

Stratigraphy of the Silurian and Devonian Rock Units in the Kyundaing – Medaw Area, Pyin-oo-lwin Township, Mandalay Region

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Abstract

Silurian and Devonian rock units are well exposed in the Kyundaing-Medaw area, 20 km north of Pyin-oo-lwin Township, Mandalay region. The present research aims to describe the stratigraphical characteristics of Silurian (Nyaungbaw Formation) and Devonian (Zebingyi Formation) rock units in the Kyundaing-Medaw area. The study area is situated in the western marginal zone of Eastern Highlands. Nyaungbaw Formation is composed of greenish to purplish grey, phacoidal limestone interbedded with thinly-bedded calcareous shale and thinly-bedded, yellowish to buff colours siltstone and marl. The calcareous shales are rich in fossil. The phacoidal structure is the main characteristics of this formation. Zebingyi Formation consists of thin-bedded, yellowish, pinkish, whitish and reddish brown quartzose sandstone dark grey to black limestone and carbonaceous siltstone. This formation is exposed in the south east part of Taungtalon Hill and eastern part of the Kyundaing Village. Nyaungbaw Formation may be interpreted as shallow warm marine environment which becomes shallow at the end of Silurian. The phacoidal texture may be formed due to either tidal and wave action or sub-seasolution or both. The Zebingyi Formation may be considered that the possible depositional environment is under lagoonal and restricted marine condition.

Key words: Stratigraphy, Nyaungbaw Formation, Zebingyi Formation, Pyin-oo-lwin Township

Introduction

Most of the Paleozoic rock units are well exposed in the Kyundaing-Medaw area, 20 km north of Pyin-oo-lwin Township, Mandalay Region. A few previous authors have carried out the researches in this area. However, systematic and stratigraphic investigations have not been conducted yet. Therefore, the geological investigation has been carried out in order to know the geological and stratigraphical aspects of the Silurian and Devonian rock units which are exposed in the study area.

Location and size

The study area of Medaw-Kyundaing is situated about 20 km north of Pyin-oo-lwin Township, Mandalay Region (Figure-1). It lies on the topographic map no. 93 B/8 and B/12. The study area is located from 22° 14' 00" N to 22° 10' 30"N and from 96° 26' 30"E to 96° 30' 25"E. It is also bounded by horizontal grid co-ordinates from 99 to 08 and vertical grid co-ordinates from 85 to 92. The total aerial coverage is about 36.2 square kilometers.

Topography

Topographically the study area is a highly mountainous terrain. Most of the topographic trends are nearly N-S direction. The western part is higher than the eastern part. Very steep scarps are observed in the western part especially in the Ordovician Units. The prominent hills in the area are Taungtalon Hill (1240 m), and Hmanchein Taung (1307 m). The rolling hills and flat plains are observed in the eastern part of the area.

Drainage

The dominant drainage pattern is dendritic (Figure- 2). Sub-trellic pattern is also found in the clastic rock units. Kywe Inn Chaung and Medaw Chaung are the main streams which are flowing from north to south in the study area. The short radial pattern of streams, sinkholes, caves and karst topography are conspicuous in carbonate and dolomite units.

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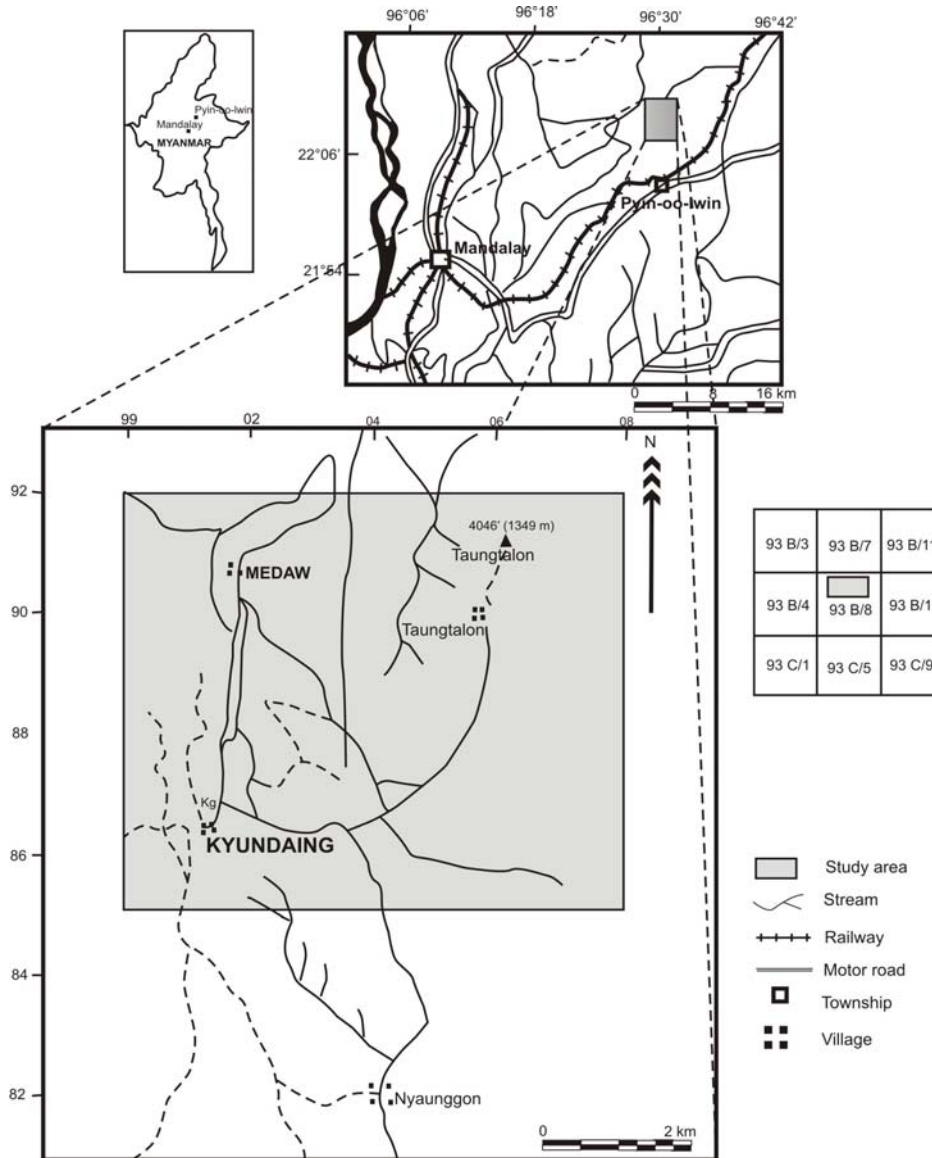


Figure (1) Geographic position of the study area.

Aims and objectives

The present work aims to describe the stratigraphical aspects of the Silurian and Devonian rock units which are exposed in the study area. The main purposes of this research are as follows:

- (1) To study of the detailed geology of the Kyundaing-Medaw area in order to know the various lithologic characters of the study area.
- (2) To contribute the detailed geological and stratigraphical aspects of Silurian and Devonian rock units in the Kyundaing-Medaw area.

Materials and Methods

The general traverses have been taken out from the whole area to study various rock units which are exposed in the study area. The representative rock samples and fossil specimens were collected from the different rock units. The stratigraphic columnar sections were measured in the Silurian and Devonian rock units by using Jacob's Staff method. The primary structures of the clastic and carbonate rocks are recorded in order to know the

stratigraphic significance and depositional environment. Besides, the collected fossils are identified in order to know the geological age, to correlate the rock units and to consider possible depositional environments.

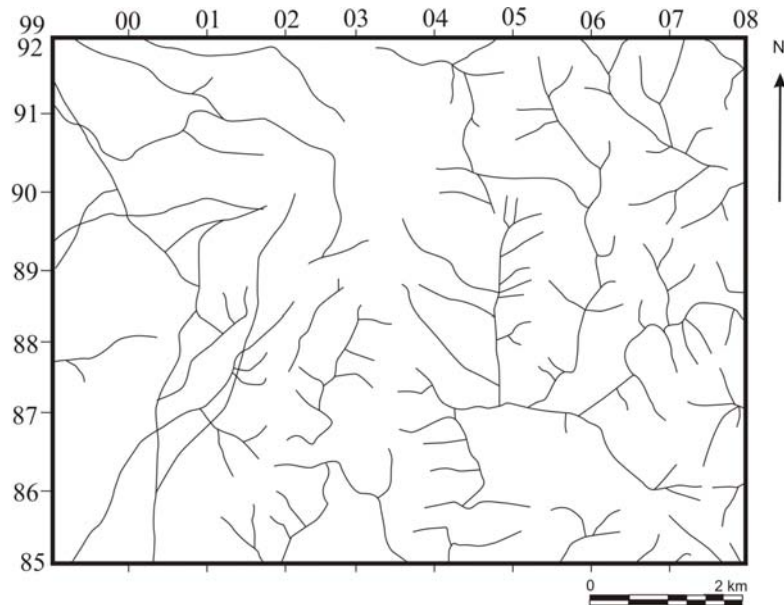


Figure (2) Drainage Map of the study area.

Regional Geologic Setting

The present study area occupies the western marginal zone of Eastern Highlands. The northern part of the study area is a narrow folded mountain of the northern Shan State. The geology of the study area is mainly made up of Ordovician to Devonian rock units from west to east, these are Sitha Formation (Middle Ordovician), Kyaingtaung Formation (Late Ordovician), Nyaungbaw Formation (Silurian), Zebingyi Formation (Early Devonian), and Maymyo Dolomite Formation (Middle to Late Devonian).

Sitha Formation is composed of medium to thick-bedded grey cherty Limestone with irregular silt partings and thin layers of buff colour siltstone in some places. This formation is well exposed at foot hills and stream section along the western ranges of Kyundaing and west of Nyaunggon Villages. It is the oldest stratigraphic unit of the study area.

Kyaingtaung Formation is mainly made up of thick-bedded to massive, yellowish grey to reddish brown micaceous siltstone, marls and medium-bedded silty limestone. These rocks are found in the western part of the study area. This unit is fossiliferous, especially Brachipods (*Orthis* sp.) and crinoid stem fragments.

Nyaungbaw Formation is composed of greenish to purplish grey, phacoidal limestone interbedded with thinly-bedded calcareous shale and thinly bedded, yellowish to buff colour siltstone and marl. The calcareous shales are rich in fossil and highly jointed. The phacoidal structure is the main characteristics of this formation. This unit is widely exposed in west and southwest of Nyaunggon, Kyundaing, Medaw Villages.

Zebingyi Formation consists of thin-bedded, yellowish, pinkish, whitish and reddish brown quartzose sandstone dark grey to black limestone and carbonaceous siltstone. This formation is exposed in the south east part of Taungtalon Hill and eastern part of the Kyundaing Village.

Maymyo Dolomite Formation is mainly made up of thick-bedded to massive, highly jointed, white colour, dolomite limestone and dolomite. It is well exposed at the eastern part of the Nyaunggon Village and Taungtalon Hill. It is the youngest stratigraphic unit of the study area.

Regional geological structure

The present study area occupies the western margin of Eastern Highlands. Strata in this area are generally trending nearly N-S. Faults are well developed in the present area, and they are longitudinal and cross faults. The major faults are more or less parallel with the ranges which run nearly N-S. Medaw fault is found in the N of the study area and is striking nearly N-S. Maymyo Dolomite Formation, dolomitic limestone and quartzose sandstone in Zebingyi Formation are highly jointed and brecciated. Joints are also commonly presented in Nyaungbaw, Kyaingtaung, and Sitha Formations.

Stratigraphy

The stratigraphy of the study area includes Maymyo Dolomite Formation (Middle Devonian to Early Triassic), Zebingyi Formation (Early Devonian), Nyaungbaw Formation (Silurian) Kyaingtaung Formation (Late Ordovician) and Sitha Formation (Middle Ordovician).

Succession	-	Geological age
5. Maymyo Dolomite Formation	-	Middle Devonian to Early Triassic
4. Zebingyi Formation	-	Early Devonian
3. Nyaungbaw Formation	-	Silurian
2. Kyaingtaung Formation	-	Late Ordovician
1. Sitha Formation	-	Middle Ordovician

Nyaungbaw Formation

Name derivation

Noetling (1890) first described the limestone with the distinct phacoidal structure, designated them of the Pyintha limestone and regarded as Silurian in age. Later, La Touche (1913) described it as Nyaungbaw limestone containing *Camarocrinus asiaticus*, and assigned to the Upper Ordovician. I.G.C.P (1980) proposed the name "Nyaungbaw Formation" and assigned to the same unit. San San Myint (1998) termed "Nyaungbaw Formation" is composed of the rock units of purplish to greenish grey, reddish brown nodular limestone with distinct phacoidal structure with thin calcareous shale intercalations and argillaceous limestone.

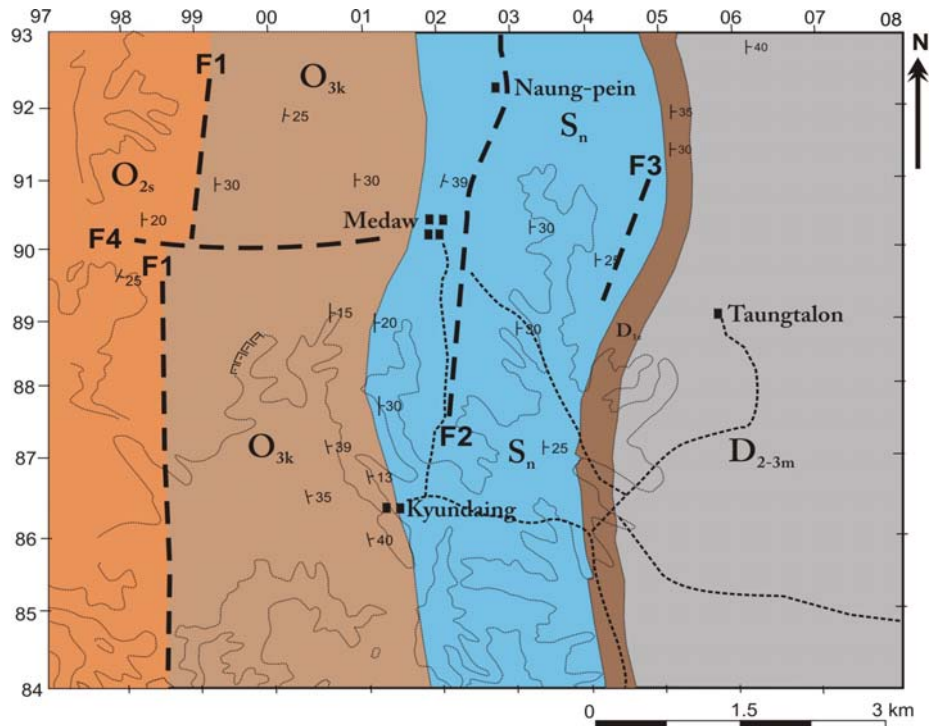
Type section and distribution

The type section of Nyaungbaw Formation is located in the vicinity of Nyaungbaw village which is situated just beside the Mandalay-Pyin-oo-lwin car road and is far about 22 miles (35.2 km) from Mandalay (grid co-ordinate 490828 on topographic map 93C/5).

This unit is widely exposed and covered about two-third of the study area. In the area, it is well exposed in the central part, vicinities of Kyundaing and Medaw Villages (Figure-3).

Lithology

The phacoidal or nodular structure is the characteristic feature of the Nyaungbaw Formation (Figures- 4 & 5). It is mainly composed of medium- to thick-bedded, purple to reddish brown, chocolate brown, and grey green phacoidal limestone, and subordinate amount of thinly bedded graptolite-bearing calcareous shale, and yellowish to buff colored siltstone and marls (Figures- 6 & 7).



Legend

- D_{2-3m} Maymyo Dolomite Formation (Middle - Late Devonian)
- D_{1e} Zebingyi Formation (Early Devonian)
- S_n Nyaungbaw Formation (Silurian)
- O_{3k} Kyaingtaung Formation (Upper Ordovician)
- O_{2s} Sitha Formation (Middle Ordovician)
- Lithologic boundary
- - - Fault

Figure (3) Geological map of the Kyundaing-Medaw Area (modified after Hla Wai, 1973)

The systematic stratigraphic columnar section was carried out by Jacob’s staff method during the field period (Figure-8). As shown in this section, the lower and middle parts are mainly composed of medium- to thick-bedded, purple to reddish brown, and chocolate brown phacoidal limestone containing *Michelinoceras* sp. In addition, these phacoidal limestones are interbedded with thinly bedded, buff colored siltstone and calcareous shale and are intercalated between siltstone and limestone.

The upper part is essentially composed of highly jointed and thinly bedded yellowish to buff colored siltstone with crinoid stems, brachiopods and burrow structures. Marls and greenish gray to purplish phacoidal nodular limestone can be seen as subordinate units.

The gray and white color, medium- to thick-bedded, very hard and compact, unfossiliferous orthoquartzite is found at the end of the section.

Structure and nature of contact

In the present area, the Nyaungbaw Formation is generally trending N-S and dipping towards NE at (20° to 30°). The contact between the Nyaungbaw Formation and the underlying Kyaingtaung Formation is gradational and it can be seen in the west of Kyaundaing Village. This formation passes upward gradationally into the Zebingyi Formation near Poncheng Village (grid co-ordinate 037863).

Faunal content

Crinoid stems are very common and distinct in yellowish to buff colored siltstone and marls. Cephalopods of *Michelinoceras* sp. are well preserved in nodular limestone. Graptolites are fairly common in white, calcareous shale and siltstone. Trilobites and Bryozoans are few. The following important fauna are collected from the Nyaungbaw Formation.

- Graptolites : *Climacograptus rectangularis* , *Orthograptus visculusus*
 Cephalopods : *Michelinoceras* sp.
 Bryozoan : *Valenus* sp.
 Echinoids : Crinoid stems and plates
 Trace fossils : Burrows

According to the lithologic characteristics, faunal content and its stratigraphic relations, the Nyaungbaw Formation is assigned to Silurian age.

Age and correlation

According to the above fauna, the age of the Nyaungbaw Formation in the study area is assumed to the Early Silurian. The Nyaungbaw Formation of the present area can be correlated with the Pang-hsa-pye beds of La Touche (1913) and Linwe Formation of Myint Lwin Thein (1973) in the Southern Shan States. Moreover, this formation can also be correlated with the Tanjong Dendang limestone and Mempelam limestone in Malaysia (Aye Ko Aung, 2009).

Stratigraphic relationship

The gradational contact between Nyaungbaw Formation and Ordovician units show no stratigraphic break during deposition. There is a continuous deposition between Linwe Formation of Silurian age and Devonian units in southern Shan States due to conodont results (Maung Maung, 2009). Although there is no strong faunal evidence in the study area of northern Shan States, deposition of Nyaungbaw Formation during Silurian age may be continued to Devonian age.

Zebingyi Formation

Name derivation

La Touche (1913) firstly described Zebingyi rocks as Zebingyi Stage for the rocks crop out on both sides of Zebingyi Syncline in Pyin Oo Lwin Township. Pascoe (1959) renamed Zebingyi Series for that sequence of Zebingyi rocks (Upper Silurian). Later the Zebingyi rocks are termed as Zebingyi Beds by Pascoe, 1959, Garson et al., (1977). Subsequently the I.G.C.P (1980) informally first used Zebingyi Formation for a group of rock composed essentially of argillaceous limestone and black shale at the type section in the vicinity of Zebingyi village and assigned the age as late Silurian to Early Devonian. That name was followed by Brickmann in Bender, 1983, Wolfart, et al. (1984) and by most researchers and assigned its age as Early Devonian (Pragian-? Emsian) and from Gedinnian to Lower Emsian respectively.



Figure (4) Thick- to very thick- bedded phacoidal or nodular limestone of Nyaungbaw Formation



Figure (5) Buff colour siltstone intercalated with medium-bedded phacoidal limestone



Figure (6) *Climacograptus* sp. in the calcareous shale of Nyaungbaw Formation



Figure (7) *Michelinoceras* sp. in phacoidal limestone of Nyaungbaw Formation

Type section and distribution

The type section of Zebingyi Formation is located in the vicinity of Zebingyi Village, 4 km north of junction of Mandalay Pyin-oo-lwin highway and Zibingyi car road (grid coordinate 841541 in one inch Topographic Map, 93B/8) Pyin-oo-lwin Township.

The unit is fairly widely distributed in Northern Shan State especially around Pyin-oo-lwin Township. In the present area it is exposed in a very Limited extent.

Lithology

The rock of this formation is mainly composed of thin-medium, dark grey to black, carbonaceous shale and Limestone. The middle part is buff to grayish purple, thin medium bedded, bioturbated silty marl and siltstone and unfossiliferous dolomitic limestone. Thin- to medium-bedded, yellowish to reddish brown quartzose sandstone is in the upper part.

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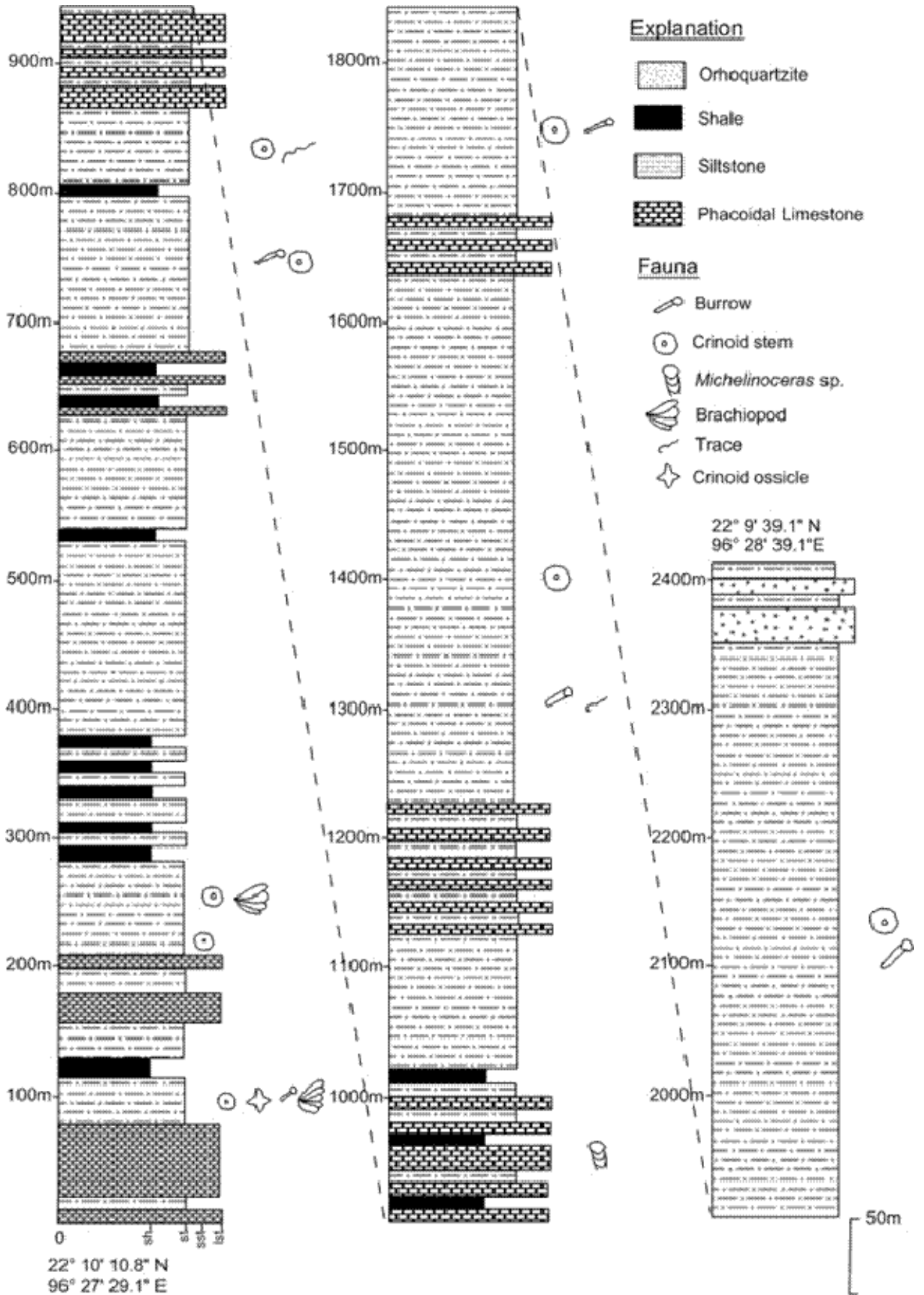


Figure (8) Stratigraphic columnar section of the Nyaungbaw Formation in the study area

Total thickness of rock units of Zebingyi Formation is 310.89 m. It can be subdivided into four subunits (Figure-9). There are (1) Black limestone; (2) Calcareous siltstone; (3) Orthoquartzite; and (4) Dolomitic limestone.

Subunit (1) Black limestone is mainly composed of medium to thick bedded (91.44m) and the fossil is rare. This unit has a contact gradationally with the highly weathered calcareous siltstone subunit.

Subunit (2) Calcareous siltstone is mainly composed of highly weathered buff coloured calcareous siltstone intercalated with dolomitic limestone. It is fossiliferous: *Tentaculites* sp., trilobites, crinoids stem fragments, crinoids ossicle fragments, brachiopod, and burrows.

Subunit (3) White colour orthoquartzite is poorly exposed in the study area and it is gradationally contacted with the subunit (2) calcareous siltstone. It is coarse-grained, massive, loosely cemented and highly weathered.

Subunit (4) Dolomitic limestone is mainly made up of dolomitic limestone. It is grey to reddish brown coloured, thin- to medium-bedded, medium- to coarse-grained dolomitic limestone. The fossils are absent in this unit.

Faunal content

Buff-coloured calcareous silty marl and siltstone of the Zebingyi Formation are richly fossiliferous, containing abundant pteropods, trilobite brachiopods. Other identifiable worm tubes and trace fossils are also present (Figures 10 -15).

- Pteropods : *Tentaculite* sp., *Styliolina* sp.
- Trilobites : *Odontochile* sp., *Dalmanites* sp., *Phacops* sp., *Lichas* sp.
- Brachiopods : *Orthis* sp., *Platyorthis* sp.
- Bryzoans : *Vaienus* sp., Crinoids and cystoids plates.
- Echinoid : Cystoids and cystoids structure
- Trace fossils : Trails and burrowing structure

Age and correlation

Nowakia sp., *Phacops* sp., crinoid stem fragments, and brachiopods are common in the Calcareous Siltstone (subunit-2). These faunal assemblages generally indicate the Early Devonian age. Paseoe (1959) and Berry & Boucot (1972) also assumed a Pridoli Gedinna age based on the content of *Tentaculites elegans* of the Zebingyi Formation. Accordingly, the Zebingyi Formation can be correlated with the Zebingyi Beds of La Touche (1913) in northern Shan State. It can be stratigraphically equivalent with the *Tentaculites* shale in the Thailand, and the *Tentaculites elegans* beds of the Wasshi Formation in the West Yunnan.

Stratigraphic relationship

The Zebingyi Formation overlies the Nyaungbaw Formation shows continuous sedimentation and there may be a possible disconformity between these two units.

Depositional Environment

In the columnar section of Nyaungbaw Formation, the lower and middle parts are mainly composed of medium- to thick-bedded, purple to reddish brown and chocolate brown, phacoidal limestone but buff colored siltstone is dominant in the upper part. And then the siltstone unit is also highly jointed and fossiliferous. Calcareous shale is intercalated between siltstone and limestone. At the end of the section, the gray and white color, medium- to thick-bedded, very hard and compact orthoquartzite is found.

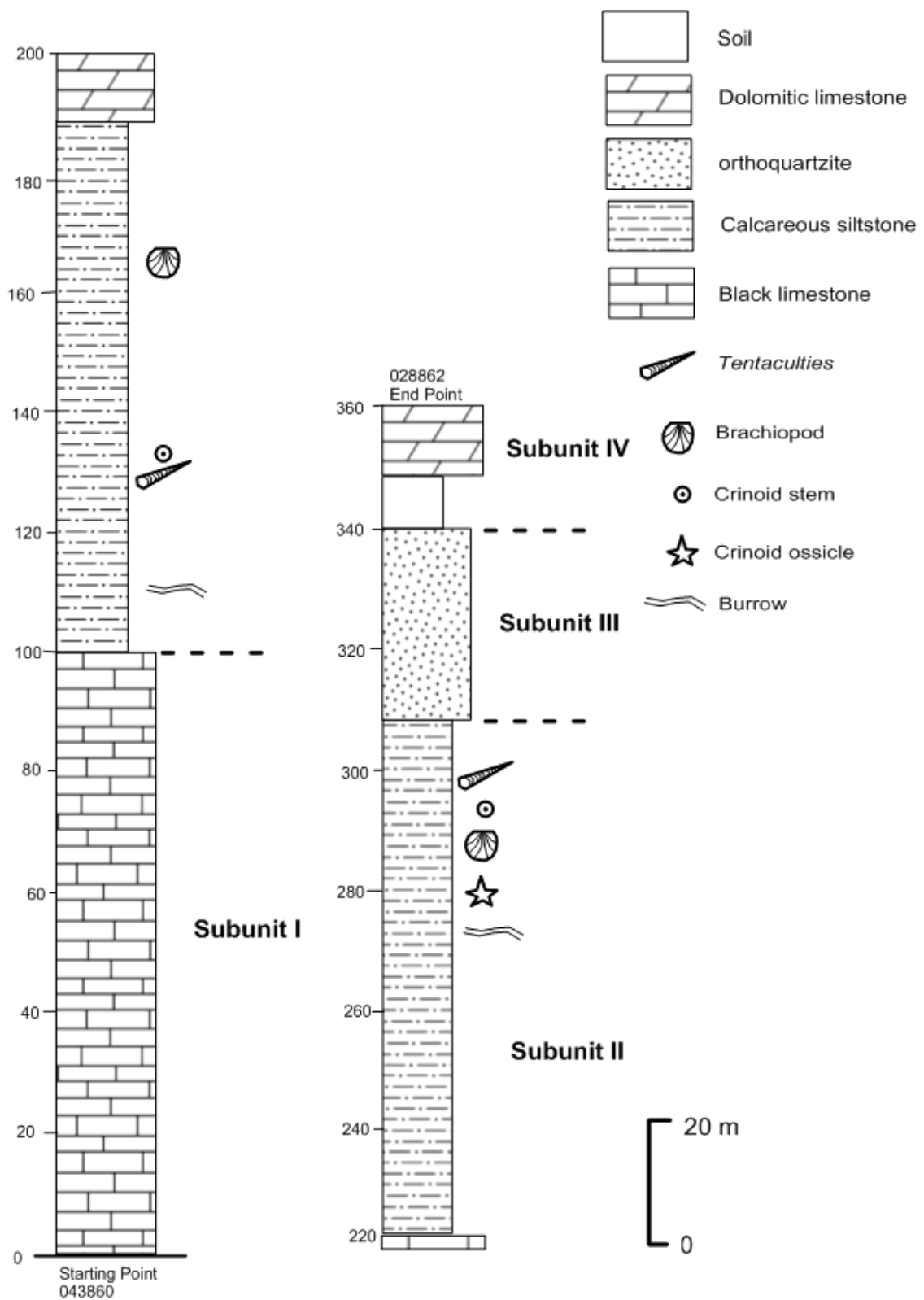


Figure (9) Lithostratigraphic measured section of the Zebingyi Formation in the study area



Figure (10) The exposure of the highly weathered calcareous siltstone



Figure (11) The dolomitic limestone exposure of Zebingyi Formation



Figure (12) Brachiopod in calcareous siltstone



Figure (13) *Nowakia* sp. in reddish siltstone



Figure (14) Burrow in siltstone unit



Figure (15) *Atrypa* sp. in calcareous siltstone

Due to the phacoidal texture and lithology the depositional environment of Nyaungbaw Formation may be interpreted as shallow warm marine environment which becomes shallow at the end of Silurian. The phacoidal texture may be formed due to either tidal and wave action or sub-seasolution or both.

Zebingyi Formation is mainly made up of black limestone, calcareous siltstone intercalated with dolomitic limestone and orthoquartzite. It is fossiliferous: Tentaculites,

Nowakia sp., trilobites, crinoids stem fragments, crinoid ossicle fragments, brachiopod, and burrows. These may be assumed that the possible depositional environment is under lagoonal and restricted marine condition.

Conclusion

Silurian (Nyaungbaw Formation) and Devonian (Zebingyi Formation) rock units are well exposed in the Kyundaing-Medaw area, 20 km north of Pyin-oo-lwin Township, Mandalay region. Highly mountainous terrain is the dominant topographic feature in the study area and are nearly N-S trending. The dominant drainage pattern is dendritic pattern. Sub-trellis pattern is also found in the clastic rock units. The short radial pattern of streams, sinkholes, caves and karst topography are conspicuous in carbonate and dolomite units.

The present work aims to investigate the detailed geological features of the Kyundaing-Medaw area and to describe stratigraphical aspects of Silurian and Devonian rock units in the Kyundaing-Medaw area.

The present study area occupies the western marginal zone of Eastern Highlands. The Ordovician to Devonian rock units such as Sitha Formation (Middle Ordovician), Kyaingtaung Formation (Late Ordovician), Nyaungbaw Formation (Silurian), Zibingyi Formation (Early Devonian), and Maymyo Dolomite Formation (Middle to Late Devonian).

Nyaungbaw Formation is composed of greenish to purplish grey, phacoidal limestone interbedded with thinly-bedded calcareous shale and thinly-bedded, yellowish to buff colours siltstone and marl. The calcareous shales are rich in fossil and highly jointed. The phacoidal structure is the main characteristics of this formation. This unit is widely exposed in west and southwest of Nyaunggon, Kyundaing, Medaw Villages.

Zebingyi Formation consists of thin-bedded, yellowish, pinkish, whitish and reddish brown quartzose sandstone dark grey to black limestone and carbonaceous siltstone. This formation exposed in the south east part of Taungtalon hill and eastern part of the Kyundaing Village.

The lower and middle parts of Nyaungbaw Formation are mainly composed of medium- to thick-bedded, purple to reddish brown and chocolate brown, phacoidal limestone but buff colored siltstone is dominant in the upper part. And then the siltstone unit is also highly jointed and fossiliferous. Calcareous shale is intercalated between siltstone and limestone. At the end of the section, the gray and white color, medium- to thick-bedded, very hard and compact orthoquartzite is found. According to the lithological and paleontological characters, the depositional environment of Nyaungbaw Formation may be interpreted as shallow warm marine environment which becomes shallow at the end of Silurian. The phacoidal texture may be formed due to either tidal and wave action or sub-sea solution or both.

Zebingyi Formation is mainly made up of black limestone, calcareous siltstone intercalated with dolomitic limestone and orthoquartzite. It is fossiliferous: *Nowakia* sp., trilobites, crinoids stem fragments, crinoid ossicle fragments, brachiopod, and burrows. It may be considered that the possible depositional environment is under lagoonal and restricted marine condition.

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References

- Aye Ko Aung, (2009) Revision on the stratigraphy of the Zebingyi Formation, Pyin-oo-lwin District, Myanmar. *Journal of Myanmar Geoscience Society*.
- Bender, F. (1983) *Geology of Burma*; Gebrüder Borntraeger, Berlin-Stuttgart: p. 230.
- Berry, W. B. N., and Boucot, A. J. (1972) Correlation of the Southeast Asian and near Eastern Silurian Rocks. *Special Paper of the Geological Society of America*, **137**, Boulder, Colorado: 65p.
- Brown, J. C. and Sondhi, V. P. (1934) The geology of the country between Kalaw and Taunggyi, southern Shan States. *Rec. Geol. Surv. India*, **56**:166-248.
- Brunschweiler, R. O. (1970) Contribution to the Post-Silurian Geology of Burma (Northern Shan State and Karen State); *Jour. Geol., Soc. Australia*, **17**:(1): 63-74.
- Burmese National Committee, I.G.C.P. (1980) *Stratigraphic Field Excursion in the Pyin-Oo-Lwin, Yadanatheingyi, Hsipaw and Bawdwin Areas* (Field Excursion No.7); unpublished report, p.29.
- Chhibber, H. L. (1934) *Geology of Burma*; London, MacMillan Co. Ltd., 588pp
- Garson, M. S., Amos, B. J., and Mitchell, A. H. G. (1976) Geology of the area around Neyangga and Ye-ngan, southern Shan State, Burma. *Overseas Mem. Inst. Geol. Sci.*, **2**: p-77.
- Gramann, F., Lain, F., and Stoppel, D. (1972) Paleontological evidence of Triassic age for Limestone from the southern Shan States and Kayah State of Burma. *Geologisches Jahrbuch, Reihe B*. Heft 1, Hannover: 3-33.
- Hla Wai (1973) *Stratigraphy and Paleontology of Paleozoic Rocks of Medaw Area*, Pyin-oo-lwin Township, unpublished M.Sc. Thesis, Department of Geology, Mandalay University: 133pp.
- Hla Myint (1984) *Geology of the Ngwetaung-Taunggyun Area, Patheingyi and Pyin-oo-lwin Township*, unpublished M.Sc. Thesis, Department of Geology, Mandalay University: 106 pp.
- Hla Thein (1991) Lower Silurian Graptolites from Pyin Oo Lwin Area, *Georeports*,**1**(1):11-22.
- Kay Khaing Myint (2005) *Stratigraphy and Sedimentation of Naungkangyi Area, Pyin-oo-lwin Township*, unpublished, M.Sc. Thesis, Department of Geology, Kyaukse University.
- Ko Ko Gyi (1991) *Geology and Mineral Resources of Kyawenadauk-Okpho Area, Pyin-oo-lwin in Township*, unpublished M.Sc. Thesis, Department of Geology, Mandalay University: 148pp.
- La Touche, T.H.D. (1913) Geology of the Northern Shan State, *Mem. Geol. Surv. India*, **39**:1-379.
- Maung Maung (2009) First Record of Late Silurian Conodonts of the Linwe Formation, Ywa-ngan Township, Shan State (South). *Journal of Myanmar Geosciences Society* **2**(1): 49-60.
- Myint Lwin Thein (1973) The Lower Paleozoic Stratigraphy of the Western Part of Southern Shan State, Burma; *Geol. Soc. Malaysia Bull.* **6**.
- Noetling, F. (1890) Field notes from the Shan Hills (Upper Burma).- *Rec. Geol. Surv. India*, **23**, 2:78-89.
- Nwe Nwe San (2005) *Stratigraphy and Sedimentation of Medaw-Nyaunggon Area, Pyin-oo-lwin Township*, unpublished, M.Sc. Thesis, Department of Geology, Kyaukse University.
- Pascoe, E. H. (1959) A Manual of the Geology of India and Burma; *3rd Ed., v.2 Govt., India*, **24**: 99-119.
- San San Myint (1998) *Geology of the Naung-Tha kaw Thayetkon-His -Hsong Area, Pyin-oo-lwin and Naung Cho Townships*, unpublished M.Sc. Thesis, Geol. Dept., Mandalay University.
- Thaw Tint and Hla Wai (1970) The Lower Devonian trilobite fauna from the East Medaw area, Pyin-oo-lwin District, Union of Burma, *Journal of Science and Technology, Yangon*, **3**(2): 283-306.