# Petrography and Petrogenesis of Low - Grade Metamorphic Rocks of Pang Yawng Area, Kyaing Tong Township, Eastern Shan State

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**Abstract**

The study area is situated about 8 km north of Kyaing Tong. Kyaing Although Kyaing Tong area is well-known in Kyaing Tong Granite which is mainly made up of different granitoids associated with low-grade metamorphic rocks and sedimentary rocks. This study was made on the focus of petrology and petrogenesis of low grade metamorphic rocks. This is the first reported for petrography and petrogenesis works of these rocks from the study area. There have no earlier petrological studies available for this area. Low-grade metamorphic rocks are slate, quartzite and argillite units. Microscopic study of argillite lack in this study but it is described only field relationship. Host rocks may be pelitic rocks and psammitic rocks of turbiditic sediments of Chaung Magyi Group (Upper Precambrian age) which are characterized by low pressure and temperature retrograde metamorphism. Biotite+muscovite +chlorite+quartz mineral assemblages are recognized in this area.

**Keywords:** low-grade metamorphic rocks, petrography, petrogenesis and Kyaing Tong

## Introduction

The study area is situated about 8 km north of Kyaing Tong. It covers a part of 93O/11, one inch topographic map. This area is included in UTM map sheet No.2199/11. Kyaing Tong – Mong La car roads pass through the study area. The location map and satellite image of the study area are shown in figures (1) and (2). Geological map of the Pang Yawng-Wan Ping area, Kyaing Tong Township, Eastern Shan State is shown in figure (3).

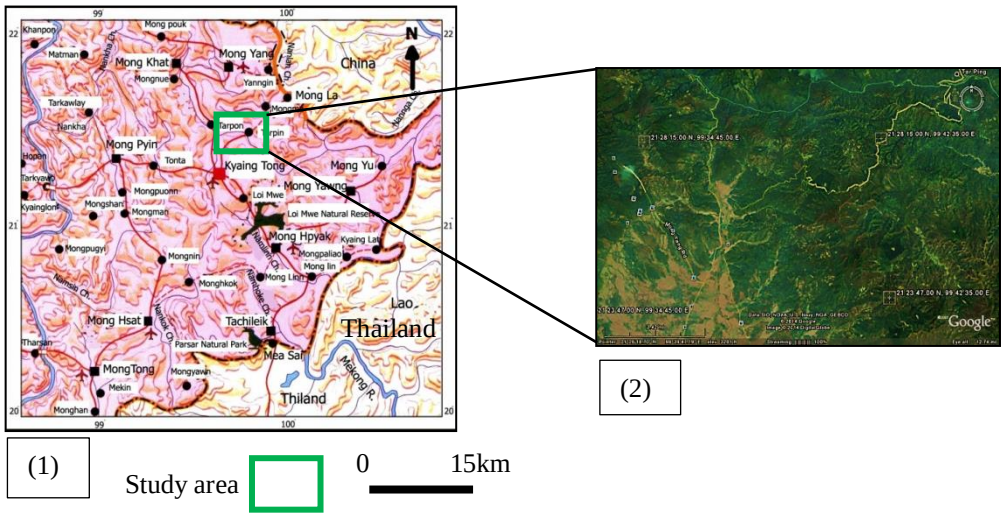


Figure (1). Location map of the study area.

Figure (2). Satellite image of the study area. (Source: Google Earth, 2014)

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## Methods of Study

The following field methods and laboratory methods have been carried out for the present work.

### Field Methods

1. Using the compass and bearing method.
2. Using GPS method for locating geological elements.
3. Using field equipment and technique for detailed field studies.
4. Surveying detail data collection for geological mapping of the study area.
5. Systematic sampling of rock samples from surface outcrops for petrographical studies.

### Laboratory Methods

Representative rock samples were collected from distinctive lithologic units covering the study area. Detailed microscopic studies were made on more than 20 thin sections cut from representative samples. For detail microscopic identification, the works of William, Turner and Gilbert (1953), Kerr (1959), Harker (1964), Yardley, MacKenzie and Guilford (1990), Barker (1998) and Raith, Raase & Reinhardt (2011) are used.

## Regional Geologic Setting

The study area in the easternmost province of Myanmar, comprising high lands and plateaus, east of the Sagaing fault, referred to as the Eastern High Lands Province (EHP) covers the entire eastern half of the country, located in the western part of the older micro-continental block, known as the Shan-Thai Block (STB) which is part of the Sibumasu Block (SB). The Sibumasu Block was also sutured with the Indochina Block to the east, forming a more extensive landmass called Sundaland which covers much of the mainland of Southeast Asia and is often addressed as Sunda Plate or Southeast Asian plate (Win Swe, 2012). This region is geotectonically situated in the eastern part of Shan- Tenasserim Block. Also it forms part of the land mass of the Indo-Chinese Peninsula (Yunnan, Thailand and Malaysia), which extends to the south in Sundaland (Hutchison, 1973). The easternmost part of the study area is approximately bordered by the Mekong River. The middle course of the river is largely controlled by the regional position of granitic intrusions and metamorphic rocks mostly situated on the right bank of the river regionally trending NE to NS striking bands. They are regionally presumably interrupted by intercalations of marine rocks which are probably due to the episodic inundations (Wolfart, 1984). Shan-Thai Block is situated to the west of the Ailaoshan and Nan- Uttaradit sutures and to the east of the Lujiang and Pan Laung Fault (Bunopas, 1994). Together with southwestern Yunnan it also covers eastern Myanmar (including the present study area), most of the western and Peninsula Thailand and western Peninsular Malaysia (Quinglai Feng, 2005). The present area lies within the Eastern Granitoid Belt of Myanmar (Khin Zaw, 1990).

## Rock Sequence of the Study Area

The rock sequence of the study area is shown in (Table 1). The rock sequence is established on the basis of the field relationships and geochronology.

Table (1). Rock Sequence of the Study Area.

| Rock Units | Age |
|---|---|
| Alluvium<br>Pegmatite/Aplite<br>Hornblende Granite<br>Porphyritic Biotite Granite<br>Foliated Granite<br>Biotite Granite<br>Leucogranite<br>Granodiorite | Quaternary<br><br><br>Late Triassic (Gardiner et,al.2016) |
| Argillite<br>Slate<br>Quartzite | Upper Precambria (Roughly equivalent to Chaung Magyi Series)<br>(Khin Zaw, 1990 & Maung Thein, 2014) |

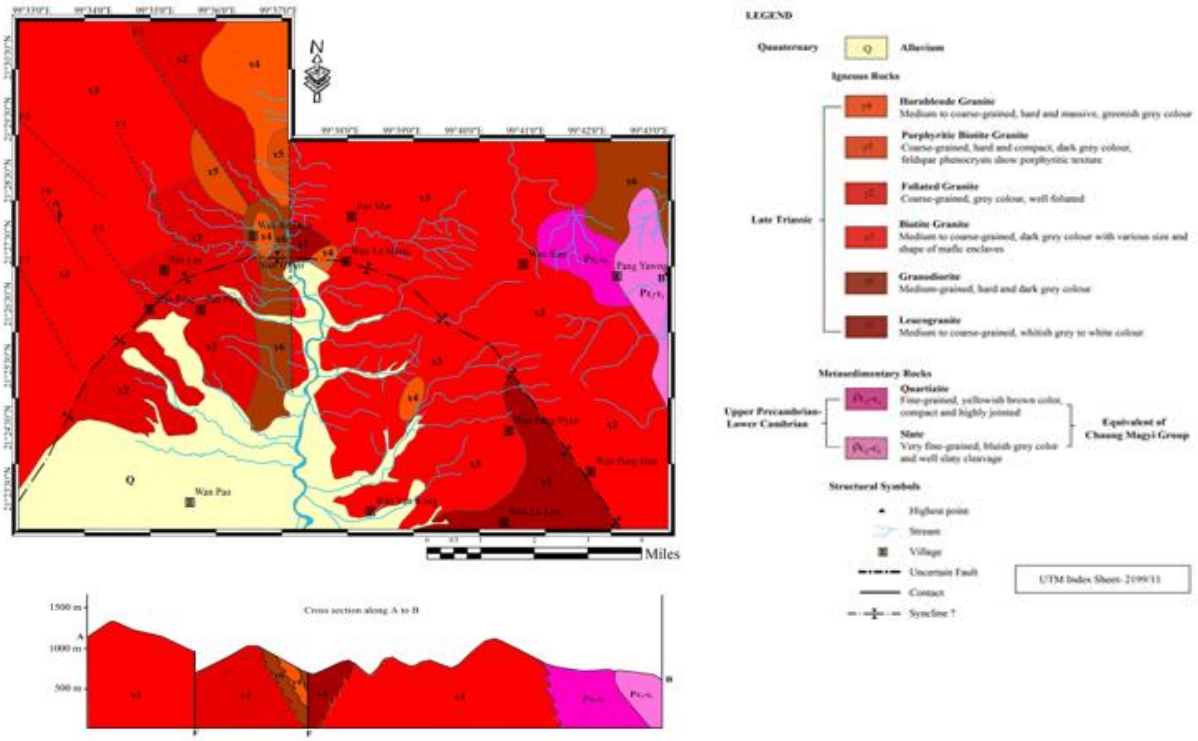


Figure (3). Geological map of the Pang Yawng – Wan Ping Area, Kyaing Tong Township, Eastern Shan State.

## Petrography

### Quartzite

Quartzite is observed in the northeasternmost part of the area, especially near Pang Yawng village (Loc 21º 27′ 15.7″ N & 99º 42′ 07.8″ E). Lithologically, it shows fine-grained, hard, yellowish brown on weathered surface and yellowish white color on fresh surface. It is 0.5m to 1.8m in thick in individual bedding. It is mainly composed of quartz grains. It is found together with slate in outcrop. Alternating slate and quartzite are frequently found in the field (Fig. 4.a). Outcrop nature yields pseudo bedding by intercalation of slate layer (Fig. 4.b). Microscopically, it shows fine grained, granoblastic texture. It is composed of 90%

quartz with alkali feldspar and plagioclase in minor amount. Quartz grains ranges from 0.1mm to 3mm in diameter and characterized by concavo convex contact, suture contact and wavy extinction (Fig. 4.c). Strongly interlocking textures are also observed. Some quartz grains show granulation features probably due to intense deformation. Some quartz grains are elongated, partially recrystallized, strain shadowed and preferably oriented (Fig. 4.d).

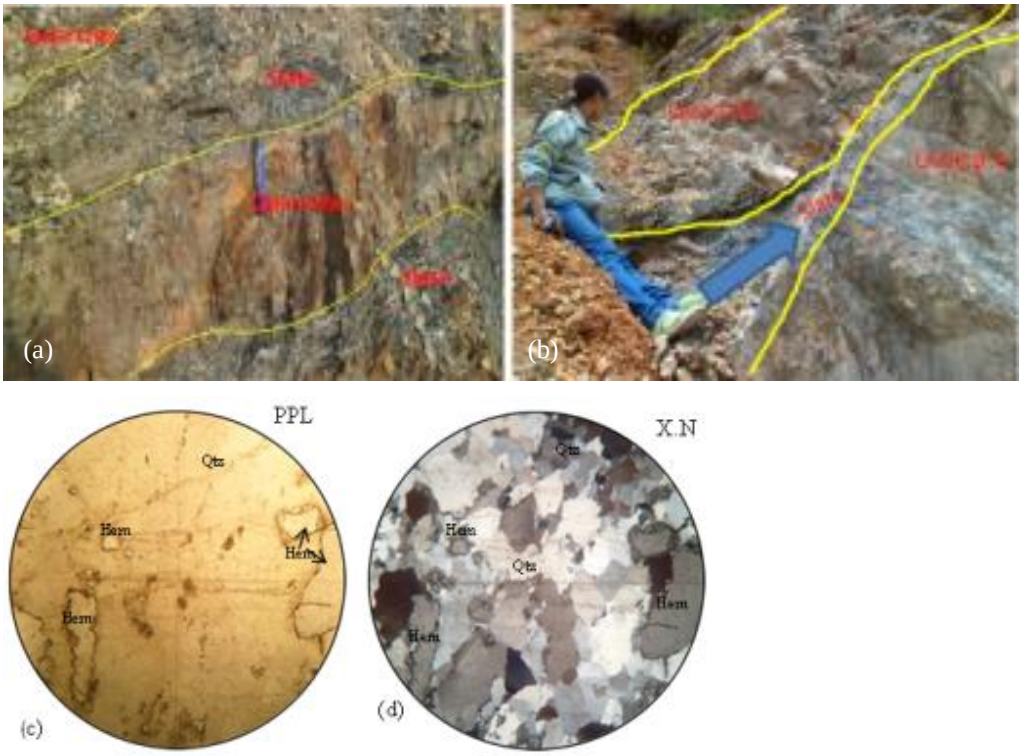


Figure (4). (a). Alternate layers (inter-bedded) of yellowish brown quartzite and highly brecciated bluish grey slate found NE of Pang Yawng village (Loc. 21º 27′ 15.7″ N & 99º 42′ 07.8″ E), (b). Outcrop of reddish brown quartzite exposed in the vicinity of Pang Yawng village (Loc. 21º 27′ 15.7″ N & 99º 42′ 07.8″ E), (c). Photomicrograph showing quartzite, under PPL view and (d). Photomicrograph showing hematite (Hem) in quartz (Qtz) crystals with intergrowth boundaries, suture contact and concavo convex contact showing wavy extinction in quartzite, under XN view. Field of View (FOV) is 3mm.

## Slate

Slate is well exposed along the Kyaing Tong - Mong La road section, especially just north of Pang Yawng village. Megascopically, it is very fine grained, bluish grey on weathered surface (Fig. 5.a) and dark color on fresh surface. Slaty cleavage is a distinct character of this unit which is well exposed in some places. Foliated and intense weathered nature is clearly seen in the field (Fig. 5.b). Minor fault is noted in this unit. Due to less induration, the layer is readily crushed and is being ground due to intense weathering and deformation. It is recognized together with intercalated quartzite band (Fig. 5.c & 5.d). Microscopically, slate is low grade aphanitic metamorphic rock that has a dull luster on well-developed pervasive slaty cleavages. It is mainly composed of aphanitic platy phyllosilicate minerals. This rock contains detrital grains of quartz and alkali feldspar. Quartz crystals are elongated and give parallel alignment due to intense deformation processes. At an advanced

stage of diagenesis, the clay minerals are altered to dominantly chlorite. Chloritization, epidotization and sericitizations are also noted along the cleavage planes. Parallel alignment of foliated texture is clearly seen under X.N (Fig. 5.e & 5.f). Micro fault and secondary deformation are also noteworthy.


Figure (5). (a). Outcrop of weathered slate bed showing bluish grey at northeast of Pang Yawng village (Loc 21º 27′ 08.8″N and 99º 42′ 06.8″E), (b). Close-up view of slaty cleavage developed in slate unit (Loc 21º 27′ 10.1″N and 99º 42′ 07.1″E), (c). Contact of slate bed and quartzite, (d). Slate layer alternated with quartzite band at northeast of Pang Yawng village (Loc 21º 27′ 08.8″N and 99º 42′ 29″E), (e) Photomicrograph showing distinct slaty cleavage, under XN, and (f) Well foliated texture and parallel alignment of elongated quartz (Qtz), green chlorite (Chl) and platy phyllosilicate minerals, under XN. FOV is 3mm.

### Argillite

This unit is observed in the northeastern part of the study area, especially northeast of Pang Yawng village (Loc 21º 27′ 07.7″ N & 99º 42′ 06.2″ E). Megascopically, it is very fine-grained, readily crushed by hand and massive in nature. Weathered surface shows black color and fresh surface is light grey to yellow (Fig. 6.a). It consists mostly of mud and shale components. They have been altered and indurated by pressure and cementation. In some outcrops, it is fairly brecciated (Fig. 6.b). Judging from field observation this unit is the lowest grade metamorphic rock / metasedimentary rock of the area.


Figure (6). Well - bedded nature of buff color argillite exposed northeast of Pang Yawng village, (a) outcrop view and (b) close-up view. (Loc 21º 27′ 07.7″ N & 99º 42′ 06.2″ E)

## Petrogenesis

### Type of Metamorphism

In the study area, regional metamorphism is mainly confined to the northeastern corner of the study area. Host rocks may be pelitic rocks and psammitic rocks in view of the occurrences of low grade slate, quartzite and argillite. Quartzite is limitedly exposed at the northeastern margin of granitic batholiths. Quartzite intercalated with slate and argillites are distinctly affected by low pressure and temperature retrograde metamorphic rocks. It may be considered as it is formed during uplifting and cooling processes of pelitic and psammitic rocks. It is true theory that retrograde alteration mineral assemblages are indicative of lower temperatures and/ or pressures of crystallization than the peak temperature assemblages in crystalline rock, their most distinctive features is that they almost invariably involve hydration (Schwartz & Todd, 1941).

### Metamorphic Facies

The metamorphic facies classification, nomenclature and defining mineral assemblages used in this study are based on the works of Turner (1967), Winkler (1979), Miyashiro (1973) and Hyndman (1972, 1985). Representative mineral assemblages of AKF diagram is shown in (Fig. 7). Greenschist facies is observed in the northeastern part of the study area where quartzite intercalated with slate and argillites are well exposed. Biotite + muscovite + chlorite + quartz mineral assemblages indicate that they belong to the greenschist facies. The greenschist facies area is more typically reflected through due to the continent-continent collision (after Miyashiro, 1973). The following mineral reactions and relations might have determined the metamorphic facies and metamorphic grades in the study area.

Slate typically contains chlorite, muscovite, biotite, quartz and accessories as albite. Argillite is mainly composed of detrital k-feldspar and chlorite, from which biotite can be formed by the reaction:

K-feldspar + chlorite $\longrightarrow$ biotite + muscovite + quartz + $H_2O$ (Winkler, 1979)

Quartzite intercalated with slate occurs in some parts of the area. This suggests the prevalence of greenschist facies of regional metamorphism.

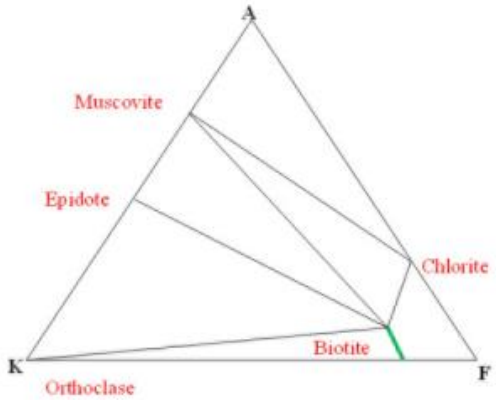


Figure (7). AKF diagram showing the mineral assemblages of Greenschist facies (After Hyndman, 1985)

**Possible Pressure- Temperature Estimation**

The P-T conditions for the reaction and formation of metamorphic mineral assemblages in the study area can be estimated as follows. Greenschist facies is usually occurred at the temperature range about 300˚ C to 500˚ C and pressure 2kb to 4kb (Winkler, 1979). For this reason, the estimate P-T condition of metamorphism in the study area may range from 2-4kb and 300˚C-500˚ C in (Fig. 8).

Low grade metamorphic rocks of slate, quartzite and argillite in the area are entirely devoid of any relic fossil which is assigned to older age. But they are regarded as regionally metamorphosed by turbiditic sediments of Chaung Magyi Group (Upper Precambrian age) according to Khin Zaw (1990) and Maung Thein (2014).

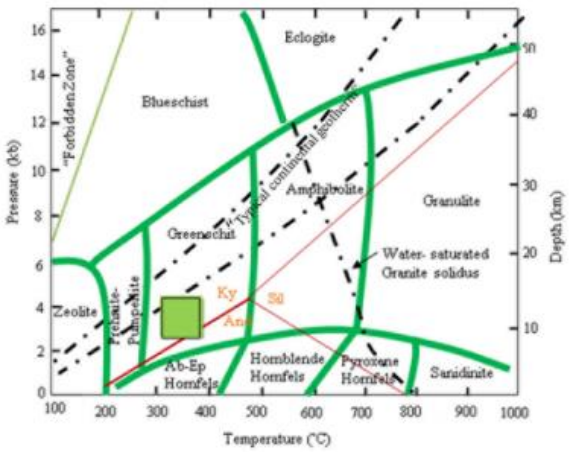


Figure (8). Possible Temperature-Pressure diagram showing the probable conditions of metamorphism of the study area. (after Winter, 2010)

## Regional Tectonic Setting

Plate tectonic interpretations of geological events within the Burmese region have been made by many workers in recent years (Mitchell, 1977, Mitchell and Garson, 1976, Goossens, 1978, Curray *et al.*, 1979, 1982, Hla Maung, 1980, 1987, Win Swe, 1981a, b, Maung Thein, 1983, Bender, 1983, Khin Zaw, 1986, 1987a, 1989). Barber, Khin Zaw and Crow (2017) stated that geologically, Myanmar can be divided into seven north-south tectonic units. From west to east these are: (1) Indo-Myanmar Ranges; (2) West Myanmar (Burma) Block; (3) Mogok Metamorphic Belt; (4) Slate Belt; (5) Paunglaung Mawchi Zone; units 3, 4 and 5 also comprise the (6) Shan Scarps Area; and (7) Shan Plateau. They mentioned that the eastern Myanmar, like the western part of Thailand, is considered to form part of Sibumasu. The study area is entirely comprised in Shan Plateau. The Pang Yawng - Wan Ping area is underlain by Kyaing Tong batholiths which from the important part of eastern granitoids belt of Myanmar (Khin Zaw, 1990). Tawngpeng granitoid (La Touche, 1913) is also northern part of eastern granitoid belt of Myanmar. It lies in the northern Shan State and occurs as a very large intrusion in NE Myanmar, comprising Bawdwin Mine, a volcanic-hosted, Ag-rich, polymetallic (Pb-Zn-Cu-Ag-Ba) massive sulfide deposit (Khin Zaw, 1990) as far north as the Myanmar-Chinese border and extends northwards into Yunnan. Northern portion of the eastern granitoid belt of Myanmar, the Tawngpeng granitoids intruded the Chaung Magyi Group of Upper Precambrian age. On the other hand, main bodies of eastern granitoid belt of Myanmar, the Kyaing Tong granitoids also possess the same geological characteristics. Eastern granitoid belt of Myanmar lies in important mineralized granitoid province in the Southeast Asian region. It is geographically considered as a part of the Shan-Thai Block, tectonically defined as a part of Sibumasu Block, especially considered as a northern continuation of Inthanon Zone of central granitoid belt of Thailand.

Khin Zaw, (1990) described that the eastern belt granitoids extend southwards and are geographically continuous with Triassic granites of northern Thailand and Sn-W-bearing, mesozonal, Permo-Triassic granitoids of Western Malay Peninsula further south. He stated that the eastern belt granitoids intrude the turbiditic Chaung Magyi Group of Upper Precambrian age. Beckinsale *et al.*, (1979) also suggested a volcanic arc setting for the Permian and Triassic volcanic rocks in central northern Thailand.

In Malaysia, Hutchison (1977) demonstrated on the basis of radiometric dating the Sn-W bearing, mesozonal Main Range granitoids in western Malaysia and the epizonal, Boundary Range granitoids in the eastern Malaysia. Malay Peninsula are predominantly of Permian to Triassic, whereas the Sn related, granitoid rocks in the northern Thailand are mostly Triassic (e.g. Teggin 1975, Besang *et al.*, 1975). Mitchell (1977) maintained that the Permo-Triassic, epizonal granitoid plutons in eastern peninsular Malaysia were emplaced in a continental crust above an east-dipping subduction zone and the granitoid plutons in the western Malay Peninsula and northern Thailand were emplaced during continental collision related to the Upper Triassic "Indosinian Orogeny". The present study area is concerned with the Indosinian II event of Late Triassic closure of Palaeotethys with respect to both I & S-types granitoids of the area (Khine Zar Wai, 2018).

## Conclusion

This work is a newly reported of petrology and petrogenesis of low-grade metamorphic rocks exposed at the Pang Yawn area. These rocks are occurred association with biotite granite pluton (near Pang Yawng village) of Kyaing Tong batholiths. But sharp contact does not occur between biotite granite and quartzite intercalated with slate units. The

distinctive features of low- grade metamorphic rocks are slate, quartzite and argillite. Host rocks may be pelitic and psammitic sediments of turbiditic Chaung Magyi group (Upper Precambrian age) because of the occurrences of low grade slate and quartzite. Microscopically, quartzite shows granulation features probably due to intense deformation during metamorphism. Chloritization, epidotization and sericitizations are also noted along the cleavage planes of slate which alteration mineral assemblages are due to involve hydration that it is indicative features of lower temperatures and/ or pressures of crystallization. Therefore, occurrences of quartzite intercalated with slate and argillites are distinctly affected of retrograde metamorphism by low pressure and temperature signature. Mineral assemblages of biotite + muscovite + chlorite + quartz indicate that they belong to greenschist facies. Greenschist facies is usually occurred at the temperature range about 300˚ C to 500˚ C and pressure 2kb to 4kb which is followed by the low-grade metamorphic rocks of study area. It can be concluded that low-grade regional metamorphism and greenschist facies can be contributed to this area reveal the evidences of typical mineral assemblages and field occurrences. The occurrences of quartzite, slate and argillite can be considered as prevail the crustal thickening processes related to plate collision of continental boundary of Sibumasu. It may be derived from considering as the effect of lithospheric collision is to thicken the lithosphere, especially the upper layer of Sibumasu crust.

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