	-	11	5

Metamorphism

Types of metamorphism

Regional metamorphism can be observed in the research area. It is the most widespread and common type. It is characterized by the widespread occurrence of gneiss and calc-silicate rocks throughout the area. The occurrences of biotite hornblende gneiss and calc-silicate rocks containing the minerals diopside, scapolite, biotite, hornblende and sphene, type of metamorphism in the research area reached in amphibolite facies.

Generally, the regional strike of area is NNW-SSE and all metamorphic follow the regional trend. Therefore, it is obvious that the research area had undergone predominately one major phase of regional metamorphism.

Mineral assemblages and metamorphic facies

The nomenclature, defining mineral assemblages and metamorphic facies classification made in this area are based on Turner and Verhoogen (1960).

Mineral assemblages of the research area are described below. The mineral assemblages are used to define the metamorphic grade and facies. The mineral assemblages are graphically represented by means of ACF and AKF diagram.

According to the mineral assemblages, the regional metamorphism of the research area took place under "amphibolite facies" (Turner,1968), (Figure 16).

Regional metamorphism **Rock Type**

Amphibolite facies

(a)Pelitic rock

1. Alkali-feldspar+ quartz+ plagioclase+ hornblende+ biotite+ sphene Gn

(b)Calcareous rock

1. Calcite+ quartz+ scapolite+ diopside+ sphene+ alkali-feldspar CSR
2. Calcite+ Spinel M
3. Calcite+ phlogopite+ diopside M
4. Calcite+ diopside+ phlogopite M

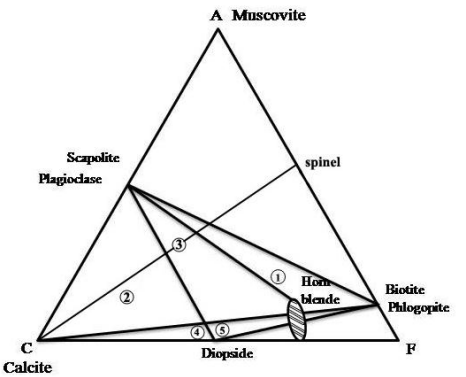

Figure 16: Mineral assemblages and metamorphic facies recognized in Pin-le-inn and Nyaung-ok area

Mineralogy

Calcite

It is major constituent of marble (Figure 17a & b). Two sets of rhombohedral cleavages may distinct. Polysynthetic twinning and twinkling effect are very common in calcite.

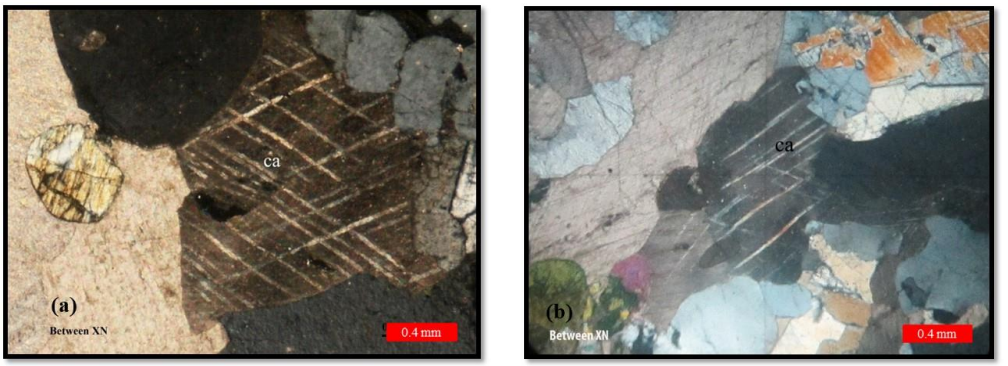

Figure 17: (a) (b) Photomicrograph of calcite in calc-silicate rock, ca=calcite

Plagioclase feldspar

Plagioclase feldspar is essential in biotite granite, hornblende granite, calc-silicate rock and biotite hornblende gneiss. Polysynthetic twinnings are well observed and twin bands are slightly bent. Most of the plagioclases are inclined extinction. Extinction angle increased with increasing calcium content. Plagioclasse are determined by using Michel-Levy method. Biotite granite is the range of plagioclase composition is "Albite to Oligoclase" from An_{10} to An_{14}. Hornblende granite is the range of plagioclase composition is "Albite to Oligoclase" from An_{10} to An_{11} (Figure 18a&b).

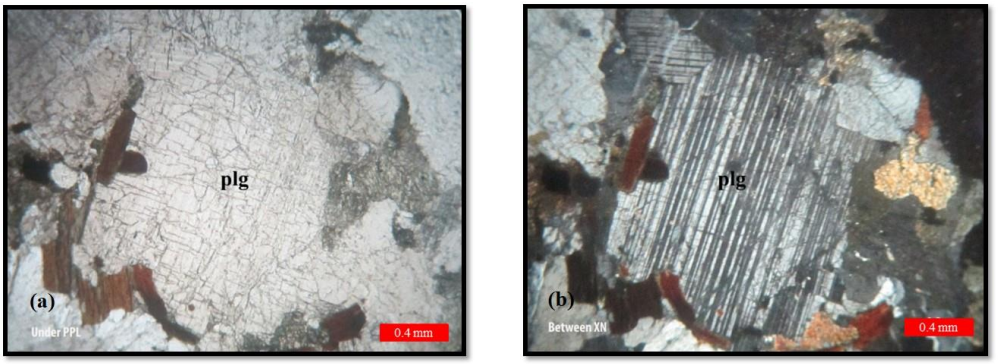

Figure 18: (a) (b) Photomicrograph of plagioclase in biotite hornblende gneiss, pgl=plagioclase

Quartz

Quartz is including in gneiss and CSR units. In quartzofeldspathic units, the grain size is ranged from less than 1 mm to more than 5mm (Figure 19a & b).

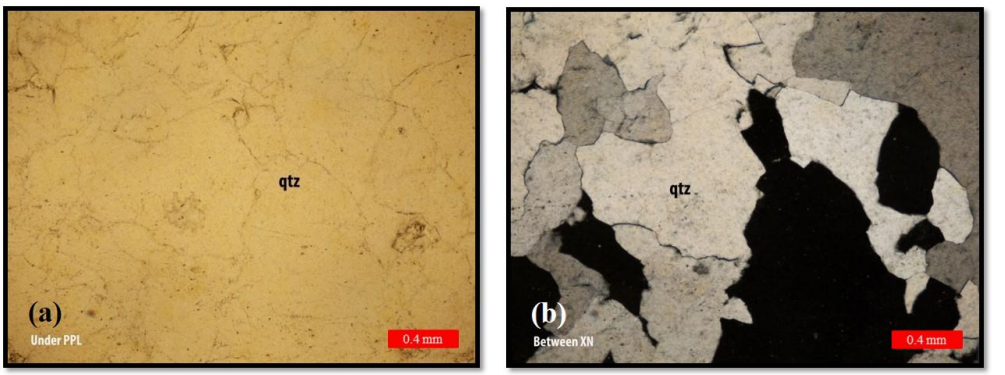

Figure 19: (a) (b) Photomicrograph of quartz in quartz vein, qtz=quartz

Hornblende

Hornblende is dominant in biotite hornblende gneiss (Figure 20a & b).

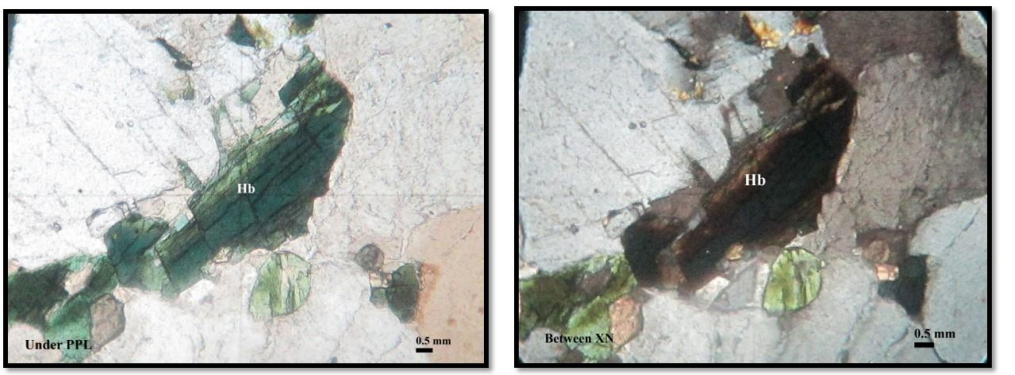

Figure 20: (a) (b) Photomicrograph of hornblende in biotite hornblende gneiss, Hb=hornblende

Diopside

Diopside is mainly found in marble and calc-silicate rock (Figure 21a & b).

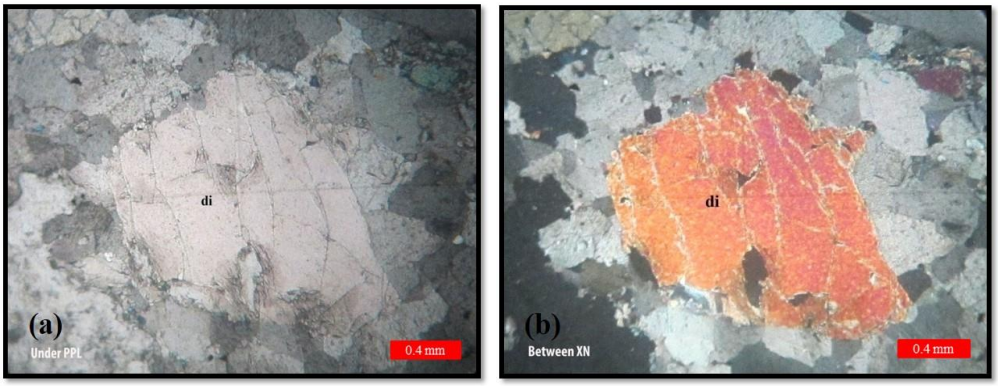

Figure 21: (a) (b) Photomicrograph of diopside in diopside marble, di=diopside

Phlogopite

Phlogopite in this area is associated with diopside marble and white marble. (Figure 22a & b)

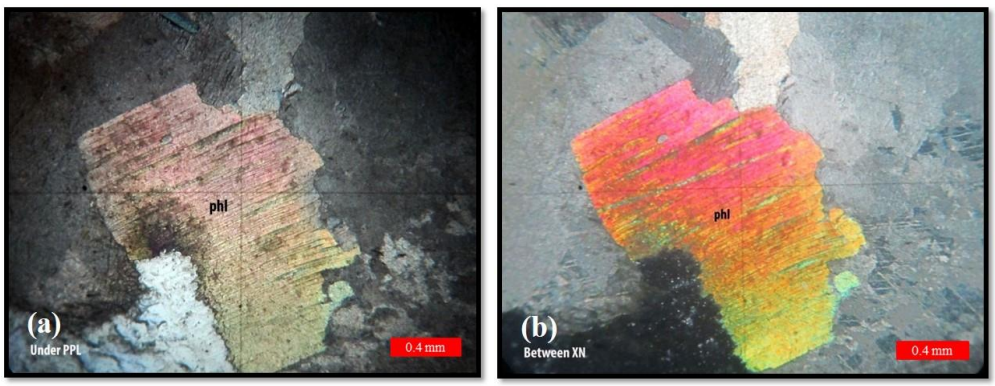

Figure 22: (a) (b) Photomicrograph of phlogopite in phlogopite marble, phl=phlogopite

Sphene

Sphene is widely distributed in this area as a minor constituent. Sphene is common in biotite-hornblende gneiss and calc-silicate rocks. (Figure 23a & b)

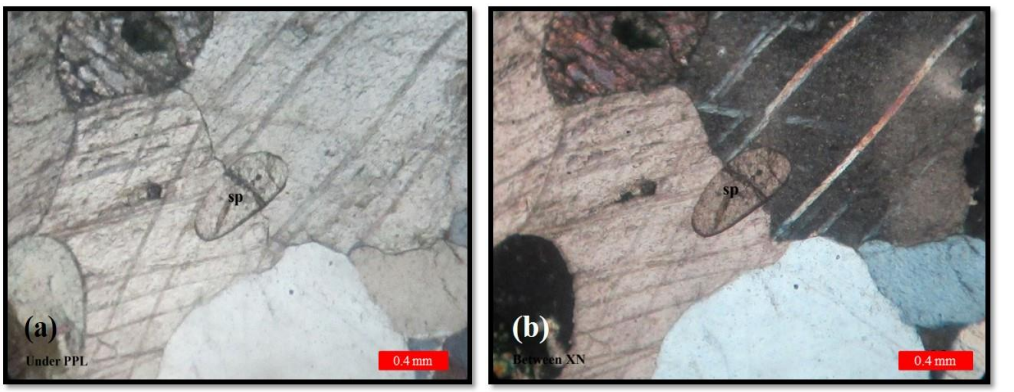

Figure 23: (a) (b) Photomicrograph of sphene in calc-silicate rocks, sp=sphene

Garnet

It is found in marble unit, gneiss unit, pegmatite veins and quartzofeldspathic veins. (Figure24a & b)

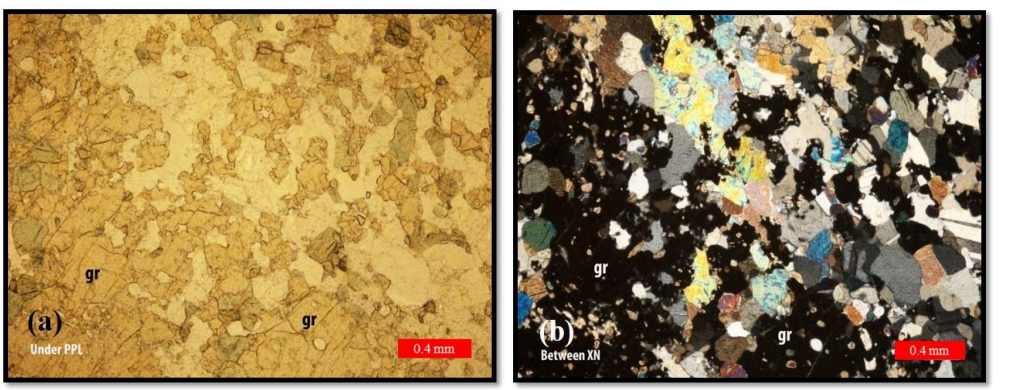

Figure 24: (a) (b) Photomicrograph of garnet aggregates in pegmatite dykes, gr=garnet

Scapolite

It is very common in calc-silicate rocks. Scapolite shows strong birefringence. (Figure 25a & b)

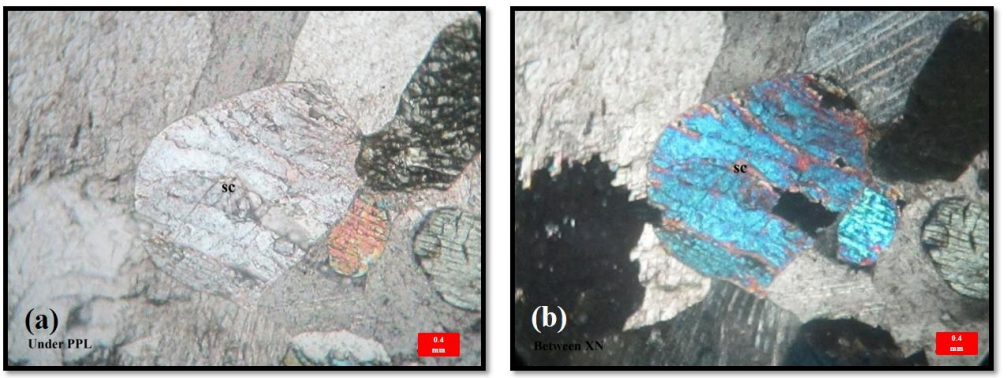

Figure 25: (a) (b) Photomicrograph of scapolite in calc-silicate rocks, sc=scapolite

Spinel

It can only occur in marble unit. (Figure 26a & b)

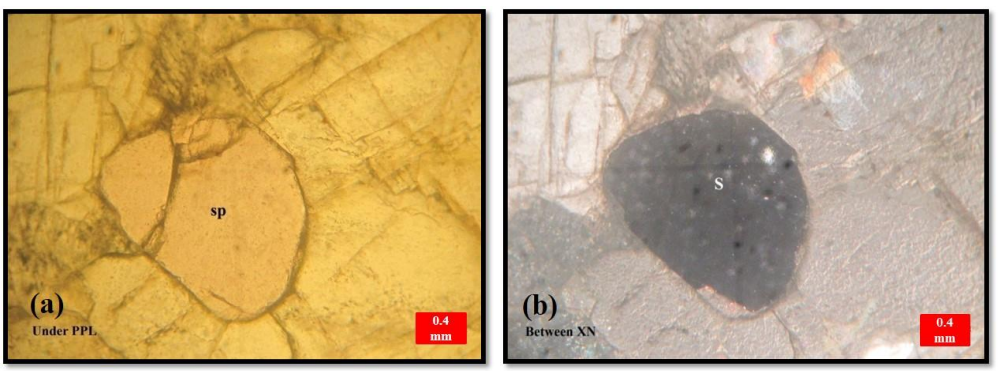

Figure 26: (a) (b) Photomicrograph of spinel in white marble: S= spinel

Opaque minerals

They cannot be identified by under thin section, according to their shape. Possible opaque minerals are pyrite, magnetite and illuminate.

Economic minerals

The limited occurrences of some gems and industrial minerals can be encountered in the research area. This area can be operated the systematic production of gem minerals as the research area is a part of Mogok stone tract. Well-known decorative materials of pure white marble productions were operated since last some years ago in this area (Figure 27a & b). Gem minerals found in the research area are spinel, garnet, tourmaline, diopside and sphene, and they need to produce systematic mining method under safety site. The main products from white marble are beautiful red spinel and crystals reach up to 1.5cm in size. Numerous rough stones of spinel are abundantly found in marble at Yatkanzin Taung. But clear red-rose spinels are not found in sufficient quantity to warrant extraction (Figure 28a, b & c).Lots of garnet crystals noticeably found in pegmatite dykes at Bodawgyi Taung and they are almandine garnet (Figure 29).Tourmaline and sphene occur in the veins of pegmatite dykes in some places of Bodawgyi Taung range. (Figure30).

Figure 27: (a) Old white marble quarry at the base of Yatkanzin Taung (b) Pure white marble plates excavated from the research area were used as a construction material

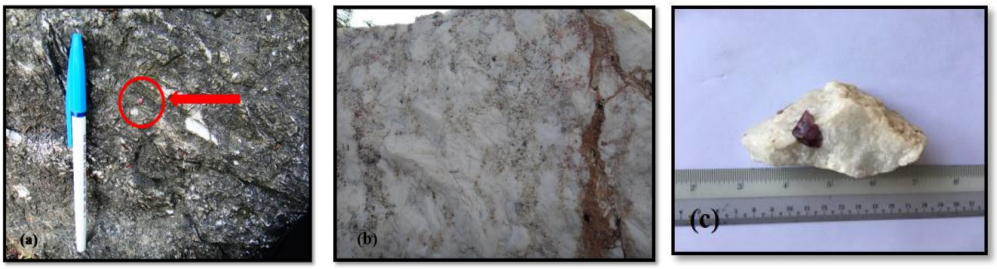

Figure28: (a) Spinel found in white marble outcrop at Yatkanzin Taung, Location: N-22° 22′ 41.4″, E-96° 4′ 57.2″,Facing: 120°, (b)Spinel segregation found in white marble exposure at Yatkanzin Taung,Location: N-22° 21′ 34.4″, E-96° 05′ 01.3″,Facing: 145°, (c)A super rare large red spinel notably found in white marble at Yatkanzin Taung

Figure 29: Some garnets are thrown by weathering found in the vein of pegmatite dykes at Bodawgyi Taung,Location: N-22° 21′ 25.8″, E-96° 05′ 17.3″,Facing: 90°

Figure 30: Tourmaline found in pegmatite dykes at Bodawgyi Taung,Location: N-22° 21′ 25.4″, E-96° 05′ 28.3″

Summary and Conclusions

The research area is situated in Madaya Township. Metasedimentary rocks are marbles, calc-silicate rocks and gneisses. Minerals occur in this area consists of calcite, alkali feldspar, plagioclase feldspar, quartz, hornblende, biotite, diopside, phlogopite, sphene, spinel, garnet and scapolite. According to

the mineral assemblages, the regional metamorphism of the research area took place under "amphibolite facies". The limited occurrences of some gems and industrial minerals can be encountered in this area.

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