

An Integrated Stratigraphic and Biostratigraphic Analysis of Southern Part of Ayeyarwady Delta Basin

Thet Htar Aung¹, Tin Myint Oo², Khaing Zin Phyu³, Lynn Myint⁴

Abstract

Ayeyarwady Delta Basin occupies southernmost part of Central lowlands of Myanmar located between latitudes 15°44'00"-17°59'00"N and longitudes 94°15'00"-96°20'00"E covering 3.418x10⁵ Km². In the present study an integrated lithostratigraphic and biostratigraphic analysis of southern part of the Ayeyarwady Delta Basin was conducted based on outcrops, seismic and well data. During the February 2019 a geological field checking was carried out in three areas; Myaungmya, Puri Point and Mawdin. The outcrop stratigraphy of these areas are examined and collected rock samples for petrological and paleontological analysis. The stratigraphic succession of the areas from older to younger is; Mawdin Fm, Kanbala Fm, Taunggale Fm, Tumyaung Fm, Kwingyaung Fm, Kathabaung Fm and Irrawaddy Fm. The seismic sequence stratigraphic analysis of the Ayeyarwady Delta Basin was conducted by MOGE and eight overall traceable unconformities and important reflectors were identified and correlated as far as possible with the data from the drilled wells and the outcrops. The electrofacies analysis was attempted by using electrical log motif and SP curve of the wells to define boundaries of the formations. Biostratigraphy of the Tumyaung, Kwingyaung and Kathabaung formations are analyzed in conjunction with of the results of MOGE. Paleogene /Neogene unconformity is greatly evident by a remarkable foraminiferal onset. The general marine record is of Lower Miocene age and begins with a relatively rapid basinal deepening characterized by rich planktonic foraminiferal microfaunas. The Oligocene larger benthonic foraminiferal assemblage were not found in the Ayeyarwady Delta area.

Keywords: lithostratigraphic, biostratigraphic, petrological, paleontological, electrofacies

Introduction

Myanmar can be subdivided into three main N-S trending linear belts namely; (1) Eastern Highlands (2) Central Lowlands (3) Western Ranges (Rakhine Yoma, Chin Hills, Naga Hills and Rakhine coast). Ayeyarwady Delta Basin occupies the southernmost part of Central Lowlands covering 3.418x10⁵ Km² Figure 1.

Stratigraphy

Mawdin Formation, Mawdin Area

The formation of the age is Triassic to Early Eocene and thickness is 8600 ft ±. The argillaceous Mawdin Formation is named after the Mawdin Pagoda around which the middle part of the formation is well exposed. The beds are also exposed in the area west of Patheingyi, central and western slope of the Rakhine Yoma is built up of this formation. The formation is made up of crushed, strongly deformed and isoclinally folded monotonous slaty shales, black slaty shale and subordinate amount of sandstones, siltstones, grits, tuffs and tuffaceous sandstones and exotics. The middle consists of alternations of grey to black slaty

¹Lecturer, Geology Department, Maubin University

²Lecturer, Geology Department, University of Yangon

³Lecturer, Geology Department, West Yangon University

⁴Chairman, Myanmar Association of Petroleum Geologists

shale, sandstones, siltstones and tuffaceous sandstones. Tuffs and grits are locally around Mawdin Point. Exotic blocks of sandstones, limestones, siltstones and coal pieces were locally noticed. Figure 2, 3, 4, 5, 6.

Tumyaung Formation, Purian Point

A ten-meter-thick transgressive calcarenite section of the Tumyaung Formation. (Oligocene-Early Miocene) rests immediately above the Taunggale unconformity. The basal two meters of the transgressive unit consists of glauconitic claystones containing fish vertebrae. Bioturbated, calcarenites with abundant horizontal and vertical worm tubes succeed the claystone interval and comprise the remaining 8 meters of the calcarenite section. The basal Tumyaung clastic section is overlain by a 1-2 meter large benthic foram-rhodolite grainstone bed. The remainder of the Tumyaung Formation are a series of volcanic tuffs deposits. Periodically within the pyroclastic section are thin beds of foram grainstones and siliceous claystones Figure 7, 8, 9.

Myaungmya (Yesaing) Area

Lithologically and paleontologically, the stratigraphic succession of the rocks of Myaungmya Area are established as below;

Formation	Age
Irrawaddy Formation	Pliocene
	Unconformity
Kathabaung Formation	Late Miocene
Kwinyaung Formation	Middle Miocene
Tumyaung Formation	Early Miocene
	Unconformity
Taunggale Formation	Eocene

Tumyaung Formation

The formation of the age is Early Miocene and thickness is 5210 ft ±. The sandstone, tuffaceous sandstone, tuffs and limestones to the area between eastern Long Island in the west and Nayapyangyi Chaung in the east, the name Tumyaung Formation is named after Tumyaung Village. The Formation is widely distributed in the Tumyaung area and on the Long Island area Figure: 10.

Kwinyaung Formation

The formation of the age is Middle Miocene and thickness is 2570 ft ±. The carbonate sequence lying conformably above the Tumyaung Formation, the term Kwinyaung Formation is named after Kwinyaung village. The Tumyaung /Kwinyaung boundary is everywhere covered by alluvium. It is made up of about 80% of limestone, and about 20% of thin calcareous shale interbeds. The limestone is locally hard, coarse and ridge forming rock Figure 11.

Kathabaung Formation

The formation of the age is Late Miocene and thickness is 1835 ft ±. The Kwinyaung Formation is conformably overlain by the sandy sequence now termed as Kathabaung Formation after Kathabaung Village. The Kwinyaung, Kathabaung contact is fixed at the top of the last ridge forming limestone. The formation is made up of calcareous sandstones and calcareous shales. The

calcareous sandstones dominating the formation are greyish brown, fine grained, slightly micaceous and fossiliferous Figure 12, 13.

Stratigraphic Succession of Ayeyarwady Delta Basin

Table 1 This Stratigraphic Succession is established base on seismic, wells log and outcrop

Age	Area	Ayeyarwady Delta Basin West Flank	Ayeyarwady Delta Basin East Flank	Lithology
Quaternary Pliocene		Irrawaddy Fm.	Fluviatile Irrawaddian	Sand, gravel, clay, Sandstone, lignite, fossil wood
Late Miocene		Kathabaung Fm.	Estuarine Irrawaddian Obogon Kyaukkok	Alternation of sandstones and shale Massive calcareous sandstone and shale
Middle Miocene		Kwingyaung Fm		Fossiliferous marls and Miogypsinal limestones
Early Miocene		Tumyaung Fm	<i>Prawbwe</i>	Calystones with tuff bands Sandy limestones, transgressive bioherms ?
Late Oligocene		Unnamed Fm (Pathein well 1 Tada U well		Lime facies of Late Oligocene
Middle Oligocene?			Upper part of Undifferentiated Eocene	Fine grained and laminated mica sandstones and claystones
Late Eocene		Taungale Fm	Yaw f.m	Nummulitic Limestones
Middle Eocene		?	Lower part of Undifferentiated Eocene	Greywackes, conglomerates
Lower Eocene		Kanbala Series		Limestones, coal measures
Triassic to Eocene		Mawdin Fm	Eocene flysch	Thrusted and sheared flyschoid sequences with exotic blocks

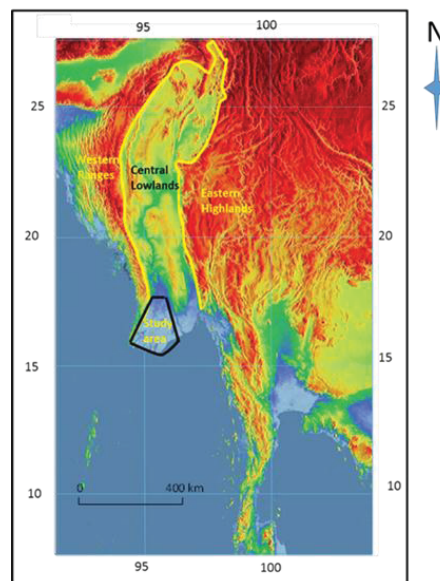


Figure1 Geomorphological Map of the Study Area (Source Google)



Figure 2 Folded shale and sandstone unit of slaty Mawdin Formation



Figure 3 Alternation of sand and black shale unit of Mawdin Formation



Figure 4 Coal pieces of Mawdin Formation



Figure 5 Gritty Sandstone unit of Mawdin Formation



Figure 6 Alternation of siltstones and tuffaceous sandstone(lens shape)unit of Mawdin Formation



Figure 7 Volcanic tuff forming steep cliff unit of Tumyaung Formation



Figure 8The stratified volcanic tuff composed of angular volcanic clasts and iron oxide of Tumaung Formation



Figure 9 Very hard tuffaceous sandstone of Tumaung Formation

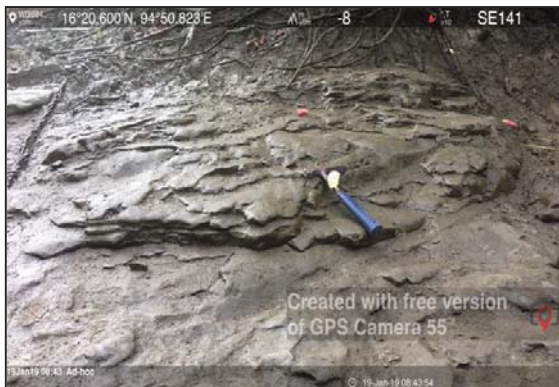


Figure 10 Thin bedded grey colour fine sandstone Tumaung Formation (Kyaukpyakalay Formation Village)



Figure 11 Light grey fossiliferous limestone unit of Kwingyaung (Yesaing quarries)



Figure 12 Greyish brown sandstone unit of Kathabaung Fm (Kathabaung Village)



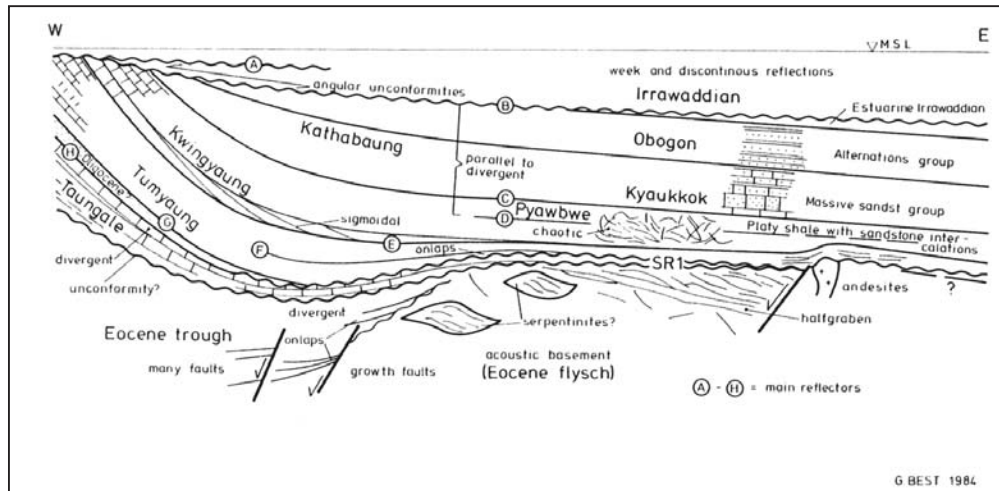
Figure 13 Calcareous shale unit of Kathabaung Fm

Seismic Sequence Stratigraphic Analysis

Dr. G. Best from Federal Institute for Geosciences and Natural Resources of Germany investigated seismic stratigraphy of Ayeyarwady Delta Basin in 1984 based on seismic profiles, wells data and surface geology. A total of 1650 km of seismic lines (6 -12 folds coverage and recording length of 5 -6 seconds) and 14 deep wells and geological section along the western edge of the basin were incorporated in the interpretation. The evaluatable reflections were only received down to the base of the Oligo-Miocene (“SR-1” reflector,) the layers underlying this interface were difficult to interpret (acoustic basement). The most important reflection patterns and sequences are being described by Dr. G. Best. Eight overall traceable unconformities and important reflectors are marked with letters A-H and correlated as far as possible with the data from the boreholes and the outcrops Figure 14.

- A- Unconformity planes within the Irrawaddy Formation
- B- Unconformity at the base of the Irrawaddy Formation
- C- Approximate base of Kyaukkok Formation or base Kathabaung Formation
- D- In the upper Pyawbwe Formation (approx. top of deep marine Pyawbwe Formation)
- E- Base of Middle Miocene (= base Kwingyaung Formation)
- F- In Tumyaung Formation
- G- Base of Early Miocene (= base Tumyaung Formation)
- H- Base of Upper Oligocene

Figure 14 Facies Section of Pathein Area (WEST-EAST)



Biostratigraphy

Location of samples collected from Myaungmya (Yesaing) Area in the present field trip.

FORMATION

SAMPLE LOCATION

TUMYAUNG FM	16 20'00" N	94 50'23"E
KWINGYAUNG FM	16 18'60" N	94 48'40"E
KATHABAUNG FM	16 17'22" N	94 51'57"E

Tumyaung Formation (Early Miocene), Myaungmya (Yesaing) Area

The Tumyaung Formation is the oldest of the Neogene Formations in the southern Ayeyarwady Delta area. Biostratigraphically the Tumyaung Formation ranges up to the basal Middle Miocene. Tumyaung Formation is deposited partly in a deeper basinal environment. It can be concluded that the remarkable decrease in the smaller benthonic foraminifera diversity, the missing of larger benthonic foraminifers and the relatively high abundance of radiolarians Figure 15, 16, 17.

Kwingyaung Formation (Middle Miocene), Myaungmya (Yesaing) Area

Microfaunas of the Kwingyaung Formation are dominated by planktonic foraminifers and rare smaller benthonics Figure 18, 19, 20.

Kathabaung Formation (Late Miocene), Myaungmya (Yesaing) Area

The base of Kathabaung Formation is of Middle Miocene age. Younger planktonic foraminiferal zones were not yet found in that area Figure 21, 22.



Figure 15 Specimen of Nummulites sp. 1
32 x

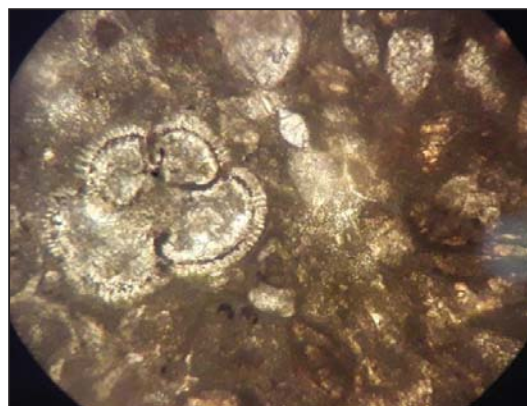


Figure 16 Globigerinoides conglobatus
Oblique equatorial section 32 x

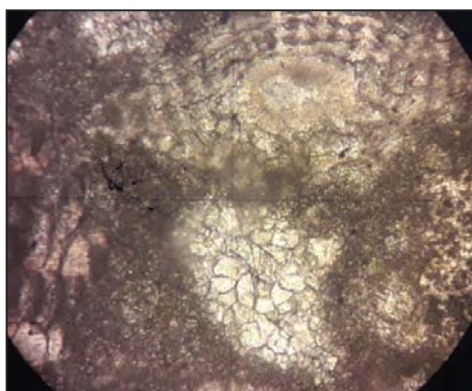


Figure 17 The sparry calcite partly replaced
Lepidocyclina benthonic foram 32 x.

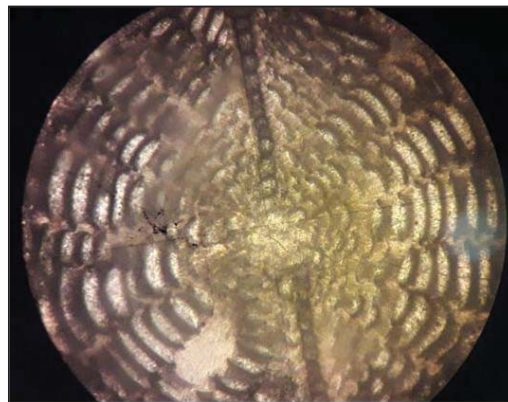


Figure 18 Vertical section of
(Nephrolepidian) sp. 32 x

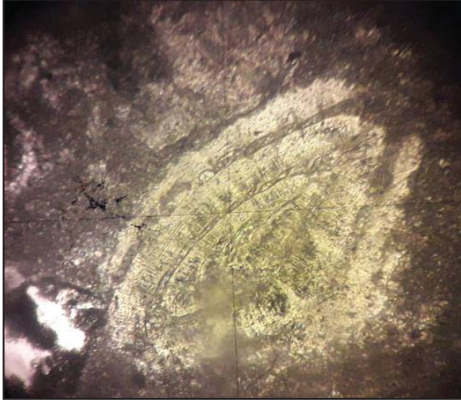


Figure 19 *Nummulites stratorecticulata* 32 x

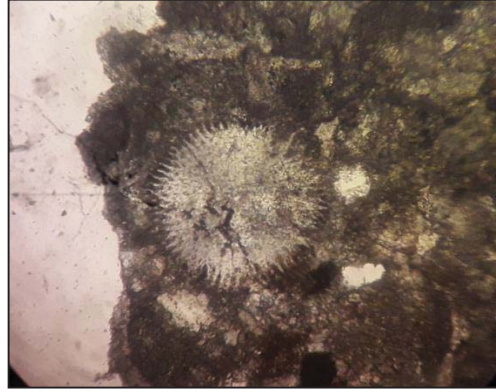


Figure 20 *Orbulina suturalis*, Globulina planktonic Foraminifera 32 x.

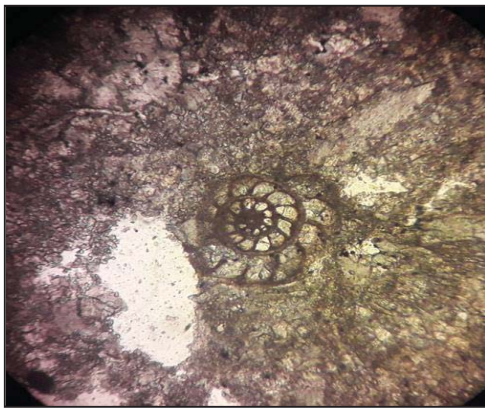


Figure 21 *Pellatispira orbitoloidea* 32 x

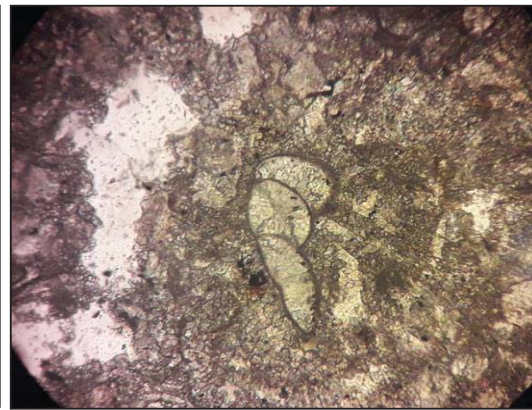


Figure 22 Unidentifiable Foraminifera may be replaced by calcite 32 x

Interpretation of Biostratigraphic Data

In Patheingyi area, Oligocene Globorotalia opima opima Zone and to the late Eocene Globorotalia cerroazulensis Zone are both identified in an open-marine environment. The Paleogene /Neogene unconformity is greatly evident by a remarkable foraminiferal onset. The general marine record is of Lower Miocene age and begins with a relatively rapid basinal deepening characterized by rich planktonic foraminiferal microfaunas. The fully marine influence reached into northern parts of the Ayeyarwady Delta area during the Lower and Middle Miocene interval. At the same time, the filling up of the Ayeyarwady Delta area increase southward by progressive deposition of calcareous, mainly larger foraminifers containing sheets or bodies. The following assemblages are typical for the Ayeyarwady Delta area: - Nummulite assemblage of Late Eocene age, and-Miogypsina - Lepidocyclina - Heterostegina assemblage of Miocene age. The Miogypsina - Lepidocyclina- Heterostegina assemblage is typical for the time interval from the upper part of the Lower Miocene through the lower part of the Middle Miocene. The Oligocene larger benthonic foraminiferal assemblage were not found in the Ayeyarwady Delta area. The progressively moving transgression during the early Neogene is represented by the Tumyaung, Kwingyaung and basal parts of the Kathabaung Formations; it ranges in the Patheingyi area up to the

Middle Miocene Globorotalia fohsi lobata-robusta Zone. A biostratigraphic age of the unconformity which separates the Kathabaung and the younger Irrawaddy Formation is not determined due to the lack of foraminifers. For the youngest part of the Irrawaddy Formation a short-time marine ingressions is shown at the Pliocene-Pleistocene interval (Globorotalia humerosa-crassa formisinterval Zone).

Conclusion

Outcrop Stratigraphy can be divided into three parts; 1. Mawdin Area - Mawdin Formation, Kanbala Formation, 2. Purian Point – Taunggale Formation, Tumaung Formation 3. Myaungmya Area – Taunggale Formation, Tumaung Formation, Kwingyaung Formation, Kathabaung Formation and Irrawaddy Formation. Eight overall traceable unconformities and important reflectors are marked with letters A-H and correlated as far as possible with the data from the boreholes and the outcrops. The electrofacies analysis was attempted by using electrical log motif and SP curve to define boundaries of Kathabaung Formation, Kwingyaung Formation and Strong Reflector 1- (Lower Miocene Limestones) in Kyontani well-1. The sedimentary processes of Kwingyaung Formation are identified by Spontaneous Potential curve. The Paleogene /Neogene unconformity is greatly evident by a remarkable foraminiferal onset. The Oligocene larger benthonic foraminiferal assemblage were not found in the Ayeyarwady Delta area.

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References

- Dr. G. Best**, November 1984, Report on the seismic stratigraphic investigations in the Irrawaddy Basin.
- Dr. W. Weiß**, February 28, 1985. Cretaceous and Tertiary foraminiferal biostratigraphy of the Irrawaddy Delta area.
- Mr. J.P. Maret**, Total Exploration & Production Myanmar, June 21, 1994. Petrography, Paleogeography, and Reservoir Implications of Selected Late Eocene through Early Miocene Surface Samples from the Irrawaddy Delta, Myanmar.