Mineralogy of the Metamorphic Rocks in the Taungnyo Area, Sagaing Township, Sagaing Region

Ei San Mon[1], Wathon Chit[2] and Chaw Su Hlaing[3]

Abstract

The study area, Taungnyo area, is located at the north of SagaingTownship, Sagaing Region. If covers 8 km length and 9 km width. The total coverage area is 72 square kilometers. It is bounded by vertical grids 042 to 052 and horizontal grids 054 to 063 in the one inch topographic maps 84 O/13 and 93 C/1.The study area lies at the eastern margin of the Central Myanmar Tertiary Belt and close to western margin of Eastern High land. Sagaing metamorphics (Precambrian to Lower Paleozoic) contain marble, calcsilicate rocks and gneiss and Minwun metamorphics (Middle to Upper Triassic?) conatin schist. By sedimentary rocks, Male Formation (Lower to Middle Eocene) and Irrawaddy Formation (Pontian to Villafranchian) are also present. Marble can be divided into diopside- phlogotpite- forsterite marble, phlogopite-forsterite marble and white marble. Gneiss can be divided into hornblende-biotite gneiss, biotite-gneiss and leucogneiss. Schist can be divided into garnet-mica schist and actinolite schist. Many minerals in the rock types of this study area are actinolite, antigorite, apatite, biotite, calcite, chlorite, diopside, feldspar, forsterite, garnet, hornblende, muscovite, phlogopite, quartz, sphene and spinel.

Keywords: Taungnyo area, eastern margin, Tertiary Belt, Sagaing metamorphics,Minwun metamorphics.

INTRODUCTION

The study area is located in the Taungnyo area, northern part of the Sagaing Township, Sagaing Division. The area is bounded; east by Ayeyarwaddy river, west by Kaunghmudaw In, south by Sagaing Township and north by Yega area. The area is limited between vertical grids 042 to 052 and horizontal grids 054 to 063. Topographic Map reference are 84 O/13, 93 C/1 one inch topographic maps. The area bounded by latitude between 21 ˚53’ N to 21 58’ N and longitude 95˚ 56’ E to 96˚ 2’ E. The length and width of the area is 8km by 9km, so that the total mapped coverage is approximately 72 square kilometers.

The study area lies in the Central Myanmar low land. It is divided into three physiographic units. They are mountainous unit, rolling hilly unit and plain topographic unit. The mountainous unit, Sagaing ridge lie in the middle part of the area and N-S trending. It is thickly forested and is dissected by many tributaries. In the Sagaing ridge, the highest mountain is 834 feet above the sea level.

The rolling hilly unit, Minwun ridge is also thickly forested and is dissected by many tributaries. It is N-S trending.

The plain topographic unit is divided into eastern plain topographic unit and western plain topographic unit. The eastern plaintopographic unit is bounded east by Ayeyarwaddy river. The western plain topographic unit is covered by alluvial and bounded west by Kaunghmudaw In.

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Many tributaries in the Sagaing ridge flowing from W to E, into the Ayeyarwaddyriver. The tributaries in the Minwun ridge are flowing from E to W. The Ayeyarwaddy river is flowing N-S. The drainage pattern is generally coarse dendritic, fine-dendritic and trellis patterns. Parallel pattern and V-shape valleys are also present. The Sagaing Fault lies in the middle part of the arsea and N-S trending.

General Geology

In the study area, Paleozoic to Precambrian metamorphic rocks, (Sagaing metamorphic), Middle to Upper Triassic (?) metamorphic rocks (Minwun metamorphic), Lower to Middle Eocene sedimentary rock (Male sandstone) and Pontian to Villafranchian sedimentary rock (Irrawaddy sandstone) are exposed. Myint Thein, Kyaw Tint, and Kan Saw (1979) studied the geology of the part of the eastern margin of the Central Myanmar belt between Sagaing and Tagaung. The various lithologic units are distributed in the area which is shown in the outcome geological map (Fig.1).

The Sagaing Metamorphics was the southern continuation of the Mogok Series which regarded as Archean in age (by La Touche, 1913). According to Chhibber (1934), the age of the metamorphic rocks of the Sagaing hills are the same as those of the Mogok Stone Tract which is Precambrian in age. Kan Saw (1976) divided the metamorphic of the present area into Sagaing metamorphic and Minwun metamorphic on the basic of lithological and structural correlation. The Sagaing is characterized by its calcareous and pelitic classes of metamorphic whereas those in the Minwun are area of basic. The former are found in the region east of the Sagaing Fault while the latter are exposed in the west of the fault. The sedimentary rocks are widely exposed in the study area. Especially one third of the area, the sedimentary strata are mainly composed of clastic sedimentary rocks belonging to Male and Irrawaddy formation. These are unconformably overlain by Quaternary deposits. Rock units of the study area is shown in Table (1).

Table (1) Rock units of the study area (Modified after Maw MawMyint, 1993)

Rock Units	Lithology	Age
Recent Alluvium	Alluvium	Holocene
~~	Unconformity	~~~~~~~~~~
Irrawaddy Formation	Gritty sandstone Silty sandstone Fanglomerate	Pontian to Villafranchian
~~	Unconformity	~~~~~~~~~~
Male Formation	Interbedded fine-grained sandstone and medium to coarse-grained sandstone Gritty sandstone interbedded with fine-grained sandstone	Lower to Middle Eocene
~~	Unconformity	~~~~~~~~~~
Minwun metamorphic	Garnet – muscovite / biotite schist Actinolite schist	Middle to Upper Triassic (?)
~~	Unconformity	~~~~~~~~~~
Sagaing metamorphics	Diopside-phlogopite –forsterite marble, Phlogopite - forsterite marble, White marble	Precambrian to Lower Paleozoic
	Calc silicate rock	
	Banded hornblende biotite – gneiss, Biotite gneiss, Leucogneiss	

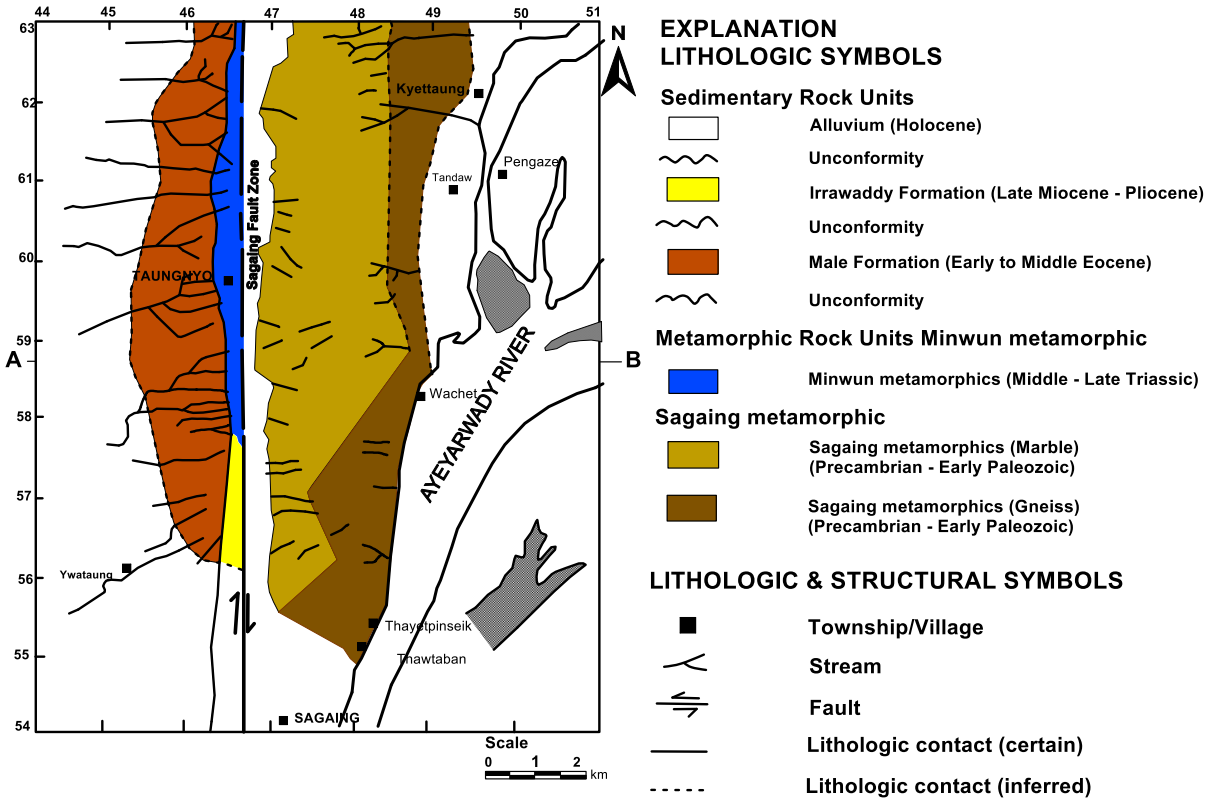

Figure (1) Geological map of the Taungnyo area, Sagaing Township, Sagaing Region

Metamorphic Rocks

Sagaing Metamorphics

Sagaing metamorphic rocks exposed along the Sagaing ridge, mainly composed of marble, calc-silicate rocks and gneiss.

Marble

Marble are widely exposed on the western flank of the Sagaing ridge. Marble generally give east dipping and N-S trending unit. Diopside - phlogopite - forsterite marbles are well exposed at north of Wachet village and northwest of Shinhla, west Kyettaung village (Fig. 2). These rocks give light in fresh colour and dark grey in weather colour. They are found as massive form and highly jointed. These marbles may probably be formed by metamorphic differentiation processes. This unit is thick bedded, hard and compact. Phlogopite - forsterite marbles are well exposed at W of Tandaw village and W of Wachet village (Fig. 3). It shows dull in weather and light colour in fresh surface. They are found as massive, hard and compact. They have not jointed nature. White marbles are found in the middle part of the area especially well exposed west of Tandaw village. They are interbedded with phlogopiteforsterite marble. They have milky white colour in fresh surface and dark grey colour in weather surface. They are found as massive and give eastward dipping. This unit contacts with calcsilicate rock unit (Fig. 4).

Calc-silicate rocks

Calc-silicate rock unit contacts with eastern boundary of white marble unit. They are well exposed in the northern part of the study area. They give pale green in fresh colour and dull colour in weather surface. They generally show NE-SW strike with east dipping (Fig. 5).

Gneiss

Gneiss are widely exposed along the eastern flank of the Sagaing ridge, especially along the side of Yega-Wachet. Sagaing car road. Banded hornblende gneiss is cropping out around Thayetpinseik. This unit is thin to medium bedded, hard and compact. They show well banded nature due to alternative arrangement of quartz-feldspar rich (Felsic) layers and hornblende biotite rich (Mafic) layers. Sometime pegmatite veins are intruded in this rocks. (Fig.6) Quartzofeldspathic veins are common through out this unit. It is mainly composed of quartz, feldspar and hornblende. Biotite occurs as minor amount. Their foliation is NW-SE direction.

Biotite gneiss are well exposed at around the Watchet village and northern part of the study area (Fig. 7). They have thin to medium bedded nature, mainly composed of feldspar, quartz, biotite and other accessory minerals. In hand specimen, foliation is well marked by platy brown biotite layers in quartzofeldspathic groundmass. They are fine to medium grained, friable and highly jointed. Their foliation is striking NW-SE direction. In some places, they show mylonitic nature. Leucogneiss is cropping out along the sides of Wachet-Sagaing Car-road, especially north of Thayetpinseik (Fig. 8). It is thin to medium bedded nature. They give whitish in colour. It is mainly composed of quartz, feldspar and minor amount of muscovite. They are medium to coarse grained, slightly foliated and highly jointed.

Minwun Metamorphics

Schist

Minwun metamorphic exposed along the Minwun ridge. Minwun metamorphic is composed of schist; garnet-muscovite / biotite schist garnet – muscovite / biotite schist are probable sedimentary derivatives. Minwun metamorphic shows east dipping. Minwun meatmorphics were possibly metamorphosed Mesozoic especially (Triassic) similar to schist of Tigyaing-Katha and Indaw area (Maung Maung 1987).

Garnet-muscovite / biotite schist is well exposed in the central part of the Minwun range. It is grey to whitish in colour and medium to coarse grained rocks. They are mainly composed of muscovite, biotite, quartz, feldspar, garnet and other accessory minerals. Foliations is accentuated by mineral lamination of thin layers of micas and quartz + feldspar. This unit is NW-SE direction and generally gives east dipping (Fig. 9). Actinolite schist are exposed at north of Taungnyo village. It gives light green colour in fresh surface and sometime shows accicularactinolite crystals. This rock is mainly composed of quartz, feldspar, actinolite, hornblende and other accessory minerals.

Fig. (2) Outcrop nature of diopside- phlogopite-forsterite marble (W of the Kyettaung Village) Location: N 21˚ 56′59.2″ E 96˚ 00′10.5″, Looking forward: 35˚

Fig. (3) Outcrop nature of phlogopite – forsterite marble (W of Wachetvillge) Location. N 21˚ 55′ 16.5″ E 95˚ 59′22.6″Looking forward: N

Fig. (4) White marble in the quarry (W of Tandaw Village) Location. N 21˚ 56′18.7″ E 95˚ 59′45.5″Looking forward: 330˚

Fig. (5) Outcrop nature of calcsilicate rocks (W of Pangaze Village) Location.N 21˚ 56′34.5″ E 96˚ 00′07.5″Looking forward: 330˚

Fig. (6) Quartzofeldspathic vein intruding in banded hornblende-biotitegneiss (around Thayetpinseik) Location: N 21˚ 53′45.7″ E 95˚ 59′30.7″,Looking forward: 180˚

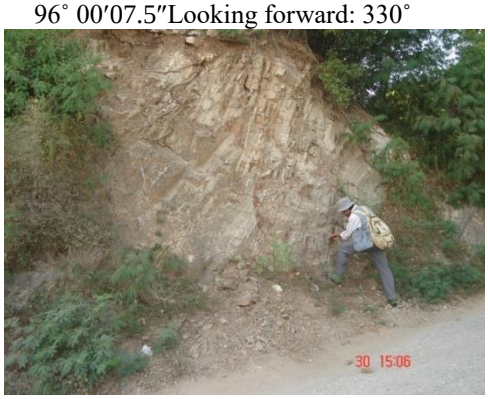

Fig. (7) Outcrop nature of biotite-gneiss(around Wachet Village) Location: N 21˚ 54′ 42.1″, E 96˚ 00′ 04.5″, Looking forward: 347˚

Fig. (8) Outcrop nature of leucogneiss (N of Tayetpinseik) Location: N 21˚ 53′56.5″ E 95˚ 59′51.7″,Looking forward: 238˚

Fig. (9) Outcrop nature of garnet-mica schist (N of Taungnyo Village) Location: N 21˚ 56′ 16.2″, E 95˚ 59′ 07.1″, Looking forward: N

Mineralogy

In the study area, Taungnyo area, north of Sagaing city, there are Sagaing metamorphic, Minwun metamorphics and sedimentary rocks. Sagaing metamorphics contain marble, calc-silicate rocks and gneiss. Minwun metomorphics contain garnet mica schist and actinolite schist Sedimentary rocks contain Male sandstone and Irrawaddy sandstone. There are 16 minerals identify according to Rutley (2000), Kerr (1959) and Moorhouse (1957) is described in Table. 2.

Table (2) The mineral assemblages of the various units of study area

Metamorphic Rocks				**Sedimentary Rocks**
Marble	**Gneiss**	**Calcsilicate Rock**	**Schist**	**Sandstone**
Calcite	Quartz	Calcite	Biotite	Quartz
Diopide	Feldspar	Diopside	Feldspar	Feldspar
Phlogopite	Homblende	Forsterite	Quartz	Biotite
Forsterite	Biotite	Sphene	Muscovite	Muscovite
Spinel	Sphene	Hornblende	Chlorite	
Antigorite		Feldspar	Garnet	
		Quartz	Actinolite,	
			Epidote	

Actinolite

Actinolite occurs in schist unit from Minwun metamorphic. In hand specimen, it can be visible as accicular crystal. Under the microscope, it is colorless to pale green long prismatic crystal and columnar to fibrous aggregates. It has two sets of cleavage fair high relief and middle second order interference colors. It is parallel extinction.

It is associated with chlorite, quartz and hornblende. Under the microscope, it is colorless to pale green long prismatic crystal and columnar to fibrous aggregates. It has two sets of cleavage fair high relief and middle second order interference colors. It is parallel extinction. It is associated with chlorite, quartz and hornblende. (Fig.10).

Antigorite

Antigorite mostly occurs in metamorphic rocks, especially in marble. In hand specimen, it is not visible.Under the microscope, antigorite is colourless to plate green. It occurs as anhedral crystals. Its relief is low and it have first order interference colour. It gives parallel extinction. It shows fine fibrous structure and aggregate structure. Antigorite is the main constituent of serpentine. It is formed by hydrothermal alteration of forsterite.(Fig.11).

Biotite

Biotite is a widely distributed and common mineral. It is a prominent constituent of schist and gneiss. In hand specimen, it occurs as brown color crystal. Sometime, it shows foliation of the mineral. Under the microscope, it is strong pleochroism from yellows to pale brown.It is commonly observed as lamellar aggregates and tabular form. It is characterized by one set of cleavage and parallel extinction. It gives fair relief and third order interference color. Twinning according to the mica law may be present.

It can be distinguished by its darker color and stronger absorption. It is often more or less alter to chlorite. It usually occurs together with quartz, feldspar hornblende and muscovite in schist and gneiss.

Calcite

Calcite mostly occurs in metamorphic rocks especially in marble and also occurs in sedimentary rock, limestone. In hand specimen, it occurs as colorless rhomb shape crystal with three sets of cleavage. Under the microscope, it is colorless, anhedral crystal. It has perfect rhombohedral cleavage, usually shows two intersecting lines at oblique angle 75°. In the aggregate of fine grained calcite, cleavage may not occur. Its relief varies with the orientation and it has higher order interference color. Thin film and twin lamellae of calcite show bright interference color under plane polarized light. It gives symmetrical extinction and sometimes polysynthetic twinning. It is usually associated with diposide, forsterite, and phlogopite. (Fig.12).

Chlorite

It is occurs in metamorphic rocks, schist. In the hand specimen, it is not visible. Under the microscope, it is colorless thick tabular crystal. It has one set of cleavage. It gives fair relief and isotropic in basal sections. It occurs together with actinolite and quartz.

Diopside

Diopside mostly occurs in marble and calc-silicate rock. In hand specimen, it shows green color, granular crystal, mostly occur as coarse-grained. Under the microscope, it is pale green, four or eight sided subhedral crystal. It has two sets of cleavage cut at 87° and 93°. It shows fairly high relief and second order interference color. It gives symmetrical extinction. It has larger extinction angle (37° to 44°). Diopside is altered to tremolite-actinolite. It is especially characteristic of contact metamorphic zones. It is associated with calcite, phlogopite and forsterite.

Epidote

It occurs in metamorphic rocks, especially in schist. In the hand specimen. It is not distinct. Under the microscope, it is colorless to yellowish green granular or columnar aggregates. It has one set cleavage and high relief. The maximum interference color is low second order to upper third-order color. It gives parallel extinction in elongate section. It is associated with actinolite and chlorite.

Feldspar

Feldspar is most common mineral in the rock. In the study area, feldspar occurs in gneiss, schist and sandstone. Plagioclase feldspar and orthoclase feldspar are more common. In hand specimen, it occurs as milky white color. Under the microscope, Orthoclase feldspar is colorless to cloudy. It occurs as phenocrysts, anhedral to subhedral crystal. It is low relief and grey or white of the first order interference color. It gives simple twin. It can be distinguished by its large axial angle. Plagioclase is more common mineral. It is colorless in thin section. It occurs as anhedral to subhedral crystals. It has low relief and first order interference color. It can be ditinguished by polysynthetic twinning. The composition of plagioclase determined by Michel Levy's Method are in the lab, as shown in Table 5. B. Feldspar associated with quartz, hornblende and biotite (Fig.13).

Forsterite

It mostly occurs in metarcorphic rock, marble and also occurs in calc-silicate rock. In hand specimen, it is yellowish green in color, granular form. Under the microscope, it is

colorless and subhedral to euhedral crystal. It has fairly high relief. It has irregular fracture and second order interference color. It shows parallel extinction. Forsterite is an iron free olivine has somewhat lower indices of refraction. It is highly altered to antigorite. Forsterite is also associated with phlogopite, diopside and calcite (Fig.14).

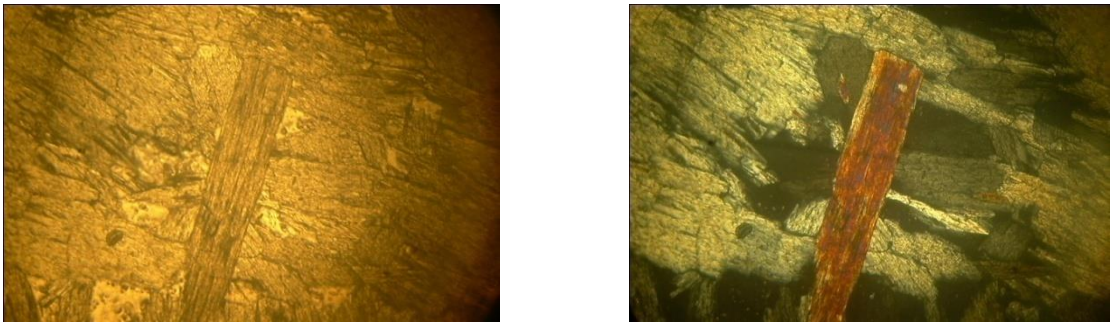

Fig. (10) Showing long prismatic crystal of actinolite in schist (PPL), (XN)

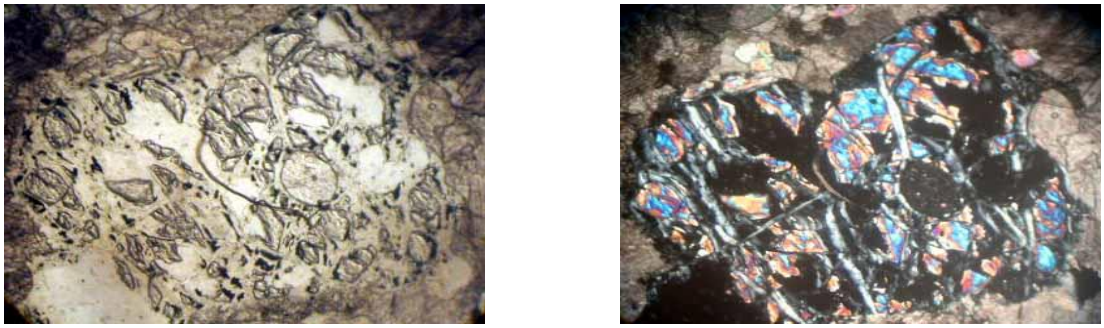

Fig. (11) Showing forsterite altered to antigorite (PPL), (XN)

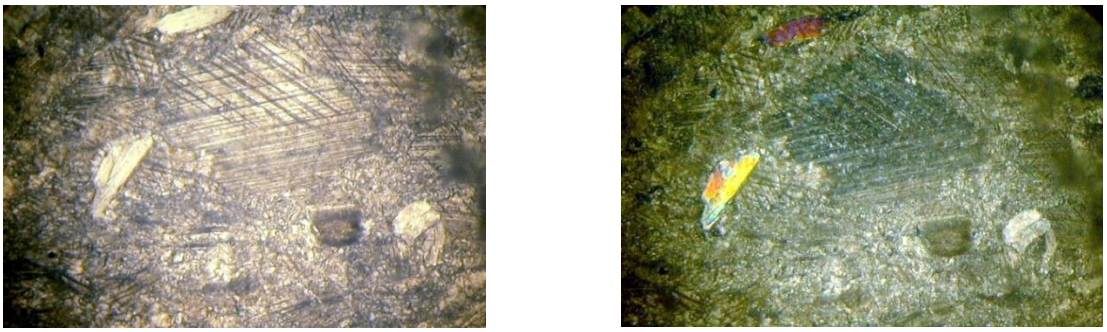

Fig. (12) Showing calcite and phlogopite in white marble (PPL), (XN)

Fig. (13.a) Showing sericitization of feldspar in schist (XN)

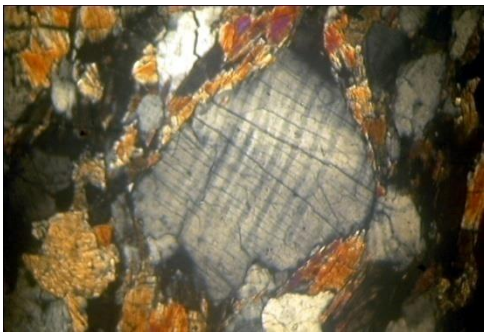

Fig. (13.b) Showing bent twin lamellar of plagioclase feldspar in homblendebiotite gneiss (XN)

Garnet

Garnet mostly occurs in metamorphic rocks, especially in micaschist. It also occurs common detrital mineral. In the hand specimen, it occurs as pink granular form.Under the microscope, it is colorless in thin section. It is euhedral in six sided section with irregular fracture. It shows very high relief and isotropic between crossed polars. Garnet is mostly associated with muscovite, biotite, quartz and feldspar. (Fig.15).

Hornblende

Hornblende commonly occurs in metamorphic rocks, schist gneiss and also occurs in calc-silicate rock. In hand specimen, it shows green color prismatic crystals. It causes foliation in schist and gneiss. Under the microscope it is distinct pleochroism from green to brown in coloranhedral crystal. It has two sets of cleavage at angles of about 56° and 124°. It gives rather high relief and middle second order interference color. It shows symmetrical extinction in basal section. In longitudinal section, it shows inclined extinction with extinction angle (20°). (Fig.16). It has distinguishing features that are cleavage, pleochroism and maximum extinction angle. It is associated with quartz, feldspar biotite and muscovite.

Muscovite

It is very common in metamorphic rocks such as schist, gneiss and also occurs in sedimentary rock, sandstone. In hand specimen, it is not distinct common. It caused foliation in schist and gneiss. Under the microscope it is colorless and scaly aggregate. It has one set of cleavage and parallel extinction. It shows upper second order interference color. It is common as a detrital mineral, especially in sandstone. Muscovite is associated with quartz, feldspar and biotite.

Table (3) Plagioclase feldspar composition determined by Mitchel Levy's Methods

No	Rock Type	Right Extinction Angle	Left Extinction Angle	Average Extinction Angle	Feldspar composition
1	Gneiss	37°	31°	34°	Labradorite
2		31°	37°	34°	Labradorite
3		41°	36°	38.5°	Labradorite
4		40°	46°	43°	Bytownite
5		40°	37°	38.5°	Labradorite
6		43°	45°	44°	Bytownite
7		43°	47°	45°	Bytownite
8		40°	43°	41.5°	Bytownite
9		46°°	40°	43°	Bytownite
10		41°	40°	40.5°	Bytownite
11		30°	27°	28.5°	Labradorite
12		30°	34°	32°	Labradorite
13	Schist	41°	44°	42.5°	Bytownite
14		25°	28°	26.5°	Andesine
15		26°	22°	24°	Andesine
16		25°	20°	22.5°	Andesine
17		17°	22°	19.5°	Albite/Andesine
18		23°	24°	28.5°	Andesine
19		19°	25°	22°	Andesine
20		30°	25°	27.5°	Andesine
21		42°	40°	41°	Bytownite
22		25°	29°	27°	Andesine

Phlogopite

It mostly occurs in metamorphic rocks, marble and sedimentary rock, limestone. In hand specimen, it occurs as golden yellow crystal. It occurs as coarse-grauirred. Under the microscope, it is colorless in thin section. It gives slightly pleochroism. It is found in six-sided thick tabular. It is tabular form with one set of cleavage. It shows fair relief and the maximum interference color is middle of the third order. It usually gives parallel extinction. It can be distinguished by lighter color, weaker absorption and its smaller angle. It is associated with forsterite, diopide and spinel.

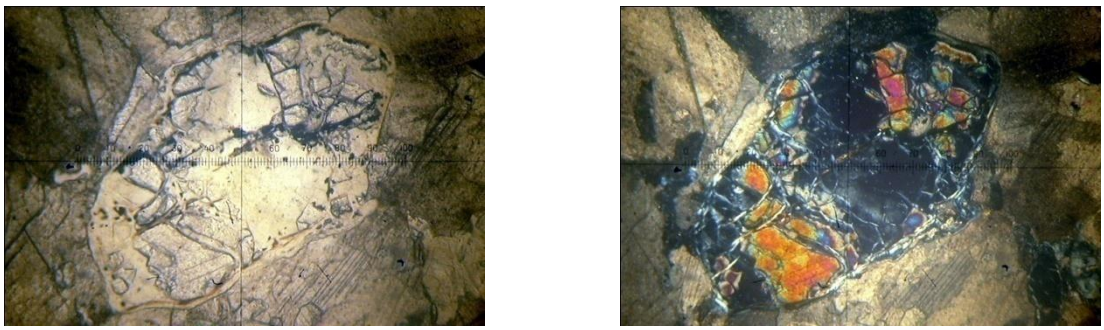

Fig. (14) Showing porphyroblast of forsterite in phlogopite-forsterite marble (PPL), (XN)

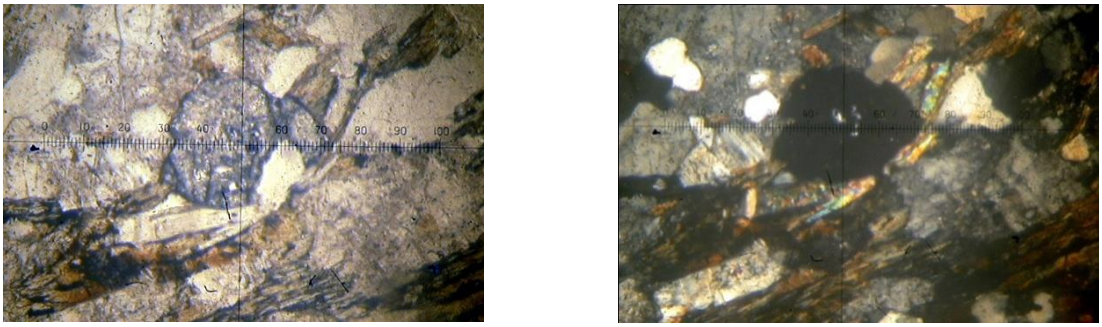

Fig. (15) Showing garnet which occur in garnet-mica schist (PPL), (XN)

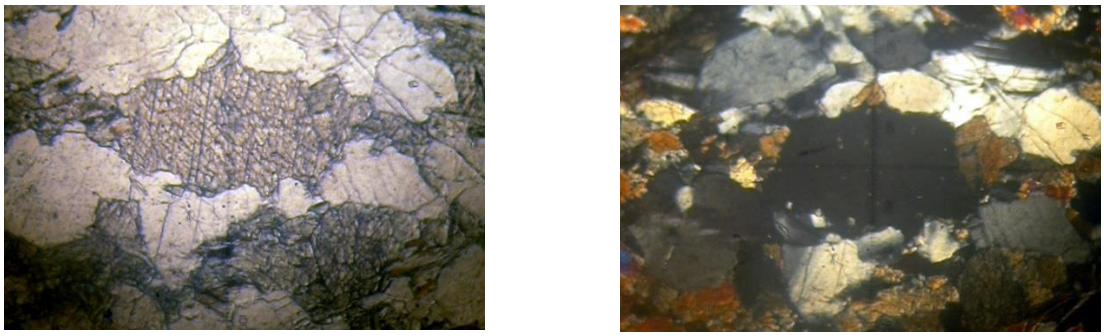

Fig. (16) Showing two sets cleavage of hornblende in hornblende biotite gneiss (PPL), (XN)

Quartz

It is very abundant in many rock types as an essential, accessory or secondary mineral. It is especially abundant in sandstone. It is also present in gneiss and schist. In the hand specimen, it occurs as colorless by quartz. The foliations of schist and gneiss are caused by quartz.

Under the microscope, it is colorless anhedral to subhedral crystal. It may occur as intergrown with orthoclase and plagioclase. It has absent cleavage and very low relief. The maximum interference color is first order white. Quartz gives irregular and wavy extinction caused by strain is common.

It has distinguishing features that are lack of alteration, absence of cleavage, absence of twinning and very low relief. It is associated with feldspar, hornblende and biotite. Quartz is also one of the most common detrital minerals.

Sphene

It occurs as a distributed accessory mineral in metamorphic rocks such as gneiss, schist and calc-silicate rocks. In the hand specimen, it is not visible. Under the microscope, it occurs as colorless euhedral crystal. It has parting directions are not parallel to the crystal outlines. It shows very high relief and the interference color is higher order white (Fig.17). It gives symmetrical extinction. It is associated with quartz and feldspar.

Spinel

It occurs in metamorphic rocks such as marble and also occur in metamorphic limestone. In the hand specimen, it occurs as red colourcoarse grained. Under the microscope, it is colorless subhedral to euhedral crystal. It may not show the cleavage. It has high relief and it is isotropic in XN. It does not show the twin plane. Spinel is associated with phlogopite, forsterite marble. It is rather common as detrited mineral (Fig. 18).

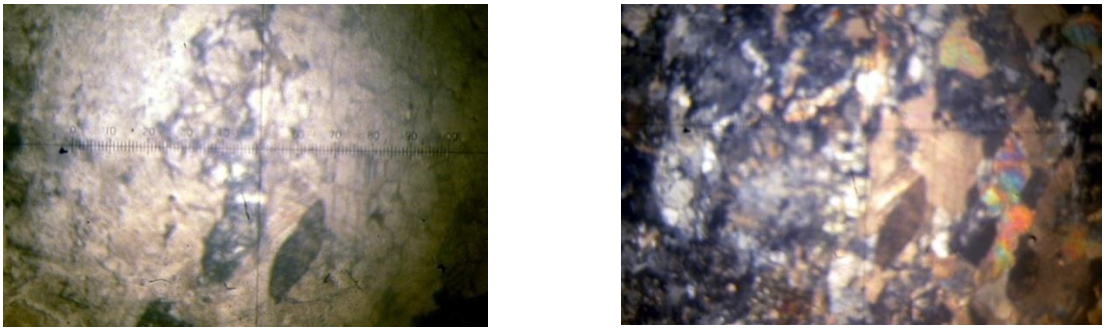

Fig.17 Showing sphene in diopside-phlogopite-forsterite marble (PPL), (XN)

Fig. (18) Showing spinel in phlogopite-forsetrite marble (PPL),(XN)

CONCLUSION

Sagaing metamorphics (Precambrian to Lower Paleozoic), and Minwun metamorphics (Middle to Upper Triassic ?) are presented. By the sedimentary rocks, Male Formation (Lower to Middle Eocene) and Irrawaddy Formation (Pontian to Villafranchian) are also presented.

The study area lies at the eastern margin of the Central Myanmar Tetriary Belt and close to western margin of Eastern High land. Sagaing metamorphics (marble, calc– silicate rocks and gneiss), Minwun metamorphics (garnet – mica – schist and actinolite schist) and Irrawaddy sandstone Male sandstone and alluvial are recognized. In the Sagaing metamorphics, marble can be divided into three units, phlogopite-diopside-forsterite marble, phlogopite-forsterite marble and white marble. Gneiss can be divided into three units, hornblende-biotite gneiss, biotite gneiss and leucogneiss. Garnet mica schist and actinolite schist are present in the Minwun metamorphics. In the study area, Male sandstone occurs in the western part of the study area and Irrawaddy sandstone are well exposed in the southern part of the study area.

The 16 minerals observed in the study area are actinolite, antigorite, biotite, calcite, chlorite, diopside, epidote, feldspar, forsterite, garnet, hornblende, muscovite, phlogopite, quartz, sphene and spinel.

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References

Chhibber, H.L, (1934).*Geology of Burma* : London, Mac. Millan.

Kan Saw, (1976). *Geology of the Northern Mingun-KabwetArea* : Univ. of Mandaly, Master's thesis.

Kerr, P.F, (1959).*Optical Mineralogy* : New York, McGraw-Hill, Inc.

La Touche, T.H.D, (1913). Geology of the Northern Shan States :*Mem. Geol.Surv.India,* v. 39.

MaungMaung, (1980). *Geology of the Kyaukta-Yega Area*:Univ. of Mandalay, report.

Maw MawMyint, (1993).*Geology of the Sheinmaga-HtonboArea*, Univ. of Mandalay.

Moorhouse, W.W, (1957). *The Study on Rocks in Thin Section*:New York, Harper & Row, Inc. N.

MyintThein, Kyaw Tint, and Kan Saw, (1979). Geology of the Easterm Margin of the Central Burma Belt between Sagaing and Tagaung:Univ. of Mandalay, unpub, report.

Rutley's,(2000).*Element of Mineralogy***.** 27^{th}ed, New Delhi, India.