SERPENTINIZATION IN THE MWETAUNG OPHIOLITE, TIDDIM TOWNSHIP, CHIN STATE

Thidar Win[1], Shwe Soe[2], Teza Kyaw[3]

Abstract

The study area is bounded by the latitude 23° 22' to 23° 30' N and the longitude 94° 00' to 94° 03' E, in one inch topographic map 84-I/3. It is located about 17 miles (27 km) NW of Kalemyo, Sagaing Region and Tiddim Township of Northern Chin Hills. In this area, Mwetaung Hill lies prominently on the eastern flank of the northern Chin Hills. It conspicuosly high hill protruding from the alluvial plain is wholly built up of ultramafic rocks tectonically bounded by the highly folded Pane Chaung Group to the west. The most ultramafic rocks of the study area are completely serpentinized. Serpentinization is a widespread process in ophiolitic mantle. In study area serpentinites or serpentinized ultramafic rocks are classified into three typesof serpentinites: massive serpentinite, sheared serpentinite and cross-fibre serpentinite, based on their physical appearances and microscopic study.into type 1, type 5 and type 8. Degree of serpentinization for the study area is early to advanced stage. Serpentinite textures such as mesh texture, ribbon texture and bladed mat are found. Magnetite is present in minor amounts in all types of the rocks. Their nature and textures are important for the determination of the degree of serpentinization. Serpentinites derived from ophiolite peridotites is probably equilibrated at low temperature below about 500°C. The time of serpentinization in the study area is Early Cretaceous because it is related to the time of emplacement of the ultramafic body.

Keywords: Serpentinization, Ultramafic rocks, Mwetaung, Ophiolite

Introduction

Location, Accessibility and Physiography

The study area is bounded by the latitude 23° 22' to 23° 30' N and the longitude 94° 00' to 94° 03' E, in one inch topographic map 84-I/3. It is located about 17 miles (27 km) NW of Kalemyo. The area lies prominently on the eastern flank of the northern Chin Hills, Sagaing Region and Tiddim Township of Northern Chin Hills It is good accessible from Kalemyo by car and motor cycle throughout the year. The location map of the area is shown in (Fig.1).

Regional Geologic Setting

Myanmar can be subdivided into six N-S trending major tectonic domains. From west to east are: (1) Rakhine Coastal Strip as an ensimaticforedeep, (2) Indoburman Ranges as an outer arc or forearc, (3) Western Innerburman Tertiary Basin as an interarc basin, (4) Central Volcanic Belt (Central Volcanic Line) as an inner magmatic volcanic arc, (5) Eastern Innerburman Tertiary Basin as backarc basin and (6) Shan-Taninthayi massif as ensialic Sinoburman Ranges (Bender, 1983, Khin Zaw, 1990). The Indoburman Ranges (Western Ranges) of Myanmar, consisting of the Naga Hills, Chin Hills and Rakhine Yoma, are underlain by thick, mildly deformed, slightly folded, and weakly metamorphosed (Fig. 2).

[1] Dr. Associate Professor, Department of Geology, Kalay University
[2] Lecturer, Department of Geology, Yadanabon University
[3] Dr. Associate Professor, Department of Geology, Monywa University

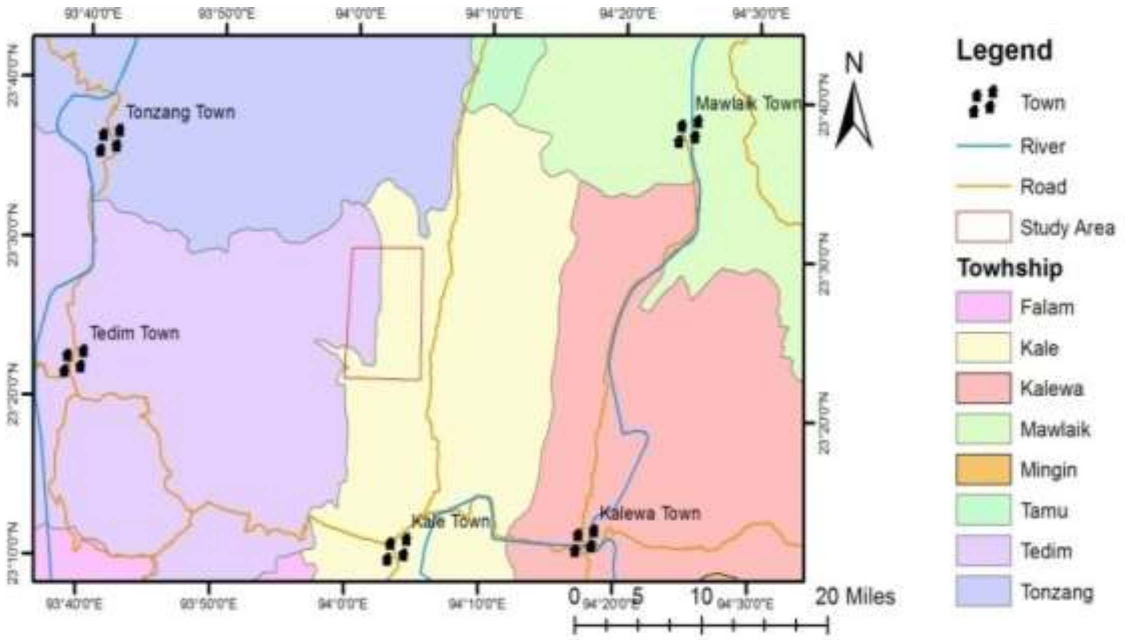


Figure 1 Location map of the study area

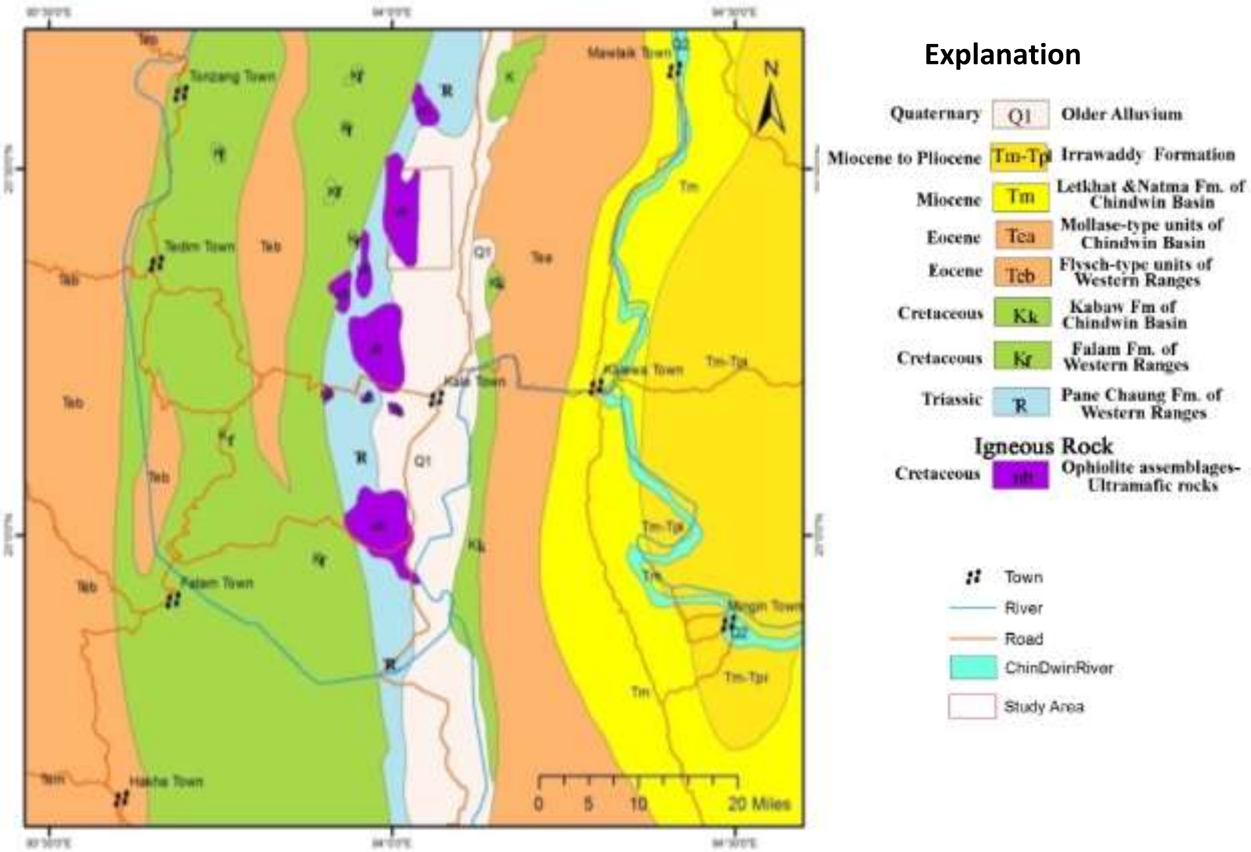


Figure 2 Regional Geological Map showing the study area (After Myanmar Geosciences Society: 2014)

The study area occupies the boundary between western margin of the Innerburman Tertiary Basin and at the foot of eastern Indoburman Ranges. According to Hutchison (1975), the study area lies in the main ophiolite belt of Naga Line. The area falls within the Western Ophiolite Belt of Myanmar (Hla Htay, 1985; Mitchell, 1993). It is suggested to be dismembered and incomplete ophiolite belt, consisting of ultramafic rocks, pillow lava, basic dykes, spilite, radiolarian chert, small amounts of limestones Mwetaung hill of the study area lies prominently on the eastern flank of the northern Chin Hills.

Purpose and Method of study

This research is focus to describe detailed types of serpentinization, classified serpentinization processes, determination of the degree of serpentinization, described texture, and temperature of serpentinization of the study area. During the field period, the topographic map 84-I/3 is enlarged to a scale of four inches to one mile and used as base map to plot all the measured geological data. In the laboratory, the representative specimens collected from the field were prepared to more than (30) thin sections for mineralogical characterization of the various rock types were recorded by using field data and microscopic studies.

Serpentinization

1. Types of Serpentinites

The ultramafic rocks such as harzburgite, dunite and lherzolite in the study area were partially to completely serpentinized. Three types of serpentinites could be differentiated in the area according to their physical appearance and microscopic features. In the field, three main categories of serpentinites can be distinguished by their physical appearance, Thidar Win(2014). They are massive serpentinite, sheared serpentinite and cross-fibre serpentinite(Fig.3).

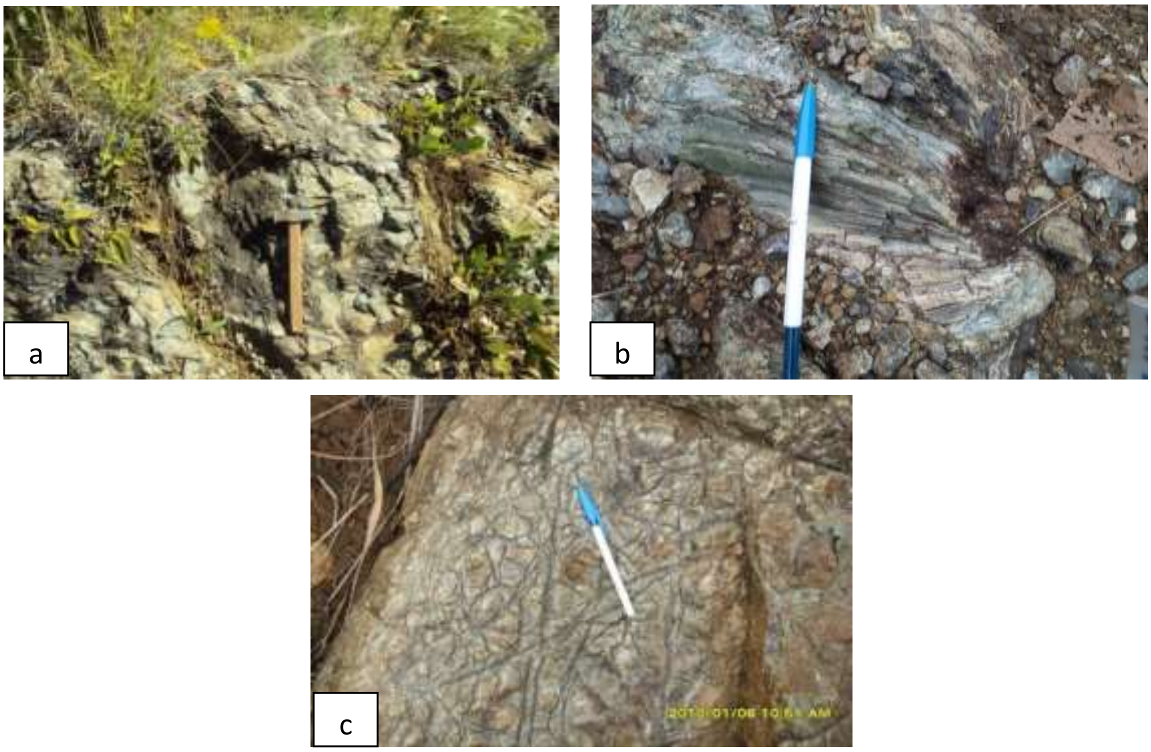


Figure 3 Exposures of various serpentinites (a) massive serpentinite, (b) sheared serpentinite and (c) cross-fibre serpentinite

Table 1 Eight types of serpentinization process (Wicks and Whittaker, 1977)

Type	Condition	Texture	Mineral	Regime	Remarks
Type 1.*	-Falling temperature (or constant) -Absence of substantial shearing -Nucleation of antigorite	Pseudomorphic texture	Antigorite	A	Fracture-filling veins produced with this type will be composed of antigorite
Type 2.	-Falling temperature (or constant) -Presence of substantial shearing -Nucleation of antigorite		Antigorite	A	
Type 3.	-Falling temperature (or constant) -Absence of substantial shearing -No nucleation of antigorite	Pseudomorphic texture	Lizardite Lizardite ± brucite	B&C	Chrysotile does not usually occur in abundance in the pseudomorph, but may occur in veins along joint planes with or without lizardite and brucite
Type 4.	-Falling temperature -Presence of substantial shearing -No nucleation of antigorite	Foliated non-pseudomorphic texture	Chrysotile ±	B&C	With or without lizardite, and chrysotile ± lizardite ± brucite veins
Type 5.*	-Rising temperature -Absence of substantial shearing -No nucleation of antigorite	Recrystallization of pseudomorphic texture,Nonpseudo mor-phic texture	Lizardite ± brucite Chrysotile ± Lizardite ± brucite	B&C	Associated veins with similar in mineralogy.
Type 6.	-Rising temperature -Presence of substantial shearing -No nucleation of antigorite	Foliated non-pseudomorphic texture	Chrysotile ± Lizardite ± brucite	B&C	Less frequently multi layered lizardite ± brucite.
Type 7.	-Rising temperature -Absence of substantial shearing -Nucleation of antigorite	Recrystallization of type 3 texture, non-pseudo-morphic,crude pseudo- morphic, texture	Antigorite+_brucite	B, C & A	
Type 8.*	-Rising temperature -Presence of substantial shearing -Nucleation of antigorite	Foliated non-pseudomorphic texture	Antigorite+_brucite	B, C & A	

* Types of serpentinization found in the study area

Following the work of Wicks and Whittaker, 1977, a possible model of serpentinization was described in Table (1). There are eight types of serpentinization process based on the conditions of temperatures, presence of substantial shear, and nucleation of antigorite. In accordance with the classification by Wicks and Whittaker (1977), type-1, type-5 and type-8 serpentinization process can be observed in the study area.

1.1 Massive serpentinite

This type is the most common serpentinite in the area. In this type, the chief mineral is antigorite, and lizardite and brucite occur as accessory minerals. Pseudomorphic texture (mesh texture) is predominant over non-pseudomorphic texture (interpenetrating texture). Locally, chrysotile is seen as veins by fracture filling. So, it is possibly matched with the type 1 of Wicks and Whittaker.

1.2 Sheared Serpentinite

This type is characterized by higher tectonic strain. So, shearing features are found in this type. The chief mineral is antigorite with lizardite, chrysotile and brucite in minor amounts. The type of serpentinization is possibly type 8 of Wicks and Whittaker (1977).

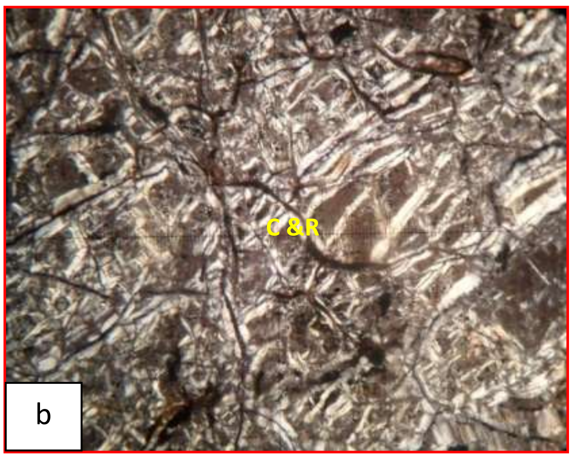
1.3 Cross-fibre Serpentinite

In this type, chrysotile, lizardite and magnetite in order of abundance are chief minerals. The texture is non-pseudomorphic, and dislocated chrysotile veinlets indicate post-deformation event. This type of serpentinization may be type 5.

2. Textures of serpentinization

Wicks and Whittaker (1977) defined three main serpentinite textures; (a) pseudomorphic, (b) non-pseudomorphic, and (c) intermediate texture. Maltaman (1978) also described serpentinite textures as mesh texture, ribbon texture and bladed mat. In the pseudomorphic texture, the original minerals of olivine and pyroxene crystals are observed as relicts. Non-pseudomorphic texture can be sub-divided into interpenetrating and interlocking texture. Interpenetrating texture is mainly composed of antigorite, and interlocking texture comprises grains of serpentine. In the early stage of serpentinization, the textures of the original peridotites are still preserved. In the last stage of serpentinization, olivine and orthopyroxene grains occur as rare relicts in the rock and veins.

Mesh texture consists of cores and cords in which the cores represent the centre of serpentinized olivines and the cords represent the serpentinized grain boundaries or fractures Fig. (4a,b). Hourglass texture, interpenetrating and interlocking, is also found in some thin sections (Fig.4c).



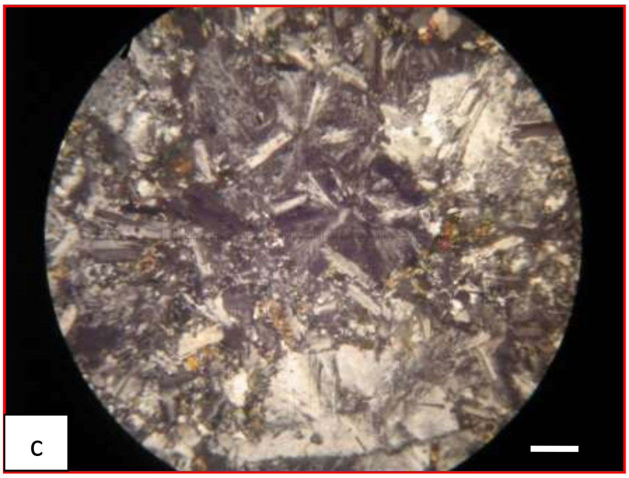
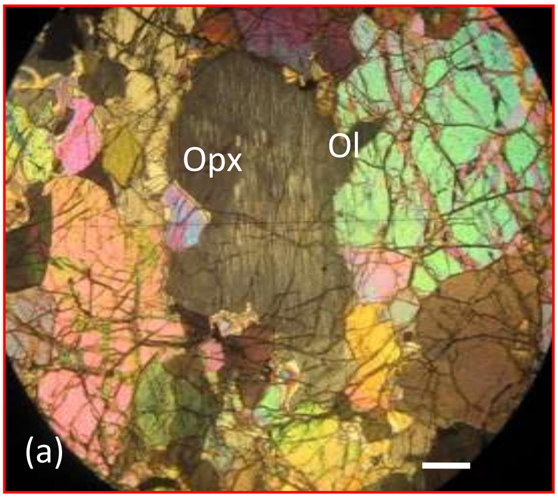


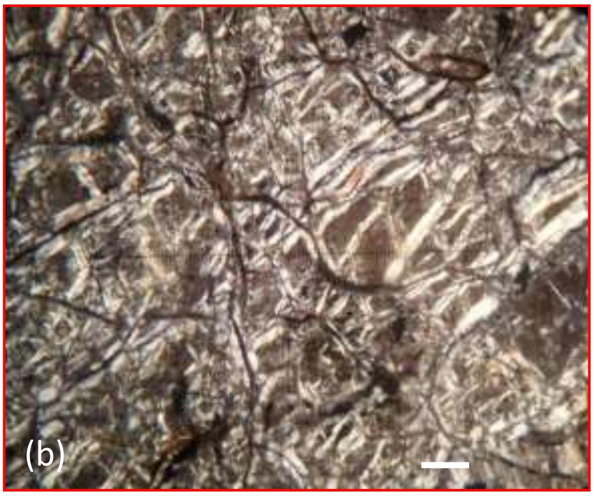
Figure 4 Serpentinite textures, core (C) and ring (R) (a) outcrop view and (b) photomicrographic view. (c) Photomicrographs of hourglass texture in serpentinite.

3. Degree of Serpentinization

In massive serpentinite, the advanced stage is predominant, but the early stage is rare. In sheared serpentinite, early to advanced stage texture is common, whereas in cross-fibre serpentinite moderate and advanced stage textures are abundant. In the early stage of serpentinization, the textures of the original peridotites are still preserved. Relicts of olivine and orthopyroxene are visible in them (Fig. 5 a).

Most of the serpentines are cut by late-stage serpentine veins, with a high variety of morphologies and textures that imply different mechanisms and conditions of formation. Several fine thread-like serpentine veins and veinlets occur in criss-cross pattern. As the serpentinization progresses, relicts of olivine and pyroxene begin keeping only the skeletal remains of the minerals. Mesh textures (Fig. 5 b) and bastite textures appear in the rocks in place of pyroxene and olivine (Fig. 5 c). It is noted that magnetite is present in minor amounts in all types of ultramafic rocks. Their nature and textures are important for the determination of the degree of serpentinization. There is often a correlation between the distribution of magnetite and degree of serpentinization and the colour of the serpentinites (Wicks & Whittaker, 1977). During the early stage, magnetite formed as discrete fine-grains throughout the whole unit. When the degree of serpentinization is increased, magnetite is developed in mesh centre of concentrated small disseminated grains, and in the advanced stage, magnetite is present in large amounts and in granular form (Fig.5 d).





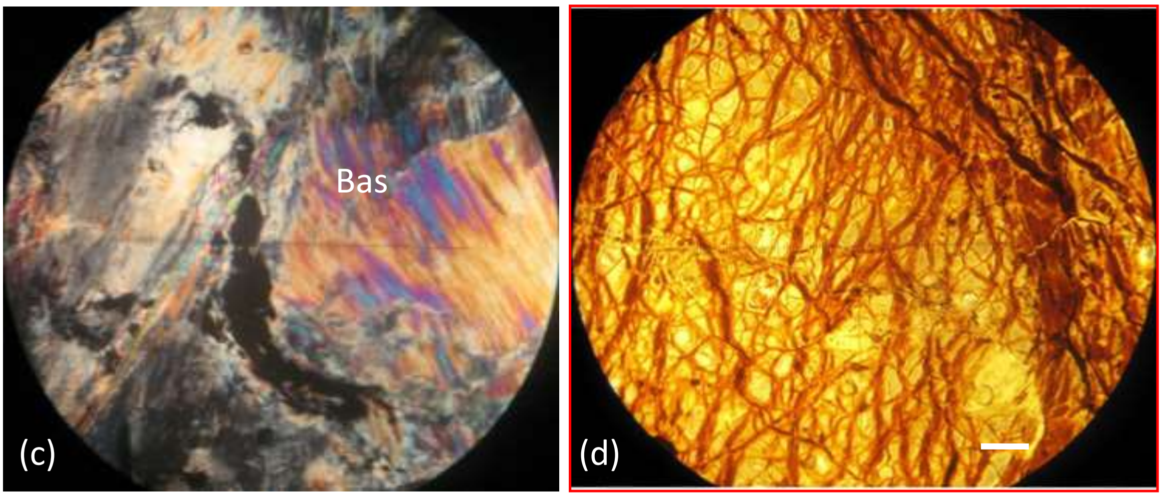


Figure 5 Photomicrographs showing the increasing degree of serpentinization in ultramafic rocks (Opx= orthopyroxene, Ol= olivine, Bas= bastite) (Scale bar is 1 mm).

4. Temperature of serpentinization

Serpentinites derived from ophiolite peridotites are probably formed by the hydration in the lithosphere at temperature below 500°C (Fig.6). Pyroxene deforms plastically at temperature higher >800°C than the upper temperature boundary of serpentinization 550°C. Thus, pyroxene foliations and lineations must have formed while the rock was still peridotite in the mantle and before serpentinization. Recognition of serpent species in ophiolite assemblages, therefore, can be of establishing P-T conditions during serpentinization. Serpentinization may have formed in a condition of low pressure and low temperature.

Serpentinite contains three main minerals; lizardite, chrysotile and antigorite with minor amounts of bastite, and brucite. Lizardite is stable at low temperature (50-300°C), and chrysotile is metastable (Evan, 2004). Antigorite may be stable at higher temperatures than lizardite and chrysotile.

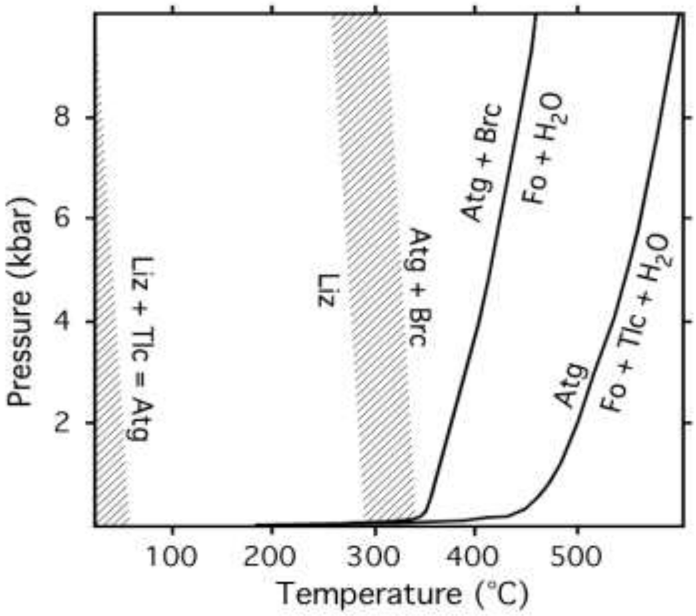


Figure 6 P-T diagram for serpentine minerals (modified from Evans, 2004). Shaded areas show uncertainty in location of reactions. Liz = lizardite, Tlc = talc, Atg = antigorite, Brc = brucite, Fo = forsterite.

5. Time of serpentinization

Since no absolute age is obtained as yet, relative age, citing the views of previous observers and the field observations is to be considered. Chhibber (1934) early described the age of serpentine as Late Cretaceous to Early Eocene. This assumption is in agreement with the postulated age of Mitchell (1979)'s. Accordind to the Chuan-Liu et.,al,(2016) they are studied the age of Myanmar Ophiolites including the Kalaymyo Ophiolite suggested that the Kalaymyo area of Mwetaung Ophiolite was formed duing Early Cretaceous Therefore, the time of serpentinization in the study area was probably during Early Cretaceous because it is related to the time of emplacement of the ultramafic body.

Conclusion

Mwetaung ultramafic body lies as the part of Indoburman Ranges and including in the Western Ophiolite Belt. Serpentine minerals are the weathering product of ultramafic igneous rocks. There are three types of serpentinites;massive, sheared and crossed fiber serpentinite. Three types of serpentine texture are pseudomorphic, non-pseudomorphic and serpentine veins texture. Pseudomorphic texture shows mesh texture and hourglass texture while non-pseudomorphic texture exhibit interpenetrating and interlocking texture. Magnetite is present in minor amounts in all types of the rocks. Their nature and textures are important for the determination of the degree of serpentinization. Degree of serpentinization for the study area is early to advanced stage. Serpentinites derived from ophiolite peridotites is probably equilibrated at low temperature below about 500°C. The time of serpentinization in the study area is Early Cretaceous because it is related to the time of emplacement of the ultramafic body.

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