Petrography and Estimation of Depositional Environment on Thitsipin Formation of Naung Wo Area, Pinlaung Township, Southern Shan State

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Abstract

The study area occupies southern part of Kawlaw-Pinlaung Basin and it is a region covering the southern continuation of the Eastern Highlands. It forms as a part of the western marginal zone of Shan Plateau. Kalaw – Pinlaung Basin. The major stratigraphic units occured in the study area are Thitsipin Formation and Thigaungtaung Formation of Plateau Limestone Group (Late Permian to Early Triassic), Loi-an Group (Middle Jurassic – Early Cretaceous), Kalaw Formation (Cretaeous) and Legaing Limestone Formation (Late Cretaceous). Lithologically, Thitsipin Formation mainly composed of slightly dolomitized gray coloured calcitic limestone, silt laminated limestone and whitish grey coloured limestone containing some chert nodules. These limestones are commonly dolomitized but some organic remains such as algae, bryozoan and hashes of bivalves, brachiopods, gastropods and corals are not uncommon. Petrographically, the Thitsipin Formation can be classified as (1) Ooidal Packstone - Grainstone, (2) Bioclastic Packstone – Grainstone, (3) Dolomitized Peloidal Wackestone, (4) Bioclastic Wackstone, and (5) Mudstone. In facts, the occurrence of early dolomitization and low fauna content are indicating tidal-flat origin. The bioclasts present and dominance of grainstones indicate shallow – water condition with relatively strong wave and current action, and the sediment represents the accumulation in current washed shoal conditions. The present of ooids with may be deposited in the oxygenated water and form above to below wave base. Marine ooids originate in warm, high energy, shallow-water environment; particularly in tidal bars.

Keywords: Petrography, Depositional environment, Thitsipin Formation, Naung Wo area

Introduction

The study area occupies southern part of Kawlaw-Pinlaung Basin and it is a region covering the southern continuation of the Eastern Highlands. It forms as a part of the western marginal zone of Shan Plateau. It lies between latitudes 19º 52′-19º 59′ north and longitudes 96º 50′-96º 58′ east. It extended about 6 miles from east to west and 7 miles from north to south. The total coverage of the area is approximately 42 square miles of fairly rugged terrain. The location map of the study area is shown in (Fig. 1).

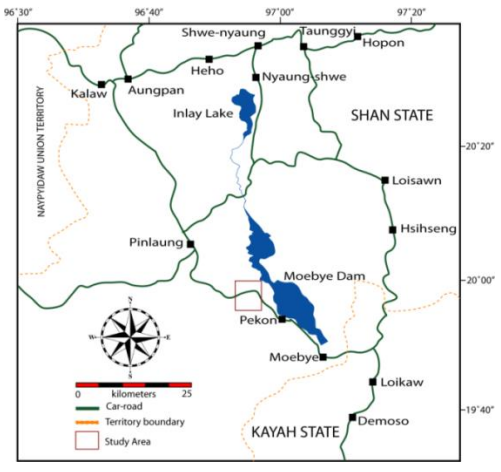

Figure 1. Location map of the study area

Regional geologic setting

The study area probably occupies the part of the southern Kalaw – Pinlaung Basin, made up of the Jurassic –Cretaceous sediments and is generally bounded by the carbonates of the Plateau Limestone Group of Late Carboniferous to Middle Triassic age.

The Kalaw-Pinlaung Basin, a NNW – SSE trending elongated through of 30 miles long and 7 mile wide with thick sequence of Mesozoic sedimentary rocks, is situated on the western margin of the Shan – Taninthayi Block or the Eastern Highlands of Myanmar. It extends southwards from Pan Laung valley through Kalaw and up to the southern parts of the Loikaw area. The study area lies in the southeastern part of the Kalaw – Pinlaung Basin. The basin is bounded immediately in the west by the partly metamorphosed clastic sediments of Carboniferous – Permian Lebyin Group and in the east mainly by the Plateau Limestone Group. The Loi-an Group (Lower Jurassic – Lower Cretaceous in age, essentially with clastic marine and brackish water sediment). Taungni Formation (Lower Cretaceous in age) and the Kalaw Group (Upper Cretaceous in age) are major lithostratigraphic units of the Kalaw – Pinlaung Basin (Khin Maung Win *et.al*, 1980).

Basement of basin at the western margin is formed by the quarzites, slates, pebbly greywacke and mudstone of Lebyin Group, and at the eastern margin

by the limestone and dolomites of the Plateau Limestone Group. The Loi-an Group, Jurassic in age, unconformably overlie both the Plateau Limestone Group and the Lebyin Group. The thick sequence of Loi-an Group developed in the present area is chiefly composed of grey to dark grey sandstone, siltstone, and mudstones. This group is overlain by the continental deposits of Kalaw Red Beds that is composed of reddish sandstones, conglomerates, siltstone and shale.

Stratigraphy

The study area is situated at the southern part of Kalaw-Pinlaung Basin and located near the western marginal zone of Shan Plateau. The major stratigraphic units occur in the study area are Thitsipin Formation and Thigaungdaung Formation of Plateau Limestone Group (Late Permian to Early Triassic), Loi-an Group (Middle Jurassic – Early Cretaceous), Kalaw Formation (Cretaceous) and Legaing Limestone Formation (Late Cretaceous) as shown in figure (2). The lithostratigraphic units of the Naung Wo -Lonpyin area have been classified in descending order as table. 1.

Table 1. Stratigraphic Succession of the Study Area

Succession	Unit	Age
6	Alluvial	Quaternary
	------unconformity------	
5.	Legaing Limestone Formation	Late Cretaceous
4.	Kalaw Formation	Late Jurassic – Early Cretaceous
	------unconformity------	
3.	Loi-an Group	Middle Jurassic – Early Cretaceous
	------unconformity------	
	Plateau Limestone Group	
2.	Thigaungdaung Formation	Early Triassic
1.	Thitsipin Formation	Middle – Late Permian

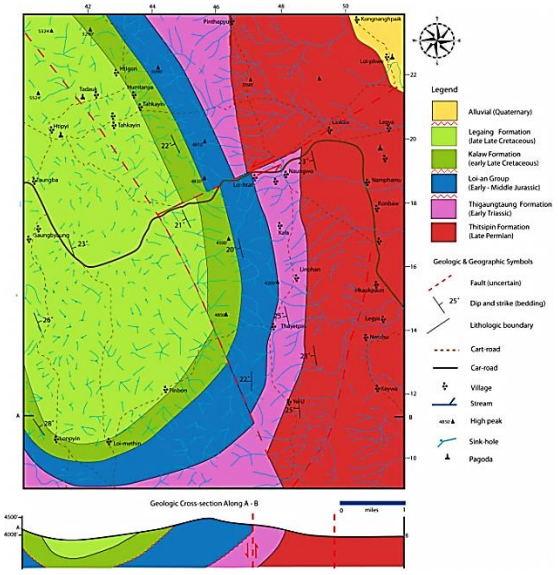

Figure 2. Geological map and geologic cross-section of study area

Petrography of Thitsipin Formation

The study area is situated at the southern part of Kalaw-Pinlaung Basin and located near the western marginal zone of Shan Plateau. In the study area, the lithologic units consist mainly of carbonate rocks, viz, Thitsipin Formation and Thigaungdaung Formation of Plateau Limestone Group (Late Permian to Early Triassic) and Legaing Limestone Formation (Late Cretaceous). In the present investigation, petrographical and lithostratigraphical analysis is carried out to reconstruct the depositional environment of carbonate rock units of study area. Petrographic classifications used in the study area follow those of Folk (1959), Dunham (1962).

Petrographically interpretation of depositional environment of carbonate rocks are due to the carbonate rocks classification of Folk (1959) and Dunham (1962), Wilson (1975), Tucker & Wright (1990), Adams and Mackenzie (1998), and Flugel (2010).

Thitsipin Formation

The Thitsipin Limestone Formation show dotted with hills, which are made up of Permian reefal limestones. The limestone is bedded or massive and dolomitized in many places. At the base of this formation, the limestone is purplish grey or dark grey in color, fine - grained bedded rocks but sandstone showing massive and inter stratification with calcareous silty shales of purple color. Karst topography in the Thitsipin Limestone Formation is also noted. Thick - bedded to massive, bluish grey cliff-forming Thitsipin Limestone Formation is also found.

In the study area, petrographically, the Thitsipin Formation can be classified as (1) Ooidal Packstone - Grainstone, (2) Bioclastic Packstone – Grainstone, (3) Dolomitized Peloidal Wackestone, (4) Bioclastic Wackstone, and (5) Mudstone.

Ooidal packstone-grainstone

Megascopic description

It is well-exposed, thick to massive, fine to medium-grained, hard and compact; light to dark grey coloured limestone unit of Thitsipin Formation, and it is occurred in the southern peak of Naung Wo range and along the rail-way section (Fig. 3).

Microscopic description

It is mainly consisted of grains (peloid 15 %, ooid 45%), and cement (sparite 35% and micrite 5%) in total volume. Petrographically, grains in thin-section are rounded to sub-rounded, poorly sorted, ranging in size 0.5 to 2mm and sparsely embedded in the fine-grained sparry calcite and micrite. The micritic matrix occurs as internal sediment.

Figure 3. Thick to massive, fine- to medium-grained, hard and compact, light to dark grey coloured limestone unit of Thitsipin Formation Loc – 495188, Facing – NE

Generally, oval-shaped ooids (<5mm in diameter) are probable formerly aragonitic but now replaced with calcite and original concentric ring structures are poorly preserved. Some compaction of oomoulds indicates that the calcite spar cement is a burial precipitate. Sub-rounded and small micrite peloids are also common.

The pressure dissolution seam filled with post calcite spar is break and slightly displaced the spherical ooids indicating the mechanical compaction during diagenesis. According to the classification of carbonate rock by Folk (1959), the rock can be named as Pel-Oo-sparite. This rock can be named Ooidal Packstone-Grainstone (Dunham, 1962) because the content of ooids and peloids are embedded in microcrystalline lime mud (Fig. 4 & Fig. 5).

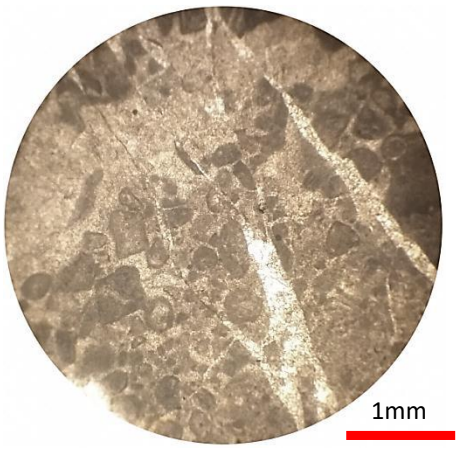

Figure 4. Photomicrographs show small spheroidal ooids, peloids and micrite with veins filled sparry calcite

Figure 5. Photomicrographs show large oval-shaped ooids with poorly preserved concentric ring filled with sparry calcite and micrite

Interpretation of depositional environment

The bedding nature, wavy discontinuous, silt lamination in limestone, diversity of fossil, high content of lime mud, reflects relatively much greater depth with slight energy condition. In this unit with high disversity and large of fauna strongly suggest good current circulation and normal marine salinity with well oxygenated condition. The present of ooids which may be deposited in the oxygenated water and form above to below wave base. Marine ooids originate in warm, high energy, shallow-water environment; particularly in tidalbars.

Bioclastic packstone – grainstone

Megascopic description

This unit is well-exposed in the southern part of study area such as Naungbin village, Thayetpin village. It is fine grained, thick to massive, hard and compact, whitish grey in fresh colour and dark grey in weathered coloured fossiliferous limestone unit of Thitsipin Formation (Fig. 6).

Microscopic description

It is mainly composed about of bioclasts (50%), micrite (35%), sparry calcite (15%). Some bioclasts are filled with internal sediments and sparry calcite, and the walls of some shell fragments are completely replaced by calcite, some septal structures are preserved as relicts at the periphery, infilling of micrite sediments took placed (Fig. 7). According to Folk (1959), the rock can be classified as biomicrite. This limestone is bioclastic Packstone - Grainstone of Dunham (1962).

Figure 6. Fine grained, thick to massive, grey to dark grey fossiliferous limestone unit of Thitsipin Formation (Loc. – 493198, Facing – overview)

Interpretation of depositional environments

The bioclasts present and dominance of grainstones indicate shallow – water condition with relatively strong wave and current action, and the sediment represents the accumulation in current washed shoal conditions.

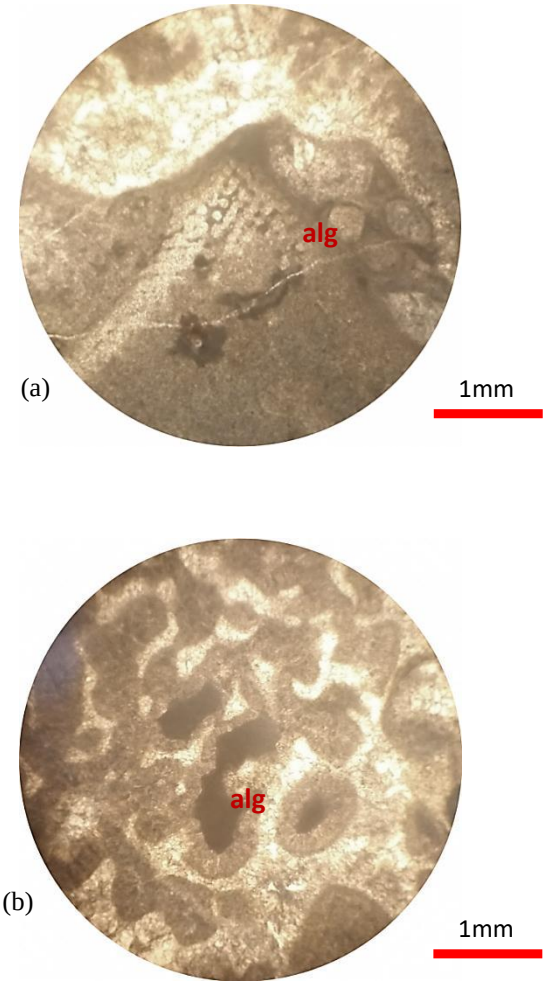

Figure 7. Photomicrograph showing (a) – (b) algals infilling micrites and replaced by calcite in the wall and some insides

Dolomitized peloidal wackestone

Megascopic description

This unit is well-exposed in the eastern part of study area especially the best exposures are occurred in many quarries of study area. It is usually massive, some are medium to thick, highly jointed, numerous calcite veined, brecciated, medium to coarse grained, grey to light grey in colour. Criss-cross jointing is typical surface features of dolomitic limestone unit of Thitsipin Formation (Fig. 8)

Figure 8. Medium to thick-bedded, highly jointed, and brecciated, medium to coarse grained, grey to light grey in colour dolomitic limestone unit of Thitsipin Formation. Facing – SSE, Loc - 490193

Microscopic description

It is mainly composed of dolomite (30%), peloids (35%) and lithic fragments (10%) and micrite (20%), sparry calcite (5%). Dolomites are very fine-grained (dolomicrite) and showed anhedral xenotopic texture (Fig. 9). Dolomitizaion process probably be destroyed the original structure of limestone and resulted the brecciation. Micrites are showed dark in colour and sparry calcite filled along the fractures and surrounded the lithic fragments. Small spherical-shaped peloids seem to be micritized peloids. According to the classification of carbonate rock by Folk (1959), the rock can be named as dolomitized micrite. In classification of Dunham (1962), the rock can be named as Dolomitized Peloidal Wackestone.

Interpretation of depositional environment

The dominant nature of limestone is diagnostic character for high energy condition (Reading, 1986). This may be deposited in an open shelf margin environment.

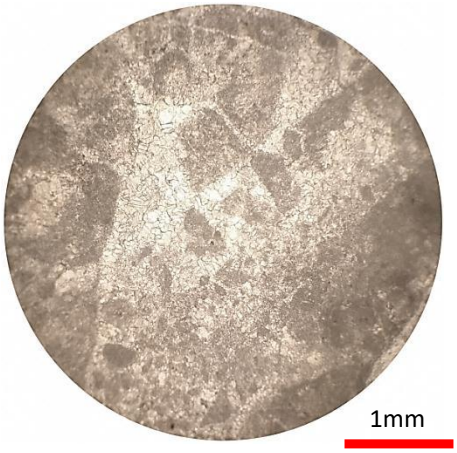

Figure 9. Photomicrograph showing fine-grained anhedral dolomicrite mossice sparry calcite filled veins in the micrite and small peloid and lithic fragments of dolomitized Peloidal Wackestone

Bioclastic wackstone

Megascopic description

It is fine- to medium-grained, massive, slightly dolomitized, and sub-indurated, poorly fossiliferous, light grey to grey limestone unit of Thitsipin Formation (Fig. 10). This unit occurs along the Loikaw-Pinlaung high-way cut section and southern parts of study area.

Microscopic description

According to microscopic examination, the slides are composed of micrite (70%) and sparry calcite (10%) and biocalst (>10%), micritized peloids (<5%) and a few dolomite. The bioclasts including crinoid, foraminifera and others unclassified fossil fragments which are filled with calcite and micrite later.

Figure 10. Fine to medium grained, massive, slightly dolomitized, and sub-indurated, poorly fossiliferous, light grey to grey limestone unit of Thitsipin Formation (Loc – 495193, Facing – SW)

Sparry calcite occurs as secondary deposition along the micro-fractures (Fig. 11 & Fig. 12). According to Fork (1962), the rock can be classified as biomicrite. This limestone is Bioclastic Wackstone of Dunham.

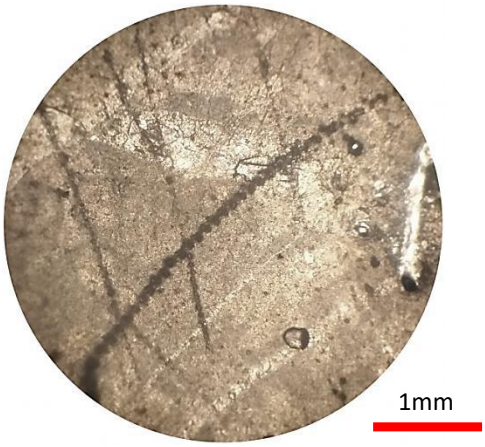

Figure 11. Photomicrographs showing unclassified fossil fragments, micrite, microfractures filled with sparry calcite

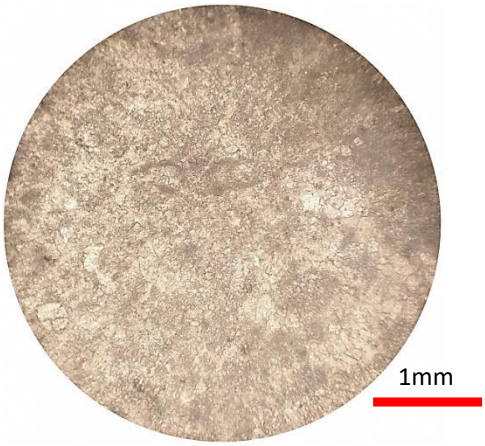

Figure 12. Photomicrographs showing biocalsts, micrite, dolomite, sparry calcite and peloids in limestone unit of Thitsipin Formation

Interpretation of depositional environment

High micrite content is the valuable indicator of shallow and low energy environment. The occurrence of early dolomitization and low fauna content are indicating tidal-flat origin.

Mudstone

Megascopic description

This rock unit is locally exposed in the area of Naung Wo Hill. It is well-exposed, calcite veined, thick to massive and grey to dark in colour (Fig. 13).

Microscopic description

It is purely composed of micrite over 90% with a few silt-sizes, moderately well sorted and angular quartz grains are floating and scattered throughout the micrite, and small micritized peloids and fractures filled with sparry calcite (Fig. 14). According to Fork (1962), the rock can be classified as Micrite and Mudstone by Dunham.

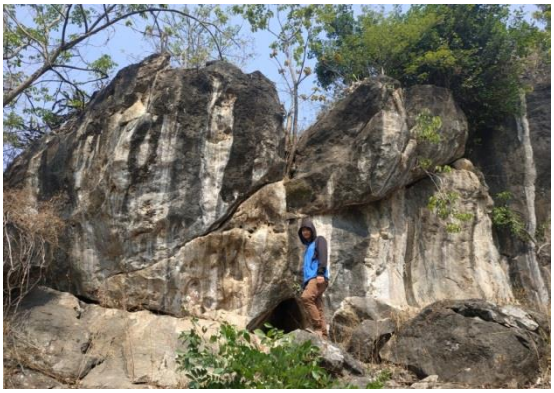

Figure 13. Outcrop nature of massive, fine-grained, grey to dark grey colour micritic limestone unit of Thitsipin Formation (Loc. – 489115, Facing – E)

Interpretation of depositional environment

According to the Tucker (2001), it is composed of over 90% of micrite and it is represented the low energy, lagoonal or outer shelf/ramp environment.

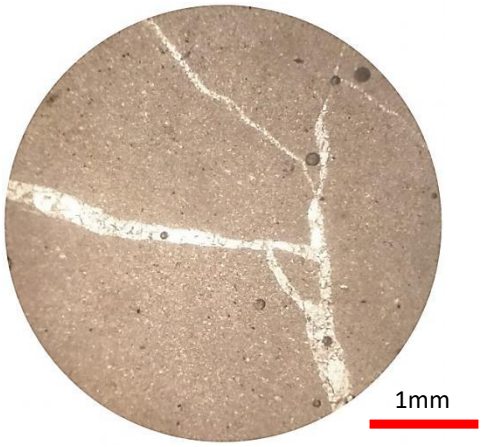

Figure 14. Photomicrograph showing Mudstone unit of Thitsipin Formation

Discussion and conclusion

The study area occupies southern part of Kawlaw-Pinlaung Basin and it is a region covering the southern continuation of the Eastern Highlands. It forms as a part of the western marginal zone of Shan Plateau. It lies between latitudes 19º 52′-19º 59′ north and longitudes 96º 50′-96º 58′ east. It is bounded by vertical grids 400 to 520 and horizontal grids 090 to 240 in one inch topographic map No. 94 A/13 of Myanmar Survey Department.

The major stratigraphic units occured in the study area are Thitsipin Formation and Thigaungdaung Formation of Plateau Limestone Group (Late Permian to Early Triassic), Loi-an Group (Middle Jurassic – Early Cretaceous), Kalaw Formation (Cretaeous) and Legaing Limestone Formation (Late Cretaceous).

Petrographically, the Thitsipin Formation can be classified as (1) Ooidal Packstone - Grainstone, (2) Bioclastic Packstone – Grainstone, (3) Dolomitized Peloidal Wackestone, (4) Bioclastic Wackstone, and (5) Mudstone. Thigaungdaung Limestone Formation can be divided into (1) Bioclastic Peloidal Packstone, (2) Dolomitized Peloidal Wackstone, (3) Intraclastic Wackestone, (4) Dolomitized Mudstone, (5) Laminated chert bearing Mudstone, and (6) Laminated Mudstone. Petrographic classification of Legaing Limestone Formation can be grouped into (1) Chert bearing Bioclastic Peloidal Packstone, (2) Dolomitized Intraclastic Packstone and (3) Dolomitized Bioclastic Wackestone.

The occurrence of early dolomitization and low fauna content are indicating tidal-flat origin. The bioclasts present and dominance of grainstones indicate shallow – water condition with relatively strong wave and current action, and the sediment represents the accumulation in current washed shoal conditions. The present of ooids with may be deposited in the oxygenated water and form above to below wave base. Marine ooids originate in warm, high energy, shallow-water environment; particularly in tidal bars. The dominant nature of limestone is diagnostic character for high energy condition (Reading, 1986). This may be deposited in an open shelf margin environment.

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References

Adams, A. E. and W. S. Mackenzie (1984). *Atlas of sedimentary rocks under the microscope.* Longman Scientific & technical, John Wiley & Sons, Inc., 104.

Dunham, R. J. (1962). Classification of Carbonate rocks according to depositional texture, in Ham. W.E., (ed), Symposium classification of carbonate rocks. *Assoc. Pet. Geol. Mem.*1, 108-121.

Flugel, E. (2010). Microfacies of carbonate rocks, 2nd Edition, Springer-Lodon.

Folk, R. L. (1959).*Practical Petrographic Classification of Limestone*, Bull Amer., Assoc, Petroleum Geologist V (43),pp,1-38.

Khin Maung Win (1980), *Stratigraphy of the Northern Part of the Kalaw- Pinlaung Basin (Jurassic-Cretaceous) of the Southern Shan Plateau Region, Burma. Unpublished Paper*. Rangon University p. 44.

Reading, H. G. (1986), *Sedimentary Environments and Facies*: Blackwell Scientific Publications.

Tucker, M. E. and Wright, V. P. (1990).*Carbonate sedimentology*, Oxford London Blackwell scientific Publications, 482p.

Tucker, M. E. (2001). *Sedimentary Petrology*. Blackwell Scientific Publications,

Wilson, J. L. (1975).*Carbonatefacies in geologic history*, New York, Springer- Verlag, 471p.