Geology and Petrographical Characteristics of Metamorphic Rock Units Exposed in Zingyaik Area, Paung Township, Mon State

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Abstract

The research area is located in the northern part of Paung Township, Mon State. Topographically, it is moderately high relief and the prominent peaks are Kalama Taung (921m) and Zingyaik Taung (809m), and which is rich in the central part of the area. The drainage pattern shows especially in dendritic pattern. It is composed of igneous and metamorphic rock units. This research mainly focuses on the geology and petrographical characteristics of metamorphic rock units: gneiss with the age of Pre- Oligocene, banded quartzite, quartzite, phyllite and slate with the age of Early Carboniferous. It is randomly oriented feldspar phenocrysts gradually change to give rise to preferred orientation as a result of gradational transformation of porphyritic biotite granite into gneiss. Quartzite can be classified as two kinds: banding nature quartzite and sugary texture quartzite. According to identification of mineral assemblages, the facies of the regional metamorphism is considered to be greenschist facies and amphibolite facies and the metamorphic grade is low to medium grade and increasing from east to west.

Keywords: Zingyaik area, metamorphic units, regional metamorphism, greenschist facies, petrographical characterisitcs

INTRODUCTION

Location and Size

The study area is located in the northern part of Paung Townships, Mon State. It is bounded by the latitude N 16° 41′ 00″ to N 16° 45′ 00″ and longitude E 97° 25′ 00″ to E 97° 28′ 30″. It is extending area, N-S 4.8 km, E-W 7.2 km and the total covering area about is 43.2 km^2 in one inch topographic map No.94H/6 (Fig.1).

Physiography

Topographically, the area is moderately high relief and the highest peak is Zingyaik Taung (809m) and it is situated in the western part of the area. The western part and middle portion are the lowlying areas. In the eastern part, there are occasionally low hills and mounds, the highest point is (125m). The western most part is more rugged than the eastern part and most of the ranges are highly dissected, so that deep valleys and steep mountain slopes with many waterfalls are common.

In this area, the major streams of the Kadaik Chaung, Kogwe Chaung (local name) and Kyauk-thin-baw Chaung (local name) are flowing in NNW-SSE direction. Generally, the drainage density and texture of the whole area may be regarded as medium to coarse. The drainage pattern is mainly dendritic pattern and in some parts of the area is subparallel and parallel pattern in some parts of the area.

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REGIONAL GEOLOGY

The regional geologic setting of Zingyaik-Taung area and its environs shows in Figure (2). Regionally, it is located at the eastern margin of the central lowland and partly on the wstern margin of the Shan-Tanintharyi region. Igneous rocks along Shan boundary fault system and Tenasserim granitoids in the Sino-Burman Ranges are recently described by Bender (1983). It also lie along the Central granitoid belt and emplaced during continent-arc collision at the early stage of westward migrating, east dipping subduction zone during the Upper Mesozoic and Lower Eocene (Khin Zaw,1990).

As shown in figure, Zingyaik plutonic mass of Mesozoic age was intruded into metasedimentary rocks of the Upper Paleozoic age. This intrusion may be the northern continuation of Tin-Tungsten mineralized granite of Tanintharyi Division (Nyan Thin, 1984). The eastern and central part of the region is covered by alluvial plains. Tectonically and topographically, most parts of the region are trending more or less parallel, being approximately NNW-SSE.

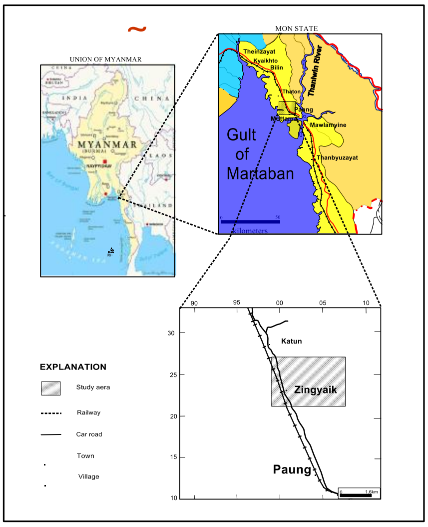


Fig 1. Location map of the study area

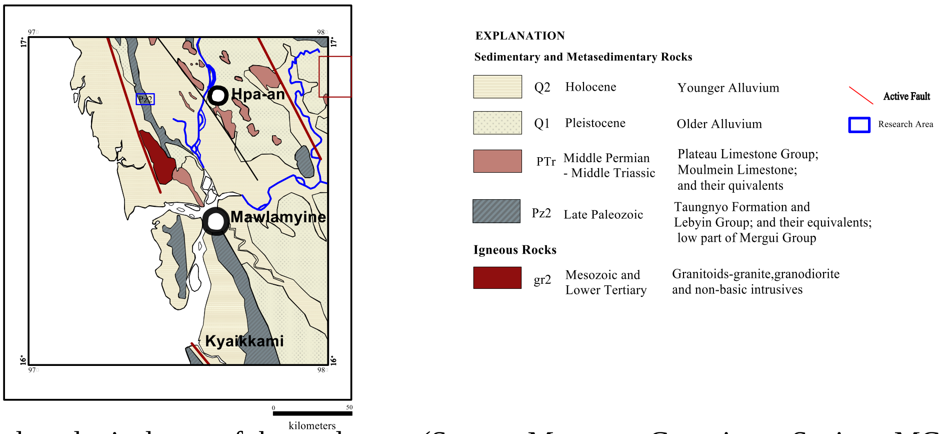


Fig 2. Regional geological map of the study area (Source; Myanmar Geoscience Society, MGS 2014)

Background Geology

The study area can be divided into two units such as older metamorphic rocks and younger granitic rocks. The metamorphic rocks mainly exposed in the easternmost and westernmost parts of the study area. Based on field observations, five metamorphic units were recognized: gneiss, banded quartzite, quartzite, phyllite and slate. Gneiss occupied in the westernmost part of the area. Geological map of the study area is shown in figure 3.

Rock sequence

The rock sequence is as follows Table. (1).

Table (1) Rock sequence of the study area

Rock Units	**Age**
Alluvium	Holocene
Older alluvium and lateritic soil	Pleistocene
Unconformity	
Igneous Rocks	
Biotite microgranite Porphyritic biotite granite	Probably late Cretaceous to early Eocene
Metamorphic rocks	
Gneiss	Pre- Oligocene
Slate Quartzite Phyllite Banded quartzite	Early Carboniferous

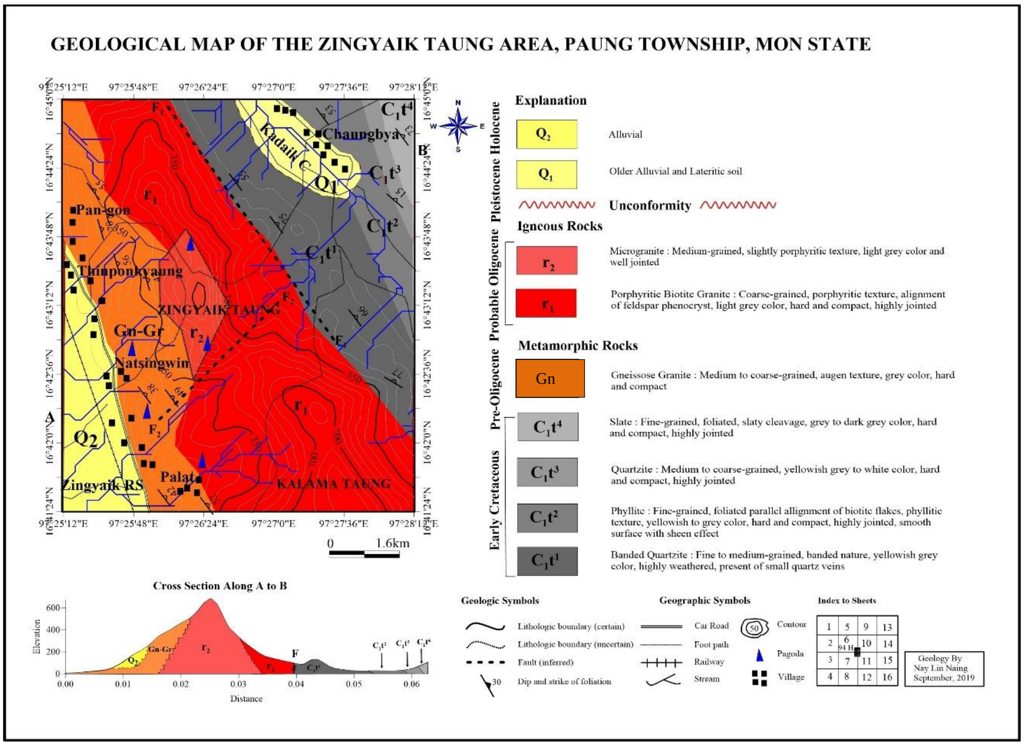


Fig 3. Geological Map of the eastern part of Zingyaik Taung area, Paung Township, Mon State. (After modified, Yi Lar Htun, 2009)

Metamorphic rocks

The metamorphic units of the study area occupiey in the eastern part of the area with their characteristic NNW-SSE trend. It is covered about 30% of the study area. They exposed in local areas, limited in extent and are mainly confined to the marginal portion of granitic body. The metamorphic rocks of the study area are subdivided into five units such as gneiss, banded quartzite, quartzite, phyllite and slate.

Gneiss

Generally, randomly oriented feldspar phenocrysts gradually change to give rise to preferred orientation as a result of gradational transformation of porphyritic biotite granite into gneiss. Fresh exposure of the rock shows greyish colour but turns to yellow or buff colour when weathered. In some places, the rock shows a close similarity in mineral composition with the former porphyritic biotite granite.

This unit is restricted to the peripheries of porphyritic granite body, especially at the westernmost part of the Zingyaik range. General trend of the foliation of this unit is NNW-SSE in direction. Sometimes feldspar altered to kaoline (Fig. 4). Exfoliation is distinct in this unit. (Fig. 5). It is highly jointed and small quartzofeldspathic veins are also observed (Fig. 6, 7).

Banded quartzite

Banded quartzite is the most abundant in metamorphic rock units. It is medium bedded, highly jointed and numerous quartz veins are found in it (Fig.8-a,b). The thickness of the quartz veins ranges from 0.5 inch to 1 inch. Banded nature due to parallel orientation of elongated quartz and mica flakes, (Fig.9-a,b).

Fig 4. Weathering (kaolinization) of gneiss at northern part of Zingyaik Taung (Loc.N16˚44´12.9˝ E97˚ 25´ 24.7˝, Facing 135˚)

Fig 5. Exfoliation or spheroidal weathering of gneiss at northern part of Zingyaik Taung (Loc.N16˚ 44´01.7˝E97˚25´32.6˝, Facing 60)

Fig 6. Quartzofeldspathic vein intruding into gneiss in near at China mine. (Loc.N16˚44´18.9˝ E97˚25´ 34.9 ˝, Facing120˚)

Fig 7. Vertical jointed nature of gneiss at near Palat Village (Loc.N16˚41´12.7˝E97˚25´55.6 ˝,

Facing174˚)

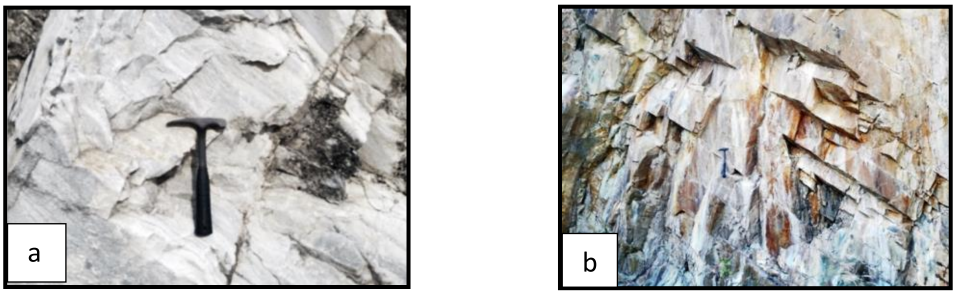


Fig 8. (a) Fine to medium-grained texture quartzite.
(Loc.N16˚41´02.7˝ E97˚26´3.1˝, Facing 335°)
(b) Highly jointed nature of quartzite at the eastern part of the Zingyaik mountain.
(Loc. N16˚43´52.2˝ E97˚27´26.6˝, Facing 244°)

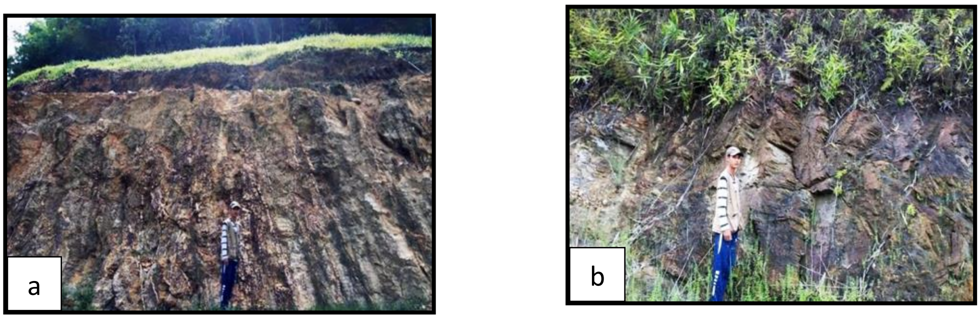


Fig 9. (a) Highly weathered of banded quartzite at near Kadaik Dam
(Loc. N16˚44´30.1˝ E 97˚28´1.5˝, Facing 72˚)
(b) Quartzite with poorly jointed nature at near Kadaik Dam
(Loc. N16˚44´34.1˝ E 97˚27´59.5˝, Facing 102˚)

Quartzite

It is hard and compact. It shows fine- to medium-grained, whitish to light grey coloured on the weathered surface. Some are rather coarse-grained and sugary in appearance (Fig. 10). They are well jointed where the most common being the nearly vertical sets (Fig. 10). Numerous quartz veinlets cross cutting these quartzite resulted a sort of criss cross pattern, Fig. (11).

Phyllite

The exposures occur along the Kadaik Chaung, (Loc. N16˚43΄48.7″ E97˚28΄9.6″, Facing 200˚) It is usually fine-grained, thin to medium bedded and bluish grey to grey colour. It shows phyllitic texture and well jointed nature. It shows east dipping and trending in NNW-SSE direction Fig.(12-a). At the kadaik dam, this unit is intercalated with slate (Fig.12-b).

Slate

In the easternmost part of the area, it is intercalated with phyllite (Fig. 14). This unit is generally grade into phyllite in the west due to increasing metamorphic grade. Minor fold is also occurred in this unit, Fig (13).

Fig 10. Well jointed nature of quartzite at eastern part of Kadaik Dam. (Loc. N16˚44΄42.7″ E97˚27΄ 52.2″, Facing 65˚)

Fig 11. Small quartz veins are intruded into quartzite at near Kadaik Dam. (Loc. N16˚43΄31.1″ E97˚27΄47.5″, Facing 23˚)

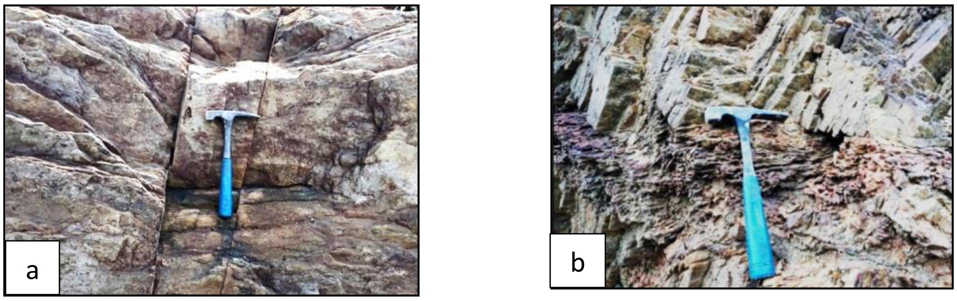


Fig 12. (a) Jointed nature of Phyllite at eastern part of Kadaik Dam (Loc. N16˚43΄48.7″ E97˚28΄9.6″, Facing 200˚)
(b) Phyllite intercalated with slate at eastern part of Kadaik Dam. (Loc. N16˚43΄15.2″ E97˚28΄8.8″, Facing 55˚

Fig 13. Minor fold in slate at near Kadaik Dam. (Loc. N16˚44΄4.2″ E97˚28΄12.9″, Facing 60˚)

Fig 14. Vertical jointed nature of slate at near Kadaik Dam. (Loc. N16˚44΄28.1″ E97˚ 28΄6.6″, Facing 53˚)

PETROGRAPHY

Microscopic description of gneiss

The mineral constituents for the most parts are similar to those of the porphyritic biotite granite especially in containing alkalifeldspar, quartz and plagioclase feldspar. Biotite, sphene, apatite and opaque minerals are as a rule found as accessory minerals. The rock on the whole is coarse-grained, with a peculiar porphyroblastic gneissose texture and augen structure.

Quartz usually occurs as anhedral grains which sometimes show effects of granulation, sutured boundaries and strain shadows. The mineral tends to show more elongated character as compared with the quartz of the parent granite. Large grains exhibit wavy extinction. Mosaics of small quartz grains are also present. Fractured quartz crystals are also occurred (Fig. 15).

Alkalifeldspar comprises orthoclase, microcline, and perthite. Various types of perthites are beautifully observed such as string perthite, path perthite and microcline perthite (Fig. 15, 16, 17). Tectonically produced augen structure of K-feldspar is surrounded by recrystallized and plastically mobilized quartz and biotite (Fig. 18, 19, 20). Plagioclase is subhedral in shape. Numerous fractures and bent twin lamellae are quite common in it. Biotite is more or less fresh but sometimes it is partially altered to chlorite. Foliation of the rocks can be traced by making use of alignment of biotite flakes. Its cleavages are bent (Fig. 21). Opaque minerals like magnetite and apatite occur as accessory minerals biotite flakes. Its cleavages are bent (Fig. 21). Opaque minerals magnetite and apatite occur as accessory minerals.

Microscopic description of banded quartzite

It is mainly composed of quartz, mica, orthoclase, chlorite and iron ore. Faint to moderate foliation due to parallel orientation of elongated quartz and mica flakes, (Fig.22,23). Biotite occurs as minute flakes and muscovite occurs as thin tabular shaped. Accessory minerals are epidote, chlorite, apatite and opaque minerals.

Microscopic description of phyllite

It is mainly composed of quartz, biotite and muscovite. Quartz grains are subrounded and they also occurred in fine-grained groundmass. It shows well foliated texture. Biotite is common in this unit. Elongated quartz grains and mica flakes are parallel to the alignment, (Fig.24**).**

Microscopic description of quartzite

Quartzite as it's name implies, is chiefly composed of fine to medium-grained quartz with granoblastic mosaic of equant grains, forming interlocking sutured boundaries (Fig. 25-a,b). Biotite makes up about 3% to 5% of total grains and some are partly or wholy altered to chlorite. The content of biotite in rock varies from place to place. Among the grains, quartz constitutes about 50% to 60% and alkalifeldspar makes up 5% to 10% of the total grains. Plagioclase are partly altered to sericite. Most of the alkalifeldspars are orthoclase and microcline.

Microscopic description of slate

It shows slaty texture and is mainly composed of minute quartz, biotite, chlorite and sericite, Fig. (26 a,b).Some quartz porphyroblasts are recrystallized along the foliation planes. Strain shadow effects on quartz grains are noted.

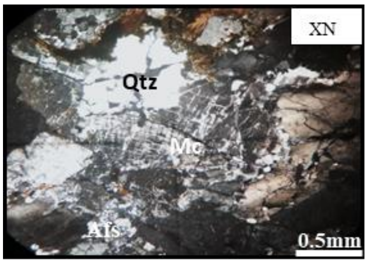


Fig 15. Photomicrograph showing fracture quartz grain and microcline perthite in gneiss.

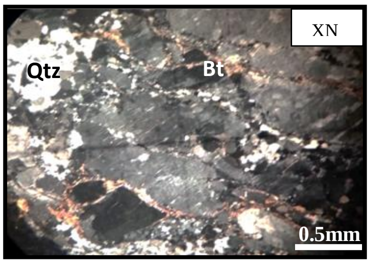


Fig 16. Photomicrograph showing string perthite in gneiss.

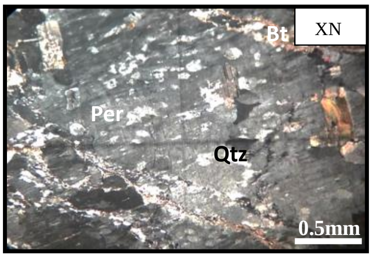


Fig 17. Photomicrograph showing patch perthite in gneiss.

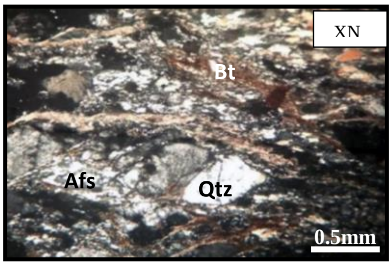


Fig 18. Photomicrograph shows marginal granulation and biotite flakes swirl around the phenocrysts showing augen structure in gneiss.

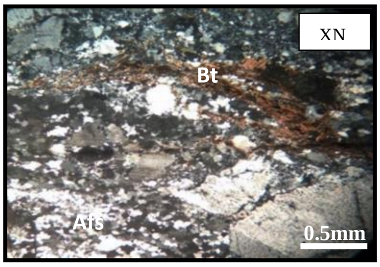


Fig 19. Photomicrograph showing marginal granulation alkalifeldspar phenocrysts in gneiss.

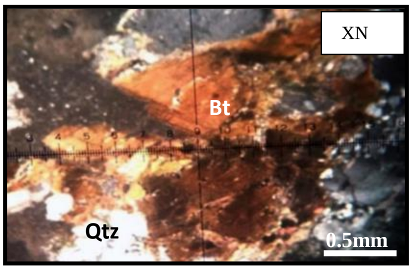


Fig 21. Photomicrograph showing marginal granulation and curved twin planes of biotite flakes in gneiss

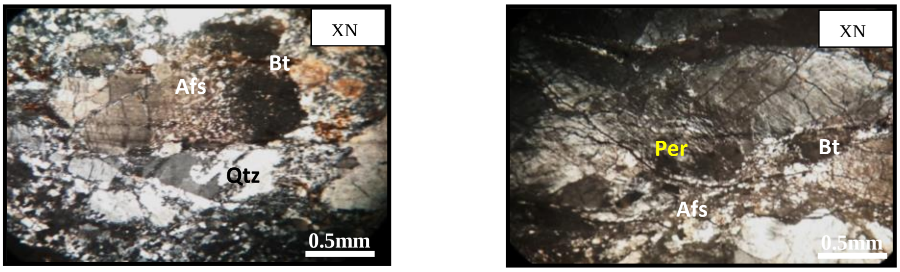


Fig 20. Photomicrograph showing sericitization of alkalifeldspar phenocrysts in gneiss.

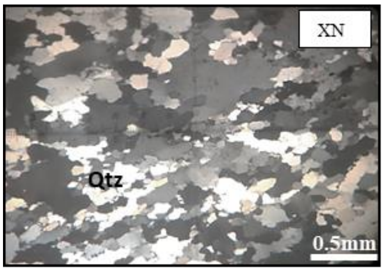


Fig 22. Photomicrograph showing suture contact and elongated quartz(qtz) in banded quartzite between XN, 4X.

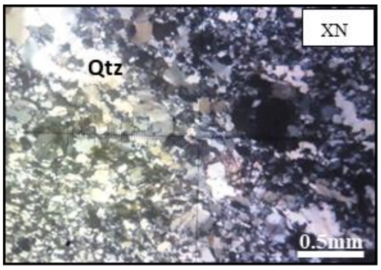


Fig 23. Photomicrograph showing The foliation of quartz (qtz) grain in banded quartzite between XN, 4X

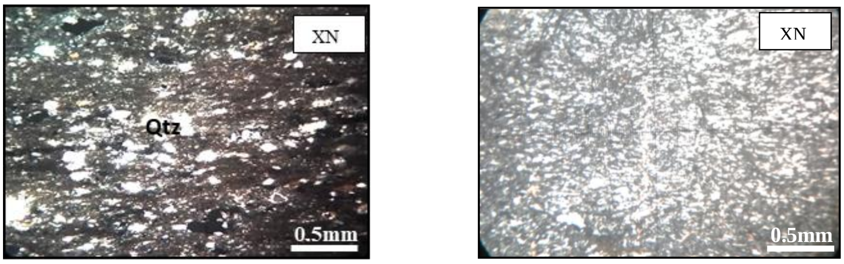


Fig 24. Photomicrograph showing small quartz grains are aligned with mica in phyllite

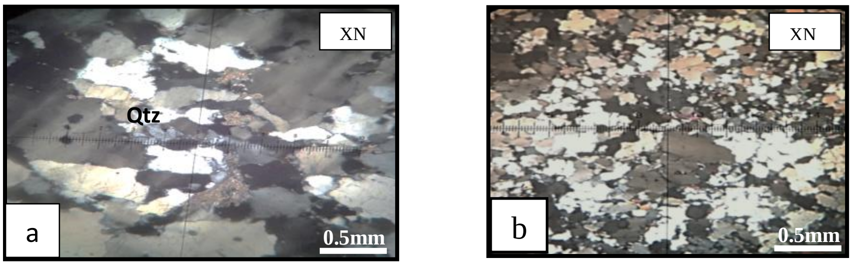


Fig 25. (a)and (b) Photomicrograph showing sutured contact and undulosed extinction of quartz in quartzite.

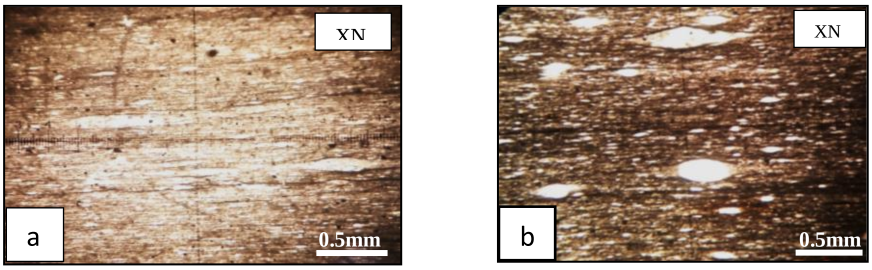


Fig 26. Photomicrograph showing minute elongated quartz are parallel with mica in slate, (a) and (b).

Mineral Assemblages, Metamorphic Facies and Grade

The area under investigation had experienced is a major regional metamorphism. Evidences of regional metamorphism are observed the most study area. Especially, the common rock types are gneissose granite, banded quartzite, phyllite, quartzite and slate.

Mineral assemblages, facies classification and nomenclature are mainly based on Winkler (1979), Hyndman (1985), Bucher & Frey (1994) and Winter (2013). According to the mineral assemblages notably two types of metamorphic facies are recognized such as greenschist facies and amphibolite facies (Table-4.1). AKF diagrams of representative mineral assemblages are as shown in Fig. (4.1, 4.2).

The probable P-T condition of regional metamorphism rocks of greenschist facies range in temperature between 300˚C-450˚C and pressure 2 kilobars to 9 kilobars and amphibolite facies range in temperature between 450˚C to 700˚C and the pressure is about 4 kilobars to 10 kilobars. (Turner, 1968) (Fig.4.3). In the study area, based on field relationships and mineral assemblagesthe, it may be concluded the metamorphic grade is increasing from east to west and subjected to low to medium grade regional metamorphism.

Mineral assemblages and metamorphic facies of study area

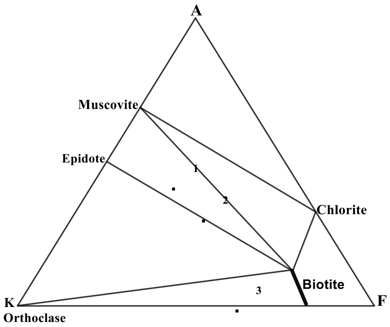
Regional Metamorphism

I. Greenschist Facies

Pelitic groups		**Mineral assemblages**
1. Phyllite	-	biotite + quartz + muscovite
2. Slate	-	biotite +quartz +muscovite
Quartzofeldspathic Group		**Mineral assemblages**
3. Banded quartzite	-	quartz+orthoclase+plagioclase+ biotite+muscovite+chlorite

II. Amphibolite Facies

Quartzofeldspathic group		**Mineral assemblages**
1. Gneissose granite	-	orthoclase+quartz+plagioclase+biotite+ muscovite+microcline±epidote
2. Quartzite	-	quartz+orthoclase+biotite+muscovite
	-	quartz+plagioclase+orthoclase+ biotite+epidote



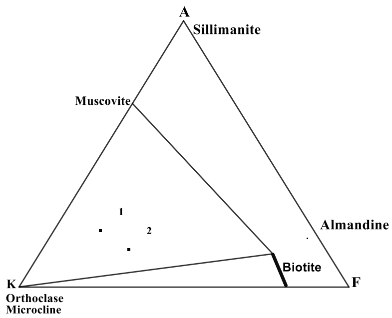


Fig (4.1) AKF diagram of greenschist facies (after Turner and Verhoogen, 1960)
Fig (4.2) AKF diagram of amphibolite facies (after Turner and Verhoogen, 1960)

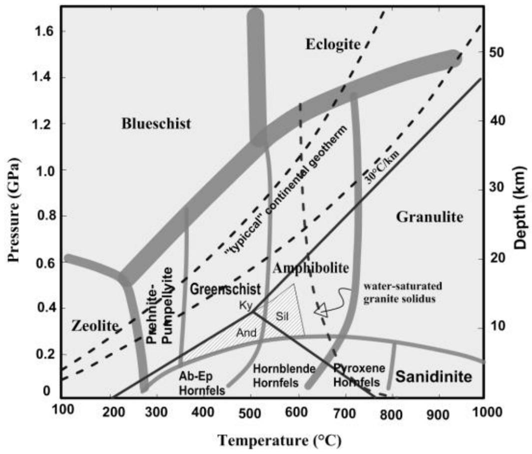


Fig (4.3) P-T diagram illustrating the probable metamorphic condition of the study area (Winter, 2013)

CONCLUSION

The study area is located in Zingyaik area, Paung Townships, Mon State. Topographically, the area is moderately high relief and the highest peak is Zingyaik Taung (809m) and it is situated in the western part of the area. The westernmost part is more rugged than the eastern part and most of the ranges are highly dissected, so that deep valleys and steep mountain slopes with many waterfalls are common. Generally, the drainage density and texture of the whole area may be regarded as medium to coarse. The drainage pattern is mainly dendritic pattern and in some parts of the area is subparallel and parallel pattern. Regionally, Zingyaik plutonic mass of Mesozoic age intruded into metasedimentary rocks of the Upper Paleozoic age. The study area can be divided into two units such as older metamorphic rocks and the younger granitic rocks. The metamorphic rocks mainly exposed in the easternmost part of the study area and which comprises gneiss, banded quartzite, phyllite, quartzite, and slate. On the basis of mineral assemblages, the facies of the regional metamorphism is considered to be greenschist facies and amphibolite facies. The probable P-T condition of the regional metamorphism of greenschist facies range in temperature between 300˚C-450˚C and pressure 2 kilobars to 9 kilobars and amphibolite facies range in temperature between 450˚C to 700˚C and the pressure is about 4 kilobars to 10 kilobars. (Turner, 1968). In study area, the metamorphic grade is low to medium grade and increasing from east to west.

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References

Hla Yin Min, 2009. “Petrological Study on Zingyaik Taung Area, Paung Township, Mon State”. (Unpublished MSc. Thesis), Mawlamyine University.

Kerr, P.F, 1959. Optical Mineralogy, Mc.graw hill book companu, New York.

Khin Zaw, 1990. Geological, Petrological and Geochemical characteristics of Granitoid rocks in Burma (Unpub).

Khine Khine Thet Lwin, 2014. Petrology of Zingyaik area, Paung Township, Mon State: Unpub. PhD. Dissertation,University of Yangon.

Khin Myo Min, 2015. Mineralogical and Petrological Studies of the Igneous and Metamorphic Rocks of the Eastern Part of Myohla-Yeni Area, Yedashe and Thandaunggyi Township: Unpub. PhD. Dissertation, University of Yangon.

Turner, F.J., 1968. Metamorphic Petrology, Mineralogical Petrology. Mc. Graw-Hill Book Company, p.403.

Winkler,H.G F, 1979. Petrogenesis of Metamorphic Rocks, Springer-Verlag New York INC. p.348

Yi Lar Htun, 2009. "Petrological point of view on Kalama Taung area, Paung Township, Mon State: M.Sc. Thesis, Mawlamyine University.