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Petrology of Devonian Strata in Naungcho Area, Naungcho Township

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Abstract

The present work deals with the systematic classification of the Paleozoic sequence in Naungcho area, situated about 30 miles north-east of Pyin-oo-lwin, in Naungcho Township. The Devonian strata of the study area can be differentiated into two lithostratigraphic units of formation rank, viz., Maymyo Dolomite Formation (Middle-Late Devonian) and Zebingyi Formation (Early Devonian). In the view of petrology, the sedimentary sequences of the present area can be classified into two microfacies; (i) biomicrite/ bioclastic-wackestone and (ii) laminated micrite/ mudstone in the Zebingyi Formation. Furthermore, there can also be classified into two microfacies, such as (i) micritic dolomite/ muddy dolomite and dolomitized sandy pelmicrite/ dolomitized sandy peloidal wackestone-packstone in the Maymyo Dolomite Formation. According to lithology, faunal content, and sedimentary structure, the depositional environments of all these units can be concluded as follow; the restricted shallow lagoon environment for the Zebingyi Formation, and warm, slightly agitated shallow marine environment for the Maymyo Dolomite Formation.

Key words: Zibingyi Formation, Maymyo Dolomite Formation, benthonic trilobites and brachiopods, lagoon environment, marine environment

Introduction

The Naungcho area, a part of the Eastern Highland, is situated about 57.6 km, north-east of Pyin-Oo-Lwin township. The present area is located at latitude 22° 07′ N to 22° 21′ N and 96° 43′ E to 96° 52′ E in one inch topographic maps 93 B/11, B/12, B/15 and B/16. It covers approximately 261.6 km^2 of rugged and mountainous terrain. The Mandalay-Lashio motor-road and railway run across the area from west to east and hence, the area is readily accessible by car and train throughout the year. The aims of the present research work are to report petrologic analysis of the carbonate rocks viz., Zibingyis and Maymyo Dolomites and then, to conclude the depositional environments of each lithologic unit based upon the fossil evidences observed.

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The numerous works on the geology of the Northern Shan State had been published. Among them, works done by La Touche (1913), Brown and Sondhi (1934), Chhibber (1934), Pascoe (1959), Brunnschweiler (1970), Myint Lwin Thein (1973), and Bender (1983) are remarkable. Some unpublished M.Sc. theses and a number of field reports for B. Sc., B. Sc. (Honours) classes from universities' field parties had been made in Pyin-oo-lwin and Naungcho townships. The geological map of the study area is shown in (Fig.1).

Method of study and Materials

Numerous traverses parallel to and across the regional structures were selected to make a detailed mapping by using tape and compass method, GPS and topographic maps. Fossils localities, faults, dips, strikes, and joints of various lithologic units were observed and measured. The thickness of each stratum measured in this field is adopted by Ingram's scale (1954). The rock samples were systematically collected and carefully marked and were later thin sectioned and studied under a petrographic microscope. Fossils from different units were collected and later identified to ascertain the stratigraphic positions of lithostratigraphic units. Tape and compass traverse method and Jacob staff's method were used to make the stratigraphic column of the formations.

Zebingyi Formation

I.G.C.P. (1980) used the term 'Zebingyi Formation' for a group of strata mainly composed of argillaceous limestone, black carbonaceous shale, without any particular structure, medium- to thick-bedded, locally containing abundant minute pteropods and assigned as Earlay Devonian (Berry and Boucot, 1972).

Aye Ko Aung (2000) applied the name 'Zebingyi Formation' to the same unit. This formation contain shale, siltstone, limestone and quartzose sandstone and is divisible into three members; Khinzo Chaung Limestone Member, In-ni Chaung Limestone Member, and Doganaing Chaung Quartzose Sandstone Member.

In the present area, the term Zebingyi Formation is accepted to describe a unit of carbonaceous siltstone and black limestone interbeds, yellow to buff-colored siltstone when weathered.

Distribution

Rocks of this unit is distinctly exposed in the western limb of the Kyaukkyan Younging Upward Synform and generally trending NNW-SSE and dipping toward NE-SW with average dip amounts 25°. Good exposure can only be observed in the SW of Kyaukkyan village. Detailed mapping in the northern part of the Shan Plateau has indicated that the distribution of Zebingyi bed is rather widespread.

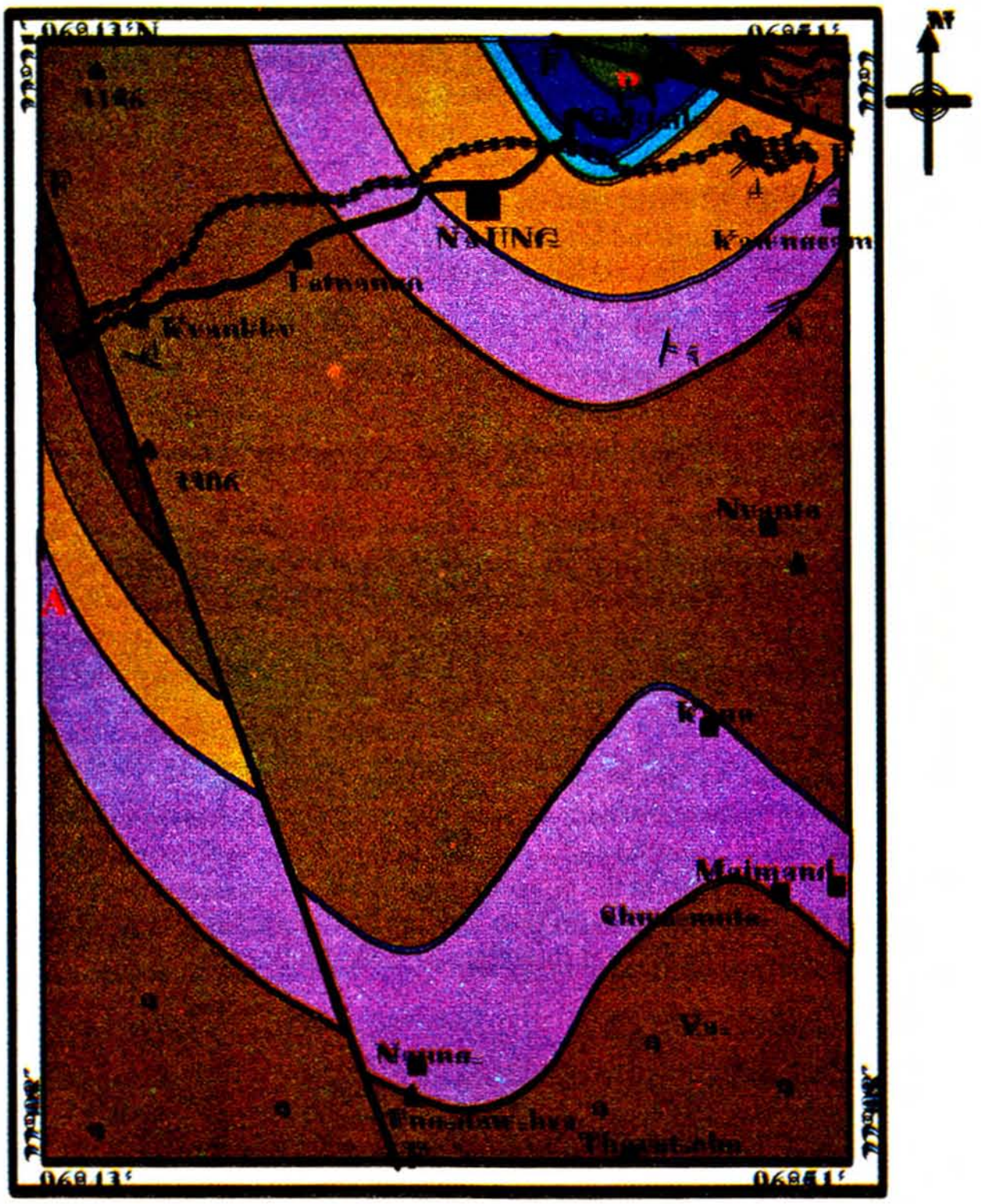

Fig. (1) Geological map of the Naungcho Area

EXPLANATION

NWABANGYI FORMATION (Late Permian to Middle Triassic)
(pale grey, thin- to medium-bedded, partly laminated carbonates with numerous foraminifera)

THITSIPIN LIMESTONE FORMATION (Early Permian)
Thin- to medium-bedded, white, light grey to grey, very fine-grained interbedded with thinly bedded calcareous shale or mudstone and locally dolomitized

Unconformity

MAYMYO DOLOMITE FORMATION (Middle to Late Devonian)
Medium-bedded, light grey to grey, highly brecciated, fine-grained limestone, thick-bedded to massive, light grey to grey, brecciated and locally dolomitized, calcitic limestone

ZEBINGYI FORMATION (Early Devonian)
Thin- to medium-bedded, grey to dark grey, fine-grained laminated black carbonaceous siltstone, black limestone, shale and buff-colour marl.

NAMHSIM FORMATION (Late Silurian)
Reddish brown to light brown, fine-grained, compact, thin- to medium-bedded sandstone with subordinate sandy marls.

NYAUNGBAW FORMATION (Early Silurian)
Greyish, greenish to purple phacoidal limestone interbedded with thinly beded, purple, calcareous shale and yellowish to buff siltstone in the upper part, medium- to thick-bedded, purple to reddish brown, chocolate brown, grey to grey green, argillaceous limestone and white to silty marl in the lower part.

KYAINGTAUNG FORMATION (Late Devonian)
Thin- to medium-bedded, greenish grey to grey silty limestone interbedded with thin partings of calcareous shale, buff-coloured siltstone and marl in the upper part, thick-bedded to massive, yellowish grey to greenish grey, micaceous calcareous siltstone and marl with lime parting rich in fossiliferous in the lower part.

GEOLOGIC & GEOGRAPHIC SYMBOLS

Sharp contact

Fault

25° Dip and strike of bedding

Car road & Railway

Village

Village & Town

Pagoda

Lithology and Structure

The Zebingyi Formation consists of thin- to medium-bedded, dark grey to black calcareous siltstone and black limestone. In the present area, siltstones are mostly calcareous and fossiliferous. These black siltstones are markedly fissile and broken into papery thin layers.

In the present area, the Zebingyi Formation has a very limited aerial extent with a NNW- SSE trending and dip towards NE and SW with an average dip amount 25°. The contact between the Zebingyi Formation and underlying unit is not observed whereas the contact with the overlying Maymyo Dolomite Formation in Kyaukkyan area is conformable.

Fauna and age

The buff-colored calcareous shale, silty marl and siltstone of Zebingyi Formation are fossiliferous, containing abundant nowakids, trilobites and brachiopods (Fig.2a, 2b, 2c). Other unidentifiable warm-burrowed tubes are also present.

Nowakids:*Nowakia* sp., *Styliolina* sp.

Graptolites: *Monograptus* sp.

: *Styliolina* sp.

Trilobites : *Phacops* sp.

The above faunal assemblages generally indicate the Early Devonian. Berry and Boucot (1972) also assumed a Gedinnian (Lower most Devonian) age based on the faunal content of graptolites and trilobites of the Zebingyi Formation. The Early Devonian (Pragian) age for the Zebingyi Formation is confirmed by the evidence of graptolites from Pyintha area (Jaeger, 1983) and of the conodonts dacryoconarid tentaculites (Aye Ko Aung, 2000).

Field parties of Mandalay University led by Bo San and Zaw Min Thein (1995) collected the coral fauna assemblages from upper part of the Zebingyi Formation. The coral fauna also indicate the Early Devonian (Pragian) age (Aye Ko Aung, per. Com., 2000).

Correlation

On the basis of overall characteristics, the present section of the Khinzo Chaung Limestone Member of the Zebingyi Formation (Aye Ko

Aung, 2000), can be correlated with the Zebingyi Beds of La Touche (1913) and the Kywetaung Formation of southern Shan State (Min Swe, per. Com., 2000). So far as it is known at present, the stratigraphic equivalents of the Zebingyi Formation are the *Tentaculites elagan* -bearing beds of the Whitish Formation in the west Yunnan (Kobayashi, 1960).

Fig.(2.a) *Phynolaspirina*

Fig.(2.b) ? *Meristella* sp.

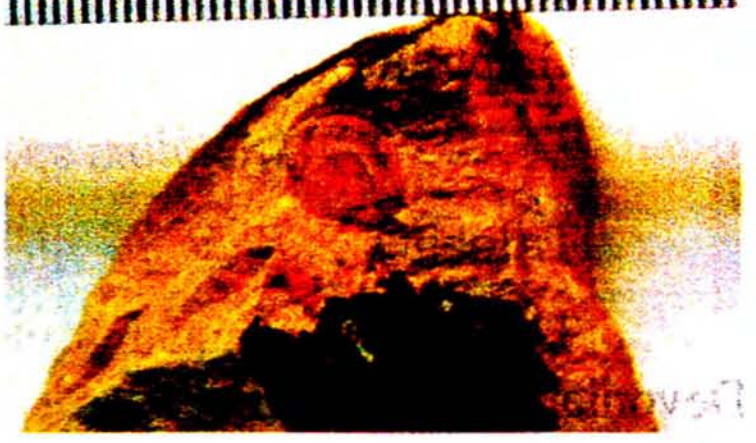

Fig.(2.c) ?*Pustulina sp*

Fig.(2) The fossils collected from Zebingyi Formation, west of Kyaukkyan Village.

Maymyo Dolomite Formation

The term Plateau Limestone was first described by La Touche (1913) for a thick carbonate sequence which covers a large part of the Shan State.

He subdivided it into a lower dolomitic part (the Devonian Lower Plateau Limestone) and upper calcitic part (the Permian Limestone). Pascoe (1959) suggested a three-fold subdivision of the Plateau limestone in which a calcitic unit is sandwiched between two dolomitic units.

On the basis of new fossils findings the name Plateau Limestone was abandoned because it was defined as a carbonate rock sequence that was originally placed in the Permo-Carboniferous (Gramann *et al.*, 1972, Amos, 1975, Garson *et al.*, 1976, Brownmann *et al.*, 1975; Mitchell *et al.*, 1977 and Bender, 1983). Brunnschweiller (1970) described that the name Plateau Limestone as used in earlier literature is inappropriate because the term 'Plateau' is virtually meaningless as a geographical term. He, therefore, proposed the name 'Shan Dolomite' which consists largely of dolomtic part of the Shan Plateau (Devonian).

Amos (1975) used to describe the name Shan Dolomite Group and be subdivided into a Devonian and possibly Carboniferous Maymyo Dolomite Formation and a Permo-Triassic Nwabangyi Dolomite Formation.

Burmese National Committee (1980) also used the term Maymyo Dolomite Formation (Devonian) to describe the dolomite for the exposure in the Pyin-Oo-Lwin south area. They also mentioned that the dolomites of Maymyo Formation were characteristically brecciated and the dolomitization processes produced a saccharoidal texture. The Dolomite is the result of extensive digenetic dolomitization of the Devonian Limestone.

Distribution

The Maymyo Dolomite generally crops out in the eastern, western and southern parts of the area. Good exposures are found on the rolling terrain. The extensively scattered exposures of this unit are covered by terra-rosa in most part of the area. Red soil, terra-rossa, covered the area is fertilized to cultivate. In the vicinity of Letpangon, Namhsio, Panglong, Shwemotehtaw and Naungleng villages where covered by terra-rossa are found with grass.

Lithology and Structure

The Maymyo Dolomite Formation is mainly composed of light grey to grey brecciated dolomitic limestone, sandy limestone and shale. The dolomitic limestones are mostly massive to rarely thick-bedded with craggy appearance and frequently stained red by iron oxide both on the surface and the joint planes. In places, secondary calcite veins are developed in small vugs in the rock. Its granular texture produces a sandy feel. Buff to black shale is thinly-bedded and fissile.

The Maymyo Dolomite Formation is broadly exposed in antiform-synform structure with gentle dips. The general trend of the unit is NNE-SSW and generally dips toward east with very low angle of dips. Stratigraphically, there is no clear-cut stratigraphic contact between the lower and upper members of the Maymyo Dolomite Formation.

The Maymyo Dolomite Formation conformably overlies the older units of the area. The conformable contact between the Maymyo Dolomite Formation and Zebingyi Formation can be observed near the 72/5 miles on Mandalay-Lashio motor-road in the western part of Kyaukkyan Village and it has an unconformable contact with Nyaungbaw Formation at the northern part of the Goktwin Bridge. The younger unit, Nwabangyi Dolomite Formation, also overlies the Maymyo Dolomite Formation with an unconformity in the eastern part of the Naungcho Township.

Correlation

The Maymyo Dolomite Formation can be correlated with the Plateau Limestone of La Touche (1913), Shan Dolomite of Brunnschweiler (1970), Shan Dolomite Group of Amos (1975), Maymyo Formation of I.G.C.P. (1980), Nwabangyi Dolomite Formation in the southern Shan State of Garson *et al.* (1976) and Thigaungdaung Limestone in Aungban-Heho area, southern Shan State of Gramann *et al.*, (1972).

Microfacies Analysis of the Rocks of Zebingyi Formation

Microfacies 1.Biomicrite / Bioclastic wackestone

Microscopically, it consists of micrite (85%), bioclasts (10%) and silt size quartz grains (5%). The matrix is the fine-grained calcite and some are argillaceous. The most common bioclasts are pteropods, some bryozoans and brachiopods. The isopachous rims are found in the matrix (Fig.3).

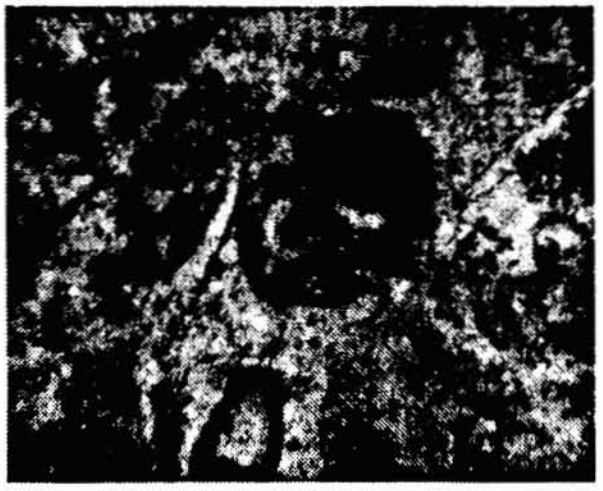

Fig. (3) Photomicrograph showing miliolid, (a) Mollusc shell, partly filled with the calcite spar, (b) isopachous rim, and (c) also present in the biomicrite of Zebingyi Formation (40X,PPL)

Bioclasts: They occur as a whole shell or fragments. They are randomly oriented in the micritic matrix. Some of them are filled with calcite or neospar.

Pteropods: They are Nowakia sp. and Stylolina sp. observed as basal, longitudinal and diagonal section. In the basal section, they occurred as sub-rounded shape and thin ouiter wall formed as a thin layer parallel to the periphery of body whorl. Inner portion was entirely filled with neospar. The wedge shape with saw teeth outlines occur in the longitudinal section. This form is easily distinguishable from other fossils. It is also filled with neospar. Sometimes central cannals have been filled with radially arranged micro-calcite grains giving rise to beautiful radial extinction. Inclusion of purite crystals are rarely observed in pteropod fragments.

Bryozoans: It occurs as the thick wall of laminated calcite and surrounding cement filled the pores.

Brachiopod: It occurs as the shell with internal laminated or fibrous structure.

Quartz silts: The detrital quartz silts are scattered in the micritic matrix. They are angular to sub-rounded and moderately sorted.

Texture

Sometimes, the quartz silt grains aligned parallel to the argillaceous materials. Diagenetic features observed in this section are (i) the parallel orientation of quartz silt and argillaceous materials formed due to the weight of overlying materials. (ii) Microstylolitic seams in micrite and at some grains are resulted from pressure solution process. (iii) Neospar in veins, voids and some bioclasts by the process of neomorphism. In some places, micritic enlargement is also occurred (i.e. aggrading neomorphism).

Environment

The abundance of micrite, texture and structure of this limestone suggests a restricted circulation shelf lagoon environment. This limestone can be assigned to the Standard Microfacies 19 and Standard Facies Belt 8 (Wilson, 1975).

Microfacies II. Laminated micrite/Mudstone

Under the microscope, it is composed almost entirely of micrite (90%). Detrial quartz silt and others constitute as much as (10%) of the

rock. There are very rare or lack of bioclasts. In this rock, most of the quartz grains are oriented along the argillaceous lamination. The neospar noted in the rocks are characterized by filling in the veins. The stylolite seams are fairly common in this rock.

The diagenetic feature interpretations are:

(i) Compaction produced the parallel orientation of argillaceous materials and quartz silt.

(ii) Pressure solution caused the microstylolite seams

(iii) Neomorphism caused the neospars which filled veins and veinlets.

(iv) Authigenesis-euthedral pyrite crystals (porphyrotope) embedded in the micrite are evident this process.

Environment

Mainly composed of fine-grained micrite, appearance of parallel lamination and dark colour indicate a deposition by low to moderate bottom current in a restricted circulation shelf environment. It can be comparable with Standard Microfacies 19 and Standard Facies Belt 8.

Microfacies Analysis of the Rocks of Maymyo Dolomite Formation

Microfacies 1. Micritic dolomite/ Muddy dolomite-wackestone

Microscopically, it is dominated by dolomite crystals amounting about 92% and micrite 8%. Bioclasts are rare or absent. Pyrite constitutes from 1% to 2% of the rock volume. Dolomite: The rhomb-shape dolomite crystals are the most 0.05 mm to 0.03mm in diameter and both euhedral. The composition of original carbonate mud may be interpreted as Mg rich constituents. The dolomite aggregates are mosaics of subhedral to euhedral grains and tightly interlocked. The fail interlock of adjacent dolomite crystals formed the intergranular porosity. The completely formed biotas are very rare due to the highly dolomitization which obliterated all traces of organic structure. The association of barogue dolomite and zoned dolomite can be seen in thin section under microscope.

The most common deagenetic features observed in this section are:

(i) Compaction: Generally close-packed rock fabric is formed by the weight of overlying sediments.

(ii) Dolomitization: Dolomite is the common component of this limestone. It indicated that the original limestone has been totally replaced by dolomite due to the mimicking dolomitization. In some places, the patches of micrite are the relic of partial dolomitization (Fig. 4).

(iii) Neomorphism: Neospar filled the veins and microfractures by neomorphism.

(iv) Disseminated authigenic pyrite crystals formed by authigenesis.

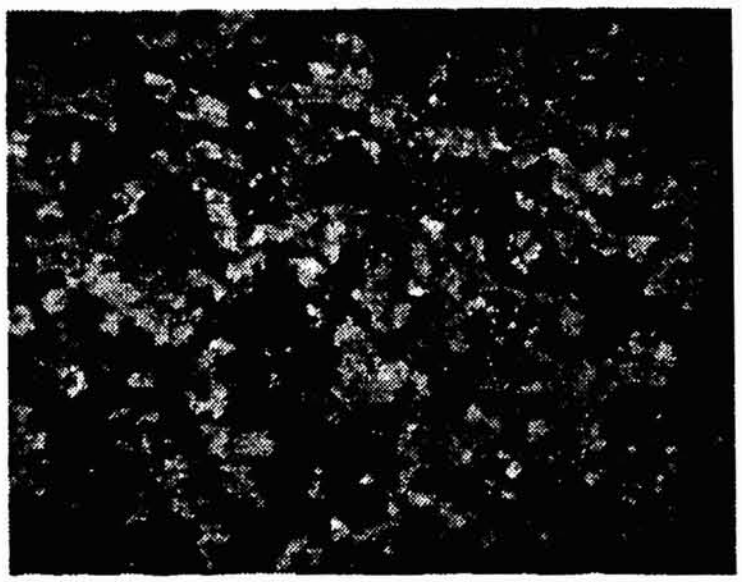

Fig. (4) Photomicrograph showing the medium-grained xenotopic dolomite crystals; some of which are replaced by sparites indicating the break in sedimentation after Maymyo Dolomite Formation (40X, PPL)

Texture

Dolomite crystals are subhedral to euhedral. Patches of micrite occur as ghost texture. Tightly interlocking dolomite crystals occur as compromise boundary and concavo-convex contact. Some dolomite crystals distinctly zoned by chemical difference.

Environment

On the basis of above mentioned facts, this limestone has been deposited in deep water below wave base.

This limestone may be correlated to the Standard Microfacies 3 and Standard Facies Belt1and 3 (Wilson, 1975).

Microfacies II. Dolomitized sandy pelmicrite/Dolomitized sandy peloidal wackestone-packstone

Under the microscopic view, it contains 10% of pellets. Micrite content ranges from 50% to 70%, dolomite 10% and some magnetite 5%.

Pellets: The pellets are the most abundant allochem. They are circular to elliptical in cross-section and it ranges in size from 0.7mm to 0.15mm. In some places, lithic pellets are also observed. These grains composed of micrite and lacking any recognizable internal structure. Most of the borders of pellets are hazy, indistinct and tend to emerge into the surrounding micrite and they are faecal origin.

Dolomite: Dolomites are partly replaced in micrite and some faecal pellets. They are subhedral to euhedral and sometimes occur within the coarse-grained calcite.

Some prominent diagenetic features are:

(i) Some peloidal grains are deformed by compaction.

(ii) Microstylolitic seam (Fig.5) that cut across the micrite and dislocated. Some peloidal grains are due to the process of pressure solution.

(iii) Displacement of scattered dolomite crystals in micrite are formed by the partial dolomitization.

(iv) Mosaic of the calcite neomorph in some pellets and veins are due to the process of neomorphism.

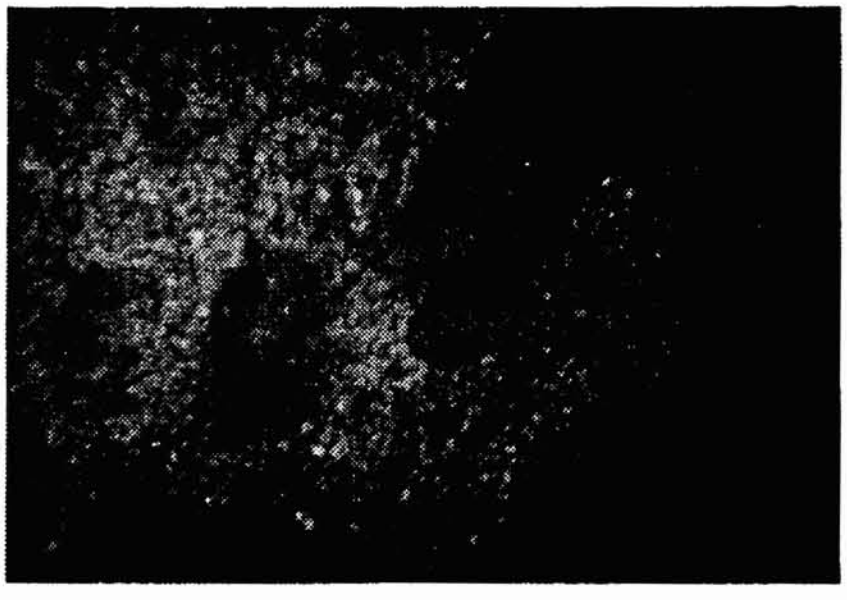

Fig. (5) Photomicrograph showing the microstylolite cutting the pellets embedded in the microspar cement and which indicate the late diagenetic stage in the Maymyo Dolomite Formation. (40X, PPL)

Environment

General light color and occurrence of pellets assigned to the deposition of restricted bay or pond (Wilson, 1975). It could reasonably assign to Standard Microfacies 19 and Standard Facies Belt 8.

Conclusion

The Zebingyi Formation is characterized by the presence of thin- to medium- bedded, carbonaceous black siltstone, mudstone, yellow to buff silty marl, ash-white to light grey micritic limestone.

This formation consists of benthonic trilobites and brachiopods and the pelagic fauna of *Nawakia* sp, *Styliolin*a sp and algae. The black siltstones are fissile and break into semi-flexible papery thin layer. Thin- to medium-bedded carbonaceous, black limestones are mostly abundant in this formation. And so, low Eh and slightly quiet water environment is probably required for the preservation of organic matters in fine-grained, dark carbonate mud, to prevent oxidation of organic compound to carbon dioxide plus water.

At the lower part of the Zebingyi Formation, the fine-grained mudstone was formed under fairly deep marine condition and a low energy condition. The light color of limestone is commonly enhanced by oxidation and weathering.

The preservation of organic matter is also due to more rapid burial and more uniform marine condition, with no change for periodic oxidation caused by storm waves. Siliceous or argillaceous limestone formed under basinal environment generally gives dark colour.

The above mentioned statements inform that the Zebingyi Formation was laid down in the restricted lagoon with euxinic condition.

In the study area, the Maymyo Dolomite Formation is made up of light grey to grey, massive to rarely thick bedded, dolomitic limestone in lower part and chocolate, light grey, medium to thick-bedded limestone in the upper part. Generally, the light color and fossiliferous limestone occur dominantly in lime mud in some horizon. These indicate that the depositional site of the Maymyo Dolomite Formation was shallow marine environment.

The presence of pellets in the limestone is the evidence to indicate low energy, warm supersaturated sea of restricted condition. The pellets stay dull and pitted in low energy environments (Scoffin, 1987).

Therefore, it may be concluded that Maymyo Dolomite Formation was deposited in a warm, slightly agitated shallow marine environment.

Acknowledgement

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