The Study of *Tentaculites*-bearing Beds in the Southern Part of Yaksawk Township, Southern Shan State

Chit Sein[1], Saw Ngwe Khaing[1], and Win Naing[2]

Abstract

The study area is situated in the northeastern part of Momakha range, in the southern part of Yaksawk Township, southern Shan State. The *Tentaculities*-bearing beds are well exposed in the study area and can be further subdivided into five different units based on their lithologic aspects such as Grey limestone unit, Siltstone, Shale and limestone unit, Limestone and shale unit, Quartzose sandstone unit, and Whitish limestone unit. The lower boundary of the *Tentaculities*-bearing beds with the limestones of the Linwe Formation is conformable. Stratigraphic relationship between *Tentaculites*-bearing beds and the overlying Plateau limestone is considered to be unconformable. *Tentaculites*-bearing bed in the study area is composed essentially of five lithofacies and three sublithofacies. The grey limestone unit of lithofacies (1) was formed at the very shallow marine environment. The siltstone-shale and interbedded limestone unit of lithofacies (2) may be deposited in the environment not far from the shore. The dominance of lime mud indicates low energy condition in lithofacies (3). Dark colour and paucity of biota indicate that water near the bottom was restricted and seemingly euxinic and it may be considered that it was deposited at the restricted marine shelf such as lagoonal environment. The quartzose sandstone unit of lithofacies (4), the environmental condition is not hospital for the living organisms. These sediments are accumulated on the beach environment. The whitish limestone unit of lithofacies (5) reflects shallow water condition probably at open marine shelf environment.

Key words: *Tentaculites*-bearing beds, Yaksawk Township, five lithofacies and three sublithofacies.

Introduction

Although the *Tentaculites*-bearing beds have been recorded in the southern Shan State, the reports of these *Tentaculites*-beds are very few in Myanmar. The present work is aimed to be carried out the lithofacies in order to know the possible depositional environment of these *Tentaculites*-bearing beds.

Location of the study area

The study area is situated in the northeastern part of Momahka range, in the southern part of Yaksawk Township, southern Shan State. The *Tentaculites*- bearing beds are mainly exposed in the area between 4370 feet (1332.2 m) peak and Sizon Village (Figure 1).

Previous works

The *Tentaculites*-bearing limestone present in the study area was first introduced by Min Swe (personal communication, 1998). This unit has not yet assigned to a formal lithostratigraphic unit in the southern Shan State since Brown and Sondhi (1933) first noticed the *Tentaculites*-bearing unit in the southern Shan State especially at the Yawng- hwe, northeast bank of the Inle Lake.

Pascoe (1959) made the report on the *Tentaculites*-bearing unit of southern Shan State, in the Mibayataung area, south of Heho plain and on the eastern flank of Zawgyi Basin in Yaksawk Township. Myint Lwin Thein (1973) also pointed out that *Tentaculites* associated with *Styliolina clavulus*, *Eutomis* cf. *phalonga* occurred at the upper horizons of

[1]Assistant Lecturer, Department of Geology, Hinthada University
[2]Pro-Rector, Mawlamyine University

the Mibayataung Group. Wolfort *et al.* (1984) also recorded that, the *Tentaculites*-bearing beds occurred at the area, near Pangpet, southeast of Taunggyi.

Aye Ko Aung (2000) has recently remapped and stratigraphically measured the *Tentaculites*-bearing unit in the southern part of the Taungchun range in Taunggyi Township and also recorded other possible Devonian black carbonaceous limestone outcrops in a small creep at the eastern foot hill of the west Pinsin Hill.

Aye Aye Han (1999) and Kyi Kyi Swe (1999) found the *Tentaculites*-bearing unit in their study area at the southern part of the present area. They used the name Kywedaung informal lithostratigraphic unit and Kywedaung Formation in their M. Sc. Thesis respectively.

Yin Min Htwe (2000) studied the *Tentaculites*-bearing unit in this area and reported the lithographical and stratigraphical aspects in her M.Sc Thesis.

Chit Sein *et al.* (2009) reported the lithology and lithofacies of *Tentaculites*-bearing beds in the southern part of Yaksawk area in order to know the possible depositional environment.

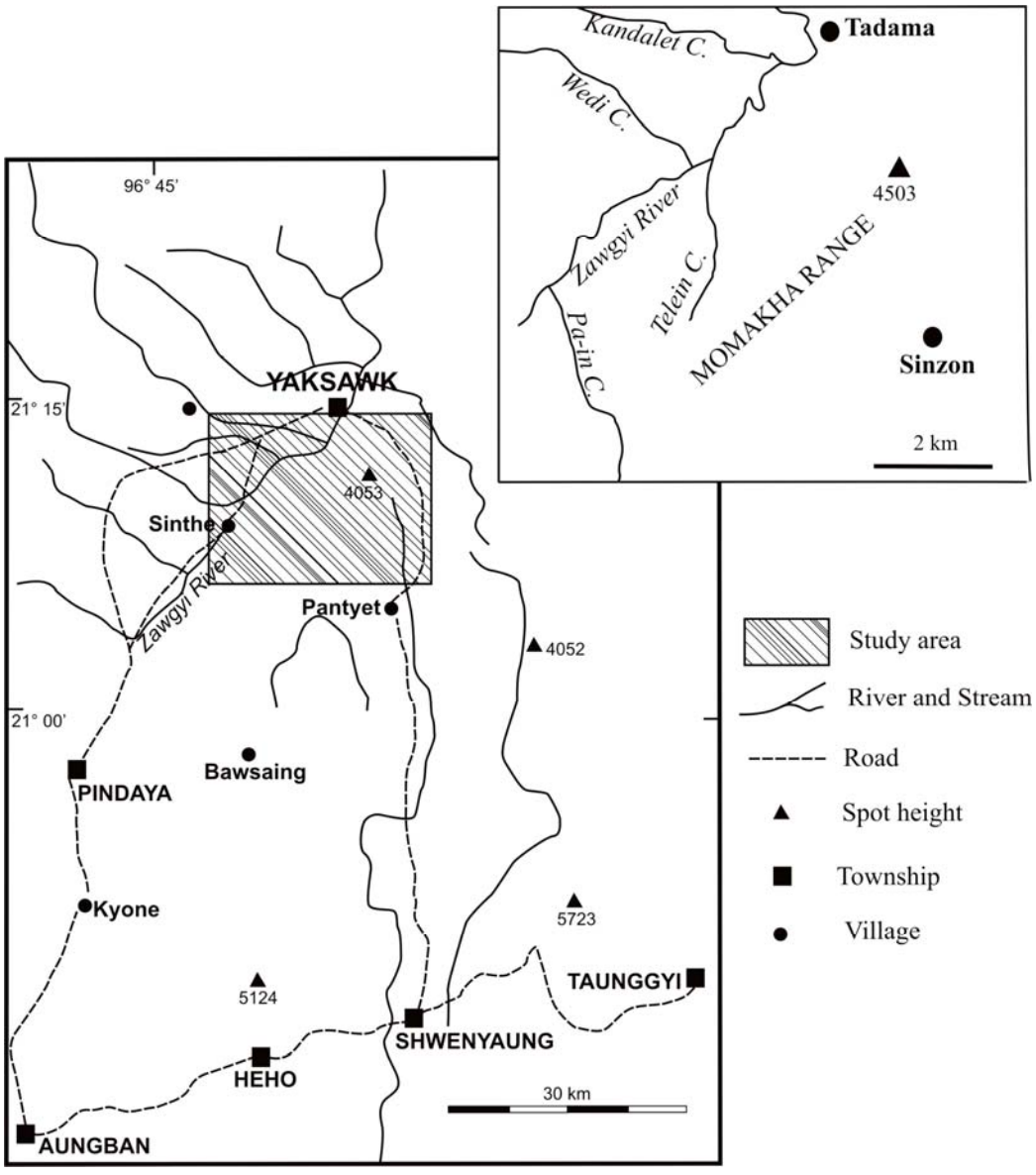

Figure 1 Geographic position of the study area

In this paper, the name "*Tentaculites*-bearing beds" is used here for the sequence of yellow sandstone and purple shale with *Tentaculites* and brachipods, black limestone and black shale, quartzose sandstone and whitish micritic limestone exposed in the study area.

Geographic distribution

The rocks representing these beds are mainly exposed in the area between 4370 feet peak (1332.2 m) and Sizon Village. The strartigraphic columnar sections have been made in the *Tentaculites*-bearing beds (Figure 2), and the stratigraphic thickness of the beds at the composite section is about 53.91 m (Figure 3).

Purposes of research

The present work is aimed to describe the lithological characteristics of the study area; to analyze the lithofacies in order to interpret the possible depositional environment of the *Tentaculites*-bearing beds of the study area; and to determine the stratigraphic position studying the stratigraphic columnar sections of the *Tentaculites*-bearing beds of the present area.

Methods of study

The traverse has been done by using geological compass, meter tape and G.P.S. Detailed columnar measured sections were made nearly perpendicular to the strike of *Tentaculites*-bearing beds. The rock and fossil especially *Tentaculites* sp. specimens were collected from the particular localities. Considerable thin sections were carried out in order to describe the lithologic and lithofacies description under petrologic microscope. Petrographic classification of carbonate rock units in the present area is mainly based on the classification of Dunham (1962) to analyze the depositional texture of the rocks of *Tentaculites*-bearing beds.

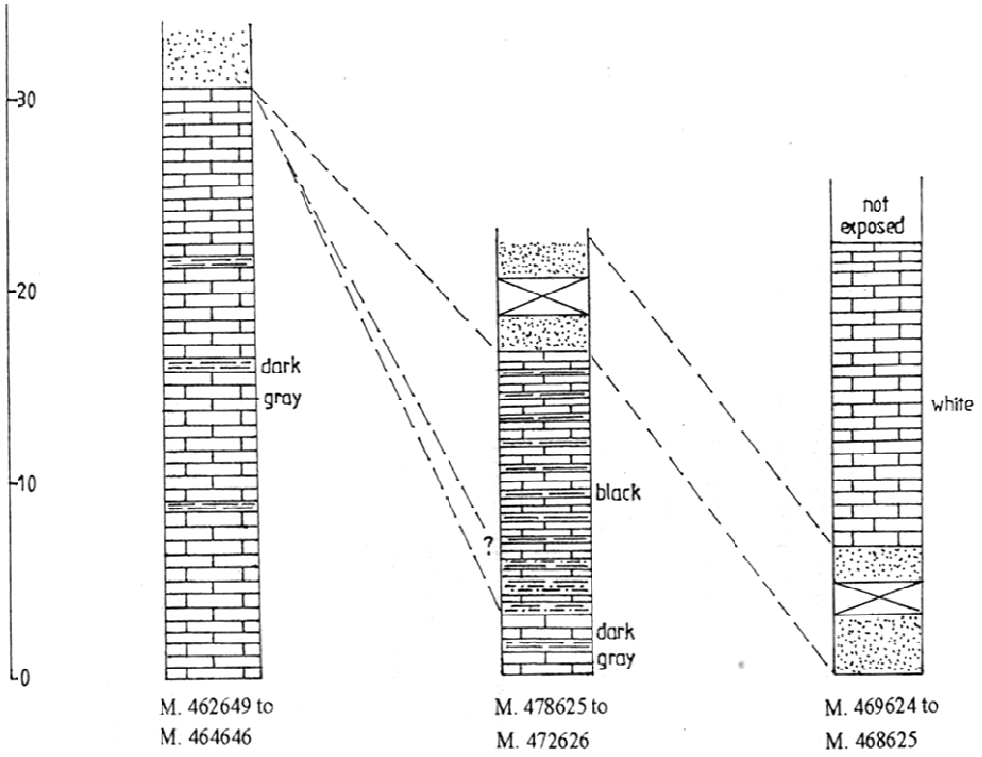

Figure 2 Composite stratigraphic columnar sections and correlation of individual section of the *Tentaculites*-bearing beds. (cited from Yin Min Htwe, 2000)

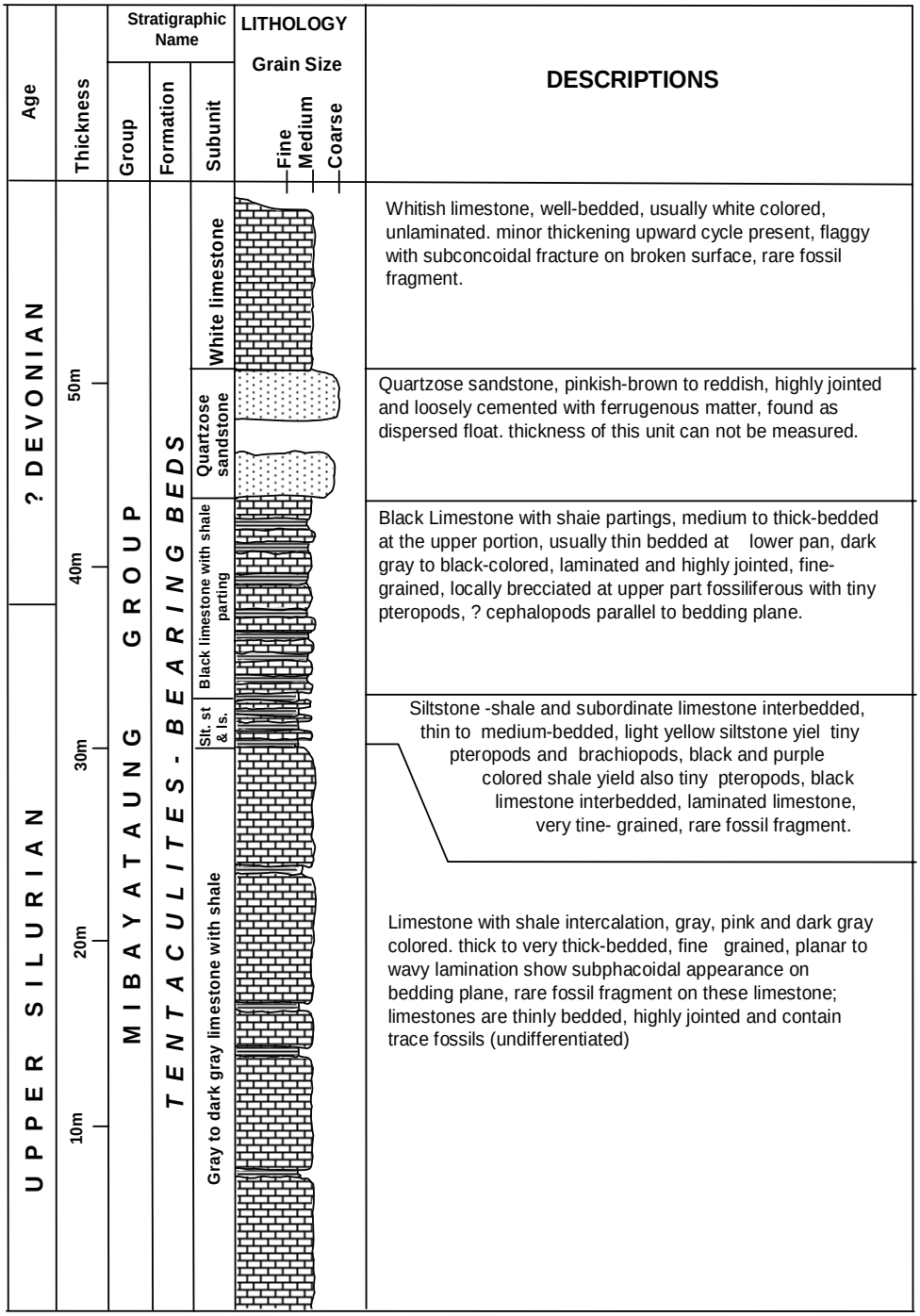

Figure 3 Stratigraphic section of the *Tentaculites*-bearing beds of the study area (cited from Yin Min Htwe, 2000)

Lithostratigraphy

The *Tentaculites*-bearing beds can be further subdivided into five different units mainly based on their lithologic aspects.

(1) Grey limestone unit
(2) Siltstone, shale and limestone unit
(3) Limestone and shale unit
(4) Quartzose sandstone unit
(5) Whitish limestone unit

(1) Grey limestone unit

This unit is exposed at the 4370' peak (1332.2 m) and in the vicinity of Waphyu Taung (Locality: M 472680). The rock types are predominantly of micritic, hard, sometimes brecciated, well bedded, generally pink to dark grey in colour and intercalated with calcareous shale. The individual limestone beds show 30 to 90 cm thick. At the top, however, the rocks become massive with faint bedding trace. The shale beds are characterized by thinly bedded nature (about 2 to 5 cm thick).The limestone passes upward the overlying siltstone, shale and limestone of the formation with a sharp contact.

(2) Siltstone-shale and limestone unit

This unit is observed along the cart- track from Thaminlwinkwing to Pinpyit. It is made up of light yellow to buff coloured siltstone, purple and black calcareous shale and dark grey to black limestone. The siltstone and shale are mostly calcareous and fossiliferous with tiny pteropods such as *Tentaculites* sp. *Styliolina* sp. and brachiopods. In some places, the shale and siltstone are friable and generally poorly exposed or highly weathered.

(3) Limestone and shale unit

The rocks are well exposed only on the west of the cart-track to Pinpyit Village, lying immediately over the siltstone-shale and limestone unit. It is composed mainly of medium to thick-bedded, dark grey to black, argillaceous limestone interbedded with thin to medium-bedded black calcareous shale. The black argillaceous limestone exhibits some small solution holes (2-3 cm in diameter). The limestone and shale are mostly calcareous and fossiliferous with tiny pteropods. In the upper part this unit is highly jointed and locally brecciated. The limestone and shale of this unit passes upward to the overlying reddish sandstone with a sharp contact again.

(4) Quartzose sandstone unit

This unit is best exposed in the vicinity of 4370' peak (1332.2 m). Their exposures are clearly seen along the hillocks at the north of the village of Shwepontha. The unit consists of poorly bedded, grey, pinkish- brown to reddish quartzose sandstone with subordinate amount of black carbonaceous shale. Sandstone shows sugary texture and loosely cemented with ferruginous matter, hence, it can easily be broken into fragments.

The quartzose sandstone of this unit has a sharp contact with the overlying uppermost unit of the whitish micritic limestone.

(5) Whitish limestone unit

This unit occupied the upper part of the *Tentaculites*-bearing beds. It is exposed only in the vicinity of 4079' peak (1299 m) situated at the south of Thitsaytaung (4370 feet) (1332.2 m). The whitish limestone is made up essentially of ash-grey to light grey, well bedded limestone with subconcoidal fracture on the broken surface. Thickness of individual bed ranges from 12- 38 cm.

Lithostratigraphic relationship

The lower boundary of the *Tentaculites*-bearing beds with the limestones of the Linwe Formation is conformable. The purple phacoidal limestone of the Linwe Formation passes gradationally upward into the limestone of pale purple to grey coloured with silt lamination show subphacoidal in appearance. Stratigraphic relationship between *Tentaculites*-bearing beds and the overlying Plateau limestone is considered to be unconformable. The contact can be observed on the southernmost part of the area where the black limestone and shale unit of the *Tentaculites*-bearing beds is seen unconformable overlain by the brecciated dolomitic limestone of the Plateau Limestone Group.

Fossils and age

Well bedded limestone and black shale, siltstone interbedded with shale and subordinate black limestone are usually fossiliferous. The fossils collected are identified as follows: Pteropods; *Tentaculites* elegans, *Styliolina* sp., Brachiopods, and *Meristina* sp.

The occurrence of *Tentaculites* elegans in the limestone beds suggested the Pridoli-Gedinne (Early Devonian) age (Pascoe, 1959) for the *Tentaculites*-bearing beds of the present area and it can be correlated with the Zebingyi Formation of the northern Shan State (Wolfart *et al.,* 1984).

Lithofacies Study

Tentaculites-bearing bed in the study area is composed essentially of five lithofacies and three sublithofacies. These lithofacies are:

Lithofacies (1) Micrite (grey limestone)

Lithofacies (2) Siltstone, shale and interbedded limestone

- Sublithofacies (2a) Yellow calcareous siltstone
- Sublithofacies (2b) Purple shale
- Sublithofacies (2c) Micrite

Lithofacies (3) Biomicrite with shale

Lithofacies (4) Quartzose sandstone

Lithofacies (5) Micrite (whitish limestone)

The depositional process of each microfacies is interpreted as closely as possible.

Descriptions of lithofacies

Lithofacies (1): Micrite (grey limestone)

Megascopic descriptions: This lithofacies occupies the lowest part of the *Tentaculites*-bearing beds. It is grey, bluish grey to dark grey, well bedded (medium bedded), laminated and some silt laminations show subphacoidal in appearance.

Microscopic description: Petrographically, the rocks consist mainly of about 85% micrite, about 4-5% bioclasts, about 5-6% of quartz silt grains and about 2-4% of pyrite crystals (Figure 4A). Bioclastic materials are derived from broken fragments of Ostracods and *Tentaculites* sp. (Figure 4B). The bioclasts are pteropod shells such as *Tentaculites* sp. and *Styliolina* sp. The content of *Tentaculites* is rare in the middle part of this lithofacies and randomly scattered (Figure 5). However in the upper portion of this microfacies, the *Tentaculites* are more common and most of the fossils are found along the lamination (Figure 6). Quartz silt grains are sub-angular to sub-rounded, with size averaging about 0.01 mm in diameter. Pyrite crystals occur as cube forms and are embedded in the burrow-filled sediments (Figure 7).

Lithofacies (2): Siltstone, shale and interbedded limestone

This microfacies can be divided into three sub-lithofacies according to the different sediment types.

Sublithofacies (2a): Yellow calcareous siltstone

Microscopic description: Petrographically the rocks are made up of about 70% of fine-grained carbonate matrix, about 20% of bioclastic grains and the remaining per cents are silt-sized detrital quartz. Bioclastic grains are *Tentaculites*, brachiopod fragments and unidentified shell fragments. Quartz grains are subangular to subrounded with oriented fabrics more or less parallel to the laminations.

Sublithofacies (2b): Purple shale

Megascopic descriptions: It is made up dominantly of purple coloured, sometimes black, thinly bedded, hard and compact calcareous shale.

Microscopic description: Petrographically, the rocks are mainly composed of argillaceous biomicrite containing about 5% of bioclasts, 20-30 % of terrigenous quartz and mica and the remaining about 65% of microcrystalline carbonate. Bioclasts are mainly derived from crinoids and other shell fragments. Micritization is also recognized on the periphery and cleavage planes of crinoids (Figure 8).

Sub-lithofacies-2(c): Micrite

Megascopic descriptions: This rock is usually dark, thin to medium bedded, sometimes silt-laminated and interbedded with yellow siltstone.

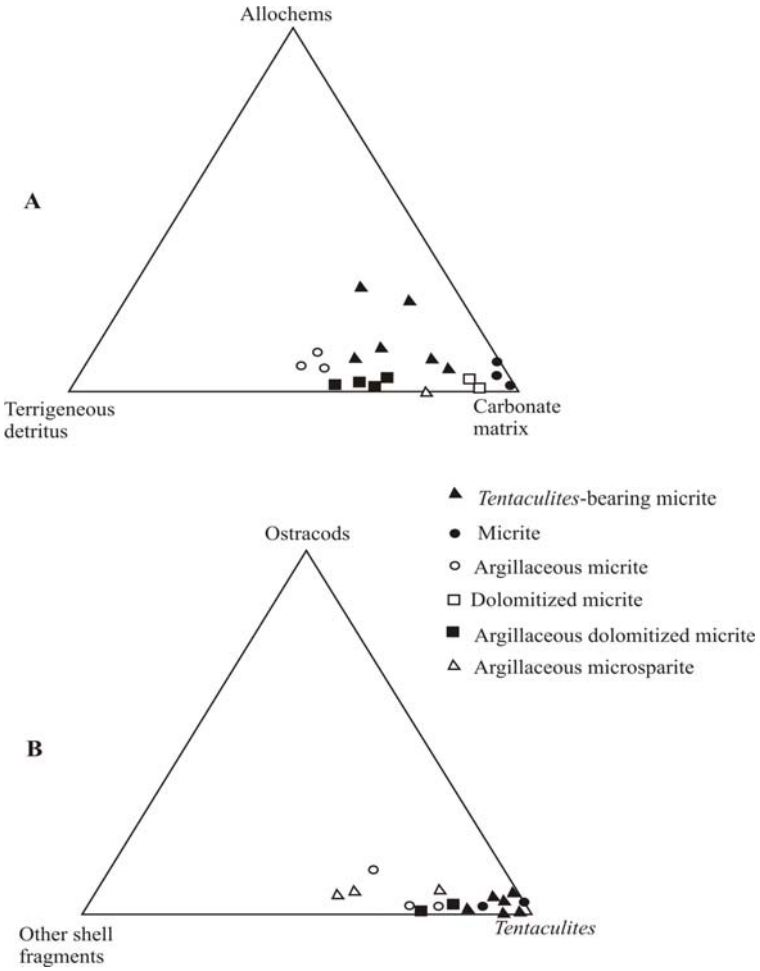

Figure (4) Petrographic plots of the *Tentaculites*-bearing beds.

(A) Based on the relative proportion of allochems, carbonate matrix and terrigenous detritus.

(B) Based on the relative proportion of ostracods, *Tentaculites,* and other shell fragments

Microscopic descriptions: Petrographically, the rock units are mainly composed of 85% micrite, 7-8% bioclasts, and 5-6% quartz silt grains. Most of the bioclasts are ostracods (Figure 9). Other bioclastic grains are unidentified shell fragments. Quartz silt grains are

rounded, well-sorted grains, with size about 0.005 mm in average diameter. Discontinuous carbonaceous seams are locally present.

Lithofacies (3): Biomicrite with shale

Megascopic descriptions: These rocks show generally black in colour, thin to medium bedded, laminated nature and a minor amount of shale parting.

Microscopic descriptions: Petrographically, the rock consists mainly of 70% micrite, 10-12% bioclasts, 10-15% quartz- silt grains and 2% pyrite crystals. Most of the bioclasts are *Tentaculites* (Figure 10). Other bioclasts contains ostracod, brachiopod, and other identified shell fragments. Some bioclastics are partially replaced by neospar. Terrigenous quartz grains are subangular to subrounded, ill-sorted grains ranging from 0.003-0.02 mm in diameter. Pyrite shows irregular grains and scattered in the micritic groundmass.

Lithofacies (4): Quartzose sandstone

Megascopic descriptions: The rock units are mainly occurred as dispersed float on the hillocks. The sandstone is sugared, poorly bedded, ferrugenous and intensely brecciated. .

Microscopic descriptions: Petrographically, these rocks consist of 95% detrital quartz, 4% microcrystalline calcite and 1% iron oxide. The detrital quartz silt grains are subrounded to rounded, moderately sorted grains averaging about 0.25 mm to 0.3 mm in size (Figure 11). Most of the pore spaces and fractures are filled with microcrystalline calcite.

Lithofacies (5): Micrite (whitish limestone)

Megascopic descriptions: The limestone consists of ash-white to light grey thin to medium bedded, fine-grained limestone showing subconcoidal fractures. Fossils are very rare. The bed thickness is persistent.

Microscopic descriptions: Petrographically, these rocks mainly consist of 85% micrite, 10% sparry calcite and 5% quartz silt (Figure 12). Subangular quartz grains are scattered on the whole area. Some burrowings are also present in the micrite.

Interpretation of possible depositional environment

On the basis of primary sedimentary structures, depositional texture, allochem constituents, faunal content and other diagnosis features, the rocks of *Tentaculites*- bearing beds can be compared with standard facies belts 7, 8, and 4 of Wilson (1975).

In Shan State, the Llandovery of 10 comprises black shale, but the dominance of limestone and arenite in the preceding and succeeding strata, together with their situation to the west of Mehang-Fang basin axis, indicates that these areas were mostly near the shelf. Apparently the euxinic basin facies encroached westward on to the continental shelf in Llandovery times and these areas reflect shelf-like condition (Burton, 1967).

According to the measured section, the abundant content of *Tentaculites* sp. orientation of shell fragments and quartz silt grains in the lower part of the section reflect current circulation. In the middle and upper part of the section, fossil fragments are rare but content of pyrite and dolomites are very common. It may reflect restricted in current circulation and euxinic in depositional condition.

The grey limestone unit of lithofacies (1) was formed at the very shallow marine environment. The siltstone- shale and interbedded limestone unit of lithofacies (2) may be deposited in the environment not far from the shore.

The limestone and shale unit of lithofacies (3) mainly made up for black colour, bioclastic grains, peloids, quartz silt grains, dolomite and pyrite. The dominance of lime mud

indicates low energy condition. Usually dark colour and paucity of biota suggest that water near the bottom was restricted and seemingly euxinic. It can be interpreted that it was deposited at he restricted marine shelf such as lagoonal environment.

The quartzose sandstone unit of lithofacies (4) consists of moderately well sorted quartz grains. The fossil fragments are totally absent. Environmental condition is not hospital for the living organisms. These facts probably reflect that sediments are accumulated on the beach environment.

The whitish limestone unit of lithofacies (5) contains abundant pure micrite. It may reasonably reflect shallow water condition probably at open marine shelf environment.

Conclusion

The study area is situated in the northeastern part of Momakha range, in the southern part of Yaksawk Township, southern Shan State. The present work is aimed to analyze the lithofacies in order to interpret the possible depositional environment of the *Tentaculites*-bearing beds of the study area; and to determine the stratigraphic position studying the stratigraphic columnar sections of the *Tentaculites*-bearing beds of the present area. The *Tentaculites*-bearing beds are mainly exposed in the area between 4370 feet (1332.2 m) peak and Sizon Village and stratigraphic thickness of the *Tentaculites*-bearing beds at the composite section is about 53.91 m.

The *Tentaculites*-bearing beds can be further subdivided into five different units based essentially by their lithologic aspects.

(1) Grey limestone unit
(2) Siltstone, shale and limestone unit
(3) Limestone and shale unit
(4) Quartzose sandstone unit
(5) Whitish limestone unit

The lower boundary of the *Tentaculites*-bearing beds with the limestones of the Linwe Formation is conformable. The purple phacoidal limestone of the Linwe Formation passes gradationally upward into the limestone of pale purple to grey coloured with silt lamination show subphacoidal in appearance. Stratigraphic relationship between *Tentaculites*-bearing beds and the overlying Plateau limestone is considered to be unconformable.

Tentaculites-bearing bed in the study area is composed essentially of seven lithofacies and sub-lithofacies. These are:

Lithofacies (1) Micrite (grey limestone)

Lithofacies (2) Siltstone, shale and interbedded limestone

- Sublithofacies (2a) Yellow calcareous siltstone
- Sublithofacies (2b) Purple shale
- Sublithofacies (2c) Micrite

Lithofacies (3) Biomicrite with shale

Lithofacies (4) Quartzose sandstone

Lithofacies (5) Micrite (whitish limestone)

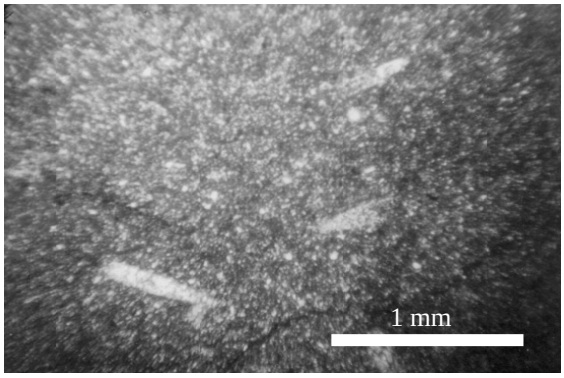

Figure 5 *Tentaculites*-bearing Micrite (Lithofacies-1). The randomly scattered tentaculitid shells and their cavities are filled with sparry calcite.

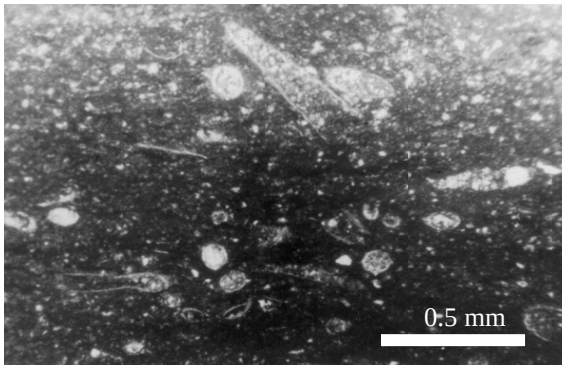

Figure 6 *Tentaculites*-bearing Micrite (Lithofacies-1).Tentaculitesshells oriented along the lamination (lower portion).

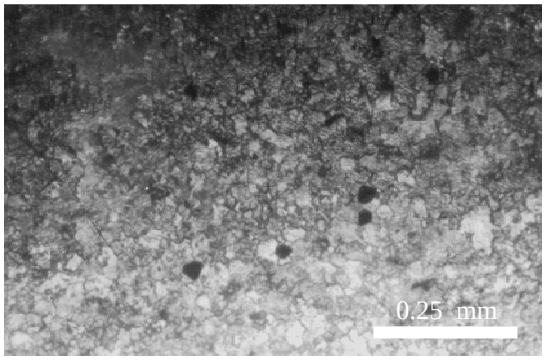

Figure 7 Micrite (Lithofacies–1). Dark, opaque octahedral shape pyrite crystals (centre).

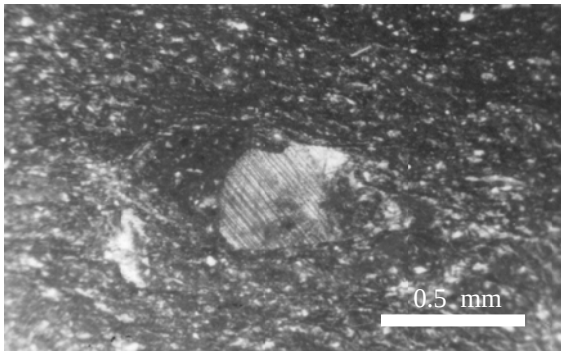

Figure 8 Purple shale unit (Sublithofacies-2b). Micritization present along the cleavage planes of crinoid plate.

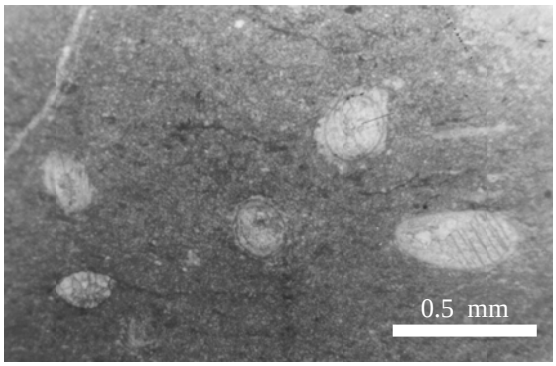

Figure 9 Micrite (Sublithofacies – 2c). The fragments of ostracods and discontinuous carbonaceous seam (left centre).

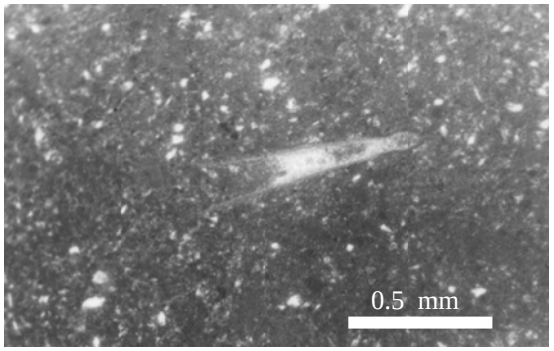

Figure 10 Biomicrite (Lithofacies – 3). The typical Tentaculites sp. (centre).

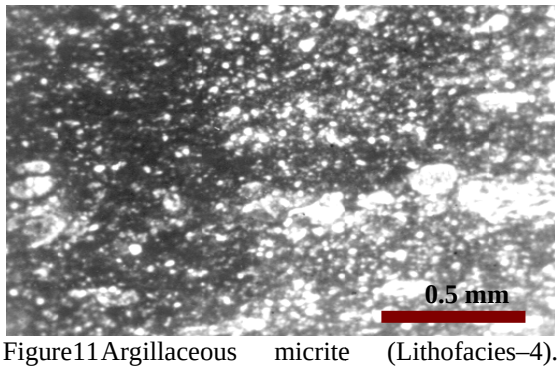

Figure11 Argillaceous micrite (Lithofacies–4). Subrounded to rounded quartz silt grains along the planar laminations.

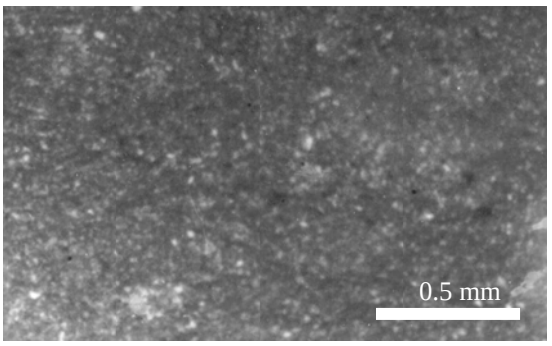

Figure 12 Dolomitized micrite (Lithofacies-5). The dolomitized micritic matrix.

The abundance of *Tentaculites* sp. orientation of shell fragments and quartz silt grains in the lower part of the section reflect current circulation. In the middle and upper part of the section, fossil fragments are rare but content of pyrite and dolomites are very common. It may reflect restricted in current circulation and euxinic in depositional condition.

The grey limestone unit of lithofacies (1) was formed at the very shallow marine environment. The siltstone-shale and interbedded limestone unit of lithofacies (2) may be deposited in the environment not far from the shore.

The dominance of lime mud indicates low energy condition in lithofacies (3). Dark colour and paucity of biota indicate that water near the bottom was restricted and seemingly euxinic and it may be considered that it was deposited at the restricted marine shelf such as lagoonal environment.

The quartzose sandstone unit of lithofacies (4), the environmental condition is not hospital for the living organisms. These sediments are accumulated on the beach environment.

The whitish limestone unit of lithofacies (5) reflects shallow water condition probably at open marine shelf environment.

Acknowledgements

We are grateful to the personnel of Department of Higher Education (Lower Myanmar), Ministry of Education, for their encouragement to come out the present work. Thanks are also due to Dr. Tin Tun Myint and Dr. Si Si Hla Bu, Pro-Rectors of Hinthada University, for their constructive suggestions for the manuscript. We are indebted to Daw Yin Min Htwe, Assistant Lecturer, Department of Geology, University of Yangon, for her kind giving a chance to do this work to complete departmental research project of Hinthada University. We would like to express our sincere gratitude to the editors of the Research Journal of Hinthada University, for their critical reading of the manuscript. This paper is presented by the Department of Geology, Hinthada University, Department of Higher Education (Lower Myanmar).

References

Aye Aye Han (1999). *Stratigraphy and sedimentology of the area between Yaksawk and Bawsaing, southern Shan State*. Unpublished, M.Sc. Thesis, Department of Geology, University of Yangon.

Aye Ko Aung (2000). *A short note on recent discovery of Tentaculites-bearing unit from Taunggyi-Taungchun range, southern Shan State*. 10th Myint Lwin Thein's Memorial Seminar Paper.

Brown, J.C. and Sondhi, V. P. (1933). The geology of the country between Kalaw and Taunggyi, southern Shan State, Burma: *Record of the Geological Survey of India*, **67:** 116-248.

Burton, C.K. (1967). Graptolite and *Tentaculites* correlations and Paleogeography of the Silurian and Devonian in the Yunnan-Malay Geosyncline, *Trans. Proc. Paleont. Soc. Japan, N. S.*, **65:** 27-46.

Chit Sein, Saw Ngwe Khaing, and Win Naing (2009). *Lithology and lithofacies of the Tentaculites-bearing beds in the area of southern part of Yaksawk Township*. Departmental Research Report, Department of Geology, Hinthada University, Department of Higher Education (Lower Myanmar), 1-17.

Dunham, R. J. (1962). Classification of carbonate rocks according to depositional texture, In Ham, W. E., eds., Classification of carbonate rocks. *Memoir of American Association of Petroleum Geology*, **1:** 108-121.

Kyi Kyi Swe (1999). *Stratigraphy and sedimentology of the Myozo area, Kalaw Township, southern Shan State.* Unpublished, M.Sc. Thesis, Department of Geology, University of Yangon.

Myint Lwin Thein (1973). The Lower Paleozoic Stratigraphy of Western Part of the southern Shan State, Burma; *Bulletin of the Geological Society of Malaysia*, **6:** 143-163.

Pascoe, E. H. (1959). *A manual of the geology of India and Burma*, **2**, 3rd ed., Govt., India Press.

Wilson, J. L. (1975). *Carbonate facies in geologic history*, Springer-Verlag, Berlin, Hidelberg, Germany.

Wolfort, R., Myo Win, Saw Bioteau, Myo Wai, Peter, U.K. Chung and Thit Lwin (1984). *Stratigraphy of the Western Shan Massif, Burma*, Geologische Jahrbuch Hannover.

Yin Min Htwe (2000). *Lithostratigraphy and lithofacies of the area, south of Yaksawk, Yaksawk Township, southern Shan State*. M.Sc. Thesis, Department of Geology, University of Yangon. 128 pp.